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(54) IMPROVED PROGAMMABLE CALCULATOR

(71) We, HEWLETT-PACKARD COMPANY OF 1501 Page Mill Road, Palo Alto, California, United States of America, a corporation organised and existing under the laws of the State of California, United States of America, do hereby declare the invention, for which we pray that a Patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned with improvements in or relating to calculators and is more especially concerned with programmable calculators that may be controlled both manually from a keyboard input unit and automatically by a stored program loaded into the calculator from the keyboard input unit or an external record member.

Computational problems may be solved manually, with the aid of a calculator (a dedicated computational keyboard-driven machine that may be either programmable or nonprogrammable), or a general purpose computer. Manual solution of computational problems is often very slow, so slow in many cases as to be an impractical, expensive, and ineffective use of the human resource, particularly when there are other alternatives for solution of the computational problems.

Non-programmable calculators may be employed to solve many relatively simple computational problems more efficiently than they could be solved by manual methods. However, the keyboard operations or language employed by these calculators is typically trivial in structure, thereby requiring many keyboard operations to solve more general arithmetic problems. Programmable calculators may be employed to solve many additional computational problems at rates hundreds of times faster than manual methods. However, the keyboard language employed by these calculators is also typically relatively simple in structure, thereby again requiring many keyboard operations to solve more general arithmetic problems.

Another basic problem with nearly all of the keyboard languages employed by conventional programmable and nonprogrammable calculators is that they allow the characteristics of the hardware of the calculator to show through to the user. Thus, the user must generally work with data movement at the hardware level, for example, by making sure that data is in certain storage registers before specifying the operations to be performed with that data and by performing other such "housekeeping" functions. In addition, these languages have been unique to a particular calculator and not ones generally familiar to those persons skilled in the computer and calculator arts.

In the past both programmable and nonprogrammable calculators have generally had very limited memories, thereby severely limiting the size of the computational problems they could be employed to solve. Because of these limitations, the relatively simple structure of the keyboard languages employed by these calculators and the "housekeeping" requirements associated with their languages have not heretofore been serious shortcomings. However, with advances in technology, the cost of memories has decreased to a point where larger memories could be economically included in programmable calculators. These larger memories have allowed larger and larger problems to be handled by programmable calculators. As a result the shortcomings of conventional calculator languages have become more critical, thereby creating the need for higher level keyboard languages.

In addition to the foregoing shortcomings, conventional programmable calculators generally have less capability and flexibility than is required to meet the needs of many users. For example, they typically cannot be readily expanded and adapted by the user to increase the amount of program and data storage memory or to perform many special keyboard functions oriented toward the environment of the user.

In some conventional programmable calculators a program stored within the calculator can be recorded onto an external magnetic record member and can later be reloaded back into the calculator from the magnetic record member. However, data and programs stored within these calculators typically cannot be separately recorded onto an external magnetic record member and later separately reloaded back into the calculator therefrom. Moreover, these calculators typically have no provision for making a program secure when it is recorded onto an external magnetic record member. Any user may therefore re-record the program or obtain an indication of the individual program steps once the program is reloaded into the calculator.

Conventional programmable calculators with self-contained output display units typically have little or no alpha capability and typically can only display the contents of one or more selected registers. They are therefore typically unable to display a line containing an alpha-numeric statement or an alphabetic message such as might be used, for example, to inform the user how to run programs with which he may be unfamiliar. Such features would be very helpful to the user both in editing programs and in simplifying their use.

Conventional programmable calculators typically have little or no capability for editing keyboard entries or programs stored within the calculator. For example, they typically have no provision for deleting, replacing, and inserting information included in or omitted from a keyboard entry or internally-stored program on a character-by-character or line-by-line basis. As another example, they typically have no provision for directly recalling any line of an internally-stored program. As a further example, they typically have no provision for automatically accommodating and sequencing program statements which are entered by the user in random order. Such features would be very helpful to the user in editing programs.

Conventional computers typically pose an interfacing problem between the user and the machine. This interface requirement takes the form of a machine-level operator with special abilities for maintaining the software system in operative condition for the user. Computer time sharing systems comprising a centrally located computer and a multiplicity of remotely located user terminals connected thereto by telephone lines have partially solved the user/machine interface problem. However, these systems lack the same flexibility as conventional computers in that they are only programmable and provide no convenient non-programmable method for performing relatively simple calculations. Both types of systems lack provision for editing a program statement from a keyboard without the necessity of retyping the entire statement.

The principal object of this invention is to provide an improved programmable calculator that has more capability and flexibility than conventional programmable calculators, that is smaller, less expensive and more efficient in calculating elementary mathematical functions than conventional computer systems, and that is easier to utilize than conventional programmable calculators or computer systems.

Another object of this invention is to provide a calculator employing BASIC computer language implemented in a read-only memory (ROM) that completely eliminates the user/machine interface requirement of conventional computers and further eliminates the necessity of learning a non-universal language such as those typically associated with conventional programmable calculators.

The present invention provides an electronic calculator comprising keyboard input means including a plurality of alphameric keys for entering one or more BASIC language statements into the calculator, an execute control key for initiating execution of a BASIC language statement entered into the calculator, and a store control key for initiating storage of a BASIC language statement entered into the calculator; memory means, coupled to said keyboard input means, for storing a program of BASIC language statements entered into the calculator; processing means coupled to said keyboard input means and said memory means, said processing means being responsive to actuation of said execute control key, following entry of a BASIC language statement into the

calculator, for executing that BASIC language statement, said processing means being further responsive to actuation of said store control key, following entry of a BASIC language statement into the calculator, for storing that BASIC language statement as part of a program in said memory means; and output means, coupled to said memory means, for providing an output indication of the result of execution of a BASIC language statement.

In a calculator as set forth in the last preceding paragraph preferably said processing means includes a read-only memory storing a plurality of routines and subroutines to be selectively performed by the calculator in executing and storing one or more BASIC language statements; said processing means is responsive to actuation of said execute control key, following entry of a BASIC language statement into the calculator, for selectively performing one or more of the routines and subroutines stored in said read-only memory to execute that BASIC language statement; and said processing means is responsive to actuation of said store control key, following entry of a BASIC language statement into the calculator, for selectively performing one or more of the routines and subroutines stored in said read-only memory to store that BASIC language statement in said memory means.

In a calculator as set forth in the last preceding paragraph or the last preceding paragraph but one preferably said keyboard input means includes a space key; and said processing means is responsive to actuation of said space key during entry of a BASIC language statement into the calculator for introducing a blank character at selected locations within that BASIC language statement.

In a calculator as set forth in any one of the last three immediately preceding paragraphs said output means may comprise printing means, coupled to said keyboard input means and memory means, for printing lines of one or more alphameric characters each; said keyboard input means including memory listing means for initiating the listing of any designated number of lines of one or more alphameric characters each then stored in said memory means; and said processing means also being coupled to said output printing means for causing said output printing means to selectively print out the designated lines of one or more alphameric characters each in response to actuation of said memory listing means.

In a calculator as set forth in the last preceding paragraph but three said keyboard input means may also comprise a plurality of keys that may be associated with user-definable functions; said memory means can store a program of one or more lines of one or more alphameric characters each as aforesaid and user-definable functions associated with said plurality of keys; said keyboard input means including memory erase means for selectively initiating the erasure of said program and/or said user-definable functions stored in said memory means; and said processing means is capable of selectively erasing a portion or all of said program, any one or all of said user-definable functions, or all of said program and all of said user definable functions as specified by actuation of said memory erase means.

In a calculator as set forth in any one of the last five immediately preceding paragraphs every stored line may be associated with a separate line number; said keyboard input means may include a halt execution key for designating the line number associated with a line at which execution is to be halted; and said calculator further comprises a program counter, coupled to said processing means, for storing the line number associated with the line currently being executed; temporary storage means, coupled to said keyboard input means and memory means, for storing the line number associated with the line at which execution is to be halted; and said processing means includes logic means, coupled to said keyboard input means, program counter, and temporary storage means, and capable of storing the line number associated with the line at which execution is to be halted in said temporary storage means in response to actuation of said halt execution key, followed by actuation of one or more alphameric keys designating that line number, prior to execution of the lines stored in said memory means and also capable of subsequently halting the execution of those lines in response to the occurrence of a condition of equality between the contents of said program counter and said temporary storage means.

In a calculator as set forth in the last preceding paragraph preferably said keyboard input means includes a first program control key; and said logic means is responsive to actuation of said first program control key, followed by actuation of one or more numeric keys designating the line number of a starting line of the

program stored in said memory means, for initiating execution of the program stored in said memory means, at that starting line.

In a calculator as set forth in the last preceding paragraph preferably said keyboard input means includes a second program control key; said memory means can store variables employed in the program stored in said memory means; said logic means is responsive to actuation of said first program control key for setting all of the variables of the program stored in said memory means to an initial state prior to initiating execution of the program; and said logic means is further responsive to actuation of said second program control key, followed by actuation of one or more numeric keys designating the line number of a line in the program stored in said memory means, for initiating execution of the program at that line number without altering the variables stored in said memory means.

In a calculator as set forth in the last preceding paragraph but seven said keyboard input means may include an initalize key; said memory means, coupled to said keyboard input means, being capable of storing a program of one or more lines of one or more alphameric characters each entered into said calculator and of storing variables associated with that program; and said processing means including logic means, coupled to said keyboard input means and memory means, for setting all of the variables of the program stored in said memory means to an initial state in response to actuation of said initialize key.

In a calculator as set forth in the last preceding paragraph preferably said logic means is responsive to entry of an array definition command by actuation of said keyboard input means to store said array definition command in said memory means; and said logic means is responsive to said array definition command, when encountered during a program execution mode of said calculator, for dedicating a portion of said memory means as storage for the previously defined array.

In a calculator as set forth in the last preceding paragraph preferably said logic means is responsive to actuation of said initialize key for executing an array definition command previously stored in said memory means.

In a calculator as set forth in the last preceding paragraph but ten every stored statement may be associated with a different number; said calculator further comprising magnetic reading and recording means, coupled to said memory means, for transferring lines of one or more alphameric characters between said memory means and a magnetic record member, said keyboard input means being operable for entering control commands into the calculator to control the operation of said magnetic reading and recording means; and said processing means includes logic means, coupled to said keyboard input means, memory means, and magnetic reading and recording means, said logic means being responsive to one of said control commands for securing any portion of said program designated by a beginning line number and an ending line number, said logic means thereafter being responsive to another of said control commands for inhibiting transfer of the secured portion of said program from said memory means to a magnetic record member.

In a calculator as set forth in the last preceding paragraph but eleven said keyboard input means may include a second plurality of keys each of which may be associated with a function of one argument, and said processing means including logic means, coupled to said keyboard input means and memory means, for associating a selected function with a selected one of said second plurality of keys in response to sequential actuation of selected ones of the first and said second pluralities of keys designating the selected function and the selected one of said second plurality of keys and for storing the selected function as part of the program stored in said memory means in response to actuation of said store control key.

In a calculator as set forth in the last preceding paragraph preferably said logic means is responsive to actuation of said execute control key, following actuation of a selected one of said second plurality of keys with which a selected function has previously been associated, for initiating execution of that selected function by said processing means.

In an electronic calculator as set forth in the last preceding paragraph but thirteen said keyboard input means may comprise a plurality of user-definable keys each of which may be associated with one or more lines of BASIC language program statements; said memory means being capable of storing lines of BASIC language program statements associated with selected ones of said plurality of definable keys; and said processing means including logic means, coupled to said keyboard input means and memory means, for initiating execution of the BASIC

language program statements associated with a selected one of said definable keys in response to actuation thereof.

In an electronic calculator as set forth in the last preceding paragraph but fourteen said processing means may be capable of defining a square matrix in response to a matrix command entered into the calculator from said keyboard input means, for thereafter storing the matrix elements in said memory means as designated from said keyboard input means, and for thereafter evaluating the determinant of the previously defined square matrix in response to a determinant command entered into the calculator from said keyboard input means.

In an electronic calculator as set forth in the preceding paragraph but fifteen preferably said processing means includes a read-only memory in which routines and subroutines for defining the square matrix, storing the matrix elements, and evaluating the determinant of the defined square matrix, are stored.

An electronic calculator as set forth in the last preceding paragraph but sixteen may further comprise a print control key for designating a print-all mode of calculator operation, said processing means including logic means, coupled to said keyboard input means, memory means, and display means, for initiating the display of lines of one or more alphameric characters entered into the calculator, alphameric error messages generated during execution of lines of one or more alphameric characters by said processing means, and executed display commands; and printing means for printing lines of one or more alphameric characters, said logic means being responsive to actuation of said print control key for initiating the printing of lines of one or more alphameric characters entered into the calculator, error messages generated during execution of lines of one or more alphameric characters by said processing means, and executed display commands.

In an electronic calculator as set forth in the last preceding paragraph but seventeen each of said alphameric keys may also be representative, either alone or in combination with others of said alphameric keys, of an ASCII character; and said calculator may further comprise buffer storage means, coupled to said keyboard input means and to said memory means, for storing a line of alphameric information entered into the calculator; said memory means being also coupled to said buffer storage means for storing a program of one or more lines of alphameric information entered into the calculator; and said processing means being also coupled to said buffer storage means for executing the line of alphameric information then stored in said buffer storage means or a program of one or more lines of alphameric information then stored in said memory means; and said processing means including logic means coupled to said keyboard input means and responsive to actuation of selected ones of said plurality of alphameric keys, singly or in combination, for generating binary codes representative of every ASCII character and for storing those binary codes in said buffer storage means.

In an electronic calculator as set forth in the last preceding paragraph preferably said keyboard input means includes a terminal transmit key; said calculator includes a modem for transmitting and receiving alphameric information over telephone lines; and said logic means is responsive to actuation of said terminal transmit key for transmitting through said modem the ASCII codes represented by the binary codes then stored in said buffer storage means.

An electronic calculator as set forth in the last preceding paragraph but nineteen may further comprise: input/output interface means, including a plurality of input/output channels, for coupling selected peripheral input/output units to the calculator; and said processing means may include logic means coupled to said keyboard input means, memory means, and input/output interface means, said logic means being responsive to execution of a binary output statement, including a base ten number and entered from said keyboard input means or stored in said memory means, for converting said base ten number to a corresponding twelve-bit binary code and for transmitting said twelve-bit binary code to a selected one of said input/output channels.

An electronic calculator as set forth in the last preceding paragraph but twenty may further comprise: input/output interface means, including a plurality of input/output channels, for coupling selected peripheral input/output units to the calculator; and said processing means may include logic means coupled to said keyboard input means, memory means, and input/output interface means, said logic means being responsive to execution of a binary read statement, entered from said keyboard input means or stored in said memory means, for reading an eight-bit word on a selected one of said input/output channels, for converting said

eight-bit word to a base ten number, and for associating said base ten number with a designated variable.

An electronic calculator as set forth in the last preceding paragraph but twenty-one may further comprise: input/output interface means, including a plurality of input/output channels, for coupling selected peripheral input/output units to the calculator; and said processing means may include logic means coupled to said keyboard input means, memory means, and input/output interface means, said logic means being responsive to execution of a status statement, entered from said keyboard input means or stored in said memory means, for interrogating a selected input/output channel to obtain an indication of the operating state of a selected peripheral input/output unit associated therewith.

In an electronic calculator as set forth in the last preceding paragraph preferably said logic means is operable for generating a number indicative of the operating state of the interrogated peripheral input/output unit.

In an electronic calculator as set forth in the last preceding paragraph but twenty-three said processing means may include logic means coupled to said keyboard input means and memory means, said logic means being responsive to execution of a rotate statement, entered from said keyboard input means or stored in said memory means, for rotating a specified number of the individual bits of a designated sixteen-bit integer word entered into the calculator or stored in said memory means.

In an electronic calculator as set forth in the last preceding paragraph preferably said logic means is responsive to execution of an AND statement for performing, according to the rules of Boolean algebra, the logical AND operation on the corresponding bits of two designated sixteen-bit integer words entered into the calculator or stored in said memory means and for associating the resulting sixteen-bit word with a specified variable.

In an electronic calculator as set forth in the last preceding paragraph but one preferably said logic means is responsive to execution of an OR statement for performing, according to the rules of Boolean algebra, the logical OR operation on the corresponding bits of two designated sixteen-bit integer words entered into the calculator or stored in said memory means and for associating the resulting sixteen-bit word with a specified variable.

In an electronic calculator as set forth in the last preceding paragraph but twenty-six said keyboard input means may employ ASCII coding; and said calculator may further comprise input/output interface means, including a plurality of input/output channels, for coupling selected peripheral input/output units to the calculator; and said processing means includes logic means coupled to said keyboard input means, memory means, and input/output interface means, said logic means being responsive to execution of an enter statement, entered from said keyboard input means or stored in said memory means, for receiving information from a selected peripheral input/output unit and for converting the received information to ASCII code when it is received from a peripheral input/output unit employing a non-ASCII code, said logic means being further responsive to execution of an output statement, entered from said keyboard input means or stored in said memory means, for transmitting information from the calculator to a selected peripheral input/output unit and for converting such information from ASCII code to any non-ASCII code employed by the selected peripheral input/output unit.

In the complete specification of our copending U.K. patent application No. 3345/76 Serial No. 1,444,142, there is disclosed electronic data processing apparatus comprising:

keyboard input means for entering lines of one or more alphameric characters each into said electronic data processing apparatus;

first memory means for storing lines of one or more alphameric characters each;

second memory means, coupled to said keyboard input means and first memory means, adapted to store a single line of one or more alphameric characters entered into said electronic data processing apparatus from said keyboard input means or recalled from said first memory means; and

display means, coupled to said second memory means, adapted to visually display the single line of one or more alphameric characters stored in said second memory means;

said display means including means for visually displaying a cursor for

designating any character position of the displayed line of one or more alphameric characters;

said keyboard input means including cursor control means for controlling the position of said cursor; and

said electronic data processing apparatus including logic means, coupled to said keyboard input means, second memory means, and display means, for positioning said cursor to designate any character position of the displayed line of one or more alphameric characters in response to actuation of said cursor control means.

In the complete specification of our copending U.K. patent application No. 3346/76 (Serial No. 1,444,143), there is disclosed electronic data processing apparatus comprising:

keyboard input means, including a plurality of numeric keys, for entering lines of one or more alphameric characters each into said electronic data processing apparatus;

first memory means for storing lines of one or more alphameric characters each;

second memory means, coupled to said keyboard input means and first memory means, for storing a line of one or more alphameric characters entered into said electronic data processing apparatus from said keyboard input means or recalled from said first memory means; and

display means, coupled to said second memory means, for visually displaying the contents thereof;

said keyboard input means including a memory recall control key for recalling a designated line of one or more alphameric characters from said first memory means to said second memory means;

each line of one or more alphameric characters stored in said first memory means being associated with a separate line number; and

said electronic data processing apparatus including logic means, coupled to said keyboard input means and first and second memory means, for transferring a line of one or more alphameric characters from said first memory means to said second memory means in response to sequential actuation of said memory recall control key and one or more of said numeric keys designating the line number associated with the line of one or more alphameric characters to be transferred.

In the complete specification of our copending U.K. patent application No. 3347/76 (Serial No. 1,444,144), there is disclosed electronic data processing apparatus comprising:

keyboard input means, including a plurality of alphameric keys, for entering lines of one or more alphameric characters each into said electronic data processing apparatus;

memory means for storing lines of one or more alphameric characters each, every stored lines of one or more alphameric characters being associated with a separate line number;

buffer storage means, coupled to said keyboard input means and memory means, for storing a line number and for storing a line of one or more alphameric characters entered into said electronic data processing apparatus; and

display means, coupled to said buffer storage means, for visually displaying the contents thereof;

said keyboard input means including a control key for designating an automatic line numbering mode; and

said electronic data processing apparatus further including a line number counter for storing a current line number, temporary storage means for storing a line number increment and logic means coupled to said keyboard input means and buffer storage means, said logic means being responsive to actuation of said control key, followed by actuation of one or more alphameric keys designating both a starting line number and a line number increment, for storing the starting line number in both said buffer storage means and said line number counter and for storing the line number increment in said temporary storage means, said logic means being further responsive to completion of each entry of a line of one or more alphameric characters into the electronic data processing apparatus for combining the contents of said line number counter and said temporary storage means and for storing the result in both said line number counter and said buffer storage means.

In the complete specification of our copending application No. 3348/76 (Serial No. 1,444,145), there is disclosed electronic data processing apparatus comprising:

keyboard input means for entering one or more lines of one or more alphameric characters each into said electronic data processing apparatus;

keyboard buffer means, coupled to said keyboard input means, for storing a line of one or more alphameric characters entered into said electronic data processing apparatus; and

read-write memory means, coupled to said keyboard input means and keyboard buffer means, for storing one or more lines of more than three alphameric characters each entered into said electronic data processing apparatus;

said keyboard input means including a plurality of keys, each representative of a single alphabetic or numeric character, for entering a representation of every alphabetic character of a selected alphabet and every numeric character from zero to nine into said electronic data processing apparatus;

said electronic data processing apparatus including read-only memory means storing routines and subroutines for recognizing particular strings of alphameric characters entered into said electronic data processing apparatus as being commands; and

said electronic data processing apparatus including processing means, coupled to said keyboard input means, read-write memory means, and read-only memory means, for selectively performing the routines and subroutines stored in said read-only memory means and for executing the commands recognized thereby.

In the complete specification of our copending U.K. patent application No. 03349/76 (Serial No. 1,444,146), there is disclosed an electronic desk-top calculator comprising:

keyboard input means with a plurality of alphameric keys for entering BASIC language commands into the calculator and with an execute key for initiating execution of BASIC language command entered into the calculator;

storage means, coupled to said keyboard input means, for storing BASIC language commands entered into the calculator; and

processing means, coupled to said keyboard input means and storage means, for immediately executing a BASIC language command in response to entry of that BASIC language command into the calculator followed by actuation of said execute key.

In the complete specification of our copending application No. 3350/76 (Serial No. 1,444,147), there is disclosed electronic data processing apparatus comprising: keyboard input means for entering alphameric information into the apparatus; X—Y plotter means including a pen for graphically plotting selected alphameric information; memory means, coupled to said keyboard input means, for storing specified X and Y offset values; and processing means coupled to said keyboard input means, X—Y plotter means, and memory means, said processing means being responsive to an offset command entered into the apparatus for storing specified X and Y offset values into said memory means, said processing means being further responsive to subsequent plot commands, including specified X and Y coordinates, for summing each specified set of X and Y coordinates with the X and Y offset values stored in said memory means and for enabling plotting of the coordinates resulting from such summation.

In the complete specification of our copending application No. 3351/76 (Serial No. 1,444,148) there is disclosed electronic data processing apparatus comprising:

keyboard input means with a plurality of keys for entering alphameric information into the data procesing apparatus;

a modem for transmitting and receiving alphameric information over telephone lines; and

logic means coupled to said keyboard input means and modem, said logic means being responsive to entry of a terminal control command for selecting one or a plurality of baud rates at which alphameric information is to be transmitted from or received by the data processing apparatus.

In the complete specification of our copending application No. 3352/76 (Serial No. 1,444,149) there is disclosed an electronic calculator comprising:

keyboard input means for entering statements of one or more alphameric characters each into the calculator;

memory means, coupled to said keyboard input means, for storing statements entered into the calculator;

processing means, coupled to said keyboard input means and said memory means, for executing statements entered into the calculator or stored in said memory means;

magnetic tape reading and recording means for reading information from and recording information onto an external tape; and said processing means further including

logic means coupled to said keyboard input means, memory means, and magnetic tape reading and recording means, said logic means being responsive to execution of a mark statement, entered from said keyboard input means or stored in said memory means, for electrically partitioning the external magnetic tape into one or more files prior to statements of one or more alphameric characters being transferred to the external magnetic tape.

The illustrated preferred embodiment of this invention is an electronic calculator employing a keyboard input unit, a magnetic tape casette reading and recording unit, a solid state output display unit, an optional external output printer unit, an input-output control unit, a memory unit, and a central processing unit to provide an adaptable programmable calculator having manual operating, automatic operating, program entering, magnetic tape reading magnetic tape recording, and alphanumeric display and print modes. The keyboard input unit includes a group of data keys for entering numeric data into the calculator, a group of control keys for controlling the various modes and operations of the calculator and the format of the output display, a group of alphanumeric keys arranged as a typewriter keyboard for entering statements, and group of user-definable keys. All of the data and alphanumeric keys and some of the control keys may also be employed for programming the calculator.

The magnetic tape cassette reading and recording unit includes a reading and recording head, a drive mechanism for driving a magnetic tape past the reading and recording head, and reading and recording drive circuits coupled to the reading and recording head for bidirectionally transferring information between the magnetic tape and the calculator as determined by keyboard commands or commands which are part of a stored program.

The input-output control unit includes a sixteen-bit universal shift register serving as an input-output register into which information may be transferred serially from the central processing unit or in parallel from the keyboard input and magnetic tape cassette reading and recording units and from which information may be transferred serially to the central processing unit or in parallel to the solid state output display, magnetic tape cassette reading and recording, and output printer units. The input-output control unit preferably also includes control logic responsive to the central processing unit for controlling the transfer of information between these units. The input-output control unit may also be employed to perform the same functions between the central processing unit and peripheral units including, for example, an external printing unit, a digitizer, a marked card reader, an X—Y plotter, an external magnetic tape unit, a disc, a typewriter, and a modem. A plurality of peripheral units may be connected at the same time to the input-output control unit by simply plugging interface modules associated with the selected peripheral units into receptacles provided therefor in a rear panel of the calculator housing.

The memory unit includes a modular random-access read-write memory having a dedicated system area and a separate user area for storing program statements and/or data. The user portion of the read-write memory may be expanded without increasing the overall dimensions of the calculator by the addition of a program storage module. Additional read-write memory made available to the user is automatically accommodated by the calculator, and the user is automatically informed when the storage capacity of the read-write memory has been exceeded.

The memory unit also includes a modular read-only memory in which routines and subroutines of assembly language instructions for performing the various functions of the calculator are stored. These routines and subroutines of the read-only memory may be expanded and adapted by the user to perform additional functions oriented toward the specific needs of the user. This is accomplished by simply plugging additional read-only memory modules into receptacles provided therefore in a side panel of the calculator housing. Added read-only memory modules are automatically accommodated by the calculator and are accessed by the calculator through a series of mnemonic tables. These tables contain mnemonics which are additions to the calculator's programming language.

Plug-in read-only memory modules include, for example, a matrix module, a string variables module, a plotter module, an extended input-output module, and a

terminal module. The matrix module makes available to the user standard BASIC language matrix functions plus an additional function which returns the determinant of a previously defined square matrix. The string variables module makes available to the user standard BASIC language string variables operations. The plotter module enables the user to conveniently plot and label on an external X—Y plotter. The extended input-output module allows the calculator to be used with a wide variety of peripheral input-output units. The terminal module facilitates interfacing the calculator with a modem for communicating, for example, with remotely located time-sharing computer systems. It further allows free text editing and storage.

The memory unit further includes a pair of recirculating sixteen-bit serial shift registers. One of these registers serves as a memory address register for serially receiving information from an arithmetic-logic unit included in the central processing unit, for parallel addressing any memory location designated by the received information back to the arithmetic-logic unit. The other of these registers serves as a memory access register for serially receiving information from the arithmetic-logic unit, for writing information in parallel into any addressed memory location, for reading information in parallel from any addressed memory location, and for serially transferring information to the arithmetic-logic unit. It also serves as a four-bit parallel shift register for transferring four bits of binary-coded-decimal information in parallel to the arithmetic-logic unit.

The central processing unit includes four recirculating sixteen-bit serial shift registers, a four-bit serial shift register, the arithmetic-logic unit, a programmable clock, and a microprocessor. Two of these sixteen-bit serial shift registers serve as accumulator registers for serially receiving information from and serially transferring information to the arithmetic-logic unit. The accumulator register employed is designated by a control flip-flop. One of the accumulator registers also serves as a four-bit parallel shift register for receiving four bits of binary-coded-decimal information in parallel from and transferring four bits of such information in parallel to the arithmetic-logic unit. The two remaining sixteen-bit serial shift registers serve as a program counter register and a qualifier register, respectively. They are also employed for serially receiving information from and serially transferring information to the arithmetic-logic unit. The four-bit serial shift register serves as an extend register for serially receiving information from either the memory access register or the arithmetic-logic unit and for serially transferring information to the arithmetic-logic unit.

The arithmetic-logic unit is employed for performing one-bit serial binary arithmetic, four-bit parallel binary-coded-decimal arithmetic, and logic operations. It may also be controlled by the microprocessor to perform bidirectional direct and indirect arithmetic between any of a plurality of the working registers and any of the registers of the read-write memory.

The programmable clock is employed to supply a variable number of shift clock pulses to the arithmetic-logic unit and to the serial shift registers of the input-output, memory, and central processing units. It is also employed to supply clock control signals to the input-output control logic and to the microprocessor.

The microprocessor includes a read-only memory in which a plurality of microinstructions and codes are stored. These microinstructions and codes are employed to perform the basic instructions of the calculator. They include a plurality of coded and non-coded microinstructions for transferring control to the input-output control logic, for controlling the addressing and accessing of the memory unit, and for controlling the operation of the two accumulator registers, the program counter register, the extend register and the arithmetic-logic unit. They also include a plurality of clock codes for controlling the operation of the programmable clock, a plurality of qualifier selection codes for selecting qualifiers and serving as primary address codes for addressing the read-only memory of the microprocessor, and a plurality of secondary address codes for addressing the read-only memory of the microprocessor. In response to a control signal from a power supply provided for the calculator, control signals for the programmable clock, and qualifier control signals from the central processing and input-output control units, the microprocessor issues the microinstructions and codes stored in the read-only memory of the microprocessor as required to process either binary or binary-coded-decimal information entered into or stored in the calculator.

In the keyboard mode, the calculator is controlled by keycodes sequentially entered into the calculator from the keyboard input unit by the user. The solid state output display unit displays either the alphanumeric representation of the

keys as they are depressed or a numeric representation of output data or alphanumeric user instructions or program results. An external output printer unit may be controlled by the user to selectively print a numeric representation of any numeric data entered into the calculator from the keyboard input unit, a numeric representation of any result calculated by the calculator, or a program listing on a line-by-line basis of the statements entered.

When the calculator is in the keyboard mode, it may also be operated in a print-all printing mode. The output printer unit then prints out each program line as it is entered by the user.

In the program running mode, the calculator is controlled by automatically obtaining an internal representation of the program statements stored in the user storage section of the read-write memory. During automatic operation of the calculator, data may be obtained from the memory unit as designated by the program, from the keyboard input unit while the operation of the calculator is stopped for data either by the program or by the user, or from the magnetic tape cassette unit as designated by the program.

When the calculator is in the program running mode, the user may also selectively employ a trace mode to check the execution of the program line-by-line in order to determine whether the program, as entered into the calculator, does in fact carry out the desired sequence of statements.

In the program entering mode, statements are sequentially entered by the user into the calculator from the keyboad input unit and are translated into an internal stored format which consists of a series of operation codes and operand names and are thereafter stored as statements of a program in the user storage section of the read-write memory.

The magnetic tape cassette reading and recording unit may be employed by the user to separately load either data, BASIC language programs, assembly language programs, or sets of user-definable key definitions into the calculator from an external magnetic tape cassette.

The magnetic tape cassette reading and recording unit may also be employed by the user to separately record either data, BASIC language programs, or sets or user-definable key definitions stored in the user section of the read-write memory onto an external magnetic tape cassette. Programs, or portions thereof, may be coded by the user as being secure when they are recorded onto an external magnetic tape cassette. The calculator detects such programs when they are reloaded into the calculator and prevents the user from re-recording them or obtaining any listing or other indication of the individual program steps contained in the secured portions of such programs.

There now follows a detailed description which is to be read with reference to the accompanying drawings of a calculator according to the present invention; it is to be clearly understood that this calculator has been selected for description to illustrate the present invention by way of example and not by way of limitation.

In the drawings:—

Figure 1 is a front perspective view of an adaptable programmable calculator according to the invention;

Figure 2 is a rear perspective view of the adaptable programmable calculator of Figure 1;

Figures 3A—B are a simplified block diagram of the adaptable programmable calculator of Figures 1 and 2;

Figures 4A—F are a memory map of the memory unit employed in the adaptable programmable calculator of Figures 1 to 3;

Figure 4′ is a diagram showing the arrangement of Figures 4A—F;

Figures 5A—B are a detailed memory map of the system read-write section of memory as shown in Figure 4A;

Figure 5′ is a diagram showing the arrangement of Figures 5A—B.

Figure 6 is a detailed memory map of the user read/write section of memory as shown in Figure 4F.

Figures 7A—C are a simplified operational logic flow chart illustrating the operation of the microprocessor employed in the central processing unit of Figures 3A—B.

Figure 7′ is a diagram showing the arrangement of Figures 7A—C.

Figure 8 is a plan view of the keyboard input unit employed in the adaptable programmable calculator of Figures 1—3B.

Figure 9 is an overall firmware block diagram for the adaptable programmable calculator.

Figures 10A—C are flow charts of floating point add and subtract routines selectable by the execution monitor of Figure 9.

Figure 11 is a flow chart of a floating point multiply routine selectable by the execution monitor of Figure 9.

Figures 12A—B are a flow chart of a floating point divide routine selectable by the execution monitor of Figure 9.

Figures 13A—C are a flow chart of a floating point square root routine selectable by the execution monitor of Figure 9.

Figure 14 is a flow chart of a store routine selectable by the execution monitor of Figure 9.

Figure 15 is a flow chart of a rounding routine employed in connection with several of the routines selectable by the execution monitor of Figure 9.

Figures 16A—B are a flow chart of a tangent X routine selectable by the execution monitor of Figure 9.

Figures 17A—B are a flow chart of an arctangent X routine selectable by the execution monitor of Figure 9.

Figures 18A—B are a flow chart of an e^x routine selectable by the execution monitor of Figure 9.

Figure 19 is a flow chart of a natural logarithm X routine selectable by the execution monitor of Figure 9.

Figure 20 is a flow chart of a subroutine employed by the tangent X and e^x routines of Figures 16A—B and 18A—B, respectively.

Figures 21A—B are a flow chart of a subroutine employed by the tangent X and arctangent X routines of Figures 16A—B and 17A—B, respectively.

Figures 22A—B are a flow chart of a subroutine employed by the e^x and natural logarithm X routines of Figures 18A—B and 19, respectively.

Figure 23 is a flow chart of a subroutine employed by the arctangent X and natural logarithm X routines of Figures 18A—B and 19, respectively.

Figure 24 is a flow chart of sine and cosine routines selectable by the exection monitor of Figure 9.

Figure 25 is a flow chart of an X^Y power routine selectable by the execution monitor of Figure 9.

Figure 26 is a flow chart of a logarithm to the base ten routine selectable by the execution monitor of Figure 9.

Figure 27 is a block diagram of the microprocessor of Figures 3A—B.

Figures 28A—D are a detailed schematic diagram of the microprocessor of Figures 3A—B and 27.

Figure 28′ is a diagram showing the arrangement of Figures 28A—D.

Figures 29A—J are detailed flow charts illustrating the operation of the microprocessor of Figures 3A—B, 27, and 28A—D.

Figures 29′ and 29″ are diagrams showing the arrangement of Figures 29A—H.

Figure 30 is a block diagram of the programmable clock of Figures 3A—B.

Figures 31A—C are a detailed schematic diagram of the programmable clock of Figures 3A—B and 30 and of a portion of the input-output control unit of Figures 3A—B.

Figure 31′ is a diagram showing the arrangement of Figures 31A—C.

Figure 32 is a waveform diagram illustrating the operation of the programmable clock of Figures 3A—B, 30, and 31A—C.

Figures 33A—D are a detailed schematic diagram of the shift register and arithmetic logic units of Figures 3A—B.

Figure 33′ is a diagram showing the arrangement of Figures 33A—D.

Figure 34 is a block diagram of the arithmetic logic unit of Figures 3A—B.

Figure 35 is a block diagram of the memory unit of Figures 3A—B.

Figures 36A—B are a schematic diagram of the read-write memory of Figures 3A—B, 4A—F, and 35.

Figure 36′ is a diagram showing the arrangement of Figures 36A—B.

Figures 37A—B are a schematic diagram of the optional add-on read-write memory of Figures 3A—B, 4A—F, and 35.

Figure 37′ is a diagram showing the arrangement of Figures 37A—B.

Figure 38 is a schematic diagram of the basic read-only memory of Figures 3A—B, 4A—F, and 35.

Figure 39 is a schematic diagram of the optional add-on read-only memory modules of Figure 35 that may be plugged into the calculator to increase the number of functions available to the user.

Figure 40 is a detailed schematic diagram of the buffer circuitry associated with the read-only memory modules of Figures 39.

Figure 41 is a block diagram of one of the read-only memory chips of Figures 38 and 39.

Figures 42A—D are a schematic diagram of one of the read-only memory chips of Figures 38 and 39.

Figure 42′ is a diagram showing the arrangement of Figures 42A—D.

Figure 43 is a memory map of the memory unit of Figures 3A—B and 4A—F illustrating how it is partitioned into the read-only and read-write memory chips of Figures 36A—B through 42A—D.

Figure 44 is a flow chart illustrating how the row members of the lists stored in the read-only memory chips are computed.

Figure 45 is a table of bit numbers and actual bits used in connection with the flow chart of Figure 44.

Figures 46A—B are a detailed schematic diagram of the memory address register of Figures 3A—B and 35 with its associated control circuitry.

Figure 46′ is a diagram showing the arrangement of Figures 46A—B.

Figure 47A—B are a waveform diagram and state sequence charts illustrating the operation of the control circuitry of Figures 46A—B.

Figure 47′ is a diagram showing the arrangement of Figures 47A—B.

Figures 48A—B are a detailed schematic diagram of the memory access register of Figures 3A—B and 35.

Figure 48′ is a diagram showing the arrangement of Figures 48A—B.

Figures 49A—D are a detailed schematic diagram of the input-output register and gating control circuits employed in the input-output control unit of Figures 3A—B.

Figure 49′ is a diagram showing the arrangement of Figures 49A—D.

Figure 50 is a schematic diagram of the source and relationship of the input-output party lines connected to the peripheral interface module receiving receptacles of Figure 20.

Figure 51 is a waveform diagram illustrating the operation of the control section of the input-output control unit of Figures 3A—B and 32.

Figure 52 is a flow chart illustrating the operation of the control section of the input-output control unit of Figures 3A—B and 31A—C.

Figure 53 is a diagram showing how a one-of-ten decoder is employed to address peripheral input-output units to the calculator through the input-output control unit of Figures 3A—B.

Figure 54 is a waveform diagram of some of the input signals employed by the input-output control unit and associated interface modules of Figures 3A—B.

Figure 55 is a waveform diagram of some of the output signals employed by the input-output control unit and associated interface modules of Figures 3A—B.

Figure 56 is a waveform diagram of some of the high speed input signals employed by the input-output control unit and associated interface modules of Figures 3A—B.

Figure 57 is a waveform diagram of some of the high speed output signals employed by the input-output control unit and associated interface modules of Figures 3A—B.

Figure 58 is a waveform diagram illustrating the operation of the interrupt mode of operation of the input-output control unit of Figures 3A—B.

Figure 59 is a schematic diagram of logic that may be used to interface an X—Y plotter to the input-output control unit of Figures 3A—B.

Figure 60 is a schematic diagram of logic that may be used to interface a printing unit to the input-output control print of Figures 3A—B.

Figure 61 is a schematic diagram of logic that may be used to interface a modem to the input-output control unit of Figures 3A—B.

Figure 62 is a schematic diagram of logic that may be used to transfer any eight-bit code into or out of the input-output control unit of Figures 3A—B.

Figure 63 A—C are a detailed schematic diagram of the keyboard input unit employed in the adaptable programmable calculator of Figures 1—3B.

Figure 63′ is a diagram showing the arrangement of Figures 63A—C.

Figure 64 is a block diagram of the magnetic tape cassette reading and recording unit employed in the calculator of Figures 1—3B.

Figure 65 is a detailed schematic diagram of the interface block of Figure 64.

Figures 66A—B are a detailed schematic diagram of the control logic block of Figure 64.

Figure 66' is a diagram showing the arrangement of Figures 66A—B.

Figures 67A—B are a detailed schematic diagram of the read-write block of Figure 64.

Figure 67' is a diagram showing the arrangement of Figures 67A—B.

Figures 68A—B are a detailed schematic diagram of the motor control block of Figure 64.

Figure 68' is a diagram showing the arrangement of Figures 68A—B.

Figure 69 is a detailed schematic diagram of the interconnect block of Figure 64.

Figure 70 is a detailed schematic diagram of the head driver and preamp blocks of Figure 64.

Figure 71 is a block diagram illustrating how the magnetic tape cassette reading and recording unit of Figures 64—70 interacts with the calculator of Figures 1—3B.

Figures 72A—F are a detailed schematic diagram of the output display unit employed in the adaptable programmable calculator of Figures 1—3B.

Figure 72' is a diagram showing the arrangement of Figures 72A—F.

Figures 73A—B are a detailed schematic diagram of the control logic circuit associated with the output display unit of Figures 72A—F.

Figure 73' is a diagram showing the arrangement of Figures 73A—B.

Figure 74 is a block diagram of the power supply system employed in the adaptable programmable calculator of Figures 1—3B.

Figures 75A—B are a detailed schematic diagram of the power supply system of Figure 74.

Figure 75' is a diagram showing the arrangement of Figures 75A—B.

Figures 76A—B are a block diagram of an interface module that may be employed to interface a typewriter to the adaptable programmable calculator of Figures 1—3B.

Figure 76' is a diagram showing the arrangement of Figures 76A—B.

Figures 77A—C are a flow chart of an input-output routine performed when a typewriter is employed with the programmable calculator of Figures 1—3B.

Figure 77' is a diagram showing the arrangement of Figures 77A—C.

Figures 78A—D are a detailed schematic diagram of the control logic block of Figures 76A—B.

Figure 78' is a diagram showing the arrangement of Figures 78A—D.

Figures 79A—B are a detailed schematic diagram of the power gates of Figures 76A—B.

Figure 79' is a diagram showing the arrangement of Figures 79A—B.

Figures 80A—B are a simplified logic diagram showing state qualifiers and instructions relating to the flow chart of Figures 77A—C.

Figure 81 is a detailed schematic diagram of the ROM, data latch, and compare circuitry of Figures 76A—B.

Figure 82 is a detailed schematic diagram of a power supply that may be employed to power the typewriter interface circuitry of Figures 78A—D, 79A—B, and 81.

Figure 83 is a flow chart of the turn-on routine which is a portion of the system monitor of Figure 4B.

Figures 84A—D are a flow chart of a routine comprising another portion of the system monitor of Figure 4B.

Figure 85 is a flow chart of the system table scan routine of Figure 4D.

Figure 86 is a flow chart of a subroutine called by the routine of Figure 85.

Figure 87 is a flow chart of the table search routine of Figure 4A.

Figures 88A—G are a flow chart of the keyboard input routine and special keyboard functions routines of Figure 4A.

Figures 89A—B are flow charts of subroutines called by the routines of Figures 88A—G.

Figure 90 is a flow chart of the clear subroutine called by various ones of the routines of Figures 4A—F.

Figure 91 is a flow chart of a subroutine called by the routine of Figure 88F.

Figure 92 is a flow chart of a subroutine called by the keyboard input routine of Figures 4A and 88A—G.

Figure 93 is a flow chart of a keyboard driver subroutine called by the subroutine of Figure 92.

Figures 94A—F are flow charts of some of the general system subroutines of Figure 4A.

Figure 95 is a flow chart of the error routine of Figure 4B.

Figures 96A—D are flow charts of the program memory manager routines of Figure 4B.

Figure 97 is a flow chart of another of the general system subroutines of Figure 4A which is also called by the routines of Figures 96A—D.

Figure 98 is a flow chart of another of the general system subroutines of Figure 4A.

Figures 99A—F are flow charts of the user-definable key routines of Figure 4A.

Figures 100A—D are flow charts of the execution monitor and keyboard execution control blocks of Figure 4C.

Figure 101 is a flow chart of the load execution routine of Figure 4D.

Figure 102 is a flow chart of the store execution routine of Figure 4D.

Figure 103 is a flow chart of the merge execution routine of Figure 4D.

Figure 104 is a flow chart of the link execution routine of Figure 4D.

Figure 105 is a flow chart of the find execution routine of Figure 4D.

Figures 106A—D are flow charts of subroutines called by the execution routines of Figures 101—104.

Figure 107 is a flow chart of the load data execution routine of Figure 4D.

Figure 108 is a flow chart of the store data execution routine of Figure 4D.

Figure 109 is a flow chart of a subroutine called by the routines of Figures 107 and 108.

Figure 110 is a flow chart of the load key execution routine of Figure 4D.

Figure 111 is a flow chart of the store key execution routine of Figure 4D.

Figure 112 is a flow chart of the load bin execution routine of Figure 4D.

Figure 113 is a flow chart of the mark execution routine of Figure 4D.

Figure 114 is a flow chart of a subroutine called by the routine of Figure 113.

Figure 115A is a flow chart of the list execution routine of Figure 4D.

Figure 115B is a flow chart of a subroutine called by the routine of Figure 115A.

Figure 116 is a flow chart of the secure routine of Figure 4D.

Figures 117A—B are a flow chart of the interrupt routine of Figure 4D.

Figures 118A—B are a flow chart of a routine for performing an OFFSET command selectable when the plotter plug-in read-only memory module is employed with the calculator.

Figure 119 is a flow chart of a routine for performing an IPLOT command selectable when the plotter plug-in read-only memory module is employed with the calculator.

Figure 120 is a flow chart of a routine for performing a LABEL command selectable when the plotter plug-in read-only memory module is employed with the calculator.

Figure 121 is a flow chart of a routine for performing a LETTER command selectable when the plotter plug-in read-only memory module is employed with the calculator.

Figure 122 is a flow chart of a routine for performing a CPLOT command selectable when the plotter plug-in read-only memory module is employed with the calculator.

Figure 123 is a flow chart of a subroutine employed by the routine of Figure 122.

Figure 124 is a flow chart of a routine for performing XAXIS and YAXIS commands selectable when the plotter plug-in read-only memory module is employed with the calculator.

Figures 125A—C are flow charts of subroutines called by the routine of Figure 124.

Figures 126A—C are flow charts of subroutines called by the routines of Figures 118—124.

Figure 127 is a flow chart of a primary entry routine employed when the terminal read-only memory module is plugged into the calculator.

Figures 128A—W are a flow chart of a keyboard input and editing routine employed when the terminal read-only memory module is plugged into the calculator.

Figures 129A—B are a flow chart of a modem interrupt service routine employed when the terminal read-only memory module is plugged into the calculator.

Figure 130 is a flow chart of a secondary entry routine employed when the terminal read-only memory module is plugged into the calculator.

Figure 131 is a flow chart of an output statement routine employed when the extended input-output read-only memory module is plugged into the calculator.

Figures 132A—D are flow charts of subroutines called by the routine of Figure 131.

Figure 133 is a flow chart of a BIN command selectable when the extended input-output plug-in read-only memory module is employed with the calculator.

Figure 134 is a flow chart of a CHAR command selectable when the extended input-output plug-in read-only memory module is employed with the calculator.

Figure 135 is a flow chart of a STAT command selectable when the extended input-output plug-in read-only memory module is employed with the calculator.

Figure 136 is a flow chart of binary ROTATE, AND, and OR commands selectable when the extended input-output plug-in read-only memory module is employed with the calculator.

Description of the Preferred Embodiment

GENERAL DESCRIPTION

Referring to Figures 1 and 2, there is shown an adaptable programmable calculator 10 including both a keyboard input unit 12 for entering information into and controlling the operation of the calculator and a magnetic tape cassette reading and recording unit 14 for recording information stored within the calculator onto one or more external tape cassettes 16 and for subsequently loading the information recorded on these and other similar magnetic tape cassettes back into the calculator. The calculator also includes a solid state output display unit 18 for displaying alphameric information stored within the calculator. All of these input and output units are mounted within a single calculator housing 24 adjacent to a curved front panel 26 thereof.

A plurality of peripheral input and output units including, for example, a line printer, a digitizer, a marked card reader, an X—Y plotter, a typewriter, a teletypewriter, an extended read-write memory unit, a magnetic disc reading and recording unit, and a modem for connecting the calculator via telephone lines to a remotely located computer, may be connected to the calculator at the same time by simply inserting interface modules 30 (Figure 3) associated with the selected peripheral units into any of four receptacles 32 provided therefor in a rear panel 34 of the calculator housing. As each interface module 30 is inserted into one of these receptacles, a spring-loaded door 38 at the entrance of the receptacle swings down allowing passage of the interface module. Once the interface module is fully inserted, a printed-circuit terminal board 40 contained within the interface module plugs into a mating edge connected mounted inside the calculator. If any of the selected peripheral units require AC line power, their power cords may be plugged into either one of two AC power outlets 42 provided therefor at the rear panel of the calculator housing 24.

Referring to the simplified block diagram shown in Figures 3A—B, it may be seen that the calculator also inludes an input-output control unit 44 (hereinafter referred to as the I/O control unit) for controlling the transfer of information to and from the input and output units, a memory unit 46 for storing and manipulating information entered into the calculator and for storing routines and subroutines of basic instructions performed by the calculator, and a central processing unit 48 (hereinafter referred to as the CPU) for controlling the execution of the routines and subroutines of basic instructions stored in the memory unit as required to process information entered into or stored within the calculator. The calculator also includes a bus system comprising an $\overline{S}$-bus 50, a T-bus 52, and an $\overline{R}$-bus 54 for transferring information from the memory and I/O control units to the CPU, from the CPU to the memory and I/O control units, and between different portions of the CPU. It further comprises a power supply for supplying DC power to the calculator and peripheral units employed therewith and for issuing a control signal $\overline{POP}$ when power is supplied to the calculator.

The I/O control unit 44 includes an input-output register 56 (hereinafter referred to as the I/O register), associated I/O gating control circuitry 58, and input-output control logic 60 (hereinafter referred to as the I/O control). I/O register 56 comprises a universal sixteen-bit shift register into which information may be transferred either bit-serially from the CPU 48 via T-bus 52 or in parallel from keyboard input unit 12, magnetic tape cassette reading and recording unit 14, and peripheral input units 28 such as the marked card reader via twelve input party

lines 62. Information may be transferred from I/O register 56 either bit-serially to CPU 48 via S-bus 50 or in parallel to magnetic tape cassette reading and recording unit 14, solid state output display unit 18, output printer unit 20, and peripheral output units 28 such as the X—Y plotter or the typewriter via sixteen output party lines 64.

I/O gating control circuitry 58 includes control circuits for controlling the transfer of information into and out of I/O register 56 in response to selected I/O qualifier control signals from CPU 48 and selected I/O control instructions from I/O control 60. It also includes an interrupt control circuit 65, a peripheral control circuit 66, a printer control circuit 68, and a display control circuit 69 for variously controlling the input and output units and issuing control signals QFG and EBT to I/O control 60 via two output lines 71 and 72. These last mentioned control circuits variously perform their control functions in response to control signal $\overline{POP}$ from the power supply, I/O qualifier control signals from CPU 48, I/O control instructions from I/O control 60, and control signals from keyboard input unit 12. Interrupt control circuit 65 initiates the transfer of information into I/O register 56 from keyboard input unit 12 or interrupting peripheral input units 28 such as the marked card reader and issues a qualifier control signal QNR to CPU 48 via output lines 73. Peripheral control circuit 66 enables interface modules 30 plugged into the calculator to respond to information from I/O register 56, control associated peripheral units 28, transfer information to and/or receive information from associated peripheral units 28, and in some cases initiate the transfer of information to I/O register 56 from the interface modules themselves. Printer control circuit 68 and display control circuit 69 enable output display unit 18, and output printer unit 20, respectively, to respond to information from I/O register 56.

When a basic I/O instruction obtained from memory unit 46 is to be executed, CPU 48 transfers control to I/O control 60 by issuing a pair of I/O microinstructions $\overline{PTR}$ and $\overline{XTR}$ thereto. In response to these I/O microinstructions from CPU 48, control signal $\overline{POP}$ from the power supply, control signals QFG and EBT from I/O gating control circuitry 58, and I/O qualifier and clock control signals from CPU 48, I/O control 60 selectively issues one or more I/O control instructions to gating control circuitry 58 as required to execute the basic I/O instructions designated by CPU 48 and issues control signals, $\overline{TTX}$, $\overline{XTR}$, QRD, and SCB to CPU 48 via output lines 74—77. The I/O qualifier control signals issued to I/O control 60 and gating control circuitry 58 by CPU 48 are derived from the basic I/O instruction to be executed. Those qualifier control signals issued to I/O control 60 designate the specific I/O control instructions to be issued by I/O control 60, while those issued to gating control circuitry 58 designate selected control circuits to be employed in executing the basic I/O instruction.

Memory unit 46 includes a modular random-access read-write memory 78 (hereinafter referred to as the RWM), a modular read-only memory 80 (hereinafter referred to as the ROM), a memory address register 82 (hereinafter referred to as the M-register), a memory access register 84 (hereinafter referred to as the T-register), and control circuitry 85 for these memories and registers. The RWM 78 and ROM 80 comprise MOS-type semiconductor memories. As shown in the memory map of Figures 4A—F the basic RWM 78 contains a dedicated system storage section of 256 sixteen-bit words extending from address 1400 to address 1777 and a separate user program and/or data storage section of 1792 sixteen-bit words extending from address 40400 to address 43777. All addresses on the memory map are represented in octal form.

An optional 2048 sixteen-bit words of RWM may be made available to the user at address 44000 to address 47777. This is accomplished by removing a top panel 90 of the calculator housing shown in Figure 1, and inserting an additional printed circuit board containing the optional memory. The additional RWM is automatically accommodated by the calculator.

As shown in the more detailed memory map of Figures 5A—B, the RWM dedicated system storage section includes 52 words (addresses 1400—1463) containing information in the form of mnemonic variables which is employed by the firmware routines shown in Figure 9. A more detailed description of these mnemonic variables is given on page 21 of the calculator basic system firmware listing located hereinafter in this specification. Addresses 1466—1477 and 1701—1737 are used as temporary storage by the various routines shown in Figure 9. Addresses 1500—1550 comprise a 41-word buffer used to contain the input characters during syntax analysis. Addresses 1551—1621 comprise a 41-word

buffer used by the single line display refresh routine of Figure 9. These 41 words along with 42 additional words (addresses 1622—1673) are used as a syntax buffer during syntax analysis. Four of these words (addresses 1622—1625) are used as temporary registers by several of the statement execution routines of Figure 9. Eight words (addresses 1630—1637) are used as two temporary floating point number registers by the formula evaluation routines of Figure 9. Addresses 1640—1677 comprise 32 words which are used by the statement execution routines of Figure 9. Eight words (addresses 1744—1747 and 1754—1757) are employed as "AR1" and "AR2" four-word working registers for performing binary-coded-decimal arithmetic. An additional eight words (addresses 1740—1743 and 1750—1753) are employed as working data registers "X_c" and "Y_c" for implementation of the trigonometric functions. These sixteen words (addresses 1740—1757) are used as temporary storage registers by all the routines of Figure 9 except the statement execution and formula evaluation routines. A variable-length "system subroutine stack" (addresses 1760—1772) is employed for storing return addresses required by programs stored in ROM 80. Four words (addresses 1773—1776) are used to store the result of the latest keyboard computation. The last word in the system RWM (address 1777) is used to store a pointer indicating the next available location for the return address of the next subroutine call within the basic system. A complete assembly language description of the system RWM is included in pages 21—24 of the calculator basic system firmware listing.

As shown in the memory map of Figures 4A—F and the more detailed memory map of Figure 6, user program and/or data storage section of RWM 78 contains 1760 word available to the user (as user addresses 40440—43777) for storing programs and/or data, 20 words dedicated for use by the interrupt routine of Figures 9 and 117A—B, and 12 words available for use by plug-in read-only memory modules. An additional 2048 sixteen-bit words may be made available to the user (as user addresses 44000—47777).

Also, as shown in the memory map of Figures 4A—B, the basic ROM 80 contains 7680 sixteen-bit words extending from address 0000 to address 1377, from address 2000 to address 16777, and from address 40000 to address 40377. Routines and subroutines of basic instructions for performing the basic functions of the calculator and constants employed by these routines and subroutines are stored in these portions of ROM 80. An additional 8192 sixteen-bit words of ROM may also be added at addresses 20000—37777 in steps of 512 and 1,024 words. This is accomplished by simply inserting plug-in ROM modules 92 into receptacles provided therefor within the calculator which are accessible through a door in the left panel of the calculator housing as illustrated in Figure 1. As each plug-in ROM module 92 is inserted into one of these receptacles a printed circuit terminal board 96 contained within the plug-in ROM module plugs into a mating edge connector mounted inside the calculator. A handle pivotally mounted at the top end of each plug-in ROM module 92 facilitates removal of the plug-in ROM module once it has been fully inserted into one of the receptacles.

Routines and subroutines of basic instructions (and any needed constants) for enabling the calculator to perform many additional functions are stored in each plug-in ROM module 92. The user himself may therefore quickly and simply adapt the calculator to perform many additional functions oriented toward his specific needs by simply plugging ROM modules of his own choosing into the calculator. Added plug-in ROM modules are automatically accommodated by the calculator.

Referring again to Figures 3A—B, M-register 82 of the memory unit comprises a recirculating sixteen-bit serial shift register into which information may be transferred bit-serially from CPU 48 via T-bus 52 and out of which information may be transferred bit-serially to CPU 48 via S-bus 50. Information shifted into M-register 82 may be employed to address any word in RWM 78 or ROM 80 via fifteen output lines 106.

T-register 84 of the memory unit comprises a recirculating sixteen-bit serial shift register into which information may be transferred either bit-serially from CPU 48 via T-bus 52 or in parallel from any addressed word in RWM 78 and ROM 80 via sixteen parallel input lines 108. Information may be transferred from T-register 84 either bit-serially to CPU 48 via S-bus 50 or parallel to any addressed word in RWM 78 via sixteen parallel output lines 110. The four least significant bits of information contained in T-register 84 may comprise binary-coded-decimal information and may be transferred from the T-register in parallel to CPU 48 via three parallel output lines 112 taken with S-bus 50.

The control circuitry 85 of the memory unit controls these transfers of

information into and out of M-register 82 and T-register 84, controls the addressing and accessing of RWM 78 and ROM 80, and refreshes RWM 78. It performs these functions in reponse to memory microinstructions, memory clock pulses, and shift clock pulses from CPU 48.

CPU 48 includes a register unit 114, an arithmetic-logic unit 116 (hereinafter referred to as the ALU), a programmable clock 118, and a microprocessor 120. Register unit 114 comprises four recirculating sixteen-bit shift registers 122, 124, 126, and 128 and one four-bit shift register 130. Shift registers 122 and 124 serve as sixteen-bit serial accumulator registers (herinafter referred to as the A-register and the B-register, respectively) into which information may be transferred bit-serially from ALU 116 via T-bus 52 and out of which information may be transferred bit-serially to ALU 116 via $\overline{R}$-bus 54. The four least significant bit positions of A-register 122 also serve as a four-bit parallel accumulator register into which four bits of binary-coded-decimal information may be transferred in parallel from ALU 116 via four parallel input lines 132 and out of which four bits of binary-coded-decimal information may also be transferred in parallel to ALU 116 via three parallel output lines 134 taken with $\overline{R}$-bus 54.

Shift register 126 serves as a sixteen-bit system program counter (hereinafter referred to as the P-register) into which information may be transferred bit-serially from ALU 116 via T-bus 52 and out of which information may be transferred bit-serially to ALU 116 via $\overline{R}$-bus 54. Information contained in the least significant bit position of P-register 126 may also be transferred as a qualifier control signal QPO to microprocessor 120 via output line 135.

Shift register 128 serves as a sixteen-bit qualifier register (hereinafter referred to as the Q-register) into which information may be transferred bit-serially from ALU 116 via T-bus 52 and out of which information may be transferred bit-serially to ALU 116 via $\overline{R}$-bus 54. Information contained in the five least significant bit positions of Q-register 128 is transferred to I/O gating control circuitry 58 as five one-bit I/O qualifier control signals Q00—Q04 via five parallel output lines 136, and information contained in the six next least significant bit positions of the Q-register is transferred to I/O control 60 as six one-bit I/O qualifier control signals Q05—Q10 via six parallel output lines 138. Similarly, information contained in the seven least significant, the ninth and eleventh least significant, and the most significant bit positions of Q-register 128 and information derived from the thirteenth, fourteenth, and fifteenth bit positions of the Q-register may be transferred to microprocessor 120 as eleven one-bit microprocessor qualifier control signals Q00—Q06, Q08, Q10, Q15, and QMR via eleven output lines 140. Information contained in the twelfth through the fifteenth least significant bit positions of Q-register 128 may be transferred to microprocessor 120 as a four-bit primary address code via four parallel output lines 142.

Shift register 130 serves as a four-bit serial extend register (hereinafter referred to as the E-register) into which information may be transferred bit-serially either from ALU 116 via T-bus 52 or from the least significant bit position of T-register 84 via input line 144. Information may also be transferred out of E-register 130 to ALU 116 via $\overline{R}$-bus 54.

Register unit 114 also includes control circuitry 146 for controlling the transfer of parallel binary-coded-decimal information into and out of A-register 122 and the transfer of serial binary information into and out of A-register 122, B-register 124, P-register 126, Q-register 128, and E-register 130. This is accomplished in response to register microinstructions from microprocessor 120, control signals $\overline{TTX}$ and $\overline{XTR}$ from I/O control 60, and shift clock control pulses from programmable clock 118. Control circuitry 146 includes a flip-flop 148 (hereinafter referred to as the A/B flip-flop) for enabling the transfer of information into and out of either the A-register 122 or the B-register 124 as determined by the state of the A/B flip-flop. The state of A/B flip-flop 148 is initially determined by information Q11 transferred to the A/B flip-flop from the twelfth least significant bit position of Q-register 128 but may be subsequently complemented one or more times by microinstruction CAB from microprocessor 120.

ALU 116 may perform either one-bit serial binary arithmetic on data received from T-register 84 or M-register 82 via $\overline{S}$-bus 50 and/or from any register of register unit 114 via $\overline{R}$-bus 54 or four-bit parallel binary-coded-decimal arithmetic on data received from T-register 84 via output lines 112 taken with $\overline{S}$-bus 50 and/or from A-register 122 via output lines 134 taken with $\overline{R}$-bus 54. It may also perform logic operations on data received from memory unit 46 and/or register unit 114 via any

of these lines. The arithmetic and logic operations performed are designated by ALU microinstructions from microprocessor 120 and are carried out in response to these microinstructions, shift clock control pulses from programmable clock 118, and control signal SCB from I/O control 60. Information is also transferred from ALU 116 to A-register 122 via output lines 132 or to I/O register 56, M-register 82, T-register 84, or any register of register unit 114 via T-bus 52 in response to microinstructions and control signals applied to these registers. If a carry results while ALU 116 is performing either one-bit serial binary arithmetic or four-bit paraliel binary-coded-decimal arithmetic, the ALU issues a corresponding qualifier control signal QBC or QDC to microprocessor 120 via one of two output lines 152 and 154.

Programmable clock 118 includes a crystal-controlled system clock 156, a clock decoder and generator 158, and a control gate 160. System clock 156 issues regularly recurring clock pulses to clock decoder and generator 158 via output line 162. In response to these regularly recurring clock pulses from system clock 156 and to four-bit clock codes from microprocessor 120, clock decoder and generator 158 issues trains of n shift clock pulses to ALU 116, M-register 82, T-register 84, and all of the registers of register unit 114 via output line 164. These trains of n shift clock pulses are employed for shifting a corresponding number of bits of serial information into or out of any of these registers or for shifting a carry bit in the ALU. The number n of pulses in each of these trains may vary from one to sixteen as determined by the number of bits of serial information required during each operation to be performed. In response to a control signal $\overline{CCO}$ from microprocessor 120, control gate 160 prevents any shift clock pulses from being applied to the ALU or any of these registers. Upon completion of each train of n shift clock pulses, clock decoder and generator 158 issues a ROM clock pulse to microprocessor 120 via output line 166 and an I/O clock pulse to I/O control 60 via output line 168. In response to the regularly recurring clock signal from system clock 56, clock decoder and generator 158 also issues correspondingly regularly recurring memory clock pulses to memory unit 46 via output line 170.

Microprocessor 120 selectively issues two I/O microinstructions to I/O control 60 via two output lines 172, six memory microinstructions to memory unit 46 via six output lines 174, thirteen register microinstructions to register unit 114 via thirteen output lines 176, and five ALU microinstructions to ALU 116 via five output lines 178. It also issues a four-bit clock code associated with each of these microinstructions to clock decoder 158 via four output lines 180. These microinstructions and associated clock codes are issued as determined by the control signal $\overline{POP}$ from the power supply, the eleven microprocessor qualifier control signals from Q-register 128, the four-bit primary address codes from Q-register 128, and the five microprocessor qualifier control signals from I/O control 60, interrupt control 65, ALU 116, and P-register 126.

As shown in the simplified flow chart of Figure 7, microprocessor 120 executes a hardware diagnostic routine (stored within the microprocessor itself) in response to the control signal $\overline{POP}$. Upon completion of this diagnostic routine, ALU 116 issues the qualifier control signal QBC indicating whether or not the diagnostic routine was successful. Microprocessor 120 thereupon responds to this qualifier control signal by entering the basic machine operating loop and issuing microinstructions causing a sixteen-bit instruction stored in ROM 80 to be loaded into T-register 84 and transferred from there to Q-register 128. Microprocessor 120 thereupon sequentially responds to one or more additional qualifier control signals by issuing microinstructions and associated clock codes for executing the instructions then contained in Q-register 128 and causing another sixteen-bit instruction stored in ROM 80 to be loaded into T-register 84 and transferred from there to the Q-register. When an instruction requiring multiple branching is contained in Q-register 128, microprocessor 120 issues a pair of microinstructions $\overline{UTR}$ and $\overline{XTR}$ causing the microprocessor to respond to a four-bit primary address code from the Q-register by issuing additional microinstructions and associated clock codes for executing the instruction contained in the Q-register.

As illustrated by the basic machine operating loop shown in the flow chart of Figure 7, microprocessor 120 initially responds to the qualifier control signal QNR either by issuing microinstructions and associated clock codes for interrupting the basic machine operating loop and executing an I/O service routine or by issuing microinstructions and associated clock codes for loading A/B flip-flop 148 with the information Q11 contained in Q-register 128. The manner in which microprocessor 120 responds is determined by the condition of the qualifier control

signal QNR, which in turn indicates whether or not the basic machine operating loop should be interrupted.

Assuming the basic machine operating loop is not to be interrupted, microprocessor 120 loads the information Q11 into A/B flip-flop 148 and responds to the qualifier control signal QMR either by issuing microinstructions for transferring an address portion of the instruction contained in Q-register 128 from T-register 84 into M-register 82 or by responding to another qualifier control signal Q15. Again, the manner in which microprocessor 120 responds is determined by the condition of the qualifier control signal QMR, which in turn indicates whether or not the instruction contained in Q-register 128 is a memory reference instruction.

Assuming the instruction contained in Q-register 128 is a memory reference instruction, microprocessor 120 transfers the required address information into the M-register 82 and responds to qualifier control signal Q10 either by issuing microinstructions and associated clock codes to select the base page of the memory (i.e. page 0) or by issuing microinstructions and associated clock codes to select the current page of the memory (i.e. the page from which the instruction contained in Q-register 128 was obtained). In either case, the microprocessor then issues microinstructions as required to read data from the preset page of the memory at the address designated by the address information last transferred into M-register 82. Upon completion of this operation, microprocessor 120 responds to qualifier control signal Q15 by issuing additional microinstructions and associated clock codes to execute an indirect memory access operation if the condition of this qualifier control signal indicates that the address information contained in M-register 82 is indirect.

Assuming the address information contained in M-register 82 is direct (or upon completion of the indirect memory access operation), microprocessor 120 issues microinstructions and associated clock codes causing the microprocessor itself to respond to a four-bit primary address code from the Q-register. The microprocessor responds by issuing additional microinstructions and associated clock codes for executing whichever one of ten possible memory reference instructions is contained in Q-register 128 and designated by the four-bit primary address code. Following execution of the designated memory reference instruction, microprocessor 120 issues microinstructions and associated clock codes causing another sixteen-bit instruction stored in ROM 80 to be loaded into T-register 84 and transferred from there to Q-register 128, thereby beginning another cycle of the basic machine operating loop.

As illustrated by other possible paths of the basic machine operating loop shown in Figure 7, microprocessor 120 sequentially responds to other qualifier control signals when other types of instructions are contained in Q-register 128. For example, when an I/O instruction is contained in Q-register 128, microprocessor 120 sequentially responds to qualifier control signals QNR, QMR, Q15, Q10, and QRD by issuing microinstructions and associated clock codes to execute the I/O instruction. It should be noted that the microprocessor qualifier control signals not shown in the simplified flow chart of Figure 7 are variously contained within those flow chart blocks requiring decisions as will hereinafter become apparent.

The calculator firmware operational diagram of Figure 9 illustrates the basic components of the calculator firmware. These components comprise routines which reside in the calculator ROM 80 and serve to implement the definition of the calculator. Control information passing between routines is represented by solid lines on the drawing.

Referring to Figure 9, it is shown that the calculator hardware units are controlled by firmware routines contained in ROM 80. These units comprise an on-off power switch 182, an alphanumeric keyboard input unit 12, a display unit 18, and a magnetic tape cassette reading and recording unit 14. The firmware routines also control an external printer 20, external tape cassette reading and recording units 14, and various other external input-output devices 244.

Operation of the calculator is begun by placing the on-off switch in the "on" position, thus forcing the hardware internal to the calculator to execute the instruction located at address 0000 of ROM 80. This instruction directs control to the start-up routine 200, which is shown in the flowchart of Figure 83, and described in detail on page 53 of the basic system firmware listing. The purposes of this routine are to initialize RWM 78, set the stack pointer address at location 1777, set the keyboard execution numeric output format to float 9, initialize certain variables in the system RWM area for later use by other firmware routines, and

initialize the various read-write pointers to the user read-write memory area shown in detail in the memory map of Figure 6.

After completion of the start-up routine, control is passed to the keyboard monitor routine 202 shown in the flowchart of Figures 84A—D and detailed on pages 53—56 of the basic system firmware listing. This routine initializes certain variables in the system RWM 78 for use by the keyboard input routine 204. It also outputs the automatic line number if necessary. It then calls for an input record from the keyboard input routine 204. When the keyboard input routine returns with a record the keyboard monitor routine searches the mnemonic tables in the assembly language program area shown in Figure 6. It then searches the mnemonic tables in each of the plug-in read-only memory modules of Figure 4E and finally searches the mnemonic tables of the main system ROM 80. A complete assembly language listing of each of the tables in read-only memory is given in the firmware listings. The subroutines which do the search of the mnemonic tables are detailed in the flowcharts of Figures 85, 86, and 87. If a match is found between the characters of the input record and any of the mnemonic tables, the keyboard monitor branches through a jump table to the appropriate syntax routine 210 for syntax analysis if the mnemonic is a statement, or branches through a jump table for execution if the mnemonic is a system command. A separate syntax analysis routine is provided for each statement and a separate execution routine is provided for each system command. Syntax and execution routines for statements and commands on an optional read-only memory module are contained in the firmware of that module. The assembly language program area is handled in the same fashion as the plug-in read-only memory module. If no mnemonic is found, control is passed to the implied LET syntax routine.

The keyboard input routine 204 is detailed in the flowcharts of Figures 88A—G, 89A—B, and 90—93. It calls on the display refresh routine 206 to refresh the 32 character single line display 18 between key entries. The display refresh routine is detailed on page 35 of the firmware listing. When a key is entered through the alphanumeric keyboard 12, the interrupt circuitry causes the calculator to execute the instruction at address 00002. This instruction causes a jump to the interrupt routine 208, which is detailed in the flowchart of Figures 117A—B and pages 257 and 258 of the firmware listing. The interrupt routine 208 saves the keycode in a memory location of the system RWM 78 and returns. The keyboard input routine 204 reads this memory word and decides what operations need to be performed for that particular keycode. The shift bit is stripped from the keycode and stored as a flag in a temporary location in system RWM 78. If the key requires that a mnemonic name be displayed, the single line display buffer shown in Figures 5A—B is cleared and the mnemonic name is entered. If an editing function is required, a routine is called to perform the editing function. If a user-definable key f0—f9 has been given, the user-definable key routine 228 is called. If an alphanumeric key has been given, the shift flag in RWM 78 is tested, and, if the shift has been given, the keycode is converted to the code for the shifted key. Then the keycode is inserted into the single line display buffer shown in Figures 5A—B, either at the end of the line or at the cursor position, if the cursor is within the line.

The user-definable key routines 228 perform the special operations for keys f0—f9. They are detailed in the flowcharts of Figures 99A—F and pages 43—47 of the firmware listing.

The syntax routines 210 translate the characters of the input record into an internal format which is more easily handled by the execution routines. If a syntax error is encountered control is passed to the error routine 238 which outputs an error message. The error routine is shown in the flowchart of Figure 95 and the firmware listing at pages 58 and 59. If no error is found, control is passed to either the memory management routines 236, if the statement is to be stored in memory, or to the routine for initialization for keyboard execution if the statement is to be executed. The memory management routines are shown in the flowcharts of Figures 96A—D, 97, and 98 and pages 16 and 60—62 of the firmware listings. The routine 230 for initialization for keyboard execution serves to initialize the run time stacks shown in the memory map of Figure 6. This routine is detailed in the flowchart of Figure 100C and pages 109—110 of the firmware listing.

When the RUN command is given, or if the INIT key is actuated, control is passed to the pre-execution processing routines 232. These routines are detailed in pages 65—77 of the firmware listing. They serve to initialize the symbol table and non-common value table areas of the user read-write memory shown in Figure 6.

Control is next passed to the execution monitor 214, which is detailed in the flowchart of Figures 100A—B and pages 108—110 of the firmware listing. This routine initializes the run time stacks in the user read-write memory of Figure 6 and initiates execution of a stored program beginning at the line number given by the user. After each statement is executed control is returned to the execution monitor, which prints the line number of the next line if the program is being executed in the trace mode. Step, stop, or error conditions are checked and program execution is terminated if any of these conditions exist. If program execution is to be continued, the jump address of the execution routine for the next statement of the program is computed, and control is passed to that routine.

Several of the statement execution routines 240 require evaluation of arithmetic functions and expressions. This is done in the formula evaluation routines 242. Several of the statement execution routines 240 require input from or output to various external input-output devices 20 and 244. This is done by calling the standard output driver 224 or an optional special I/O driver 234. Several of the statement execution routines require input from or output to an internal or external tape cassette unit 14. This is done by calling the tape cassette drivers 226. The statement execution routines for the statements that communicate with the tape cassette units are detailed in the flowcharts of Figures 101—115 and pages 250—276 of the firmware listing.

The list routine 220 is used when listing stored programs on either the single line display 18 or an external ASCII output device 20. The list routine is detailed on pages 78—82 of the firmware listing. Its function is to translate the stored program from the internal stored format into a string of ASCII characters which can be printed or displayed. To print a line of translated characters, the list routine calls on the standard output driver 242 which is detailed in Figure 94E and pages 20 and 33 of the firmware listing.

Detailed assembly language information relating to all of the firmware routines and subroutines herein described may be obtained by referring to the memory map of Figures 4A—F and the basic system firmware listing located at a later point in this specification.

Communication with the routines in the various plug-in read-only memory modules is accomplished through a series of mnemonic tables and jump tables. The standard firmware, the cassette operating firmware, and each of the plug-in read-only memory modules all contain the following tables:

(1) A statement mnemonic table
(2) A statement syntax jump table
(3) A statement execution jump table
(4) A system command mnemonic table
(5) A system command execution jump table
(6) A function mnemonic table
(7) A function execution jump table
(8) A non-formula operator mnemonic table

All of these tables, with the exception of the statement execution jump table, may appear anywhere within a memory module. The last five words in each module are used by the table scan routines of Figures 85—87 to find the actual location of the tables. The last word of each module contains a unique operation code word for that particular module. The second from last word contains a relative address of the statement mnemonic table. The third from the last word contains a relative address of the system command mnemonic table. The fourth from the last word contains a relative address to the function mnemonic table. The fifth from the last word contains a relative address to the non-formula operator table. The jump tables for statement syntax, system command execution, and function execution are located directly above their respective mnemonic tables. The statement execution jump table is located directly above the fifth from the last word of each module. The complete set of tables for the standard firmware is shown in the firmware listings at pages 48—49, 103—104, 131, and 141 of the listings.

Each of the mnemonic tables consists of a string of seven-bit ASCII character and six-bit operation code characters packed two characters per sixteen-bit word. The eight bit of each character is used to indicate whether that character is ASCII or an operation code. A zero in the eighth bit indicates ASCII and a one indicates an operation code. The seventh bit of each operation code character is used to indicate whether that operation code is the last character in that table. The jump table address for each mnemonic is found by subtracting the operation code for

that mnemonic from the starting address of the associated mnemonic table. The internal stored format for program statements consists of a series of operation codes, operand codes, and other special codes. The first word of each statement contains the line number of that statement in binary format. The second word contains both the operation code for that particular statement mnemonic and also the length of the statement. The length information is used by various firmware routines to scan from one statement to the next. The third word contains the operation code for the table or optional read-only memory module, and it also contains the first operand code. The remainder of the statement is stored with one operation code and one operand code in each word.

Formula operation codes from the table on page 132 of the firmware listing and mnemonic operation codes are stored in a five-bit field, bits 10—14. The operand codes are stored in two five-bit fields. Bits 5—9 are used to store the operand name. The name consists of an ASCII letter, A—Z, with its sixth and seventh bits removed. For example, the ASCII code for A is 1000001 and the five-bit operand code for A is 00001. Bits 0—4 are used to store the operand type. Bit 15 is used as a special flag bit. When bit 15 is set, the operand field is interpreted differently than when it is not set. The following table shows the various operand types and the special codes.

OPERAND TYPE CODE	OPERAND TYPE (BIT 15=Ø)	MEANING IF BIT 15=1
	Full Precision Variables	Constant follows in next word
00000	Simple variable	
00001	Array of 1 dimension	Fixed point decimal
00010	Array of 2 dimensions	Floating point decimal
00011	Array of unknown dimension	Binary integer
	Split Precision Variables	
00100	Simple variable	Binary line number
00101	Array of 1 dimension	
00110	Array of 2 dimensions	
	Integer Precision Variables	
01000	Simple variable	
01001	Array of 1 dimension	
01010	Array of 2 dimensions	
	Full Precision Variables	
	Letter followed by digit	
10000	Ø	
10001	1	
10010	2	
10011	3	
10100	4	
10101	5	
10110	6	
10111	7	
11000	8	
11001	9	
11110	String Variable	
11111	User defined function	Bits 5-9 contain the operation code of a function in ROM

As an example, the internal stored format for the following statements is shown in the table below:

```
10  DIM A[5]
20  LET B=C+FND(E)
30  GOTO  1ØØ
```

15	14-10	4-5	4-Ø	
0	00000	00000	01010	1Ø
0	00010	00000	00111	DIM op-code -- Length 7
0	01010	00001	00001	Table op-code -- A |dimension
1	10100	00000	00011	[-- integer follows
0	00000	00000	00101	5
0	00101	00000	00000	] -- null operand
0	00000	00000	10100	2Ø
0	10110	00000	00111	LET op-code -- Length 7
0	01010	00010	00000	Table op-code -- B
0	00111	00011	00000	= -- C
0	01001	00100	11111	+ -- FND
0	10101	00101	00000	(-- E
0	00100	00000	00000	) -- null operand
0	00000	00000	11110	30
0	00110	00000	00100	GOTO op-code -- Length 4
1	01010	00000	00100	Table op-code -- integer follows
0	00000	00011	00100	1ØØ

KEYBOARD OPERATIONS

All operations performed by the calculator may be controlled or initiated by the keyboard input unit and/or by keycodes entered into the calculator from the keyboard input unit, the magnetic tape cassette reading and recording unit, or peripheral input units such as the marked card reader and stored as program steps in the program storage section of the RWM. An operational description of the keyboard input unit is therefore now given with specific reference to the perspective view of the calculator as in Figure 1 and the plan view of the keyboard as in Figure 8, except as otherwise indicated.

Line Switch

An on-off line switch 182, which may be considered as part of the keyboard input unit, controls the application of power to the calculator and hence initiation of the control signal $\overline{POP}$ from the power supply.

As shown in Figure 2, the calculator may be operated at 240, 220, 120, or 100 volts +5%, −10% as determined by a pair of line voltage selector switches mounted at rear panel 34 of the calculator housing and at a line frequency within the range of 48 to 66 Hertz. The calculator is provided with a 6-amp fuse and either a 1-amp fuse for operation at a line voltage of 220 or 240 volts +5%, −10% or a 2-amp fuse for operation at a line voltage of 100 or 120 volts +5%, −10%. It is also provided with a three-conductor power cable 184 which, when plugged into an oppropriate AC power outlet, grounds the calculator housing. The maximum power consumption of the calculator is 150 voltamps. No more than a total of 610 voltamps may be drawn from AC power outlets 42 provided for peripheral units.

EXECUTE

The EXECUTE (often referred to as EXEC) key, when pressed, will perform the indicated operations previously keyed in, if any, and display the result of any arithmetic statements on the 32-character display. (Although the display is only 32 characters, an 80-character line can be keyed in with automatic scrolling both for programs and for keyboard operations.) Most keys, when pressed, immediately cause their mnemonic to be displayed. However, pressing certain keys, such as PRT ALL (to be discussed later), allows a particular mode to be in effect till that mode is overridden.

FIXED N, FLOAT N

Immediately after either turn-on or SCRATCH EXEC, the user read/write memory area is cleared; numerical calculations that are executed will be displayed in float-nine notation. The values 2 and 12 in float-nine notation would appear as 2.000000000E+00 and 1.200000000E+01, respectively. Float 9 refers to the nine digits succeeding the decimal point; E symbolizes x 10 raised to the power of the two digits following the E.

NOTE

In this text, individual keyboard operations will be identified by being underlined; e.g., 3 ± 2 EXEC. (On the display would appear 5.000000000E+00.)

You can specify the desired notation by pressing FIXED N or FLOAT N followed by the appropriate number from 0 through 11. The designated 'N' indicates the number of digits to be displayed to the right of the decimal point after execution.

For example:
FIXED N 7 EXEC,
then 1 2 3 4 5 6 . 7 EXEC, displays 123456.7000000
or, 1 2 3 4 5 6 7 8 9 . 1 2 3 4 5 6 7 8 9 EXEC, displays 123456789.1230000+

FLOAT N 5 EXEC,
then 1 2 3 . 4 EXEC displays 1.23400E+02
or, . 1 2 3 4 5 6 7 EXEC displays 1.23457E–01++

In fixed-n notation, a maximum of 12 digits will be displayed to the left of the decimal point; beyond that value the calculator reverts to float-n notation, with the number of digits displayed to the right of the decimal point determined by the particular fixed-n.

The FIXED N and FLOAT N keys are not programmable; that is, they can be used only in keyboard operations. Output formatting under program control is accomplished by the format statement, which is discussed below.

The calculating range of the calculator is: $-9.99999999999 \times 10^{99}$ through -10^{-99}, 0, and 10^{-99} through $9.99999999999 \times 10^{99}$.

CLEAR, DELETE LINE

Pressing either CLEAR or DELETE LINE will erase whatever previously had been displayed during keyboard operations. Pressing either key will cause ⊢ (the Lazy T) to appear on the far left of the display, indicating that the calculator is available for new inputs. The difference between the two keys occurs when a stored program line is displayed; DELETE LINE will erase the line from the stored program, whereas CLEAR will only erase the display and not affect the program line itself. (A program line can also be deleted by keying in the line number followed by END OF LINE.)

RECALL

Pressing RECALL during keyboard operations allows the last line that was

+The machine calculates to 12 significant digits regardless of the display length.
++Since only five digits can be displayed to the right of the decimal point the fifth digit is rounded.

executed to be recalled to the display; pressing RECALL during program-inputting operations allows the last program line that was input to be recalled to the display. If an error message appears on the display when an attempt is made either to execute a line in keyboard mode or to input a program line into memory, pressing RECALL will allow the original line to be reviewed for editing purposes.

RESULT

Pressing CLEAR RESULT EXEC displays the numerical value of the last arithmetic statement that was executed. The RESULT key not only allows the result of the previously executed statement to be reviewed, but also can function as an "accumulator" during arithmetic operations; e.g., by pressing

2 + 4 EXEC (in FIXED 2 notation) displays 6.00, then pressing
3 + RESULT EXEC displays 9.00, then pressing
4 + RESULT + RESULT EXEC displays 22.00.

Keying in either R E S or R E S U L T has the same effect as pressing the RESULT key.

PRINT ALL

By pressing PRINT ALL, you can determine whether or not the calculator is in print all mode. If ON appears, both the expression and the result of any executed calculation will be typed on whichever printing device is plugged into the calculator; if OFF appears, the information will appear only on the display. Pressing the PRINT ALL key a second time causes the alternative mode to be in effect. In the print all mode, each program statement is printed when END OF LINE is pressed. All error messages are also printed.

BACK, FORWARD, INSERT

The BACK and FORWARD keys can be used to edit expressions on the display. Successive presses of the BACK key will move a blinking cursor to the desired location within the display. Editing can then be performed at this location. The FORWARD key performs the same function as the back key, but in the opposite direction.

At the location of the blinking cursor, the following editing can be performed:

1. A character can be inserted by pressing INSERT. (This opens up a space to the left of the cursor, thereupon moving the cursor to the location of the space; additional presses of the INSERT key will open up more spaces, with the cursor always positioning itself in the left-most space, thus allowing for the immediate insertion of more than one character.)
2. A character can be changed by overscoring it with another character.
3. A character can be deleted by pressing either the space bar or SHIFT INSERT, the only difference being that pressing SHIFT INSERT will close up the space of the deleted character.

Holding either BACK or FORWARD down for approximately 1.5 seconds will cause the cursor to move in rapid succession in the chosen direction.

Once a line is appropriately edited, it can be immediately executed without having to move the cursor to the end of the line.

→, ←

When a line that is greater than 32 characters (80 characters maximum) is being input, the characters to the left of the display are pushed out of the display region to make room for the additional characters. To view the beginning of the input, press → (the right arrow); this operation moves the characters in the display to the right. Pressing ← (the left arrow) performs the reverse operation. Either arrow key, when held down for approximately 1.5 seconds, will repeat its operation in rapid succession.

ARITHMETIC

There are five basic numerical operators: add (+), subtract (–), multiply (*), divide (/), and exponentiate (↑). The order of execution, known as the hierarchy, is identical to the BASIC hierarchy described below. The BASIC functions described below are available on the Calculator simply by keying in the appropriate mnemonics. In addition, the value of π can be obtained by keying in P I.

When operating on trigonometric functions, the calculator assumes the angle to be in radians unless otherwise stated. To express an angle in either degrees or grads, first clear the display, then press either D E G EXEC or G R A D EXEC, respectively; then key in the expression. To revert to radians, clear the display, then press R A D EXEC. Radians, degrees, and grads are also programmable commands.

VARIABLES

The simple "scalar" variables are A through Z and AØ through Z9 (286 total). Simple variables can be used in keyboard operations; e.g., pressing A 3 = 7 EXEC assigns the value of 7 to A3. Unless the value of A3 is then changed or erased from memory, pressing 4 * A 3 EXEC will display 28. If a variable is undefined, any attempt to use this variable in an expression (other than by assigning a value to it) will result in an error message.

An array is an ordered collection of numerical data. An array (subscripted) variable can have either one or two dimensions as indicated by the subscripts, which are presented as numbers within parentheses. A(m) is a one-dimensional array (or column vector) when m designates the row of the element; A(m, n) is a two-dimensional array where m designates the row and n designates the column of the element.

The maximum size of an array is limited by the available calculator memory. At normal 12-point precision, the effective memory limitations would be approximately a (30, 30) array.

Arrays should be referenced in either a common statement or a dimension statement before use in a program; if not, the program defaults to either a 10 element array for a single subscripted array, or a 10 by 10 array for doubly subscripted arrays.

TAPE CASSETTES

The present Calculator is capable of operating with 10 tape cassettes: One cassette is available through the built-in (internal) cassette drive. Four peripheral cassette drives can be connected directly to the calculator through the four I/O slots inthe rear panel.

Five more peripheral cassette drives can be added if the user has an I/O expander box (in all, 11 peripheral devices can be added by having an expander box).

SYNTAX

The tape cassette commands have general syntactical rules which will be briefly described. The general command form, with minor variations, is:

COMMAND [UNIT] [FILE], or
COMMAND [UNIT] (FILE) [LNX_1 [LNX_2]]

Brackets [ ] indicate that the enclosed information is optional; parentheses ( ) indicate that the enclosed information is required with the particular command.

COMMAND — The various commands will be individually discussed.

UNIT — Individual units are referenced by the number sign, #, followed by the select code; the internal cassette is designated by #10 (if no select code is given, the internal cassette is assumed); the nine peripheral cassettes are identified by #1 through #9.

FILE — Files within individual cassettes are identified by file numbers; if no file is identified by number, the scratch-pad (or default) file, file 0, is assumed.

LNX_1 — indicates the beginning line number to be affected by the command.

LNX_2 — indicates either the line number where program execution is to begin following the command implementation, or the ending line number to be accessed in the command. In any command whose syntax allows LNX_1 and LNX_2, in order for LNX_2 to be designated, LNX_1 must have been specified.

All information to be input following the command must be separated by commas.

In keyboard mode, press EXEC after fulfilling the syntax requirements of a particular command to implement the command.

PREPARING A FRESH CASSETTE

To prepare a fresh cassette (one which has no markings), first open the cassette door by presing downward on the switch on the far right of the keyboard; then insert the cassette (print-side up) into the slot built into the door; be certain that the tape is wound around the left spindle — if it is not, but you wish to prepare that side of the cassette anyway, simply close the door and press REWIND.

To store information onto the cassette, first mark the files that are to be used.

PROGRAMMABLE COMMANDS

The following tape cassette commands are programmable: mark, store, load, merge, store key, load key, store data, load data, load binary, rewind, find, and tlist. These commands can also be used in the keyboard mode. The secure command, on the other hand, can be used only in the keyboard mode.

MARK

The mark command produces the designated number of files and defines the file lengths (by the number of 16-bit words per file).

Syntax: MARK [UNIT] (No. of FILES) (LENGTH)
e.g., MARK≠10,5,1000 EXEC — since unit ≠10 identifies the internal cassette, including it is superfluous; the '5' indicates the number of files to be made available; the '1000' signifies the number of 16-bit words per file.

Successive files on the tape can be marked with different word lengths as shown in the following example; MARK 3, 1000 EXEC then, MARK 2, 2000 EXEC will mark files 0, 1, 2 of the internal cassette with 1000-word lengths and will mark files 3, 4 of the same cassette with 2000-word lengths.

The length of a file can be changed; however, changing it will affect all the files following it by distorting their contents. To change the length of a particular file, first position the cassette at that file by using FIND (FIND will be discussed more thoroughly, later; then mark the file with the desired length. For Example: to mark file 12 of the internal cassette with 1000 words, press
FIND 12 EXEC then press,
MARK 1, 1000 EXEC

To mark files not previously marked (virgin files), first perform a TLIST; TLIST will be discussed thoroughly later; but for now, merely knowing that TLIST [UNIT] EXEC will list all the marked files, is sufficient. To mark virgin files, it is first necessary to mark the last file listed in TLIST+. As previously discussed, this file is located by the find command. Beginning with this file, successive virgin files can be marked by the methods previously discussed.

To mark the beginning of a tape, be certain that the tape is completely rewound.

STORE

The store command will take the program line numbers in read/write memory, and put them in the designated tape location where they will be saved.

Syntax: STORE [UNIT] [FILE] or
STORE [UNIT] (FILE) [LNX_1 [LNX_2]]

e.g.,
STORE ≠2, 3 EXEC; select code ≠ designates which cassette is being accessed; the program will then be stored on that cassette in file number 3.

In the store command, LNX_1 and LNX_2 are used to store a portion of the program: LNX_1 specifies the beginning line number to be stored; LNX_2 specifies the ending line number to be stored. If LNX_2 is not specified, the last line to be stored is assumed to be the highest-numbered program line.

For LNX_2 to be given, it is always necessary to have LNX_1; this is true for any cassette command. In addition, whenever LNX_1 is to be given, the file to be accessed must be identified; e.g.,
STORE 3, 60, 150 EXEC; file 3 of the internal cassette is located; program lines 60 through 150 in memory will then be stored into file 3.

+The number of files referenced in TLIST is always one more than the number marked by the user.

Note

Once a cassette has been marked, any file that has been marked can be accessed by giving its designated file number in a command; e.g., if five files are marked, information can be stored in file 4 even though file 3 is a virgin (empty) file, by pressing STORE 4 EXEC.

LOAD, LINK

The load command will take a program that is stored on a cassette and put it into the memory area.

Syntax: LOAD [UNIT] [FILE] or,
LOAD [UNIT] (FILE) [LNX_1 [LNX_2]]

e.g.,

LOAD EXEC assumes the internal cassette, default file (file 0) is to be loaded into the calculator; any program previously in the memory will be erased.

LOAD 5,40,10 EXEC locates file 5 on the internal cassette; the entire program on this file is renumbered beginning at line number 40, and then the program is loaded into memory; program execution is initiated at line number 10. All program line numbers beginning at line 40, that were previously in memory, will be erased and replaced by the program being loaded; if the memory previously had line numbers 10, 20, 30, it will retain them.

In both the load and the merge command, the use of LNX_1 and LNX_2 can have various results. Rules for predicting the results are given at the conclusion of the merge command discussion.

By substituting LINK for LOAD in the previous syntax, the user can implement the link command. This command operates identically to the load command with one exception:

During program execution, if a load statement is encountered, the calculator functions as though RUN EXEC were pressed — that is, the old symbol table is destroyed and a new symbol table is built; on the other hand, if a link command is encountered, the calculator functions as though CONT EXEC were pressed — that is, all variables retain their previous values.

MERGE

The merge command attempts to take program line numbers from the cassette and position them in read/write memory in front of the program currently there, between consecutive line numbers in the program currently there, or behind the program currently there. However, if any line number of the program to be entered matches a line number currently in the program, an error will result. In addition, if the line numbers of the two programs are interwoven, an error will occur; e.g., if the program currently in memory has line numbers 10, 20, 30, 40 and if the program to be merged has line numbers 15, 25, 35, the merge command will cause an error message to occur even though no two line numbers matched.

Syntax: MERGE [UNIT] [FILE] or,
MERGE [UNIT] (FILE) [LNX_1 [LNX_2]]

e.g.,

MERGE #2,1,200,100 EXEC — file 1 of the cassette with select code #2 is located; the entire program on this file is renumbered beginning at line number 200 (LNX_1) and then it is combined with the program currently in memory. Following implementation of the command, program execution will begin at line number 100 (LNX_2).

Either the merge or the load command can be used for stacking programs in read/write memory. The major difference the two commands is as follows: LOAD will erase the line numbers previously in memory, beginning at the designated LNX_1; MERGE, on the other hand, will retain all line numbers previously in 9830A memory.

In both the load and the merge command, LNX_1 and LNX_2 are predictable. Regardless of the mode, LNX_1 renumbers the program line numbers of the accessed file to begin at LNX_1; the spacing between consecutive line numbers remains the same; all GO TO statements, etc. are properly adjusted to reflect the new line numbers; this program is then loaded into user memory.

In program mode:
1. If LNX_2 is given, program execution will continue at LNX_2.
2. If LNX_2 is not given, program execution will continue either at the next higher line number of the original program or at LNX_1, whichever comes first.

In keyboard mode:
1. If LNX_2 is given, program execution will begin at LNX_2.
2. If LNX_2 is not given, the calculator will halt after loading in the program.

STORE KEY, LOAD KEY

The store key command will take all user definable keys (upper left-hand region of the keyboard) that have been defined and put them on a cassette file, which will be tagged as a key file.

The load key command takes the user definable information from the cassette and positions it in memory such that each user definable key performs the same operation that it previously did before being stored on tape.

Syntax: STORE KEY [UNIT] (FILE)
LOAD KEY [UNIT] (FILE)

Spacing may arbitrarily be left between the words STORE and KEY and the words LOAD and KEY. In general, the HP Basic language ignores blank spaces (except, of course, in a quote field where every character and space is duplicated).

STORE DATA, LOAD DATA

The store data command takes a block of data from memory and puts it on a cassette. Normally, only arrays can be stored using this command; however, if no array is specified in the comand, all data in the common statement of the program can be stored. The calculator allows simple variables in the common statement, as well as arrays; in fact, the common statement can accept simple variables, array variables, integer arrays and variables, and split arrays and variables+.

The load data command takes the data that was previously stored on a cassette file, and loads it into mainline memory. If an array has been stored, then LOADDATA must specify an array; if LOADDATA does not specify an array, an error will result. If, on the other hand, the common area will be retrieved by the load data command (in this case, no particular array can be specified in the command, lest an error occur).

Syntax: STOREDATA [UNIT] (FILE) [ARRAY]
LOAD DATA [UNIT] (FILE) [ARRAY]

e.g.,

STORE DATA 6,B EXEC will locate file 6 on the internal cassette; then the B array in the current program will be stored in this file. (A simple variable cannot be stored in this manner).

LOADDATA 6,B EXEC can then retrieve the B array and load it into memory whenever it is needed; the following command could be given, also:

LOADDATA 6,C EXEC: this would retrieve the B array and load it into memory in place of the C array, provided B and C are the same size and type.

Assume the common statement in a program looks like this: 1 COM A(8), B(5,5), D3, E.

Pressing: STORE DATA 2 EXEC will store all the common statement variables into file 2 of the internal cassette. Both the array variables and the simple variables will be retrieved by pressing: LOAD DATA 2 EXEC.

Pressing: LOAD DATA 2,A EXEC is illegal and causes an error since no particular array can be retrieved from a file if it was stored in common.

In all store and load data commands, the file to be accessed must be identified, even if it is the default file (file 0).

+The common statement acts like a dimension statement with the additional feature that data in common is saved from program to program.

LOAD BIN

The load binary command will transfer binary information — assembly language program — from the cassette to the user memory. The assembly language program may be a system diagnostic, an I/O subroutine, or a simulated "option block" designed to perform some specific function.

The assembly language program cannot be listed or displayed.

Syntax: LOAD BIN [UNIT] (FILE)

Note

Files on cassettes are tagged as: program files, key files, data files, or binary files. If an attempt is made to load from a particular file and the load command incorrectly identifies the file tag, an error will occur; e.g., pressing LOAD KEY 1 EXEC when file 1 is a program file, causes an error message to appear.

REWIND

Pressing the REWIND key, located on the right-hand side of the keyboard, immediately rewinds the internal tape cassette to the clear leader.

To rewind any other cassette, R E W I N D must be typed in, followed by the select code of the particular cassette. (The internal cassette can also be rewound by typing in R E W I N D EXEC.)

R E W I N D must be typed if the command is to be used in the programming mode.

Syntax: REWIND [UNIT]

e.g.,

R E W I N D ≠2 EXEC will rewind the cassette with select code ≠2.

FIND

The find command (previously mentioned in conjunction with the mark command) is used to locate a particular file. While the cassette is searching for the file number, a "lazy T" appears on the display. During this interval, the cassette is searching under interrupt control, thus returning control of the calculator keyboard to the user. This feature allows for the execution of one portion of a large program, while another portion is being found — thereby improving access time.

When the specified file is found, the cassette tape halts.

Syntax: FIND [UNIT] (FILE)

e.g.,

FIND ≠3 , 2 EXEC causes the cassette with select code ≠3 to search until file number 2 is located.

TLIST

Beginning with the current tape location, this command reads all subsequent file identifiers and prints out information concerning each file.

Syntax: TLIST [UNIT]

The information for each file, on the designated cassette, is printed out on one line. There are no column headers identifying the information in each line; the assumed headers are:

File No.	File Type+ Code No.)	Absolute File Size (in words)	Actual File Size (in words)	Program Line Nos. (Beginning) (LNX_1)	Program Line Nos. (Ending) (LNX_2)	Common Area (in words)

+The code numbers identifying the file types are as follows:

1 binary
2 data
3 program (source)
4 key

In addition, if the file is secured, the number 2 appears in front of the code number (this applies only to binary, source, and key files); e.g., if "24" appears in the second column, the file is a secured key file.

If a file is a data file, LNX_1, is superfluous; in this case the data is described in this column as:

0 full precision
1 split precision
2 integer precision
3 common

If the file is not a program file, the last two columns will contain no information.

NON-PROGRAMMABLE COMMANDS

SECURE

This command has the capability of concealing program lines from potential users; that is, your program could be given to another, and that person could load and run it — however, he would not be able to fetch particular program lines for viewing purposes nor could he store the program on any other cassette file.

An attempt to fetch a secured program line will result in the line number appearing on the display, followed by an *; attempts to list the program will result in the secured line numbers appearing followed by an *.

If any lines in a program are secured, the entire program is considered to be secured; that is, even though certain program statements are visible, none of the program can be reproduced onto another cassette file.

Syntax: SEC [LNX_1 [LNX_2]] or SECURE [LNX_1 [LNX_2]]

It is therefore, possible to secure specific lines within a program; e.g., pressing:

SEC 30 , 80 EXEC, followed by

STORE 2 EXEC secures lines 30 through 80 of the program in memory and then stores both the secured and unsecured portions of the program into file 2 of the internal cassette.

When a program is initially secured, it can still be reproduced onto as many files as necessry; however, once the program is scratched from memory, (even though it can be loaded back into memory) it cannot be reproduced onto any cassette files.

When program lines are secured, the entire calculator is in the secured mode. Therefore, after the secured program is stored away, the user should press SCRATCH A before inputting other programs — thus, avoiding "secured program" errors.

User definable keys (when not being used as typing aids) can be secured too. Just press FETCH (particular key) SEC EXEC and the designated key will be secured.

Note

To protect all the information on a particular cassette, break one of the tabs on the top of the cassette; this makes the cassette inaccessible for further storage.

PROGRAMMING

The programming language of the calculator is, with minor variations, BASIC as described below.

Instructions to the computer within a program are provided by program statements. Each statement in Basic has an associated line number which must appear in the left-most portion of the statement.+ Statement line numbers appear in ascending order with 9999 being the largest possible line number.

A program statement, which has been correctly keyed in, can be stored in read/write memory by pressing the END OF LINE (EOL) key. This key is situated in an area corresponding to the carriage return/line feed key on a teletype (R.T.M.) keyboard.

+The length of a statement, including the line number and including appropriate spacing, can be up to 80 characters.

AUTO #

As previously mentioned, statement line numbers can be automatically input. In its simplest form, pressing AUTO # EXEC causes line number 10 to immediately appear on the display awaiting the program statement. The line numbers of additional statements will be in ascending order with a spacing of ten between consecutive line numbers. The AUTO # (AUTO) syntax and the examples to follow present some of the alternatives in automatic line numbering.

Syntax: AUTO # [LNX_1 [Spacing]]

LNX_1 is the beginning line number to be automatically input; the desired spacing between lines can then be input if LNX_1 is given. If no spacing is indicated, a spacing of 10 is assumed.

e.g., AUTO # 30 EXEC	AUTO # 40 , 2 EXEC	AUTO # EXEC
30	40	10
40	42	20
50	44	30
⋮	⋮	⋮

When AUTO # is pressed, AUTO appears in the display.

Note

Although the CLEAR and DELETE LINE keys have previously been discussed, the following point should be made. If a program line currently being keyed in is found to be totally unacceptable (not worth salvaging by using the editing keys), it can be erased by using either the CLEAR or the DELETE LINE keys. However, if the program line numbers have been automatically input, pressing CLEAR not only erases the entire display but also eliminates the AUTO # mode, whereas pressing DELETE LINE erases only the program statement without affecting the line number itself.

PROGRAM VIEWING

There are two methods of viewing a program that is currently in memory:

1. List it on a printing device.
2. Bring it line-by-line to the display.

LIST

The list command has two specific applications: it can be used to provide a total listing of the programs in read/write memory, or it can be used to indicate the read/write memory available for inputting; e.g.,

LIST EXEC — lists all program lines that are in memory on the user's standard printing device.

LIST #3 EXEC — lists all program lines that are in memory on the peripheral with select code #3.

LIST 9999 EXEC — causes the number of 16-bit words available in memory to be displayed.

↓,↑

If a specific program line is in the display, pressing ↓ (down arrow) displays the next higher-numbered program line;+ pressing ↑ (up arrow), on the other hand, displays the next lower-numbered program line. When no program line is currently in the display, pressing ↓ would display the successively higher line from the one most recently displayed, whereas ↑ would display the successively lower line.

+It should be noted that if a program line has more than 32 characters, the first 32 characters will be displayed; by pressing ←, the rest of the line can be viewed as the display is scrolled to the left. At the end of the line ⊢ appears.

FETCH

In addition to viewing a program line-by-line, specific program lines can be immediately brought to the display by using the fetch command.

Syntax: FETCH [LNX_1]

Where LNX_1 is the specific line number to be accessed;

e.g.,

FETCH EXEC always displays the lowest-numbered program line.

FETCH 300 EXEC displays line 300 if it exists; if line 300 is not available (and there are other higher-numbered lines), the line immediately higher than 300 will be displayed; if there are no line numbers as high as 300, the highest-numbered line available in memory will be displayed.

PROGRAM EDITING

Any displayed program line can be edited by using the BACK, FORWARD, and INSERT keys.

The RECALL key, previously discussed, need only be briefly mentioned. A program line is keyed in; if an error message appears on the display when EOL is pressed, the program line can be reviewed by pressing RECALL. Appropriate editing can then be performed on the program line. The previously input line can always be recalled by pressing RECALL whether or not an error appears.

CLEAR and DELETE LINE have already been thoroughly discussed. However, to reiterate, there are two methods of deleting a program line currently in memory:

1. If the line is currently in the display, pressing DELETE LINE will erase it from memory (CLEAR only clears the display).
2. Any line in memory can be immediately deleted by keying in the appropriate line number followed by EOL.

DELETE

The delete command (to be distinguished from DELETE LINE) can selectively delete program lines.

Syntax: DELETE [LNX_1 [LNX_2]] or DEL [LNX_1 [LNX_2]]

Where LNX_1 is the first line to be deleted and LNX_2 is the last line to be deleted:

e.g.,

DELETE EXEC deletes all program lines;

DELETE 40 EXEC deletes all statements beginning at line number 40;

DELETE 50,80 EXEC deletes all lines numbered 50 through 80.

SCRATCH

The scratch command can erase a variety of things from memory:

e.g.,

SCRATCH EXEC erases all program lines and variables;

SCRATCH A EXEC erases everything from memory — program lines, user definable keys, variables (identical to turning the calculator off, then on again);

SCRATCH K EXEC erases all user definable keys (user definable keys will be discussed later);

SCRATCH V EXEC erases all variables;

SCRATCH (particular UD key) erases the particular user definable key that was pressed — pressing EXEC is not required in this case.

Scratch can be accessed either by keying in the seven letters or by pressing SCRATCH.

RENUMBER

The renumber command will take all the program line numbers and renumber them.

Syntax: RENUMBER [LNX_1 [SPACING]] or REN [LNX_1 [SPACING]]

Where LNX_1 will be the new line number of the first program statement, and SPACING will be the spacing between consecutive line numbers:

e.g.,

REN EXEC will renumber all statements by numbering the first statement '10' with a spacing of 10 between statements;

RENUMBER 30 EXEC renumbers the first statement '30' with a spacing of 10 between statements;

REN 45,20 EXEC renumbers the first statement '45' with a spacing of 20 between statements.

All statements in the program that reference another line number are appropriately corrected with the renumber command; e.g., GO TO 80 would be corrected to reference the line that replaced 80.

PROGRAM DEBUGGING

NORMAL, TRACE

The TRACE key can be used to determine the order of statement execution for a program that is currently running. Pressing TRACE during program execution causes the line numbers to be printed in the order in which they are accessed; then pressing NORMAL reverts the calculator to the normal mode. Thus, when a program is running, both TRACE and NORMAL are immediate execute keys.

When no program is running, to revert to either trace or normal mode requires pressing the appropriate key followed by EXEC. Trace mode can be set up to trace specific line numbers.

Syntax: TRACE [LNX_1 [LNX_2]]

Where LNX_1 is the first line number to be traced, and LNX_2 is the last line number to be traced;

e.g.,

TRACE 20 EXEC will trace beginning at line number 20 when the program is running.

TRACE 50,60 EXEC will trace beginning at line number 50 and ending at line number 60, each time these line numbers are executed in the program.

STOP

The stop command can be a statement within a program (to be discussed later) and can be used as a debugging tool.

As a debugging tool, STOP is extremely valuable. A program that is running can be stopped at any time by pressing STOP (the current line number of the program will be displayed). If any program lines are then edited, the program must be rerun from the beginning, using the RUN key. If no editing has been performed, the program can continue where it left off if the CONT key (to be discussed in detail later) is pressed.

While a program is stopped, the values of variables can be checked to determine if the program is doing what was intended; e.g., pressing A EXEC would determine the present value of the simple variable A.

While a program is stopped, STOP+, can have another function. Pressing STOP displays STOP; then keying in either one line number or two line numbers separated by a comma — indicates that the calculator should stop program execution at these line numbers. Pressing CONT EXEC will then start program execution; e.g., STOP 80 EXEC then CONT EXEC or RUN EXEC will cause the program to halt at line numer 80. Once a program is running under these conditions, there is one way to revert to normal program execution: After the program has halted, press STOP EXEC, then CONT EXEC, and the program will no longer stop at the given line numbers.

A line or lies can also be designated by the user in similar manner and prior to the execution of a program and without altering the program; before execution of which program execution is halted.

+When a key is not being used as an immediate execute key, whether the key itself is pressed or whether the letters displayed on the key are individually keyed in, is generally arbitrary.

STEP

After a program is halted by a stop command, execution can continue by pressing STEP. STEP is always immediate execute; it causes the program to execute the appropriate statement and then to halt. Therefore, after each statement is executed, it can be checked to ensure that it performed the required function. When a particular function is considered satisfactory, either CONT or STEP can be pressed; CONT will execute the rest of the program while STEP will execute the next program statement only.

RUN, CONTINUE

Pressing RUN EXEC causes a program to begin execution at the first statement regardless of whether the program had previously been halted by a stop command; however, if the program had been halted by a stop command, pressing CONT EXEC will begin program execution where it had previously halted.

As previously mentioned, if a program is edited after it has been halted, program execution is reinitialized at the first line by RUN EXEC+. However, if, during the halt, the values of variables are changed or other internally-programmed conditions are changed, then CONT EXEC must be pressed to keep these newly adjusted conditions intact. The following things can be done to the program while it is halted if, upon completion, the program is executed by pressing CONT EXEC:

1. Variables can be changed; e.g., B = 5 EXEC sets the simple variable B equal to 5.
2. Angular units in trigonometric functions can be changed to measure in radians, degrees, or grads, depending on the user's requirements: e.g., DEG EXEC will assume all angles to be in degrees.
3. Write, print, and display statements can be input from the keyboard (these statements will be discussed later).
4. The data pointer, which indicates the next datum to be encountered, can be reset to the beginning of the data by typing RESTORE EXEC.
5. The program can go to a particular statement and be available for execution there; e.g., GO TO 80 EXEC sets the program line counter to 80 for either step-by-step or continuous execution. (If continuous execution is desired at line number 80, the continue command can be employed, as discussed below.) IF ... THEN can also access a particular line number.
6. Any calculator-keyboard statements can be executed.

A halted program can be executed beginning at any line number by using the continue command; e.g., CONT 95 EXEC will continue execution starting at line number 95.

A program can be run beginning at any line number; e.g., RUN 110 EXEC will begin program execution at line number 110.

NOTE

The major difference between RUN and CONT is that RUN initializes all variables in the program and reverts to all normal program modes, while CONT neither affects any variables nor affects any current program modes.

PROGRAM STATEMENTS

LET

As in Basic LET A = 6 is a legitimate statement; however, the implied let statement is also allowed. Thus, A = 6 is the same as LET A = 6.

GO TO, GO SUB

The GO TO and GO SUB statements are the same as in Basic, however, each statement has one additional feature called respectively, the computed GO TO and the computed GO SUB. In either case an expression is evaluated and the rounded integer value of the expression is determined; the integer then acts as a pointer to a particular line number from a parameter listing in the statement. Some examples should explain this feature more clearly:

(In all examples, the present value of T will be 2.)

+The initialize command, to be discussed later, is also legitimate.

20 GO TO T↑2—3 OF 250, 350, 450

Since the integer value of the expression is one, the first parameter following "OF" will be accessed (line number 250).

80 GO SUB T+2.5 OF 130, 260, 330, 370, 490

The rounded integer value of the expression is 5; therefore, the subroutine beginning at line number 490, the fifth parameter following "OF", will be accessed. (Decimal values of .5 and above are always rounded) to the next higher integer value.)

Any legitimate expression can be used; if the rounded value is either less than 1 or greater than the number of parameters following "OF", then the line number following the GO TO or GO SUB statement is executed.

PRINT

The calculator has one feature in the print statement not generally available in BASIC. Alphabetic information in a quote field can be printed in either upper or lower case letters. Printing in lower case is just the opposite of that on a regular typewriter; with shift or shift lock pressed, letters inside the quote field will be printed in lower case (the display, however, will still appear in upper case). If the "at" symbol (@) is required, press SHIFT RESULT.

Quote fields in both the format and write statements also have this "lower case" feature available.

DISPLAY

The display statement performs the same function as a print statement; the difference is that the information appears on the display rather than on a printing device. Thus, when a permanent record of the information is desired, the print statement should be used. The syntax used is DISP.

FORMAT, WRITE

The format statement is a means of structuring program printers in a specified manner. The write statement defines the variables, constants, etc. that will appear on the printout; it also determines the device to be printed upon and the particular format statement to be followed. The following examples should adequately explain the features in both the format and the write statements:

e.g.,

```
5 FORMAT F10.2
6 WRITE (15, 5) .7
```

printout will be ΛΛΛΛΛΛ0.70 where the "Λ" indicates a blank space.

F10.2 — the "F" refers to fixed-point format; "10" refers to the total field width reserved for the printout "2" refers to the number of digits to the right of the decimal point. Excess space to the right of the decimal point will be filled with zeros; one space is reserved for the decimal point; two spaces are reserved to the left of the decimal point, one for a digit preceding the decimal point, another for a sign (however, only minus signs are printed).

(15, 5) — in the write statement, the information within parentheses is required. "15" refers to the printing device to be used (select code 15 refers to the standard printer); "5" refers to the line number of the format statement that is being accessed (in this case line number 5). The format statement, which is being accessed, can appear anywhere in the program listing.

.7 — in the write statement, the information following the right parenthsis is to be printed according to the designated formats. The value is always right-justified within its field width.

e.g.,

```
20 A = 62.4

           1     2    3    4    5   6,8  9   10
25 FORMAT E12.2, F7.3, X, E8.1, /, 2F4.0, 3X, E9.0

260 WRITE  (15, 25) 231, –61, –12.4, A, "∧IS∧THE∧VALUE∧OF∧A", .4, A+3
                     1    2     4    6          7                 8   10
```

printout will be:

```
        1      2 3    4
∧∧∧∧2.31E+02–61.000∧–1.2E+01

∧∧62∧IS∧THE∧VALUE∧OF∧A∧∧∧0∧∧∧∧∧7.E+01
   6       7            8  9   10
```

The format statement, the write statement, and the printout all have individual fields referenced; interlinking fields are represented by corresponding reference numbers.

Since the write statement references the format statement numbered 25, values in the write statement will be formatted as specified in this format statement.

REFERENCES

1 E12.2 indicates exponential (floating-point) notation with a field width of 12 and two digits to the right of the decimal point. The printout displays the exact form. Remember the field width must be large enough to include a leading sign, the decimal point and E±XY. Since printouts from the write statement are right justified and since "231" takes up only 8 of the 12 character field width, the four blank spaces are to the left of the value.

2 The value "–61" in the write statement totally fills the F7.3 field, therefore there is no space between this value and the previous value in the printout. Since F7.3 indicates three digits to the right of the decimal point, zeros are supplied in this case.

3 "X" indicates a space between values; therefore, the values supplied for the F7.3 and E8.1 formats will be separated in the printout by at least one space.

4 The value, –12.4 totally fills up E8.1, in fact, the last digit is suppressed since, with this field designation, only one digit can follow the decimal point.

5 "/" tells the printing device to skip one carriage return to the beginning of the next line.

6 2F4.0 specifies two consecutive fixed-point formats of F4.0 to be used for values in the write statement. The first format is for the value of A, which from program line number 20 is 62.4; when a fixed-point format specifies zero digits to the right of the decimal point, the value supplied is rounded to be an integer and the decimal point is suppressed — 62, in this case. Since the carriage return had previously been specified, this value is printed on the beginnning of the next output line.

7 Quote fields are printed in the sequence in which they occur. Since this quote field is in the write statement, it is printed immediately after 62.4 is printed in F4.0 format. Note the space in front of "IS"; without this space, the printout would read 62IS instead of 62 IS. Quote fields can appear in either the format or write statements.

8 The value, .4 is also to be printed in F4.0 format. The rounded integer value of .4 is 0 — hence, the printout.

9 "3X" indicates there should be three spaces between the values supplied for the F4.0 and the E9.0 formats.

10 Expressions can be specified in write statements. The value of A+3 is 65.4; however, with this format, it will be rounded to 7.E+01. The decimal point is not suppressed in floating-point notation when zero is specified as the number of digits to the right of the decimal point.

If there are more values presented in the write statement than there are formats in the referenced format statement, the formats will be repeated; e.g.,

```
10 FORMAT F6.2, E10.2
20 WRITE (15, 10) 18, 21, 19.3, 29.6, .71
```

printout will be:

```
∧18.00∧∧2.10E+01
∧19.30∧∧2.96E+01
∧∧0.71
```

After the first two values are printed according to the specified formats, the output printer's carriage return is activated, then two more values are printed according to the same two specified formats, etc.

Formatting Rules:

In fixed-point format, Fm.n, m stipulates total field width and n stipulates the number of digits to the right of the decimal point. If n>0, the minimum field width allowable is m = n + 3; e.g., F4.1 for a value of –.6 would print –0.6, which takes up the total field width of 4. If n = 0, the minimum field width is m = 2; e.g., F2.0 for a value of –7 would print –7, thus taking up the allotted field width.

In floating-point format, Em.n, m and n are the same as in fixed-point format. However, the minimum field width allowable is always m = n + 7.

The following are all allowed in format statements:

Fm.n —	fixed-point formats;
Em.n —	floating-point formats (often called exponential or scientific notation);
X —	space;
/ —	carriage return (for printing device);
"****" —	quote field;
B —	binary format (where write statement could have octal number, the binary equivalent would be output).

All of the above can be duplicated any number of times by leading the symbol with the appropriate number.

The following are all allowed in write statements: constants, variables, expressions, and quote fields. It should be noted that a write statement can be input from keyboard mode; that is, the write statement can reference the line number of a format statement in memory without being in the program itself.

The maximum width of both the fixed-point and the floating-point fields is 9,999. However, the programmer is effectively restricted by the allowable characters per line of the printing device.

The information in the format statement must be separated by commas.

The information in the write statement must be separated either by commas or semicolons; generally it makes no difference. However, one additional feature of the write statement is that it can perform the identical operations as the print statement; the benefit is the ability of the write statement to select the device to be printed upon. To write on a punched tape photoreader with select code 2, the write statement could be set up in the following manner:

30 WRITE (2, *) A; B; C, D

The "*" indicates that no format statement is referenced; thus, WRITE acts like a PRINT statement: data will be left justified, semicolons pack the output fields, commas spread out the fields, etc.

P TAPE

As in BASIC, PTAPE causes the computer to read in a program from the punched tape photoreader. If the photoreader select code is 5, then pressing either PTAPE #5 or PTA #5 will perform this task unless no photoreader is connected to the calculator. If a photoreader is not connected, the calculator will wait till one is hooked up to complete the command. During this time the display will be blank.

During the implementation of this command, lines being loaded into memory have their syntax checked; if a line is in error, it will be rejected — thus, only those lines with correct syntax are loaded into the calculator. To obtain a record of the rejected lines, it is necessary to put the calculator in the print-all mode prior to presing PTA #5; in print-all mode, all rejected lines are printed.

Note

To punch information onto paper tape, use the list command as discussed earlier.

MULTILINE FUNCTIONS

Multiline functions serve the same purpose as single-line functions with the added capability of being able to describe more sophisticated functions.

In single-line functions the general form of the defining function is:

statement number DEF FN single letter A to Z (simple variable)+ = expression

In multiline functions, the general form is the same aside from the equal sign and the expression; for in a multiline function, the expresion can be spread out over many statement numbers. Thus, an extremely complicated expression can appear in a more simplified manner; additional flexibility is also gained in that the value of any variable within the expression for a given value of the argument of the function; e.g.,

```
10 W = .5
20 Y = 2
30 PRINT FNA (3)
40 STOP
50 DEF FNA (X)
60 Z = X↑2 + Y↑2
70 Q = Z + 3
80 D = Q/W
90 RETURN D
100 STOP
```

When this program is run, D will return a value of 32. The return statement returns the result of FNA (X) which, in this case, is equal to D. Line 40, the stop statement is needed to keep the calculator from trying to re-execute lines 50 through 90 after D is printed; without STOP in line 40, an error occurs in line 60 since a second pass beginning at line 50, would be made with X undefined.

+The simple variable is a dummy variable which indicates where the actual argument of the function is used in the defining expression.

Any variable evaluated in the expression can be returned by the return statement, and multiple return statements are allowed; e.g.,

```
10 X = 3                          100 RETURN Z
20 INPUT Y                        110 Q = Z↑2
30 WRITE (15,900) FNG (Y)         120 IF Q ≤ 100 THEN 150
40 END                            130 PRINT "Q ="
50 DEF FNG (Y)                    140 RETURN Q
60 Y = Y + 1                      150 PRINT "Z IS"
70 Z = Y↑2*X                      160 RETURN Z
80 IF Z ≤ 100 THEN 110            900 FORMAT F12.1
90 PRINT "Z ="                    1000 END
```

In this example, a variable can be returned from three different lines (100, 140, 160) depending on the initial value of Y; Z can be returned from both lines 100 and 160 if the value of Y meets certain criteria.

Caution must be taken as to the placement of the statement that calls the function (in both examples, statement 30), and it is generally advisable to put a stop statement immediately after this statement (as in line 40 of both examples); otherwise, an undesirable loop may develop.

If correctly entered, the function of a function can be evaluated.

STOP, END

STOP was previously discussed, with emphasis on its program debugging capabilities. Now it will be discussed as a program statement, emphasizing the differences between it and the end statement.

When the program encounters a stop statement, it halts and is waiting; if CONT EXEC is then pressed, the program will continue with the statement following the STOP. This is not true if an end statement is encountered; the program will halt, but if CONT EXEC is pressed, the calculator will revert back to the lowest-numbered statement in memory. Therefore, the stop statement should be used between stacked programs that are to be run sequentially. When STOP is used in this manner, the values of simple variables can be passed from program to program.

A program should be terminated by encountering either a STOP or an END. The highest-numbered program statement need not be an end statement.

INPUTTING DATA

Program data can be input in three ways: the input statement, the read and data statements, and the initialize command. The input statement and the read and data statements are thoroughly discussed below.

INITIALIZE

The INITIALIZE key, when pressed, allocates storage space in memory for array variables. After the required data is keyed in, the program can be executed by pressing CONT EXEC; remember — RUN EXEC erases the values of all variables, thereby requiring all variables to be defined in the program itself.

Simple variables can always be input in keyboard mode without using the INITIALIZE key, as long as CONT EXEC is pressed to run the program. Since array variables can be input in keyboard mode by using the initialize command, it is not necessary to define any variables in the program itself. It is still necessary, however, to identify arrays in either a dimension or a common statement.

USER-DEFINABLE KEYS

There are ten User-Definable Keys (UDK) in the upper left-hand block of the

keyboard. There are, however, effectively 20 accessible UDK's since each key can be accessed normally or with the shift key held down.

To enter UDK mode, press FETCH (particular UDK); the display will then read, KEY indicating the mode. To exit from UDK mode, press CLEAR E N D EXEC; the scratch command can also be used to exit from UDK mode — this command will, of course, erase certain information in the process. UDK mode is automatically exited when certain sequences are followed; these cases will be discussed later.

The user-definable keys can be used effectively in three ways:

1. to represent text (where text can be used as a typing aid);
2. to represent functions (where different values can be passed to the function);
3. To represent programs.

REPRESENTING TEXT

If a key represents text, merely pressing the key will immediately display the text without erasing anything that was previously on the display. Thus, commonly used words and phrases can be put on keys to serve as typing aids. Text can be put on a key in the following manner.

First, access a key by pressing FETCH (particular UDK). Then, press * followed by a character string[+] and finally EOL. Besides inputting the character string, pressing EOL in this sequence takes the user out of UDK mode. Any time the programmer wishes to use a character string, he must press the key into which the desired character string was input.

If, for example, a key was accessed by FETCH (particular UDK); then * FORMAT F10.2,X,E10.1 EOL was input. If subsequently program line number 60 needed this format, pressing 60 (particular UDK) EOL will put line number 60 into memory with the required format.

A typing-aid key can be used as an immediate execute command if an * is placed both in front of the text and following the text:

e.g.,

FETCH (UDK) * LOADDATA #4, 6, B * EOL

This command will be immediately executed whenever the UDK is pressed.

To use a key that has text, merely press the key. Pressing FETCH (particular UDK) will display the * with the text; however, text can be edited if the fetch command is used. Presing FETCH and then * will erase the old character string and then wait for new text to be input.

REPRESENTING FUNCTIONS

A user definable key can be used to represent functions — either single or multiline. In either case, after the key is accessed, the function must be preceded by a line number — input either manually or automatically.

After a key has been accessed, the following function could be input:

10 DEF FNA (X) = 7 * X –3 EOL

Whenever a value is to be passed to X (the argument of the function), first press the appropriate key; the display will read FNA. Then key in the appropriate value of the arguument, which can be either a constant or an expression (e.g. 20), and press EXEC; the value of the function will then be displayed (in this case, 137). The same result could have been achieved by using the fetch command; however, FNA would not appear automatically on the display; it would have to be keyed in along with the argument; e.g., FETCH (UDK) FNA 20 EXEC would also display 137.

If a multiline function, DEF FNB (Z), has been input, pressing the appropriate UDK causes FNB to be displayed; as before, passing a value to the argument, Z, and then pressing EXEC will compute and display the value of the function.

Functions in mainline memory and in a UDK can be called, regardless of the current operating mode.

[+]The maximum length for the character string (including the *) is 80 characters.

If a function in the calculator is defined in more than one place, the first function found with the designated name will be accessed. If the user is in UDK mode, the calculator will search for the function in the following order:

1. The current UDK program will be checked.
2. The first line of each key (in the order defined) will be checked.
3. Mainline memory will be checked.

If the user is not in UDK mode, the order of the search will be steps 3 and 2, respectively.

REPRESENTING PROGRAMS

A UDK can be used to represent an entire program. Programming rules in UDK mode are consistent with those discussed above. There is one restriction, however; if a common statement is used, its size must be less than or equal to the size of the common statement in the mainline program — for there is only one common area allocated to memory.

To run a program that is represented in a UDK, it is advisable to press RUN (particular UDK) or FETCH (UDK), then INIT (particular UDK). The program can be continued merely by pressing the (particular UDK); but if there are array variables in the program, pressing only the key will cause these variables to be undefined (similar in this respect to the continue command, which neither destroys the old symbol table nor builds a new one). After executing the program, the calculator will exit from UDK mode.

Programs represented on a UDK generally use only simple variables for the obvious ease of handling.

To list program lines on a particular UDK, press:

LIST (particular UDK);

pressing LIST EXEC in the UDK mode will list the program lines on the key currently being accessed. To selectively list particular lines on the UDK, it is first necessary to FETCH a key; then use the list command as discussed below.

To load a program from a cassette file onto one particular key, first FETCH the key, then give the load command followed by EXEC. Program lines on a particular key can be stored onto the cassette in the same manner; text (as a typing aid), however, cannot be stored in this manner.

STORE KEY and LOAD KEY can be used for any UDK regardless of the information on the key. The use of these keys is discussed below.

STATEMENTS

This is a BASIC *statement:*
1Ø INPUT A,B,C,D,E

COMMENTS

A *statement* contains a maximum of 80 characters.
A *statement* may also be called a line.

STATEMENT NUMBERS

Each BASIC statement begins with a *statement number* (in this example, 2Ø):

```
2Ø LET S=(A+B+C+D+E)/5
```

COMMENTS

The number is called a *statement number* or a *line number.*

The statement number is chosen by you, the programmer. It may be any integer from 1 to 9999 inclusive.

Each statement has a unique *statement number.* The computer uses the numbers to keep the statements in order.

Statements may be entered in any order; they are usually numbered by fives or tens so that additional statements can be easily inserted. The computer keeps them in numerical order no matter how they are entered. For example, if statements are input in the sequence 3Ø,1Ø,2Ø; the computer arranges them in the order: 1Ø,2Ø,3Ø.

INSTRUCTIONS

The statement then gives an *instruction* to the computer (in this example, PRINT):

```
3Ø PRINT S
```

COMMENTS

Instructions are sometimes called *statement types* because they identify a type of statement. For example, the statement above is a "print" statement.

OPERANDS

If the instruction requires further details, *operands* (numeric details) a supplied (In this example, 1Ø; on the previous page, "S"):

```
4Ø GO TO 1Ø
```

COMMENTS

The *operands* specify what the instruction acts upon; for example, what is PRINTed, or where to GO.

A PROGRAM

The sequence of BASIC statements given on the previous pages is called a *program.*

The last statement in a program, as shown here, is an END statement.

```
1Ø INPUT A,B,C,D,E
2Ø LET S=(A+B+C+D+E)/5
3Ø PRINT S

4Ø GO TO 1Ø
5Ø END
```

COMMENTS

The last (highest numbered) statement in a program must be an END statement.

The END statement informs the computer that the program is finished.

FREE-FORMAT LANGUAGE

BASIC is a "free format" language — the computer ignores extra blank spaces in a statement. For example, these three statements are equivalent:

```
3Ø PRINT S
3Ø PRINT  S
3ØPRINTS
```

COMMENTS

When possible, leave a space between words and numbers in a statement. This makes a program easier for people to read.

TERM: SIMPLE VARIABLE

DEFINED IN BASIC AS:	A letter (from A to Z); or a letter immediately followed by a digit (from Ø to 9).
EXAMPLES:	AØ B M5 C2 Z9 D

COMMENTS

Variables are used to represent numeric values. For instance, in the statement:

```
1Ø LET M5 = 96.7
```

M5 is a variable; 96.7 is the value of the variable M5.

There is one other type of variable in BASIC, the array (subscripted) variables; its use is explained in Section IV.

TERM: NUMBER

DEFINED IN BASIC AS:	A decimal number (the sign is optional) between 1E–99 and 9.999999999999E+99 Zero is included in this range.
EXAMPLES:	

–10008	5	3.14159	10E+37
126.257	0	10 E37	10E–37
16.01	.06784	–10 E37	1.0E+2

TERM: E NOTATION

DEFINED IN BASIC AS:	A means of expressing numbers having more than six decimal digits, in the form of a decimal number raised to some power of 1Ø.
EXAMPLES:	1.ØØØØØE+Ø6 is equal to 1,ØØØ,ØØØ and is read: "1 times 1Ø to the sixth power" (1×10^6). 1.Ø2ØØØE+Ø4 is equal to 1Ø,2ØØ 1.Ø2ØØØE–Ø4 is equal to .ØØØ1Ø2

COMMENTS

"E" notation is used to print numbers having more than six significant digits. It may also be used for input of any number.

When entering numbers in "E" notation, leading and trailing zeroes may be omitted from the number; the + sign and leading zeroes may be omitted from the exponent.

The precision of numbers is 12 decimals digits.

TERM: EXPRESSION

DEFINED IN BASIC AS:	A combination of variables, constants and operators which evaluates to a numeric value.
EXAMPLES:	(P + 5)/27 (wherein P has previously been assigned a numeric value.) Q – (N + 4) (where Q and N have previously been assigned numeric values.)

TERM: ARITHMETIC EVALUATION

DEFINED IN BASIC AS:	The process of calculating the value of an expression.

THE ASSIGNMENT OPERATOR

SYMBOL:	=
EXAMPLES:	1Ø LET A = B2 = C = Ø 2Ø LET A9 = C5 3Ø LET Y = (N–(R+5))/T 4Ø LET N5 = A + B2 5Ø LET P5 = P6=P7=A=B=98.6
GENERAL FORM:	LET *variable* = *expression*

PURPOSE

Assigns an arimethmetic or logical value to a variable.

COMMENTS

When used as an assignment operator, = is read "takes the value of," rather than "equals". It is, therefore, possible to use assignment statements such as:

```
LET X = X+2
```

This is interpreted by BASIC as: "LET X take the value of (the present value of) X, plus two."

Several assignments may be made in the same statement, as in statements 1Ø and 5Ø above.

See Section V, "Logical Operations" for a description of logical assignments.

RELATIONAL OPERATORS

SYMBOLS:	= # <> > < >= <=
EXAMPLES:	1ØØ IF A=B THEN 9ØØ 11Ø IF A+B >C THEN 91Ø 12Ø IF A+B < C+E THEN 92Ø 13Ø IF C>=D*E THEN 93Ø 14Ø IF C9<= G*H THEN 94Ø 15Ø IF P2#C9 THEN 95Ø 16Ø IF J <> K THEN 95Ø

PURPOSE

Determines the logical relationship between two expressions, as

equality:	=
inequality:	# *or* <>
greater than:	>
less than:	<
greater than or equal to:	>=
less than or equal to:	<=

COMMENTS

NOTE: It is not necessary for the novice to understand the nature of logical evaluation of relational operators, at this point. The comments below are for the experienced programmer.

Expressions using relational operators are logically evaluated, and assigned a value of "true" or "false" (the numeric value is 1 for "true," and Ø for false).

When the = symbol is used in such a way that it might have either an assignment or a relational function, BASIC assumes it is an assignment operator. For a description of the assignment statement using logical operators, see Section V, "Logical Operations."

ARITHMETIC OPERATORS

SYMBOLS:	↑ * / + –
EXAMPLES:	4Ø LET N1 = X–5 5Ø LET C2 = N↑3 6Ø LET A = (B–C)/4 7Ø LET X = ((P↑2)–(Y*X))/N+Q

PURPOSE

Represents an arithmetic operation, as:

exponentiate: ↑
multiply: *
divide: /
add: +
subtract: –

COMMENTS

The "–" symbol is also used as a sign for negative numbers. It is good practice to group arithmetic operations with parentheses when unsure of the exact order of precedence. The order of precedence (hierarchy) is:

↑
* /
+ –

with ↑ having the highest priority. Operators on the same level of priority are acted upon from left to right in a statement. See "Order of Precedence" in this Section for examples.

The symbols + and – are also used to indicate unary plus and unary minus. For example, negative numbers may be expressed in a statement without using parethesis:

```
1Ø LET A1= –B
2Ø LET C2 = D ++E
3Ø LET B5 = B ––C
```

See "Order of Precedence" in this section for examples of how unary + and unary – are interpreted.

THE AND OPERATOR

SYMBOL:	AND
EXAMPLES:	6Ø IF A9<B1 AND C≠5 THEN 1ØØ 7Ø IF T7≠T AND J=27 THEN 15Ø 8Ø IF P1 AND R>1 AND N AND V2 THEN 1Ø 9Ø PRINT X AND Y

PURPOSE

Forms a logical conjunction between two expressions. If both are "true," the conjunction is "true"; if one or both are "false," the conjunction is "false."

NOTE: It is not necessary for the novice to understand how this operator works. The comments below are for experienced programmers.

COMMENTS

The numeric value of "true" is 1, of "false" is Ø.

All non-zero values are "true." For example, statement 9Ø would print either a Ø or a 1 (the logical value of the expression X AND Y) rather than the actual numeric values of X and Y.

Control is transferred in an IF statement using AND, only when all parts of the AND conjunction are "true." For instance, example statement 8Ø requires four "true" conditions before control is transferred to statement 1Ø.

See Section V, "Logical Operations" for a more complete description of logical evaluation.

THE OR OPERATOR

SYMBOL:	OR
EXAMPLES:	1ØØ IF A>1 OR B<5 THEN 5ØØ 11Ø PRINT C OR D 12Ø LET D = X OR Y 13Ø IF (X AND Y) OR (P AND Q) THEN 6ØØ

PURPOSE

Forms the logical disjunction of two expressions. If either or both of the expressions are true, the OR disjunction is "true"; if both expressions are "false," the OR disjunction is "false."

NOTE: It is not necessary for the novice to understand how this operator works. The comments below are for experienced programmers.

COMMENTS

The numeric values are: "true" = 1, "false" = Ø.

All non-zero values are true; all zero values are false.

Control is transferred in an IF statement using OR, when either or both of the two expressions evaluate to "true."

See Section V, "Logical Operations" for a more complete description of logical evaluation.

THE NOT OPERATOR

SYMBOL:	NOT
EXAMPLES:	30 LET X = Y = Ø 35 IF NOT A THEN 300 45 IF (NOT C) AND A THEN 400 55 LET B5 = NOT P 65 PRINT NOT (X AND Y) 70 IF NOT (A=B) THEN 500

PURPOSE

Logically evaluates the complement of a given expression.

NOTE: It is not necessary for the novice to understand how this operator works. The comments below are intended for experienced programmers.

COMMENTS

If A = Ø, then NOT A = 1; if A has a non-zero value, NOT A =Ø.

The numeric values are: "true" = 1, "false" = Ø; for example, statement 65 above would print "1", since the expression NOT (X AND Y) is true.

Note that the logical specifications of an expression may be changed by evaluating the complement. In statement 35 above, if A equals zero, the evaluation would be "true" (1); since A has a numeric value of Ø, it has a logical value of "false," making NOT A "true."

See Section V, "Logical Operations" for a more complete description of logical evaluation.

ORDER OF PRECEDENCE

The order of performing operations is:

↑ *highest precedence*
NOT unary + unary –
* /
+ –

Relational Operators
AND
OR *lowest precedence*

COMMENTS

If two operators are on the same level, the order of execution is left to right, for example:

5 + 6*7 is evaluated as: 5 + (6×7)
7/14*2/5 is evaluated as: $\frac{(7/14)\times 2}{5}$

Parentheses override the order of precedence in all cases, for example:

5 + (6×3) is evaluated as: 5 + 18

and

3 + (6+(2↑2)) is evaluated as: 3 + (6+4)

Unary + and – may be used; the parentheses are assumed by BASIC. For example:

A + + B is interpreted: A + (+B)
C – + D –5 is interpreted: C – (+D)–5

Leading unary + signs are omitted from output by BASIC, but remain in program listings.

STATEMENTS

Statements are instructions to the calculator. They are contained in numbered lines within a program, and execute in the order of their line numbers. Statements cannot be executed without running a program. They tell the calculator what to do while a program is running.

Here are some examples mentioned in Section I:

LET
PRINT
INPUT

Do not attempt to memorize every detail in the "Statements" subsection; there is too much material to master in a single session. By experimenting with the sample programs and attempting to write your own programs, you will learn more quickly than by memorizing.

THE LET STATEMENT

EXAMPLES:

```
1Ø LET A = 5.Ø2
2Ø LET X = Y7 = Z = Ø
3Ø LET B9 = 5*  (X↑2)
4Ø LET D = (3*C2↑N)/(A*(N/2))
```

GENERAL FORM:
statement number LET *variable* = *number or expression or variable . . .*

PURPOSE

Used to assign or specify the value of a variable. The value may be an expression, a number, or a variable.

COMMENTS

The assignment statement must contain:

1. A statement number,
2. LET is optional
3. The variable to be assigned a value (for example, B9 in statment 3Ø above),
4. The assignment operator, an = sign,
5. The number, expression or variable to be assigned to the variable (for example, 5*(X↑2) in statement 3Ø above).

Statement 2Ø in the example above shows the use of an assignment to give the same value (Ø) to several variables. This is a useful feature for initializing variables in the beginning of a program.

REM

EXAMPLES:	1Ø REM--THIS IS AN EXAMPLE 2Ø REM: OF REM STATEMENTS 3Ø REM-------////*****!!!!! 4Ø REM. STATEMENTS ARE NOT EXECUTED BY BASIC
GENERAL FORM:	*statement number* REM *any remark or series of characters*

PURPOSE

Allows insertion of a line of remarks or comment in the listing of a program.

COMMENTS

Must be preceded by a line number. Any series of characters may follow REM.

REM lines are part of a BASIC program and are printed when the program is listed or punched; however, they are ignored when the program is executing.

Remarks are easier to read if REM is followed by a punctuation mark, as in the example statements.

PRINT

This sample program gives a variety of examples of the PRINT statement. The results are shown below.

```
1Ø LET A=B=C=1Ø
2Ø LET D1=E9=2Ø
3Ø PRINT A,B,C,D1,E9
4Ø PRINT A/B,B/C/D1+E9
5Ø PRINT "NOTE THE POWER TO EVALUATE AN
   EXPRESSION AND PRINT THE"
6Ø PRINT "VALUE IN THE SAME STATEMENT."
7Ø PRINT
8Ø PRINT
9Ø REM* "PRINT" WITH NO OPERAND CAUSES THE
   TELEPRINTER TO SKIP A LINE.
1ØØ PRINT " 'A' DIVIDED BY 'E9' =";A/E9
11Ø PRINT "11111", "22222", "33333", "44444", "55555", "66666"
12Ø PRINT "11111"; "22222"; "33333"; "44444"; "55555"; "66666"
13Ø END
```

----------RESULTS----------

```
RUN
1Ø            1Ø            1Ø            2Ø            2Ø
 1            2Ø.Ø5
NOTE THE POWER TO EVALUATE AN EXPRESSION AND
PRINT THE VALUE IN THE SAME STATEMENT.

'A' DIVIDED BY 'E9' = .5
11111         22222         33333         44444         55555
66666
1111122222333334444455555566666
```

NOTE: The "," and ";" used in statements 11Ø and 12Ø have very different effects on the format.

PRINT, Continued

GENERAL FORM:
statement number PRINT *expression , expression , . . .*
or
statement number PRINT *"any text" ; expression ; . . .*
or
statement number PRINT *"text" ; expression ; "text" , "text" , . . .*
or
statement number PRINT *any combination of text and/or expressions*
or
statement number PRINT

PURPOSE

Causes the *expressions* or *"text"* to be output to the PRINTER. Causes the printer to skip a line when used without an operand.

COMMENTS

Note the effects of , and ; on the output of the sample program. If a comma is used to separate PRINT operands, five fields are printed per printer line. If semicolon is used, up to twelve "packed" numeric fields are output per printer line (72 characters).

Text in quotes is printed literally.

NOTE: A variable name is considered as a simple expression by BASIC. For example, a statement for the first general form shown above might be:

```
1ØØ PRINT A1, B2, C3
        or
11Ø PRINT A, Z, X, T9
```

where the variables represent numeric expressions.

Remember that variable values must be defined in an assignment, INPUT, READ or FOR statement before being used in a PRINT statement.

Ending a PRINT statement with a semicolon causes the output to be printed on the same line, rather than generating a *return linefeed* after the statement is executed. For example, the sequence:

```
2Ø LET X = 1
3Ø PRINT X;
4Ø LET X=X+1
5Ø GO TO 3Ø
 :
```

produces output in this format:

```
 1   2   3   4   5   6   7   8   9   1Ø  11  12
13   14  15  16  17  18  19  20  21  22  23  24
```

Similarly, ending a PRINT statement with a comma causes output to fill all five fields on a line before moving to the next line. The trailing comma in statement 3Ø in the sequence:

```
2Ø LET X = 1
3Ø PRINT X,
4Ø LET X=X+1
5Ø GO TO 3Ø
 :
```

produces output in this format:

```
 1   2   3   4   5
 6   7   8   9   10
11   12  13  14  15
```

A PRINT statement without an operand (statments 7Ø and 8Ø in the sample program) generates a *return linefeed.*

GO TO AND MULTIBRANCH GO TO

EXAMPLES:

```
10 LET X = 20
 :
40 GO TO X+Y OF 410,420,430
50 GOTO 100
80 GOTO 10
90 GO TO N OF 100,150,180,190
```

GENERAL FORM:
statement number GO TO *statement number*
statement number GO TO *expression* OF *sequence of statement numbers*

PURPOSE

GO TO transfers control to the statement specified.

GO TO *expression*... round the *expression* to an integer *n* and transfers control to the *n*th statement number following OF.

COMMENTS

GO TO may be written: GOTO or GO TO.

Must be followed by the statement number to which control is transferred, or *expression* OF, and a sequence of statement numbers.

GO TO overrides the normal execution sequence of statements in a program.

If there is no statement number corresponding to the value of the *expression*, the GO TO is ignored.

Useful for repeating a task infinitely, or "jumping" (GOing TO) another part of a program if certain conditions are present.

GO TO should not be used to enter FOR-NEXT loops; doing so may produce unpredictable results or fatal errors.

GOSUB...RETURN

EXAMPLE:

```
5Ø READ A2
6Ø IF A2<1ØØ THEN 8Ø
7Ø GOSUB 4ØØ
 .
 .
 .
38Ø STOP (STOP frequently precedes the
          first statement of a subroutine,
          to prevent accidental entry.)
39Ø REM—THIS SUBROUTINE ASKS
     FOR A 1 OR Ø REPLY.
4ØØ PRINT "A2 IS>1ØØ"
41Ø PRINT "DO YOU WANT TO
     CONTINUE";
42Ø INPUT N
43Ø IF N ≠Ø THEN 45Ø
44Ø LET A2=Ø
45Ø RETURN
 .
 .
 .
6ØØ END
```

GENERAL FORM:

statement number GOSUB *statement number starting subroutine*

.
.
.

statement number RETURN

PURPOSE

GOSUB transfers control to the specified statement number.

RETURN transfers control to the statement following the GOSUB statement which transferred control.

GOSUB...RETURN eliminates the need to repeat frequently used groups of statements in a program.

MULTIBRANCH GOSUB

EXAMPLES:

```
2Ø GOSUB 3 OF 1ØØ,2ØØ,3ØØ,4ØØ,
   5ØØ
6Ø GOSUB N+1 OF 2ØØ,21Ø,22Ø
7Ø GOSUB N OF 8Ø,18Ø,28Ø,38Ø,
   48Ø,58Ø
```

GENERAL FORM:
statement number GOSUB *expression* OF *sequence of statement numbers...*

PURPOSE

GOSUB *expression* rounds the *expression* to an integer *n* and transfeeds control to the *n*th statement number following OF.

COMMENTS

Subroutines should be exited only with a RETURN statement.

The *expression* indicates which of the specified subroutines will be executed. For example, statement 2Ø, above transfers control to the subroutine beginning with statement 3ØØ. The *expression* specifies which statement in the sequence of five statements is used as the starting one in the subroutine.

The *expression* is evaluated as an integer. Non-integer values are rounded to the nearest integer.

If the *expression* evaluates to a number greater than the number of statements specified, or less than 1, the GOSUB is ignored.

Statement numbers in the sequence following OF must be separated by commas.

IF . . . THEN

SAMPLE PROGRAM:

```
1Ø LET N = 1Ø
2Ø READ X
3Ø IF X <=N THEN 6Ø
4Ø PRINT "X IS OVER"; N
5Ø GO TO 1ØØ
6Ø PRINT "X IS LESS THAN OR
   EQUAL TO"; N
7Ø GO TO 2Ø
8Ø STOP
 .
 .
 .
```

GENERAL FORM:
statement number IF *expression relational op expression* THEN *statement number*

PURPOSE

Transfers control to a specified statement if a specified condition is true.

COMMENTS

Sometimes described as a conditional transfer; "GO TO" is implied by IF. . .THEN, if the condition is true. In the example above, if X<=1Ø, the message in statement 6Ø is printed (statement 6Ø is executed).

Since numbers are not always represented exactly in the computer, the = operator should be used carefully in IF. . .THEN statements. Limits, such as <=,>=, etc. should be used in an IF expression, rather than =, whenever possible.

If the specified condition for transfer is not true, the program will continue executing in sequence. In the example above, if X>1Ø, the message in statement 4Ø prints.

The relational operator is optional in logical evaluations.

See Section V, "Logical Operations," for a more complete description of logical evaluation.

FOR . . . NEXT

EXAMPLES:

```
100 FOR P1 = 1 TO 5
110 FOR Q1 = N TO X
120 FOR R2 = N TO X STEP 2.5
130 FOR S  = 1 TO X STEP Y
140 NEXT S
150 NEXT R2
160 NEXT Q1
170 NEXT P1
```

Sample Program — Variable Number Of Loops

```
 40 PRINT "HOW MANY TIMES DO YOU WANT TO LOOP";
 50 INPUT A
 60 FOR J = 1 TO A
 70 PRINT "THIS IS LOOP"; J
 80 READ N1, N2, N3
 90 PRINT "THESE DATA ITEMS WERE READ:" N1; N2; N3
100 PRINT "SUM ="; (N1+N2+N3)
110 NEXT J
120 DATA 5, 6, 7, 8, 9, 10, 11, 12
130 DATA 13, 14, 15, 16, 17, 18, 19, 20, 21
140 DATA 22, 23, 24, 25, 26, 27, 28, 29, 30
150 DATA 31, 32, 33, 34
160 END
```

GENERAL FORM:

statement number FOR *simple variable = initial value* TO *final value*

or

statement no. FOR *simple var. = initial value* TO *final value* STEP *step value*

:

statement number NEXT *simple variable*

NOTE: The same simple variable must be used in both the FOR and NEXT statements of a loop.

PURPOSE

Allows controlled repitition of a group of statements within a program

COMMENTS

Initial value, final value and *step value* may be any expression.

STEP and *step value* are optional; if no step value is specified, the computer will automatically increment by one each time it executes the loop.

How the loop works:

The simple variable is assigned the value of the *initial value;* the value of the simple variable is increased by 1 (or by the *step value*) each time the loop executes. When the value of the *simple variable* passes the *final value,* control is transferred to the statement following the "NEXT" statement.

The *initial, final,* and *step values* are all evaluated upon entry to the loop and remain unchanged after entry. For example,

FOR I = 1 TO I + 5

goes from 1 to 6; that is, the *final value* does not "move" as I increases with each pass through the loop.

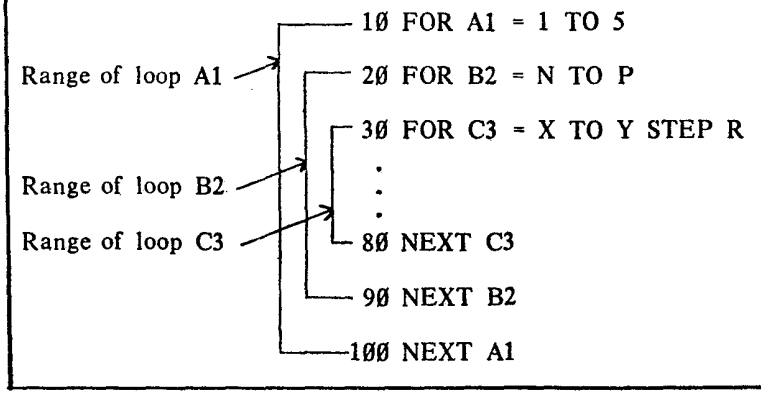
For further details on the STEP feature, see "FOR . . . NEXT with STEP" in Section III.

Try running the sample program if you are not sure what happens when FOR . . . NEXT loops are used in a program.

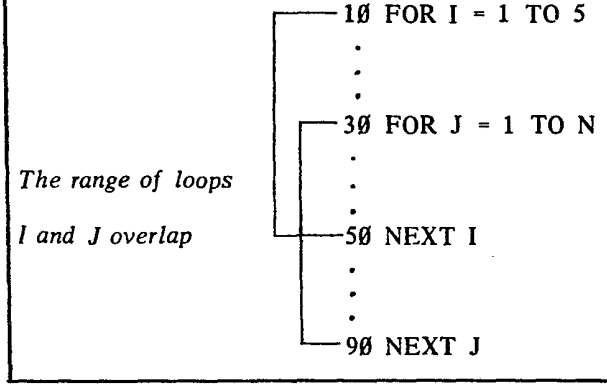
NESTING FOR . . . NEXT LOOPS

Several FOR . . . NEXT loops may be used in the same program; they may also be nested (placed inside one another). There are two important features of FOR . . . NEXT loops:

1. FOR . . . NEXT loops may be nested.



2. The range of FOR . . . NEXT loops may not overlap. The loops in the example above are nested correctly. This example shows improper nesting.



READ, DATA AND RESTORE

Sample Program using READ and DATA

```
15 FOR I=1 To 5
2Ø READ A
4ØX=A↑2
45 PRINT A; " SQUARED =";X
5Ø NEXT I
55 DATA 5.24,6.75,3Ø.8,72.65,89.72
6Ø END
```

Each data item may be read only once in this program. TSB keeps track of data with a "pointer." When the first READ statement is encountered, the "pointer" indicates that the first item in the first DATA statement is to be read; the pointer is then moved to the second item of data, and so on.

In this example, after the loop has executed five times, the pointer remains at the end of the data list. To reread the data, it is necessary to reset the pointer. A RESTORE statement moves the pointer back to the first data item.

Sample Program Using READ, DATA and RESTORE

```
 2Ø For I=1 To 5
 3Ø READ A
 4Ø LET X=A↑2
 5Ø PRINT A; "SQUARED =";X
 6Ø NEXT I
 8Ø RESTORE
1ØØ FOR J=1 To 5
11Ø READ B
12Ø LET Y=B↑4
13Ø PRINT B; "TO THE FOURTH POWER =";Y
14Ø NEXT J
15Ø DATA 5.24,6.75,30.8,72.65,89.72
16Ø END
```

GENERAL FORM:

Statement number READ *variable , variable ,...*
statement number DATA *number or string , number or string ,...*
statement number RESTORE
statement number RESTORE *statement number*

PURPOSE

The READ statement instructs TSB to read an item from a DATA statement.

The DATA statement is used for specifying data in a program. The data is read in sequence from first to last DATA statements, and from left to right within the DATA statement.

The RESTORE statement resets the pointer to the first data item, allowing data to be re-read.

RESTORE followed by a statement number resets the pointer to the first data item, beginning at the specified statement.

COMMENTS

READ statements require at least one DATA statement in the same program.

Items in a DATA statement must be separated by commas. String and numeric data may be mixed.

DATA statements may be placed anywhere in a program. The data items will be read in sequence as required.

DATA statements do not execute; they merely specify data.

The RUN command automatically sets the pointer to the first data item.

If you are not sure of the effects of READ, DATA, and RESTORE, try running the sample programs.

WAIT

EXAMPLE:	900 WAIT (1000) 990 WAIT (3000)
GENERAL FORM:	*statement number* WAIT (*expression max.* value *of 32767)*

PURPOSE

Introduces delays into a program. WAIT causes the program to wait the specified number of milliseconds (maximum 32767 milliseconds) before continuing execution.

COMMENTS

The time delay produced by WAIT is not precisely the number of milliseconds specified because there is no provision to account for time elapsed during calculation or terminal-computer communication.

One millisecond = 1/1000 second.

TERM: ROUTINE

DEFINED IN BASIC AS:	A sequence of program statements which produces a certain result.

PURPOSE

Routines are used for frequently performed operations, saving the programmer the work of defining an operation each time he uses it, and saving computer memory space.

COMMENTS

A routine may also be called a program, subroutine, or sub-program.

The task performed by a routine is defined by the programmer.

TERM: STRING

DEFINED IN BASIC AS:	0 to 255 printer characters enclosed by quotation marks (one line on a teleprinter terminal).

COMMENTS

Sample strings: "ANY CHARACTERS!?*/——"
"TEXT 1234567..."

Quotation marks may not be used within a string. Strings are used only in PRINT statements.

The statement number PRINT, and quotation marks are not included in the 65 character count. Each statement may contain up to 72 characters. Maximum string length is 72 characters minus 6 characters for "PRINT", two for the quotation marks, and the number of characters in the statement number.

TERM: FUNCTION

DEFINED IN BASIC AS:	The mathematical relationship between two variables (X and Y, for example) such that for each value of X there is one and only one value of Y.

COMMENTS

The independent variable in a function is called an argument; the dependent variable is the function value. For instance, if X is the argument, the function value is the square root of X, and Y takes the value of the function.

TERM: ARRAY OR MATRIX

DEFINED IN BASIC AS:	An ordered collection of numeric data (numbers).

COMMENTS

Arrays are divided into columns (vertical) and rows (horizontal):

C	ROWS
O	
L	
U	
M	
N	
S	

Arrays may have one or two dimensions. For example,

```
1.Ø
2.1
3.2
4.3
```

is a one-dimensional array, while

```
6 , 5 , 4
3 , 2 , 1
Ø , 9 , 8
```

is a two-dimensional array.

Array elements are referenced by their row and column position. For instance, if the two examples above were arrays A and Z respectively, 2.1 would be A(2); similarly, Ø would be Z(3,1). The references to array elements are called subscripts, and set apart with parentheses. For example, P(1,5) references the fifth element of the first row of array P; 1 and 5 are the subscripts. In X(M,N) M and N are the subscripts.

TERM: WORD

DEFINED IN BASIC AS:	The amount of computer memory space occupied by the two teleprinter characters.

COMMENTS

Numbers require two words of memory space when stored as numbers. When used within a string, numbers require 1/2 word of space per character in the number.

SUBROUTINES AND FUNCTIONS

The following pages explain BASIC features useful for repetitive operations — subroutines, programmer-defined functions and standard functions.

The programmer-defined features, such as GOSUB, FOR . . . NEXT with STEP, and DEF FN become more useful as the user gains experience and learns to use them as shortcuts.

Standard mathematical and trigonometric functions are convenient timesavers for programmers at any level. They are treated as numeric expressions by BASIC.

FOR . . . NEXT WITH STEP

EXAMPLES:

```
20 FOR I5 = 1 TO 20 STEP 2
40 FOR N2 = 0 TO -10 STEP -2
80 FOR P = 1 TO N STEP X5
90 FOR X = N TO W STEP
(N↑2-V)
  :
```

GENERAL FORM:

statement no. FOR *simple var.* = expression TO *expression* STEP *expression*

PURPOSE

Allows the user to specify the size of the increment of the FOR *variable.*

COMMENTS

The step size need not be an integer. For instance,

100 FOR N = 1 TO 2 STEP .01

is a valid statement which produces approximately 100 loop executions, incrementing N by .01 each time.

A step size of 1 is assumed if STEP is omitted from a FOR statement.

A negative step size may be used, as shown in statement 40 above.

GENERAL MATHEMATICAL FUNCTIONS

EXAMPLES:	642 PRINT EXP(N); ABS(N) 652 IF RND (Ø)>=.5 THEN 9ØØ 662 IF INT (R) ≠ 5 THEN 91Ø 672 PRINT SQR (X); LOG (X)
GENERAL FORM:	The general mathematical functions may be used as expressions, or as parts of an expression.

PURPOSE

Facilitates the use of common mathematical functions by pre-defining them as:

ABS (*expression*) the absolute value of the expression;
EXP (*expression*) the constant *e* raised to the power of the expression value (in statement 642 above, *e*↑N)
INT (*expression*) the largest integer ≤ the expression;
LOG (*expression*) the logarithm of the positively valued expression to the base *e*;
RND (*expression*) a random number between 1 and Ø; the expression is a dummy argument;
SQR (*expression*) the square root of the positively valued expression.

COMMENTS

The RND function is restartable; the sequence of random numbers using RND is identical each time a program is RUN.

TRIGONOMETRIC FUNCTIONS

EXAMPLES:	5ØØ PRINT SIN(X): COS(Y) 51Ø PRINT 3*SIN(B); TAN (C2) 52Ø PRINT ATN (22.3) 53Ø IF SIN (A2) <1 THEN 8ØØ 54Ø IF SIN (B3) = 1 AND SIN(X) < 1 THEN 9Ø

PURPOSE

Facilitates the use of common trigonometric functions by pre-defining the as:

SIN (*expression*) the sine of the expression
COS (*expression*) the cosine of the expression
TAN (*expression*) the tangent of the expression
ATN (*expression*) the arctangent of the expression

COMMENTS

The function is of the value of the expression (the value in parentheses, also called the argument).

The trigonometric functions may be used as expressions or parts of an expression.

The angle of the trigonometric functions can be specified as radians, degrees, or grads by executing a RAD, DEG, or GRAD statement. The calculator assumes radians if not specified.

THE TAB AND SGN FUNCTIONS

EXAMPLES:	5ØØ IF SGN (X) ≠ Ø THEN 8ØØ 51Ø LET > Y = SGN(X) 52Ø PRINT TAB (5); A2; TAB (2Ø) "TEXT" 53Ø PRINT TAB (N),X,Y,Z2 54Ø PRINT TAB (X+2) "HEADING", R5
GENERAL FORM:	*The TAB and SGN may be used as expressions or parts of an expression. The function forms are:*

TAB (*expression indicating number of spaces to be moved*)
SGN (*expression*)

PURPOSE

TAB (*expression*) is used only in a PRINT statement, and causes the terminal typeface to move to the space number specified by the expression (Ø to 71). The *expression* value after TAB is rounded to the nearest integer. Expression values greater than 71 cause a *return linefeed* to be generated.

SGN (*expression*) returns a 1 if the expression is greater than Ø, returns a Ø if the expression equals Ø, returns a –1 if the expression is less than Ø.

SECTION IV

MATRICES

This section explains matrix manipulation. It is intended to show the matrix capabilities of BASIC and assumes that the programmer has some knowledge of matrix theory.

TERM: MATRIX (ARRAY)

DEFINED IN BASIC AS:	An ordered collection of numeric data (numbers).

Matrix elements are referenced by subscripts following the matrix variable, indicating the row and column of the element. For example, if matrix A is:

1 2 3
4 5 6
7 8 9

the element 5 is referenced by A(2,2); likewise, 8 is A(3,2).

See Section III, "Vocabulary" for a more complete description of matrices.

DIM

EXAMPLES:

```
110 DIM A (50), B(20,20)
120 DIM Z (5,20)
130 DIM S (5,25)
140 DIM R (4,4)
```

GENERAL FORM:
statement number DIM *matrix variable (integer)...*
or
statement number DIM *matrix variable (integer , integer)...*

PURPOSE

Reserves working space in memory for a matrix.
The maximum *integer* value (matrix bound) is 255.

COMMENTS

The integers refer to the number of matrix elements if only one dimension is supplied, or to the number of rows and columns respectively, if two dimensions are given.

A matrix (array) variable is any single letter from A to Z.

Arrays not mentioned in a DIM statement are assumed to have 10 elements if one-dimensional, or 10 rows and columns if two-dimensional.

The working size of a matrix may be smaller than its physical size. For example, an array declared 9 x 9 in a DIM statement may be used to store fewer than 81 elements; the DIM statement supplies only an upper bound on the number of elements.

The absolute maximum matrix size depends on the memory size of the computer.

MAT...ZER

EXAMPLES:

```
305 MAT A = ZER
310 MAT Z = ZER (N)
315 MAT X = ZER (30, 10)
320 MAT R = ZER (N, P)
```

GENERAL FORM:
statement number MAT *matrix variable* = ZER
or
statement number MAT *matrix variable* = ZER *(expression)*
or
statement number MAT *matrix variable* = ZER *(expression , expression)*

PURPOSE

Sets all elements of the specified matrix equal to 0; a new working size may be established.

COMMENTS

The new working size in a MAT...ZER is an implicit DIM statement, and may not exceed the limit set by the DIM statement on the total number of elements in an array.

Since 0 has a logical value of "false," MAT...ZER is useful in logical initialization.

MAT . . . CON

EXAMPLES:

```
205 MAT C = CON
210 MAT A = CON (N,N)
220 MAT Z = CON (5,20)
230 MAY Y = CON (50)
```

GENERAL FORM:

statement number MAT *matrix variable* = CON

or

statement number MAT *matrix variable* = CON *(expression)*

or

statement number MAT *matrix variable* = CON *(expression , expression)*

PURPOSE

Sets up a matrix with all elements equal to 1; a new working size may be specified, within the limits of the original DIM statement on the total number of elements.

COMMENTS

The new working size (an implicit DIM statement) may be omitted as in example statement 205.

Note that since 1 has a logical value of "true," the MAT . . . CON statement is useful for logical initialization.

The expressions in new size specifications should evaluate to integers. Non-integers are rounded to the nearest integer value.

PRINTING SINGLE MATRIX ELEMENTS

EXAMPLES:

```
800 PRINT A(3)
810 PRINT A(3,3);
820 PRINT F(X);E; C5;R(N)
830 PRINT G(X,Y)
840 PRINT Z(X,Y), Z(1,5), Z(X+N),
    Z(Y+M)
```

GENERAL FORM:

statement number PRINT *matrix variable (expression) . . .*

or

statement number PRINT *matrix variable (expression , expression) . . .*

PURPOSE

Causes the specified matrix element(s) to be printed.

COMMENTS

Expressions used as subscripts should evaluate to integers. Non-integers are rounded to the nearest integer value.

A trailing semicolon packs output into twelve elements per teleprinter line, if possible (statement 810 above). A trailing comma or *return* prints five elements per line.

Expressions (or subscripts) following the matrix variable designate the row and column of the matrix element. Do not confuse these with new working size specifications, such as those following a MAT IDN statement.

INPUTTING SINGLE MATRIX ELEMENTS

EXAMPLES:

```
600 INPUT A(5)
610 INPUT B(5,8)
620 INPUT R(X), N, A(3,3),S,T
630 INPUT Z(X,Y), P3, W
640 INPUT  Z(X,Y),  Z(X+1,  Y+1),
    Z(X+R3, Y+S2)
```

GENERAL FORM:
statement number INPUT *matrix variable (expression)...*
or
statement number INPUT *matrix variable (expression , expression)...*

PURPOSE

Allows input of a specified matrix element from the keyboard.

COMMENTS

The subscripts (in *expressions*) used after the matrix variable designate the row and column of the matrix element. Do not confuse these expressions with working size specifications, such as those following a MAT READ statement.

Expressions used as subscripts should evaluate to integers. Non-integers are rounded to the nearest integer value.

Inputting, printing, and reading individual array elements are logically equivalent to simple variables and may be intermixed in INPUT, PRINT, and READ statements.

MAT PRINT

EXAMPLES:

```
500 MAT PRINT A
505 MAT PRINT A;
515 MAT PRINT A,B,C
520 MAT PRINT A,B,C;
```

GENERAL FORM:
statement number MAT PRINT *matrix variable*
or
statement number MAT PRINT *matrix variable , matrix variable...*

PURPOSE

Causes an entire matrix to be printed, row by row, with double spacing between rows.

COMMENTS

Matrices may be printed in "packed" rows up to 12 elements wide by using the ";" separator, as in example statement 505.

READING MATRIX ELEMENTS

EXAMPLES:

```
900 READ A(6)
910 READ A(9,9)
920 READ C(X); P; R7
930 READ C(X,Y)
940 READ Z(X,Y), P(R2, S5), X(4)
```

GENERAL FORM:
statement number READ *matrix variable (expression)*
or
statement number READ *matrix variable (expression , expression)...*

PURPOSE

Causes the specified matrix element to be read from the current DATA statement.

COMMENTS

Expressions (used as subscripts) should evaluate to integers. Non-integers are rounded to the nearest integer.

Expressions following the matrix variable designate the row and column of the matrix element. Do not confuse these with working size specifications, such as those following MAT READ statement.

The MAT READ statement is used to read an entire matrix from DATA statements. See details in this section.

MAT READ

EXAMPLES:

```
350 MAT READ A
370 MAT READ B(5),C,D
380 MAT READ Z (5,8)
390 MAT READ N (P3,Q7)
```

GENERAL FORM:
statement number MAT READ *matrix variable*
or
statement number MAT READ *matrix variable (expression)...*
or
statement number MAT READ matrix variable (*expression , expression)...*

PURPOSE

Reads an entire matrix from DATA statements. A new working size may be specified, within the limits of the original DIM statement.

COMMENTS

MAT READ causes the entire matrix to be filled from the current DATA statement in the row, column order: 1,1; 1,2; 1,3; etc. In this case, the DIM statement controls the number of elements read.

MATRIX ADDITION

EXAMPLES:

```
310 MAT C = B + A
320 MAT X = X + Y
330 MAT P = N + M
```

GENERAL FORM:
statement number MAT *matrix variable = matrix variable + matrix variable*

PURPOSE

Establishes a matrix equal to the sum of two matrices of identical dimensions; addition is performed element-by-element.

COMMENTS

The resulting matrix must be previously mentioned in a DIM statement if it has more than 10 elements, or 10 x 10 elements if two-dimensional. Dimensions must be the same as the operand matrices.

The same matrix may appear on both sides of the = sign, as in example statement 320.

MATRIX SUBTRACTION

EXAMPLES:

```
550 MAT C = A - B
560 MAT B = B - Z
570 MAT X = X — A
```

GENERAL FORM:
statement number MAT *matrix variable = matrix variable — matrix variable*

PURPOSE

Establishes a matrix equal to the difference of two matrices of identical dimensions; subtraction is performed element-by-element.

COMMENTS

The resulting matrix must be previously mentioned in a DIM statement if it has more than 10 elements, or 10 x 10 elements if two-dimensional. Its dimension must be the same as the operand matrices.

The same matrix may appear on both sides of the = sign, as in example statement 560.

MATRIX MULTIPLICATION

EXAMPLES:
```
930 MAT Z = B * C
940 MAT X = A *A
950 MAT C = Z * B
```

GENERAL FORM:
statement number MAT *matrix variable = matrix variable * matrix variable*

PURPOSE

Establishes a matrix equal to the product of the two specified matrices.

COMMENTS

Following the rules of matrix multiplication, if the dimensions of matrix B = (P,N) and matrix C = (N,Q), multiplying matrix B by matrix C results in a matrix of dimensions (P,Q).

Note that the product matrix must have an appropriate working size.

The same matrix variable may not appear on both sides of the = sign.

SCALAR MULTIPLICATION

EXAMPLES:
```
110 MAT A = (5) * B
115 MAT C = (10) * C
120 MAT C = (N/3) * X
130 MAT P = (Q7*N5) * R
```

GENERAL FORM:
statement number MAT *matrix variable = (expression) * matrix variable*

PURPOSE

Establishes a matrix equal to the product of a matrix multiplied by a specified expression (number); that is, each element of the original matrix is multiplied by the number.

COMMENTS

The resulting matrix must be previously mentioned in a DIM statement if it contains more than 10 elements (10 x 10 if two-dimensional).

The same matrix variable may appear on both sides of the = sign.

Both matrices must have the same working size.

COPYING A MATRIX

EXAMPLES:

```
405 MAT B = A
410 MAT X = Y
420 MAT Z = B
```

GENERAL FORM:
statement number MAT *matrix variable = matrix variable*

PURPOSE

Copies a specified matrix into a matrix of the same dimensions; copying is performed element-by-element.

COMMENTS

The resulting matrix must be previously mentioned in a DIM statement if it has more than 10 elements, or 10 x 10 if two-dimensional. It must have the same dimensions as the copied matrix.

IDENTITY MATRIX

EXAMPLES:

```
205 MAT A = IDN
210 MAT B = IDN (3,3)
215 MAT Z = IDN (Q5, Q5)
220 MAT S = IDN (6, 6)
```

GENERAL FORM:
statement number MAT *arrau variable* = IDN
or
statement number MAT *array variable* = IDN *(expression , expression)*

PURPOSE

Establishes an identity matrix (all Ø's, with a diagonal from left to right of all 1's); a new working size may be specified.

COMMENTS

The IDN matrix must be two-dimensional and square.
Specifying a new working size has the effect of a DIM statement.
Sample identity matrix:

```
1 Ø Ø
Ø 1 Ø
Ø Ø 1
```

MATRIX TRANSPOSITION

EXAMPLES:
```
959 MAT Z = TRN (A)
969 MAT X = TRN (B)
979 MAT Z = TRN (C)
```

GENERAL FORM:
statement number MAT *matrix variable* = TRN *(matrix variable)*

PURPOSE

Establishes a matrix as the transposition of a specified matrix (transposes rows and columns).

COMMENTS

Sample transposition:

Original	Transposed
1 2 3	1 4 7
4 5 6	2 5 8
7 8 9	3 6 9

Note that the dimensions of the resulting matrix must be the reverse of the original matrix. For instance, if A has dimensions of 6,5 and MAT C = TRN (A), C must have dimensions of 5,6.

Matrices cannot be transposed or inverted into themselves.

MATRIX INVERSION

EXAMPLES:
```
380 MAT A = INV(B)
390 MAT C = INV(A)
400 MAT Z = INV(Z)
```

GENERAL FORM:
statement number MAT *matrix variable* = INV *(matrix variable)*

PURPOSE

Establishes a square matrix as the inverse of the specified square matrix of the same dimensions.

COMMENTS

The inverse is the matrix by which you multiply the original matrix to obtain an identity matrix.

For example,

$$\underset{\text{Original}}{\begin{pmatrix}1&0&0\\1&1&0\\1&1&1\end{pmatrix}} \times \underset{\text{Inverse}}{\begin{pmatrix}1&0&0\\-1&1&0\\0&-1&1\end{pmatrix}} = \underset{\text{Identity}}{\begin{pmatrix}1&0&0\\0&1&0\\0&0&1\end{pmatrix}}$$

Number representation in BASIC is accurate to 6—7 decimal digits; matrix elements are rounded accordingly.

SECTION V
LOGICAL OPERATIONS

LOGICAL VALUES AND NUMERIC VALUES

A distinction should be made between logical values and the numeric values produced by logical evaluation, when using the logical capability of BASIC.

The logical value of an expression is determined by definitions established in the user's program.

The numeric values produced by logical evaluation are assigned by BASIC. The user may not assign these values.

Logical value is the value of an expression or statement, using the criteria:

any nonzero expression value = "true"
any expression value of zero = "false"

When an expression or statement is logically evaluated, it is assigned one of two numeric values, either:

1, meaning the expression or statement is "true",
or
Ø, meaning the expression or statement is "false".

RELATIONAL OPERATORS

There are two ways to use the relational operators in logical evaluations:

1. As a simple check on the numeric value of an expression.

```
EXAMPLES:    150 IF B=7 THEN 600
             200 IF A9≠27.65 THEN 700
             300 IF (Z/10)>0 THEN 800
```

When a statement is evaluated, if the "IF" condition is currently true (for example, B = 7 in statement 150), then control is transferred to the specified statement; if it is not true, control passes to the next statement in the program.

Note that the numeric value produced by the logical evaluation is unimportant when the relational operators are used in this way. The user is concerned only with the presence or absence of the condition indicated in the IF statement.

2. As a check on the numeric value produced by logically evaluating an expression, that is: "true" = 1, "false" = Ø.

```
EXAMPLES:    610 LET X=27
             615 PRINT X=27
             620 PRINT X≠27
             630 PRINT X>=27
```

The example PRINT statements give the numeric values produced by logical evaluation. For instance, statement 615 is interpreted by BASIC as "Print 1 if X equals 27, Ø if X does not equal 27." There are only two logical alternatives; 1 is used to represent "true," and Ø "false."

The numeric value of the logical evaluation is dependent on, but distinct from, the value of the expression. In the example above, X equals 27, but the numeric value of the logical expression X=27 is 1 since it describes a "true" condition.

BOOLEAN OPERATORS

There are two ways to use the Boolean Operators.

1. As logical checks on the value of an expression or expressions.

EXAMPLES:	510 IF A1 OR B THEN 670 520 IF B3 AND C9 THEN 680 530 IF NOT C9 THEN 690 540 IF X THEN 700

Statement 510 is interpreted: "If either A1 is true (has a non-zero value) or B is true (has a none-zero value), then transfer control to statement 670.

Similarly, statement 540 is interpreted: "If X is true (has a non-zero value), then transfer control to statement 700."

The Boolean operators evaluate expressions for their logical values only: these are "true" = any non-zero value, "false" = zero. For example, if B3 = 9 and C9 = –5, statement 520 would evaluate to "true," since both B3 and C9 have a non-zero value.

2. As a check on the numeric value produced by logically evaluating an expression, that is: "true" = 1, "false" = 0.

EXAMPLES:	490 LET B = C = 7 500 PRINT B AND C 510 PRINT C OR B 520 PRINT NOT B

Statements 500—520 return a numeric value of either 1, indicating that the statement has a logical value of "true", or 0, indicating a logical value of "false".

Note that the criteria for determining the logical values are:

true = any non-zero expression value
false = an expression value of 0.

The numeric value 1 or 0 is assigned accordingly.

SECTION VI
SYNTAX REQUIREMENTS OF BASIC

LEGEND

::= "is defined as . . ."
| "or"
< > enclose an element of BASIC

LANGUAGE RULES

1. The <com statement>, if any exists, must be the first statement presented and have the lowest sequence number; the last statement must be an <END statement>.
2. A sequence number may not exceed 9999 and must be non-zero.
3. Exponent integers may not have more than two digits.
4. A formal bound may not exceed 255 and must be non-zero.
5. A subroutine number must lie between 1 and 63, inclusive.
6. Strings may not contain the quote character (").
7. A <bound part> for an IDN must be doubly subscripted.
8. An array may not be inverted or transposed into itself.
9. An array may not be replaced by itself multiplied by another array.

SYNTAX REQUIREMENTS

<basic program> ::= <program statement>|<basic program> <progam statement> (1)

<program statement> ::= <sequence number> <basic statement>carriage return

<sequence number> ::= <integer> (2)

<basic statement> ::= <let statement>|<dim statement>|<com statement>|
<def statement>|<rem statement>|<go to statement>|
<if statement>|<for statement>|<next statement>|
<gosub statement>|<return statement>|<end statement>|
<stop statement>|<wait statement>|<call statement>|
<data statement>|<read statement>|<restore statement>|
<input statement>|<print statement>|<mat statement>|

<let statement> ::= <let head> <formula>

<let head> ::= LET<variable>=|<let head><variable>=

<formula> ::= <conjunction>|<formula a>OR<conjunction>

<conjunction> ::= <boolean primary>|<conjunction>AND<boolean primary>

<boolean primary> ::= <arithmetic expression>|<boolean primary>
<relational operator><arithmetic expression>

<arithmetic expression> ::= <term>|<arithmetic expression> + <term>|
<arithmetic expression> – <term>

<term> ::= <factor>|<term>*<factor>|<term>/<factor>

<factor> ::= <primary>|<sign><primary>|NOT<primary>

<primary> ::= <operand>|<primary>↑<operand>

<relational operator> ::= >|<|>=|<=|=|≠|<>

<operand> ::= <variable>|<unsigned number>|<system function>|
<function>|<formula operand>

<variable> ::= <simple variable>|<subscripted variable>

<simple variable> ::= <letter>|<letter><digit>

<subscripted variable> ::= <array identifier><subscript head><subscript>
<right bracket>

<array identifier> ::= <letter>

<subscript head> ::= <left bracket>|<left bracket><subscript>

<subscript> ::= <formula>

<letter> ::= A|B|C|D|E|F|G|H|I|J|K|L|M|N|O|P|Q|R|S|T|U|V|W|X|Y|Z

<digit> ::= 0|1|2|3|4|5|6|7|8|9

<left bracket> ::= (|[

<right bracket> ::)|]

<sign> ::= +|–

<unsigned number> ::= <decimal part>|<decimal part><exponent>

SYNTAX REQUIREMENTS, Continued

<decimal part> ::= <integer>|<integer>.<integer>|.<integer>

<integer> ::= <digit>|<integer><digit>

<exponent< ::= E<integer>|E<sign><integer> (3)

<system function> ::= <system function name><parameterpart>

<system function name> ::= SIN|COS|TAN|ATN|EXP|LOG|ABS|SQR|INT|RND|SGN

<parameter part> ::= <left bracket><actual parameter><right bracket>

<actual parameter> ::= <formula>

<function> ::= FN<letter><parameter part>

<formula operand> ::= <left bracket><formula><right bracket>

<dim statement> ::= DIM<formal array list>

<formal array list> ::= <formal array>|<formal array list>,<formal array>

<formal array> ::= <array identifier><formal bound head><formal bound><right bracket>

<formal bound head> ::= <left bracket>|<left bracket><formal bound>,

<formal bound> ::= <integer> (4)

<com statement> ::= COM<formal array list>

<def statement> ::= DEF FN<letter><left bracket><formal parameter><right bracket>=<formula>

<formal parameter> ::= <simple variable>

<rem statement> ::= REM<character string>

<character string> ::= any teletype character except carriage return, alt mode, escape, rubout, or line feed, or null, control B, control C, left arrow

<goto statement> ::= GO TO<sequence number>

<if statement> ::= IF<formula>THEN<sequence number>

<for statement> ::= <for head>|<for head>STEP<step size>

<for head> ::= FOR<for variable>=<initial value>TO<limit value>

<for variable> ::= <simple variable>

<initial value> ::= <formula>

<limit value> ::= <formula>

<step size> ::= <formula>

<next statement> ::= NEXT<for variable>

<gosub statement ::= GOSUB<sequence number>

<return statement> ::= RETURN

SYNTAX REQUIREMENTS, Continued

<end statement> ::= END

<stop statement> ::= STOP

<wait statement> ::= WAIT <parameter part>

<call statement> ::= CALL<call head> <right bracket>

<call head> ::= <left bracket> <subroutine number> | <call head>, <actual parameter>

<subroutine number> ::= <integer> (5)

<data statement> ::= DATA<constant> | <data statement>, <constant>

<constant> ::= <unsigned number> | <sign> <unsigned number>

<read statement> ::= READ<variable list>

<variable list> ::= <variable> | <variable list>' <variable>

<restore statement> ::= RESTORE

<input statement> ::= INPUT<variable list>

<print statement> ::= <print head> | <print head> <print formula>

<print head> ::= PRINT | <print head> <print part>

<print part> ::= <string> | <string> <delimiter> | <print formula> <delimiter> | <print formula> <string> | <print formula> <string> <delimiter>

<string> ::= "<character string>" (6)

<delimiter> ::= , | ;

<print formula> ::= <formula> | TAB<parameter part>

<mat statement> ::= MAT <mat body>

<mat body> ::= <mat read> | <mat print> | <mat replacement>

<mat read> ::= READ<actual array> | <mat read>, <actual array>

<actual array> ::= <array identifier> | <array identifier> <bound part>

<bound part> ::= <actual bound head> <actual bound> <right bracket>

<actual bound head> ::= <left bracket> | <left bracket> <actual bound>,

<actual bound> ::= <formula>

<mat print> ::= PRINT <mat print part> | PRINT<mat print part> <delimiter

<mat print part> ::= <array identifier> | <mat print part> <delimiter> <array identifier>

<mat replacement> ::= <array identifier> = <mat formula>

<mat formula> ::= <array identifier> | <mat function> | <array identifier> <mat operator> <array identifier> | <formula operand> * <array identifier>

SYNTAX REQUIREMENTS, Continued

<mat function> ::= <mat initialization>|<mat initialization> <bound part>|
INV<array parameter>|TRN<array parameter>

<mat initialization> ::= ZER|CON|IDN [7]

<array parameter> ::= <left bracket> <array identifier> <right bracket> [8]

<mat operator> ::= +|−|* [9]

STRINGS PLUG-IN READ-ONLY MEMORY MODULE

The strings plug-in read-only memory module makes available to the user all of the string variable functions and operations associated with standard BASIC programming language. Two additional functions not usually provided in most versions of BASIC language have been implemented. These include a POS function for determining the position of a substring within a string and a VAL function for determining the position of a substring within a string and a VAL function for determining the numeric value of a string. A discussion of these and other string functions and operations follows.

String

A set of 1 to 255 characters or the null string (no characters).

e.g. "ABCDEF"
"12345"
" "

String Variable

A variable used to store strings; consists of a single letter (A to Z) followed by a $.

e.g. A$; B$; Z$

Substring Variable

A single character or a set of continguous characters from within a string variable. The substring is defined by a subscripted string variable. A single subscript specifies the first character of the substring and implies that all characters following are part of the substring. Two subscripts specify the first and last characters of the substring.

e.g. A$ = "ABCDEF"
A$(4) = DEF
A$(1, 3) = ABC

DIM Statement

General Form:

stmt # DIM string var (#chars in string)

Purpose:

Reserves storage space for strings longer than 1 character.

Comments:

The number of characters specified for a string in its DIM statement must be expressed as an integer form 1 to 255. Strings not mentioned in a DIM statement are assumed to have length 1. The length mentioned in the DIM statement specifies the maximum number of characters which may be assigned and is known as the physical length. The actual length is the actual number of characters which has been assigned.

e.g. DIM A$(1Ø), B(5, 5), B$(255)

Source String Semantic Description

A source string is an entity from which a string value is extracted. If no substring designator is specified for a string variable, the value of the source string is the entire logical string currently assigned to it. Substring designator expressions must be at least 1 in value and the second may be no smaller than one less than the first. If one subscript is given, the value is the entire logical string beginning at the

character specified by the subscript. The subscript may be no larger than the actual length of the string plus 1. If two substring expressions are given, the source string value is the substring whose first and last characters are designated. If the specified substring extends beyond the logical length of the string, spaces are used to fill out the substring.

Assignment Statement

General Form:

line # [LET] destination string = source string

Destination String:

A destination string is an entire string variable or part of a string variable into which a source string is to be copied. The definition of the action depends on the number of substring subscripts specified in the destination string.

If no subscript qualifier is specified, the entire destination variable is replaced by the source string. The physical length of the destination string must be large enough to accommodate the entire source string.

If one substring subscript is specified, the entire value of the destination variable, beginning at the designated character, is replaced by the source string. That part of the destination variable preceding the subscript value is unchanged. The subscript value must be no more than one greater than the actual length of the destination variable.

If two subscripts are specified, the first substring subscript must be no more than one greater than the logical length of the destination variable, and the second subscript must be no greater than the physical length of the destination variable. The specified section of the destination string is replaced by the source string. If the source string is longer than the destination, it is truncated on the right. If the source string is shorter, as many trailing blanks are appended as necessary. The new actual length of the destination string is the larger of the old actuai length and the second subscript.

String Input Statement

General Form:

stmt # INPUT string or substring variable

Purpose:

Allows string values to be entered from the keyboard.

Comments:

Numeric variables may be used in the same input statement as string variables. Placing a single string variable in an input statement allows the string value to be entered without enclosing it in quotation marks. If multiple string variables are used each string value must be enclosed in quotation marks, and the values separated by commas.

e.g. 10 INPUT A$, B$, C, Al, A$(1, 5)

String Print Statement

General Form:

stmt # PRINT string or substring variable, —

Purpose:

Causes the current value of the specified string or substring variable to be output on the standard output device.

Comments:

Strings and numeric values may be mixed in a print statement. String variables are specified indentically to numeric variables. They are printed under the same format rules as quote fields. String and substring variables are printed as source strings.

A maximum of 72 characters can be printed using the print statement, i.e., all strings >72 characters are truncated at 72 characters.

String Read Statement

General Form:

stmt # READ string or substring variable

Purpose:

Causes the value of a specified string or substring variable to be read from a data statement.

Comments:
Mixed string and numeric values may be read. If the wrong data type is given in the data statement an error is given.
e.g. 10 READ A, B$(1, 1Ø), C$, B

String If Statement
General Form:
stmt # IF str.var. rel.oper. string THEN stmt #
Purpose:
Compares two strings. If the specified condition is true, control is transferred to the specified statement.
Comments:
Strings are compared one character at a time, from left to right; the first difference determines the relation. If one string ends before a difference is found, the shortest string is considered the smaller one.
Characters are compared by their ASCII representations.
The relational operators allowed are: =, ≠, <, >, <=, >=, <>
e.g. 1Ø IF A$ = "SAM" THEN sØ

String Data Statement
General Form:
stmt # DATA "string text", "string text", —
Purpose:
Specifies data in a program (string or/and numeric)
Comments:
String values must be enclosed by quotation marks and separated by commas.
String and numeric values may be mixed in a single data statement.
e.g. 10 DATA "ABC", 1.2, "DEF"

String Write Statement
General Form:
stmt # WRITE (device # , format stat #)
string or substring variable
Purpose:
Similar to the print statement but allows the specification of the output device and format statement. No field specifications are made for string variables in the format statement. They are treated identically to string constants (quote fields).

String Display Statement
General Form:
stmt # DISP string or substring variable
Purpose:
Identical to print statement except output device is 32 character display

LEN Function
General Form:
LEN string or LEN (string)
Purpose:
Obtain the length of a string for use in an arithmetic expression.
Comment:
The actual length is found which is not necessarily the same as the physical length reserved in the DIM statement.
e.g. LEN ("ABCD") = 4

POS Function
General Form:
POS string , string or POS (string , string)
Purpose:
Determine the position of a substring within a string.
Comments:
If the second string argument is a part of the first, the value of the function is the position in the first string at which the second string starts. If the second string in the argument is not a part of the first, the value of the function is zero.
e.g. POS ("ABCD" , "C") = 3

VAL Function
General Form:
VAL string or VAL (string)
Purpose:
Determine the numeric value of a string.
Comments:
The VAL function converts a string of digits into a number. The string is converted into a number by the same rules used in a numeric input statement.
e.g. VAL ("123") = 123

ERROR MESSAGES FOR STRING OPTION BLOCK

70 — string IF error
71 — string function syntax error
72 — negative string length
73 — non-contiguous string
74 — string overflow
75 — data is of wrong type
76 — VAL function argument not numeric

BNF SYNTAX DESCRIPTION

<literal string>	::="<character string>"
<character string>	::=<character>|<character string> <character>
<character>	::= any ASCII character except NULL, LINE FEED, RETURN
<letter>	::= A|B| ... X|Y|Z
<sublist>	::=<expression>|<expression>,<expression>
<string variable>	::=<simple string variable>| <simple string variable>(<sublist>)
<simple string variable>	::=<letter>$
<relational operator>	::=<|<=|=|≠|<>|>=|>
<assignment statement>	::=LET<destination string>=<source string> | <destination string>=<source string>
<destination string>	::=<string variable>
<source string>	::=<string variable>|<literal string>
<IF statement>	::=IF<destination string><relational operator><source string>THEN<line #→↑=↓↘>
<data statement>	::=DATA<constant>|<data statement>, <constant>
<constant>	::=<numeric constant>|<literal string>
<read statement>	::=READ<variable list>
<variable list>	::<read variable>|<variable list>, <read variable>
<read variable>	::=<numeric variable>|<string variable>

BNF SYNTAX DESCRIPTION — Continued

<input statement> ::=INPUT<variable list>

<print statement> ::=<print 1>|<print 2>

<print 1> ::=PRINT|<print 2>, |<print 2>; |<print 3>

<print 2> ::=<print 1><print expression>|<print 3>

<print 3> ::=(type statement><literal string>

<print expression> ::=<expression>|<source string>

WRITE and DISP statements have the same syntax as the PRINT statement.

<LEN function> ::=LEN<source string>|LEN (<source string>)

<VAL function> ::=VAL<source string>|VAL(<source string>)

<POS function> ::=POS<source string>,<source string>|POS(<source string>,<source string>)

EXTENDED INPUT/OUTPUT PLUG-IN READ-ONLY MEMORY MODULE

The extended I/O read-only memory module (hereinafter referred to as the extended I/O ROM) provides additional functions and statements so that the calculator can be made compatible with a wide variety of peripheral devices. Added functions include decimal-to-binary and octal-to-decimal conversion, status code inquiry for peripheral devices, control of spacing and line feeds in output records, and others. Use of these functions requires no special programming techniques; once the ROM is plugged in, its functions and statements become a part of the calculator, in the same way as, for example, the square root function is part of the calculator.

Some read-only memory units decrease the amount of programmable memory available to the user by automatically requiring a portion of that memory for their own internal usage, but the extended I/O ROM has no such requirement and does not affect memory availability.

The following table describes the extended I/O ROM functions and statements. Parameters shown underlined in the table are explained immediately following the table. Parameters shown in brackets may or may not be included as parts of a statement.

FUNCTION MNEMONIC	DESCRIPTION OF FUNCTION	SYNTAX
BIN	Converts decimal expression to its binary equivalent. For use in output-to-binary storage device; also provides increased control of print format.	BIN exp
OCT	Converts octal expression to decimal equivalent. For use in construction of code conversion tables; see "Conversion Tables".	OCT exp
STAT	Returns code of operational status (on, off, wait, etc.) for the device specified by the select code.	STAT select code
CHAR	Returns one byte of data from the device specified by the select code regardless of the data structure.	CHAR select code
LIN	Advances printer or typewriter the number of lines represented by the expression.	LIN exp
SPA	Advances printer or typewriter carriage the number of spaces represented by the expression.	SPA exp
ROT	Converts expression 1 to binary equivalent; performs rotation right the number of positions represented by expression 2; returns decimal equivalent. For use in special input or output code translation.	ROT (exp 1, exp 2)
INOR	Combines binary equivalents of expression 1 and expression 2 in an "inclusive or" logic operation. Returns decimal equivalent. For use in special input or output code translation.	INOR (exp 1, exp 2)

FUNCTION MNEMONIC	DESCRIPTION OF FUNCTION	SYNTAX
BIAND	Combines binary equivalents of expression 1 and expression 2 in an "and" logic operation. Returns decimal equivalent. For use in special input or output translation.	BIAND (exp 1, exp 2)

STATEMENT SYNTAX	DESCRIPTION OF STATEMENT
ENTER (select code or string name, format[, conversion table]) list[, FOR function]	Inputs data from named device or string with optional conversion to ASCII code; includes capability for iteration.
OUTPUT (select code or string name, format[, conversion table]) list	Outputs data to named device or string with optional conversion to ASCII code.

PARAMETER	EXPLANATION
exp	Expression
select code	A numeric code, from 1 to 15, uniquely representing the input or output device, as follows: select code 1—9 User assignable. select code 10 Cassette Memory. select code 11—13 reserved. select code 14 Plotter. select code 15 Typewriter or Printer.
string name	A single letter followed by a"$". Valid only when String ROM is also plugged in.
format	To reference a FORMAT statement, the line number of that statement is shown; for free-form data, an asterisk (*) is shown.
conversion table	The variable or array name given to a conversion table. See heading "Conversion Tables".
list	A list of variables, literals, expressions or numerics separated by commas.
FOR functions	To input multiple data items from one record into an array. Syntax as follows:

(FOR var 1 = exp TO exp, [(FOR var 2 = exp TO exp,] array name (var 1[, var 2])[])])

CONVERSION TABLES

Using a pre-established conversion table, a string of characters or an array of data can be converted from one code to another. The calculator makes use of standard ASCII* codes. Let us refer to all non-ASCII representation codes used by printers, car readers, paper tape readers, punches, typewriters, etc. as "foreign codes."

A conversion table is defined in the BASIC language program DIM statement Only single-dimensioned integer arrays are considered valid for use as conversion tables. In the following DIM statements, A and B are valid array structures for conversion tables, but C, D, and E are not.

```
DIM AI (150), CI(20, 30)
DIM BI ( 80), D(200), E(15, 15)
```

In order to insert conversion table information in the array, the foreign code must first be known. Suppose your paper tape reader uses EIA** coded tape. The chart following shows symbols and the equivalent tape punches for EIA code, with the octal code equivalent for each symbol.

---

* American Standard Code for Information Interchange.
** Electronic Industries Association Standard Code.

STANDARD TAPE CHANNEL NUMBERS									Symbol	EIA octal code
8	7	6	5	4	FEED	3	2	1		
		X			•				(ZERO) 0 -)	040
					•			X	1 - —	001
					•		X		2 - (2	002
			X		•		X	X	3 - #	023
					•	X			4 - $	004
			X		•	X		X	5 - %	025
			X		•	X	X		6 - '	026
					•	X	X	X	7 - &	007
				X	•				8 - *	010
			X	X	•			X	9 - (	031
	X	X			•			X	a - A	141
	X	X			•		X		b - B	142
	X	X	X		•		X	X	c - C	163
	X	X			•	X			d - D	144
	X	X	X		•	X		X	e - E	165
	X	X	X		•	X	X		f - F	166
	X	X			•	X	X	X	g - G	147
	X	X		X	•				h - H	150
	X	X	X	X	-			X	i - I	171
	X		X		•			X	j - J	121
	X		X		•		X		k - K	122
	X				•		X	X	l - L	103
	X		X		•	X			m - M	124
	X				•	X		X	n - N	105
	X				•	X	X		o - O	106
	X		X		•	X	X	X	p - P	127
	X		X	X	•				q - O	130
	X			X	•			X	r - R	111
		X	X		•		X		s - S	062
		X			•		X	X	t - T	043
		X	X		•	X			u - U	064
		X			•	X		X	v - V	045
		X			•	X	X		w - W	046
		X	X		•	X	X	X	x - X	067
		X	X	X	•				y - Y	070
		X		X	•			X	z - Z	051
			X		•				SPACE	020
	X				•				. - "	100
		X	X		•			X	/ - ?	061
				X	•		X	X	STOP	013
	X		X	X	•		X	X		133
		X	X	X	•		X	X	. - .	073
	X	X		X	•		X	X	. - .	153
			X	X	•	X				
		X		X	•	X				
	X			X	•	X			PUNCH ON	114
	X	X	X	X	•	X			UPPER CASE	174
	X	X	X		•				; - :	160
		X	X	X	•	X	X		. TAB	076
				X	•	X	X		CONTROL	016
		X		X	•	X	X	X	PUNCH OFF	067
			X	X	•	X	X	X	DATA SELECTOR (AUX. 3)	037
	X			X	•	X	X	X	FORM FEED (AUX. L)	117
			X	X	•		X			
	X			X	•		X			
		X		X	•		X		BACK SPACE	062
		X	X	X	•	X		X		
	X	X		X	•	X		X		
	X		X	X	•	X		X	ADDRESS IDEN (AUX. J)	135
				X	•	X		X		
	X	X	X	X	•		X		LOWER CASE	172
	X	X		X	•	X	X			
	X		X	X	•	X	X			
	X	X	X	X	•	X	X	X	TAPE FEED	177
X					•				CAR. RET.	200

The following chart shows the ASCII symbols with their octal code equivalents.

Symbol	ASCII Equivalent (octal code)
(Space)	Ø4Ø
!	Ø41
#	Ø43
$	Ø44
%	Ø45
&	Ø46
'	Ø47
(	Ø5O
)	Ø51
*	Ø52
+	Ø53
,	Ø54
-	Ø55
.	Ø56
/	Ø57
Ø	Ø6Ø
1	Ø61
2	Ø62
3	Ø63
4	Ø64
5	Ø65
6	Ø66
7	Ø67
8	Ø7Ø
9	Ø71
:	Ø72
;	Ø73
<	Ø74
=	Ø75
>	Ø76
?	Ø77
@	1ØØ

Symbol	ASCII Equivalent (octal code)
A	1Ø1
B	1Ø2
C	1Ø3
D	1Ø4
E	1Ø5
F	1Ø6
G	1Ø7
H	11Ø
I	111
J	112
K	113
L	114
M	115
N	116
O	117
P	12Ø
Q	121
R	122
S	123
T	124
U	125
V	126
W	127
X	13Ø
Y	131
Z	132
[	133
\	134
]	135

The following chart shows the information to be programmed into the conversion table.

Symbol	EIA (octal equiv)	ASCII (octal equiv)		Symbol	EIA (octal equiv)	ASCII (octal equiv)
Sp	020	040		A	141	101
!		041		B	142	102
#		013		C	163	163
$		044		D	144	104
%		045		E	165	105
&		046		F	166	106
1		047		G	147	107
				H	150	110
(		050		I	171	111
)		051		J	121	112
*		052		K	122	113
+		053		L	103	114
,	073	054		M	124	115
-	100	055		N	105	116
.	153	056		O	106	117
/	061	057		P	127	120
				Q	130	121
Ø	040	060		R	111	122
1	001	061		S	62	123
2	002	062		T	43	124
3	023	063		U	64	125
4	004	064		V	45	126
5	025	065		W	46	127
6	026	066		X	67	130
7	007	067		Y	70	131
8	010	070		Z	57	132
9	031	071				
:		072		[		133
;		073		\		134
<		074		]		135
=		075				
>		076				
?		077				
@		100				
CARR	200	012				

The conversion table portion of a BASIC program is shown on the chart below. Each statement defines one element in the conversion Table A with the use of the OCT function: the octal notation does not need to be translated to decimal. If decimal notation was supplied in the symbol tables, the OCT function could have been omitted; however, it is common to obtain symbol tables in the octal form rather than in decimal form.

```
10 D[M AI[128]
20 A[OCT20]=OCT40
30 A[OCT73]=OCT54
40 A[OCT100]=OCT55
50 A[OCT153]=OCT56
60 A[OCT61]=OCT57
70 A[OCT40]=OCT60
80 A[OCT1]=OCT61
90 A[OCT2]=OCT62
100 A[OCT23]=OCT63
110 A[OCT4]=OCT64
120 A[OCT25]=OCT65
130 A[OCT26]=OCT66
140 A[OCT7]=OCT67
150 A[OCT10]=OCT70
160 A[OCT31]=OCT71
170 A[OCT200]=OCT12
180 A[OCT141]=OCT101
190 A[OCT142]=OCT102
200 A[OCT163]=OCT103
210 A[OCT144]=OCT104
220 A[OCT165]=OCT105
230 A[OCT166]=OCT106
240 A[OCT147]=OCT107
250 A[OCT150]=OCT110
260 A[OCT171]=OCT111
270 A[OCT121]=OCT112
280 A[OCT122]=OCT113
290 A[OCT103]=OCT114
300 A[OCT124]=OCT115
310 A[OCT105]=OCT116
320 A[OCT106]=OCT117
330 A[OCT127]=OCT120
340 A[OCT130]=OCT121
350 A[OCT111]=OCT122
360 A[OCT62]=OCT123
370 A[OCT43]=OCT124
380 A[OCT64]=OCT125
390 A[OCT45]=OCT126
400 A[OCT46]=OCT127
410 A[OCT67]=OCT130
420 A[OCT76]=OCT131
430 A[OCT61]=OCT132
```

ENTER

When a CHAR request is keyed into the calculator for the paper tape reader, conversion is not done and the calculator will display the decimal equivalent of the EIA octal code for the symbol taken from the paper tape. In order to have automatic code conversion, the program must contain an ENTER statement.

```
410 ENTER (9, 420, A) B
```

B will be read and its ASCII equivalent found in the conversion table A. If data contained in a string is to be converted to ASCII code, the string name is used instead of the select code, and in this way conversion can be done internally as well as at time of input or output.

OUTPUT

For output of data in a foreign code, automatic code conversion is invoked by use of the OUTPUT statement.

```
500 OUTPUT (8, 510, A) B
```

The ASCII B will be found in the conversion table A and changed to the foreign code equivalent before output. Notice that the same conversion table A is used for input and output. The ENTER statement causes the calculator to look for ASCII code, (on the right of the equals (=) signs in the table) and assume that it is

receiving foreign code; whereas the OUTPUT statement causes the calculator to assume it has ASCII code, and to look for the foreign code (on the left of the equals (=) signs in the table above.

ERROR CODES

Program diagnostic or error conditions found in the Extended I/O ROM:

NUMBER	EXPLANATION
ERROR 83	End of data reached or data contains more than ten (10) blanks in a row.
ERROR 84	Invalid format specifications: format must be free format (*), E format or F format.
ERROR 85	Numeric input syntax error: multiple decimal points, more than one E in E format, etc.
ERROR 86	Conversion table not found. Check for integer initialization in DIM statement.

TERMINAL PLUG-IN READ-ONLY MEMORY MODULE

The terminal plug-in read-only memory module that is available with the calculator allows the user to enter, store, and edit free-text. It also allows the user to communicate, either directly or through an external modem, with another calculator, a computer or a time-sharing computer system. The calculator may transmit or receive BASIC language programs or free-text.

To put the calculator into terminal mode, the user types in TERM and actuates the EXECUTE key. If he wants to use the calculator for data transmission, he can specify one or two optional parameters following the TERM mnemonic. The first parameter is the select code of the modem interface module. If another select code is not specified the calculator assumes select code four. The second parameter is the baud rate of the transmitted data. If not specified, the calculator will assume 110 baud which is the same rate as a standard ASR232 teletypewriter. For example, to transmit or receive on select code six at 300 baud, the user enters TERM, 6,300 followed by actuation of the EXECUTE key. The selectable baud rate is continuous in integer increments from 3 to 300. The conversion of characters from parallel to serial format is done automatically within the calculator firmware, so that modem interface circuitry is simplified and no switches are required to change baud rate.

While the calculator is operating in the terminal mode, lines of text may be entered from the keyboard and terminated with the END-OF-LINE key. These lines must be preceded by a line number, but there is no syntax requirement for the remainder of the line. All of the line-by-line and character-by-character editing features of the calculator are available in this mode. These include listing, backspace, forward space, insert character, delete character, and display shift control. Automatic line numbering is also available. In addition, the tape cassette commands, the PTAPE command, the PRINT ALL command, and the LIST command operate normally. The LIST command syntax has been expanded to include LISTX, which means list without line numbers, as well as LIST≠SC or LISTX≠SC where SC is the select code of the modem interface, which means transmit the information through the modem to the remote system.

When the calculator is operating in the terminal mode, five of the user-definable keys take on special meaning. Key f5 becomes a teletype shift key (TELETYPE is a Registered Trade Mark), and f6 becomes a teletype control key. These keys and the lower case shift key allow the user to generate any seven-bit ASCII code. To generate a teletype shift or control character, the user first actuates the f5 and f6 keys and then actuates the appropriate key on the alpha section of the keyboard. For example, to generate a "control C", the f6 key and the C key are actuated sequentially. No character is entered into the display until after the chosen alpha key is actuated. The character entered into the display may or may not be the same as the alpha character. For instance a "shift 0" generates the symbol—┤.

Key f8 is used in the terminal mode to select even or odd parity for transmitted characters. When the terminal mode is first entered, even parity is

assumed. The user may then convert to odd parity by actuating key f8. The display will then indicate ODD. To revert back to even parity the user actuates key f8 again, and the display indicates EVEN.

Key f9 is used in the terminal mode as a transmit key. To transmit a message through the modem interface, the message is typed into the display from the keyboard, and then the line is terminated by actuating key f9. The calculator then serializes the characters entered, and transmits them at the selected baud rate. For example, to obtain a listing of a program from a remote time-sharing computer service, the user enters LIST f9. The transmit key may also be used to enter the responses in a sign-on procedure for a time-sharing service.

Key f7 is used to place the calculator into a mode for saving, in memory, an incoming program. For example, to receive and store a program from a time-sharing computer service, the user actuates key f7 followed by LIST f9. As the program is listed from the time-sharing service, the lines are stored in the calculator's user memory as free-text. If the f7 key is not actuated just prior to entering LIST f9, the program will be printed on the external line printer.

Once a program has been entered as free-text, either from a remote source or from the keyboard, and if it is a BASIC program, it may be checked for syntax errors and converted to BASIC program format in memory. This is done by typing COMP followed by actuation of the EXECUTE key. Any syntax errors will be listed, and only the lines which have correct BASIC syntax will be translated. Incorrect lines will remain in free-text format. After a program has been translated by the COMP command, it may be executed locally using any of the normal execution commands, i.e. RUN, CONT, etc. An attempt to execute an untranslated line will cause an error message (ERROR 79) to be displayed.

The receiving section of the modem driver routine operates under interrupt control which allows the user to execute programs locally and remotely at the same time. For example, the user may want to run a program on a time-sharing computer system that may take several minutes to complete. He may start the program by transmitting a RUN command. While that program is being executed, the calculator is free for normal keyboard operation or program execution. The only limitation in the mode is that this calculator may not use the display or printer at the same time as it is receiving information from the remote program.

PLOTTER PLUG-IN READ-ONLY MEMORY MODULE

The plotter plug-in read-only memory module enables the calculator to control an Hewlett-Packard 9862A calculator plotter, providing permanent graphic solutions to problems solved by the calculator.

In general, the plotter command set can be considered as consisting of two groups: plotting commands and writing commands. The user can specify any plotting units he pleases, the calculator then automatically scales those units to fit the chosen plotting area. Also, the calculator keyboard characters can be drawn in different sizes and directions.

The 'plotting' commands enable the system to automatically scale user-units; draw X and Y axes of any length, anywhere in the plotting area; make any desired tic-marks on the axes; plot points or functions; lower or raise the pen, either before or after movement; temporarily translate the established origin to any point within the plotting area and then plot, still in user-units, with respect to the new origin; plot in increments (that is, in user-units, plot any point with respect to the current pen position).

The 'writing' commands enable most calculator keyboard characters to be 'printed' on the plotter. The user can specify the position, height and width of the characters, and the direction in which they will be printed. A 'centering' command (CPLOT) enables labels to be centered on some particular point, thus simplifying labelling of axes and of specific points on the graph. The format of labels and numbers — field width, fixed or floating point, the number of digits following the decimal point, etc. — is specified by standard FORMAT statements. In addition, a unique LETTER command establishes a 'typewriter' mode enabling the plotter to be controlled and positioned from the calculator keyboard, on a character-by-character basis; this allows the user to add extra labelling or individual comments to his graphs.

INITIALIZING THE PLOTTER

Before plotting, the plotter must be prepared and the physical limits of the

plotting area must be established. The front-panel controls on the plotter are used for this purpose.

LINE AND CHART HOLD

The LINE pushbutton is the power switch for the plotter; press it to apply power, and press it again to remove power; the white LINE lamp lights whenever the plotter is ON.

Pressing CHART HOLD activates the electro-static paper hold-down mechanism. Pressing CHART HOLD again deactivates it. The plotter will not plot or letter, and the pen holder and arm will move freely in all directions when CHART HOLD is deactivated.

LOADING PAPER

To load paper, release CHART HOLD and manually move the pen arm all the way to one side of the plotter. Lay a sheet of paper on the plotting surface and smooth out any irregularities in the paper (you may also wish to ensure that the paper is squarely against the ridge at the bottom of the plotting surface); then activate CHART HOLD.

GRAPH LIMITS

The graph limit controls are used to determine the physical size of the plot.

LOWER LEFT and the two knobs to its left are used to determine the physical location of the lower left hand corner of the plotting area.

UPPER RIGHT and the two knobs to its right are used to determine the physical location of the upper right-hand corner of the plotting area. Together, the upper right-hand corner and the lower left-hand corner determine the size of the plotting area.

Also, altering the lower left-hand setting will translate the upper right-hand setting by the same direction and amount.

To specify the lower-left hand corner of the plotting area, poress LOWER LEFT; the pen will move (without touching the paper) to the lower left-hand corner of the plotting area. This point can be set anywhere within the lower left-hand quarter of the plotting surface (platen) by adjusting the two knobs associated with LOWER LEFT. Once the lower left-hand corner has been set, the upper right-hand corner is set in the same general way by pressing UPPER RIGHT and adjusting the two knobs associated with it. Once the plotting area has been determined, it can be relocated by moving the position of the lower left-hand corner — the upper right-hand corner will 'track' the change.

PLOTTING COMMANDS

NOTES: 1. All commands can be activated either from the keyboard or from a program except where noted.
2. All values in the following statements can be numbers, variables or expressions except where noted.
3. Any parameter enclosed in square brackets is optional as far as the statement containing it is concerned. However, program sense may dictate that the parameter be present in specific cases.

THE SCALE STATEMENT

SCALE Xmin, Xmax, Ymin, Ymax

Examples:

SCALE −10, 10, −5, 5

SCALE−4PI, 4PI, .3, 1.1

establishes the full-scale units for the plot. Xmin to Xmax and Ymin to Ymax correspond exactly to the limits of the horizontal and vertical edges, respectively, of the plotting area (the area is established mechanically as previously described). This also establishes the point, on or off the plotting area, where the original of the graph (0, 0) is located.

A SCALE statement must be executed before any plotting can occur. Once established the scale remains established until one of the following occurs:

A new SCALE statement is executed.
The program is initialized.
A SCRATCH or SCRATCH A or SCRATCH V is executed.
The calculator is switched off.

The parameters (X, Y, etc.) in the SCALE statement must be given in the correct order. If the minimum or maximum values are switched no ERROR message will occur; however, subsequent plotting commands may not be executed properly.

The SCALE statement has no effect on the position of the pen.

THE PEN STATEMENT

PEN

The PEN statement is a 'stand-alone' instruction requiring no parameter. It raises the pen without otherwise changing its position relative to the plotting area.

Instructions to raise or lower the pen, either before or after movement, can be easily included in several other statements (see PLOT and IPLOT so there is no special 'lower pen' instruction.

THE OFFSET STATEMENT

OFFSET X, Y

Example: OFFSET 3, –3

Temporarily offsets the origin (point 0, 0 established by the previous SCALE statement) by an amount, and in the direction, determined by the values (in user-units) of X and Y. All future plotting commands are then made with respect to the new origin until such time as that origin is again changed by means of, for example, a new OFFSET or a new SCALE statement.

The OFFSET statements are not accumulative; that is, a new "offset" is with respect to the original origin and not with respect to the last offset origin.

Offsetting greatly simplifies plotting, from the user's point of view, when it becomes necessary to divide the plotting area into several smaller segments and then make a separate plot in each segment. As the plot is made in each segment it is not necessary for the user to 'correct' each point before plotting; instead OFFSET statement moves the origin to some convenient point within that segment so that the calculator automatically makes the necessary 'corrections' for each point plotted.

THE AXIS STATEMENT

X AXIS Y-offset [, ±tic [, start point, end point]]

or Y AXIS X-offset [, ±tic [, start point, end point]]

X AXIS 3, 1, –4, 4

Draws an X–(or Y–) axis according to the parameters given in the AXIS statement. The pen is automatically raised both before and after drawing the axis.

(NOTE: The following describes the X-axis; the same information is applicable to the Y-axis if 'left' and 'right' for the X-axis are read as, respectively, 'bottom' and 'top' for the Y-axis.)

1. If no optional parameters are given, draws a straight line from left to right across the complete plotting area (from Xmin to Xmax). The line crosses the Y-axis at a point determined by the value of "y-offset'.
2. If a 'tic' parameter is included then tic marks are made along the axis as it is drawn; the value for the 'tic' determines the spacing, in user-units, between tics. The first tic is drawn at the starting point of the line. The tic parameter is usually positive (the sign is not required), but occasionally a negative tic spacing is useful — see 4, below.
3. If the start point/end point parameters are given, then the axis is drawn only between the points specified — from the start point to the end point.
4. a. A negative tic spacing when no start point/end point parameters are given results in a tic only at the left end (Xmin) of the axis.
   b. If the start point parameter is more positive than (i.e., to the right of) the end point parameter, then the axis is drawn from right to left; in this case, negative tic spacing results in normal tic marks being drawn along the axis.
   c. With the start point/end point parameters the same as in b above, a positive tic spacing results in a tic only at the right end (Xmax) of the axis.

THE PLOT STATEMENT

PLOT X, Y [, control pen]

PLOT SIN(X), COS(X), –2

Moves the pen to the co-ordinate specified by the value of X and Y.

When no optional 'control pen' parameter is given:

If the pen was raised, it moves to the point specified and then lowers.
If the pen was lowered, it remains lowered while moving to the point specified, thus drawing a line on the plotting surface.

The 'Control Pen' Parameter

The value and sign of this parameter in the PLOT (and IPLOT) statements determines whether the pen will be raised or lowered before or after it moves to the specified point.
If the parameter is:

negative — control occurs after movement;
positive — control occurs before movement;
odd — raises pen if it was lowered;
even — lowers pen if it was raised.

The value of the control parameter can be any number in the range ±32767. If the value is not an integer then it is automatically rounded up or down according to the value of the fractional part of the number; that is up to .5 or greater, or down for less than .5. (Rounding is the same as the standard rounding in the calculator; it is not the same as the INT function, where the value becomes that of the next lower integer.)

THE IPLOT STATEMENT

IPLOT deltaX, deltaY [, control pen]
IPLOT 2, −3A/4, 1

Moves the pen (from its current position) in the X direction and in the Y direction, by the amounts specified by 'deltaX' and 'deltaY', respectively.

The 'control pen' parameter is optional and operates exactly as described previously — see the PLOT STATEMENT.

Notice that the action of the IPLOT statement is such that it is as if, during the execution of that statement only, the origin (0, 0) of the graph is offset to the current position of the pen. Pen movement is then related to that offset origin.

The IPLOT statement is most useful when drawing regular geometric shapes such as, for example, a swastika (卐). In this case each point is more easily plotted with respect to the previous point, rather than with respect to the origin of the graph.

THE LABEL STATEMENT

LABEL (FORMAT statement number or *[, character height in %, Aspect ratio, angle of rotation [, paper height/paper width]]) print list

Examples: LABEL (x, 2, 2, Ø, 8.5/11) "PLOTTER"
LABEL (1ØØ) 1, A, SIN(X)

The LABEL statement is used to write alpha and numeric characters with the plotter. Several parameters are allowed which can be used to control the size, shape, and angle of rotation of the character printed. The character height can be specified in percent of the paper height. The aspect ratio is the ratio of the character height to the character width before any rotation. The angle of rotation of characters printed can be given. This parameter can be given in degrees, radians, or grads and is dependent on a previously given DEG, RAD, or GRAD statement. A fourth parameter can be specified. This is the ratio of the actual measured height of the plot paper to the measured width as set by the upper right and lower left positions. This parameter is necessary to keep proper aspect ratio of characters printed on an angle on a non-square plot. If not specified, the calculator will assume character height = 2.5%, aspect ratio = 2, rotation = Ø, and paper ratio = 1.

The format specification and the print list are the same as a WRITE statement. If a FORMAT statement number is specified, the print list is written on the plotter using the specification given in the FORMAT statement. All specifications are allowed except "B". If an "*" is used, the print list will be written according to standard format. This includes the normal definition of comma and semi-colon spacing, string fields, TAB, etc.

The LABEL statement will start printing characters at the current pen position. Anytime an end of line is needed, the plotter pen will return to the character position directly below the first character of the current line, simulating a carriage return, line feed.

If the string variables option block is also plugged into the memory, then string variables are allowed in the print list.

THE LETTER STATEMENT

LETTER

When the LETTER statement is executed, the calculator enters a unique 'typewriter' mode with the plotter as the printing device. While in this mode when the user hits any printing character on the keyboard, that character is immediately printed on the plotter at the current pen position. An EOL or EXECUTE will cause a carriage return, line-feed to be simulated. In addition, while in this mode the ↑, ↓, ←, and → keys can be used to position the pen. The ↑ and ↓ keys can cause the pen to move up or down one character position. The ← and → keys cause the pen to move left or right one character position. If the shift key is held down at the same time as a pen control key, the pen will move one-tenth of a character position. Character size, aspect ratio, and rotation can be specified by giving a LABEL statement prior to the LETTER statement.

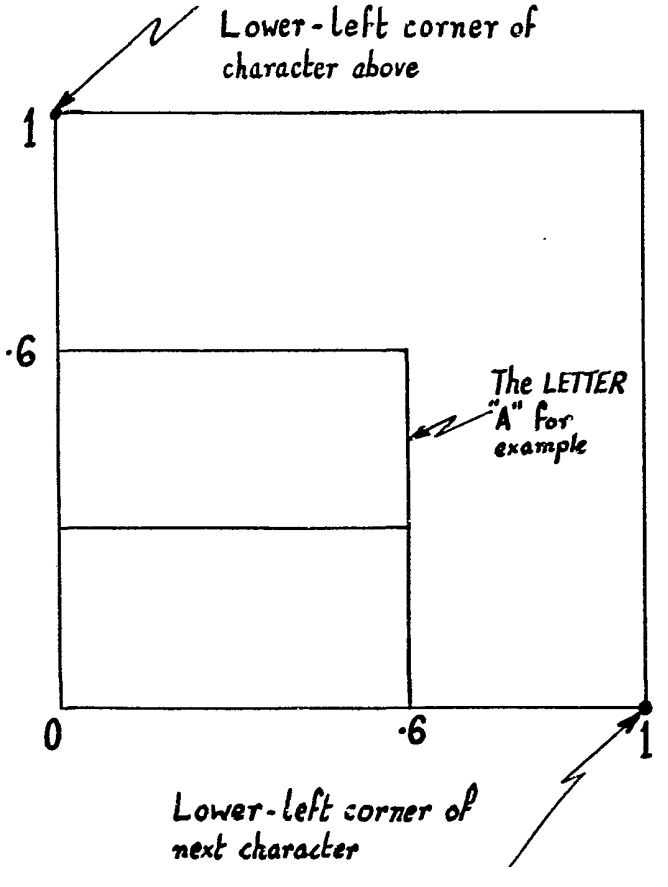
THE CPLOT STATEMENT

CPLOT delta X characters, delta Y characters

Example: CPLOT 5, −.3

The CPLOT statement is similar to the IPLOT statement in that it moves the pen to a position relative to the current pen position. The difference is that the delta X and delta Y values are specified in character size units. In the example above the pen would move five character position down. This statement is particularly useful in positioning the pen when labeling a plot using the LABEL statement.

One character space is defined as follows:



The error messages given by the plotter module are:

ERROR 80 — No scale statement executed before PLOT, IPLOT, OFFSET, or AXIS.

ERROR 81 — Character size too large (limited to = 20%) or binary mode not allowed.

ERROR 82 — OFFSET, POINT 1, or POINT 2 out of range during axis execution or tic increment in axis statement is too small.

MATRIX PLUG-IN READ-ONLY MEMORY MODULE

The Matrix read-only memory module enables the calculator to understand the MAT statements of BASIC. These statements facilitate the matrix operations of addition, substraction, initialization, scalar multiplication, matrix multiplication transposition, and inversion. A function additional to standard BASIC language matrix operations is provided for computing the determinant of a square matrix. The MAT READ and MAT PRINT commands facilitate entering data into an array and the printing thereof. The MAT INPUT command which appears in some versions of BASIC is not allowed. The matrix operations are allowed on split precision or integer arrays as well as full floating point arrays.

The operations performed by this matrix module are summarized below and additional information is provided above in section IV above.

A. MAT READ

reads numeric information from DATA statements into an array

MAT READ A

MAT READ A(3,5)

MAT READ B,W(8),X,Y

B. MAT PRINT

prints complete arrays

close packing specified with a semicolon

MAT PRINT A

MAT PRINT A;

MAT PRINT R,S;V;W

C. ZER, CON, and IDN operations

ZER: initialize an array to all zeros

CON: initialize an array to all ones

IDN: initalize an array to the identity matrix

MAT A = ZER

MAT Q = CON(9)

MAT I – IDN(4,4)

D. MAT assignment statements

assign to a matrix the result of a MAT operation

1) MAT A = B

assigns elements of A from array B

2) MAT A = B ± C

performs indicated addition or subtraction and assigns result to A

any of A, B, and C may be the same matrix

3) MAT A = B * C

performs indicated multiplication and assigns result to A

array A must be distinct from B or C

4) MAT A = (expression) * B

performs the indicated scalar multiply (each element of B is multiplied by the value of the expression) and assigns the result to A

5) MAT A = TRN(B)

assigns the transpose of B to A

array A must be distinct from B

6) MAT A = INV(B)

assigns the inverse of B to A

A and B may be the same matrix

E. DET operation

calculates the determinant of a square matrix

MAT D4 = DET(A)

KEY CODES AND MNEMONICS

All of the keys of the keyboard input unit and their associated mnemonics and binary keycodes are listed in the Table below. Every key has one mnemonic and two keycodes, (namely, a shifted keycode and an unshifted keycode). Keycodes are applied to the CPU in eight-bit binary form. The first four bits of each keycode are given in the left-most vertical column of the table below and the next three bits of each keycode are given in the uppermost row of the table below. The eighth bit of each keycode is the shift bit and is determined by whether or not the shift key of the keyboard input unit is depressed. Keycodes entered into the CPU from the keyboard input unit or from the program storage section of the memory unit are processed by the keyboard input routine 204 as generally described above in connection with Figure 9 and as shown in detail in Figures 88A—G.

KEYCODE AND MNEMONIC TABLE

b3b2b1b0	D0 b6=0 b5=0 b4=0	D1 b6=0 b5=0 b4=1	D2 b6=0 b5=1 b4=0	D3 b6=0 b5=1 b4=1	D4 b6=1 b5=0 b4=0	D5 b6=1 b5=0 b4=1	D6 b6=1 b5=1 b4=0	D7 b6=1 b5=1 b4=1
0 0 0 0	f0	RECALL	SPACE	ø		P		PA
0 0 0 1	f1	FETCH		1	A	Q		STOP
0 0 1 0	f2	BACK		2	B	R		EOL
0 0 1 1	f3	FWD		3	C	S		DL
0 1 0 0	f4	↓		4	D	T		FXD
0 1 0 1	f5	↑		5	E	U		FLT
0 1 1 0	f6	←		6	F	V		SCRATCH
0 1 1 1	f7	→		7	G	W		AUTO
1 0 0 0	f8	LOAD	(	8	H	X		
1 0 0 1	f9	STORE	)	9	I	Y		
1 0 1 0	LIST	INIT	X	* :	J	Z	CLR	
1 0 1 1	EXEC	/	+	;	K		RESULT	
1 1 0 0	CONT		,		L			
1 1 0 1	STEP	STD	-	=	M			
1 1 1 0	TRACE	NORMAL	.		N	↑		
1 1 1 1	RUN	INSERT	? /		O		ENTER EXP	

BASIC INSTRUCTION SET

Every routine and subroutine of the calculator comprises a sequence of one or more of 71 basic sixteen-bit instructions listed below. These 71 instructions are all implemented serially by the micro-processor in a time period which varies according to the specific instruction, to whether or not it is indirect, and to whether or not the skip condition has been met.

Upon completion of the execution of each instruction, the program counter (P register) has been incremented by one except for instructions JMP, JSM, and the skip instructions in which the skip condition has been met. The M-register is left with contents identical to the P-register. The contents of the addressed memory location and the A and B registers are left unchanged unless specified otherwise.

Memory Reference Group

The 14 memory reference instructions refer to a specific address in memory determined by the address field <m>, by the ZERO/CURRENT page bit, and by the DIRECT/INDIRECT bit. Page addressing and indirect addressing are both described in detail in the reference manuals for the Hewlett-Packard Model 2116 computer (hereinafter referred to as the HP 2116).

The address field <m> is a 10 bit field consisting of bits 0 through 9. The ZERO/CURRENT page bit is bit 10 and the DIRECT/INDIRECT bit is bit 15, except for reference to the A or B register in which case bit 8 becomes the DIRECT/INDIRECT bit. An indirect reference is denoted by a <, I> following the address <m>.

Memory Reference Group (continued).

REGISTER REFERENCE OF A OR B REGISTER: If the location <A> or <B> is used in place of <m> for any memory reference instruction, the instruction will treat the contents of A or B exactly as it would the contents of location <m>. See the note below on the special restriction for direct register reference of A or B.

ADA m, I Add to A. The contents of the addressed memory location m are added (binary add) to contents of the A register, and the sum remains in the A register. If carry occurs from bit 15, the E register is loaded with 0001, otherwise E is left unchanged.

ADB m, I Add to B. Otherwise identical to ADA.

CPA m, I Compare to A and skip if unequal. The contents of the addressed memory location are compared with the contents of the A register. If the two 16-bit words are different, the next instruction is skipped; that is, the P and M registers are advanced by two instead of one. Otherwise, the next instruction will be executed in normal sequence.

CPB m, I Compare to B and skip is unequal. Otherwise identical to CPA.

LDA m, I Load into A. The A register is loaded with the contents of the addressed memory location.

LDB m, I Load into B. The B register is loaded with the contents of the addressed memory location.

STA m, I Store A. The contents of the A register are stored into the addressed memory location. The previous contents of the addressed memory location are lost.

STB m, I Store B. Otherwise identical to STA.

IOR m, I "Inclusive OR" to A. The contents of the addressed location are combined with the contents of the A register as an "INCLUSIVE OR" logic operation.

ISZ m, I Increment and Skip if Zero. The ISZ instruction adds ONE to the contents of the addressed memory location. If the result of this operation is ZERO, the next instruction is skipped; that is, the P and M registers are advanced by TWO instead of ONE. The incremental value is written back into the addressed memory location. Use of ISZ with the A or B register is limited to indirect reference; see footnote on restrictions.

AND m, I Logical "AND" to A. The contents of the addressed location are combined with the contents of the A register as an "AND" logic operation.

DSZ m, I Decrement and Skip if Zero. The DSZ instruction subtracts ONE from the contents of the addressed memory location. If the result of this operation is zero, the next instruction is skipped. The decremented value is written back into the addressed memory location. Use of DSZ with the A or B register is limited to indirect reference; see footnote on restrictions.

JSM m, I Jump to Subroutine. The JSM instruction permits jumping to a subroutine in either ROM or R/W memory. The contents of the P register is stored at the address contained in location 1777 (stack pointer). The contents of the stack pointer is incremented by one, and both M and P are loaded with the referenced memory location.

JMP m, I Jump. This instruction transfers control to the contents of the addressed location. That is, the referenced memory location is loaded into both M and P registers, effecting a jump to that location.

Shift-Rotate Group

The eight shift-rotate instructions all contain a 4 bit variable shift field <n> which permits a shift of one through 16 bits; that is, $1 \leq n \leq 16$. If <n> is omitted, the shift will be treated as a one bit shift. The shift code appearing in bits 8, 7, 6, 5 is the binary code for n−1, except for SAL and SBL, in which cases the complementary code for n−1 is used.

AAR n Arithmetic right shift of A. The A register is shifted right n places with the sign bit (bit 15) filling all vacated bit positions. That is, the n+1 most significant bits become equal to the sign bit.

ABR n Arithmetic right shift of B. Otherwise identical to AAR.

SAR n Shift A right. The A register is shifted right n places with all vacated bit positions cleared. That is, the n most significant bits become equal to zero.

SBR n Shift B right. Otherwise identical to SAR.

SAL n Shift A left. The A register is shifted left n places with the n least significant bits equal to zero.

SBL n Shift B left. Otherwise identical to SAL.

RAR n Rotate A right. The A register is rotated right n places, with bit 0 rotated around to bit 15.

RBR n Rotate B right. Otherwise identical to RAR.

Alter-Skip Group

The sixteen alter-skip instructions all contain a 5-bit variable skip field <n> which, upon meeting the skip condition, permits a relative branch to any one of 32 locations. Bits 9, 8, 7, 6, 5 are coded for positive or negative relative branching in which the number <n> is the number to be added to the current address, (skip in *forward* direction), and the number<−n> is the number to be subtracted from the current address, (skip in negative direction). If <n> is omitted, it will be interpreted as a ONE.

<n>=0	CODE=00000	REPEAT SAME INSTRUCTION
<n>=1	CODE=00001	DO NEXT INSTRUCTION
<n>=2	CODE=00010	SKIP ONE INSTRUCTION
<n>=15	CODE=01111	ADD 15 TO ADDRESS
<n>=−1	CODE=11111	DO PREVIOUS INSTRUCTION
<n>=−16	CODE=10000	SUBTRACT 16 FROM ADDRESS
<n>=nothing	CODE=00001	DO NEXT INSTRUCTION

The alter bits consist of bits 10 and bits 4. The letter <S> following the instruction places a ONE in bit 10 which causes the tested bit to be *set* after the test. Similarly the letter <C> will place a ONE in bit 4 to *clear* the test bit. If both a set and clear bit are given, the set will take precedence. Alter bits do not apply to SZA, SZB, SIA, and SIB.

SZA n Skip if A zero. If all 16 bits of the A register are zero, skip to location defined by n.

SZB n Skip if B zero. Otherwise identical to SZA.

RZA n Skip if A not zero. This is a "Reverse Sense" skip of SZA.

RZB n Skip if B not zero. Otherwise identical to RZA.

SIA n Skip if A zero; then increment A. The A register is tested for zero, then incremented by one. If all 16 bits of A were zero before incrementing, skip to location defined by n.

SIB n Skip if B zero; then increment B. Otherwise identical to SIA.

Alter-Skip Group (continued)

RIA n Skip if A not zero; then increment A. This is a "Reverse Sense" skip of SIA.

RIB n Skip if B not zero; then increment B. Otherwise identical to RIA.

SLA n, S/C Skip if Least Significant bit of A is zero. If the least significant bit (bit 0) of the A register is zero, skip to location defined by n. If either S or C is present, the test bit is altered accordingly after test.

SLB n, S/C Skip if Least Significant bit of B is zero. Otherwise identical to SLA.

SAM n, S/C Skip if A is Minus. If the sign bit (bit 15) of the A register is a ONE, skip to location defined by n. If either S or C is present, bit 15 is altered after the test.

SBM n, S/C Skip if B is Minus. Otherwise identical to SAM.

SAP n, S/C Skip if A is Positive. If the sign bit (bit 15) of the A register is a ZERO, skip to location defined by n. If either S or C is present, bit 15 is altered after the test.

SBP n, S/C Skip if B is Positive. Otherwise identical to SAP.

SES n, S/C Skip if Least Significant bit of E is Set. If bit 0 of the E register is a ONE, skip to location defined by n. If either S or C is present, the entire E register is set or cleared respectively.

SEC n, S/C Skip if Least Significant bit of E is Clear. If bit 0 of the E register is a ZERO, skip to location defined by n. If either S or C is present, the entire E register is set or cleared respectively.

Complement-Execute-DMA Group.

These seven instructions include complement operations and several special-purpose instructions chosen to speed up printing and extended memory operations.

CMA Complement A. The A register is replaced by its One's complement.

CMB Complement B. The B register is replaced by its One's complement.

TCA Two's Complement A. The A register is replaced by its One's Complement and incremented by one.

TCB Two's complement B. The B register is replaced by its One's Complement and incremented by one.

EXA Execute A. The contents of the A register are treated as the current instruction, and executed in the normal manner. The A register is left unchanged unless the instruction code causes A to be altered.

EXB Execute B. Otherwise identical to EXA.

DMA Direct Memory Access. The DMA control in Extended Memory is enabled by setting the indirect bit in M and giving a WTM instruction. The next ROM clock transfers A→M and the following two cycles transfer B→M. ROM clock then remains inhibited until released by DMA control.

Note: Special Restriction for Direct Register Reference of A or B.

For the five register reference instructions which involve a write operation during execution, a register reference to A or B must be restricted to an INDIRECT reference. These instructions are STA, STB, ISZ, DSZ, and JSM. A DIRECT register reference to A or B with these instructions may result in

program modification. (This is different from the hp 2116 in which a memory reference to the A or B register is treated as a reference to locations 0 or 1 respectively.) A reference to location 0 or 1 will actually refer to locations 0 or 1 in Read Only Memory.

Input/Output Group (IOG)

The eleven IOG instructions, when given with a select code, are used for the purpose of checking flags, setting or clearing flag and control flip-flops, and transferring data between the A/B registers and the I/O register.

STF <SC> Set the flag. Set the flag flip-flop of the channel indicated by select code <SC>.

CLF <SC> Clear the flag flip-flop of the channel indicated by select code <SC>.

SFC <SC> Skip if flag clear. If the flag flip-flop is clear in the channel indicated by <SC>, skip the next instruction.

SFS <SC> H/C Skip if flag set. If the flag flip-flop is set in the channel indicated by <SC>, skip the next instruction. H/C indicates if the flag flip-flop should be held or cleared after executing SFS.

CLC <SC> H/C Clear control. Clear the control flip-flop in the channel indicated by <SC>. H/C indicates if the flag flip-flop should be held or cleared after executing CLC.

STC <SC> H/C Set Control. Set the control flip-flop in the channel indicated by <SC>. H/C indicates if the flag flip-flop should be held or cleared after executing STC.

OT* <SC> H/C Output A or B. Sixteen bits from the A/B register are output to the I/O register. H/C allows holding or clearing the flag flop after execution of OT*. The different select codes allow different functions to take place after loading the I/O register.

SC=00 Data from the A or B register is output eight bits at a time for each OT* instruction given. The A or B register is rotated right eight bits.

SC=01 The I/O register is loaded with 16 bits from the A/B registers.

SC=02 Data from the A/B register is output one bit at a time for each OT* instruction for the purpose of giving data to the Magnetic Card Reader. The I/O register is unchanged.

SC=04 The I/O register is loaded with 16 bits from the A/B register and the control flip flop for the printer is then set.

SC=08 The I/O register is loaded with 16 bits from the A/B register and the control flip flop for the display is then set.

SC=16 The I/O register is loaded with 16 bits from the A/B register and then data in the I/O register is transferred to the switch latches.

LI* <01> H/C Load into A or B. Load 16 bits of data into the A/B register from the I/O register. H/C allows holding or clearing the flag flop after LI* has been executed.

Input-Output Group (IOG), continued.

LI* <00> The least significant 8 bits of the I/O register are loaded into the most significant locations in the A or B register.

MI* <01> H/C Merge into A or B. Merge 16 bits of data into the A/B register from the I/O register by "inclusive or". H/C allows holding or clearing the flag flop after M1* has been executed.

MI* <00> The least significant 8 bits of the I/O register are combined by inclusive OR with the least significant 8 bits of the A or B register, and rotated to the most significant bit locations of the A or B register.

MAC Instruction Group

A total of 16 MAC instructions are available for operation
(a) with the whole floating-point data (like transfer, shifts, etc), or
(b) with two floating-point data words to speed up digit and word loops in arithmetic routines.

NOTE: $<A_{0-3}>$ means: contents of A-register bit 0 to 3
AR 1 is a mnemonix for arithmetic pseudo-register located in R/W memory on addresses 1744 to 1747 (octal)
AR 2 is a mnemonix for arithmetic pseudo-register located in R/W memory on addresses 1754 to 1757 (octal)
D_i means: mantissas i-th decimal digit; most significant digit is D1 least significant digit is D12 decimal point is located between D1 and D2
Every operation with mantissa means BCD-coded decimal operation.

RET Return
16-bit-number stored at highest occupied address in stack is transferred to P- and M-registers. Stack pointer (=next free address in stack) is decremented by one. <A>, <B>, <E> unchanged.

MOV Move overflow
The contents of E-register is transferred to A_{0-3}. Rest of A-register and E-register are filled by zeros. <B> unchanged.

CLR Clear a floating-point data register in R/W memory on location <A>
ZERO→<A>, <A>+1, <A>+2, <A>+3
<A>, <B>, <E> unchanged

XFR Floating-point data transfer in R/W memory from location <A> to location <B>.
Routine starts with exponent word transfer.
Data on location <A> is unchanged.
<E> unchanged.

MRX AR1 mantissa is shifted to right n-times. Exponent word remains unchanged.
$<B_{0-3}>$ = n (binary coded)
1st shift: $<A_{0-3}> \rightarrow D_1$; $D_i \rightarrow D_{i+1}$; D_{12} is lost
jth shift: $\cancel{0} \rightarrow D_1$; $D_i \rightarrow D_{i+1}$; D_{12} is lost
nth shift: $\cancel{0} \rightarrow D_1$; $D_i \rightarrow D_{i+1}$; $D_{12} \rightarrow A_{0-3}$
$\cancel{0} \rightarrow E$, A_{4-15}
each shift: $<B_{0-3}> - 1 \rightarrow B_{0-3}$
$<B_{4-15}>$ unchanged

MRY AR2 mantissa is shifted to right n-times. Otherwise identical to MRX

MLS AR2 mantissa is shifted to left once. Exponent word remains unchanged.
$\cancel{0} \rightarrow D_{12}$; $D_i \rightarrow D_{i-1}$; $D_1 \rightarrow A_{0-3}$
<B> unchanged

DRS AR1 mantissa is shifted to right once. Exponent word remains unchanged
$\not{0} \rightarrow D_1$; $D_i \rightarrow D_{i+1}$; $D_{12} \rightarrow A_{0-3}$
ZERO → E and $A_{4\times15}$
<B> unchanged

DLS AR1 mantissa is shifted to left once. Exponent word remains unchanged.
$<A_{0-3}> \rightarrow D_{12}$; $D_i \rightarrow D_{i-1}$; $D_1 \rightarrow A_{0-3}$
$\not{0} \rightarrow E$, A_{4-15}
<B> unchanged

FXA Fixed-point addition
Mantissas in pseudo-registers AR2 and AR1 are added together and result is placed into AR2. Both exponent words remain unchanged. When overflow occurs "0001" is set into E-reg., in opposite case <E> will be zero.
<AR2> + <AR1> + DC → AR2
DC = $\not{0}$ if <E> was 0000 before routine execution
DC = 1 if <E> was 1111 before routine execution
<B>, <AR1> unchanged

FMP Fast multiply
Mantissas in pseudo-registers AR2 and AR1 are added together $<B_{0-3}>$–times and result is placed into AR2.
Total decimal overflow is placed to A_{0-3}. Both exponent words remain unchanged.
<AR2> + <AR1> * $<B_{0-3}>$+DC → AR2
DC = 0 if <E> was 0000 before routine execution
DC = 1 if <E> was 1111 before routine execution
ZERO → E, A_{4-15}
<AR1> unchanged

FDV Fast divide
Mantissas in pseudo-registers AR2 and AR1 are added together so many times until first decimal overflow occurs. Result is placed into AR2. Both exponent words remain unchanged. Each addition without overflow causes +1 increment of <B>.
1st addition: <AR2> + <AR1> + DC → AR2
DC = 0 if <E> was 0000 before routine execution
DC = 1 if <E> was 1111 before routine execution
next additions: <AR2> + <AR1> → AR2
ZERO → E
<AR1> unchanged

CMX 10's complement of AR1 mantissa is placed back to AR1, and ZERO is set into E-register. Exponent word remains unchanged
<B> unchanged

CMY 10's complement of AR2 mantissa.
Otherwise identical to CMY

MDI Mantissa decimal increment.
Mantissa on location <A> is incremented by decimal ONE on D_{12} level, result is placed back into the same location, and zero is set into E-reg.
Exponent word is unchanged.
When overflow occurs, result mantissa will be
1, 000 0000 0000 (dec)
and 0001 (bin) will be set into E-reg.
<B> unchanged.

NRM Normalization
Mantissa in pseudo-register AR2 is rotated to the left to get $D_1 \neq 0$. Number of these 4-bit left shifts is stored in B_{0-3} in binary form ($<B_{4-15}>=0$)
when $<B_{0-3}>$ = 0, 1, 2,. . . ,11 (dec) → <E> = 0000
When $<B_{0-3}>$ = 12 (dec) →mantissa is zero, and <E> 0001
Exponent word remains unchanged
<A> unchanged.

The binary codes of all of the above instructions are listed in the following coding table, where * implies the A or B register, D/I means direct/indirect, A/B means A register/B register, Z/C means zero page (base page) (current page, H/S means hold test bit/set test bit, and H/C means hold test bit/clear test bit. D/I, A/B, Z/C, H/S, and H/C are all coded as 0/1.

CODING TABLE

GROUP	OCTAL	INSTR	15	14 13 12	11 10	9 8 7 6 5 4 3 2 1 0
MEMORY REFERENCE GROUP	-0----	ADx	D/I	0 0 0	A/B Z/C	← MEMORY ADDRESS →
	-1----	CPx	D/I	0 0 1	A/B Z/C	
	-2----	LDx	D/I	0 1 0	A/B Z/C	
	-3----	STx	D/I	0 1 1	A/B Z/C	
	-4----	IOR	D/I	1 0 0	0 Z/C	
	-4----	ISZ	D/I	1 0 0	1 Z/C	
	-5----	AND	D/I	1 0 1	0 Z/C	
	-5----	DSZ	D/I	1 0 1	1 Z/C	
	-6----	JSM	D/I	1 1 0	0 Z/C	
	-6----	JMP	D/I	1 1 0	1 Z/C	
SHIFT-ROTATE GROUP	07---0	A*R	0	1 1 1	A/B	← SHIFT CODE → 0 0 0 0
	07---2	S*R	0	1 1 1	A/B	0 0 1 0
	07---4	S*L	0	1 1 1	A/B	0 1 0 0
	07---6	R*R	0	1 1 1	A/B	0 1 1 0
ALTER-SKIP GROUP	07---0	SZx	0	1 1 1	A/B 0	← SKIP CODE → 0 1 0 0 0
	07---0	RZx	0	1 1 1	A/B 1	0 1 0 0 0
	07---0	SIx	0	1 1 1	A/B 0	1 1 0 0 0
	07---0	RIx	0	1 1 1	A/B 1	1 1 0 0 0
	07---1	SLx	0	1 1 1	A/B H/(S)	H/(C) 1 0 0 1
	07---2	S*M	0	1 1 1	A/B H/S	H/C 1 0 1 0
	07---3	S*P	0	1 1 1	A/B H/S	H/C 1 0 1 1
	07---4	SES	0	1 1 1	A/B H/S	H/C 1 1 0 0
	07---5	SEC	0	1 1 1	A/B H/S	H/C 1 1 0 1
REGISTER REFERENCE GROUP	07--17	ADA	0	1 1 1	A/B — —	D/I 0 0 0 0 1 1 1 1
	07--37	ADB	0	1 1 1	A/B — —	D/I 0 0 0 1 1 1 1 1
	07--57	CPA	0	1 1 1	A/B — —	D/I 0 0 1 0 1 1 1 1
	07--77	CPB	0	1 1 1	A/B — —	D/I 0 0 1 1 1 1 1 1
	07--17	LDA	0	1 1 1	A/B — —	D/I 0 1 0 0 1 1 1 1
	07--37	LDB	0	1 1 1	A/B — —	D/I 0 1 0 1 1 1 1 1
	07-557	STA	0	1 1 1	A/B — —	1 0 1 1 0 1 1 1 1
	07-577	STB	0	1 1 1	A/B — —	1 0 1 1 1 1 1 1 1
	07--17	IOR	0	1 1 1	A/B — —	D/I 1 0 0 0 1 1 1 1
	07-637	ISZ	0	1 1 1	A/B — —	1 1 0 0 1 1 1 1
	07--57	AND	0	1 1 1	A/B — —	D/I 1 0 1 0 1 1 1 1
	07-677	DSZ	0	1 1 1	A/B — —	1 1 0 1 1 1 1 1
	07-717	JSM	0	1 1 1	A/B — —	1 1 1 0 0 1 1 1
	07--37	JMP	0	1 1 1	A/B — —	D/I 1 1 0 1 1 1 1

CONTINUED

CODING TABLE CONTINUED

GROUP	OCTAL	INSTR	15 14 13 12	11 10 9	8 7 6	5 4 3	2 1 0
COMP EXECUTE DMA	07-016	EX*	0 1 1 1	A/B — —	— — —	0 0 1	1 1 0
	070036	DMA	0 1 1 1	0 — —	— — —	0 1 1	1 1 0
	07-056	CM*	0 1 1 1	A/B — —	— — —	1 0 1	1 1 0
	07-076	TC*	0 1 1 1	A/B — —	— — —	1 1 1	1 1 0
INPUT OUTPUT GROUP	1727--	STF	1 1 1 1	— 1 0	1 1 1	SELECT CODE	
	1737--	CLF	1 1 1 1	— 1 1	1 1 1		
	17-7--	SFC	1 1 1 1	— 1 H/C	1 1 1		
	17-5--	SFS	1 1 1 1	— 1 H/C	1 0 1		
	17-5--	CLC	1 1 1 1	— 1 H/C	1 0 1		
	17-6--	STC	1 1 1 1	— 1 H/C	1 1 0		
	17-1--	OT*	1 1 1 1	A/B 1 H/C	0 0 1		
	17-2--	LI*	1 1 1 1	A/B 1 H/C	0 1 0		
	17-0--	MI*	1 1 1 1	A/B 1 H/C	0 0 0		
MAC GROUP	170402	RET	1 1 1 1	0 0 0	1 0 0	0 0 0	0 1 0
	170002	MOV	1 1 1 1	0 0 0	0 0 0	0 0 0	0 1 0
	170000	CLR	1 1 1 1	0 0 0	0 0 0	0 0 0	0 0 0
	170004	XFR	1 1 1 1	0 0 0	0 0 0	0 0 0	1 0 0
	174430	MRX	1 1 1 1	1 0 0	1 0 0	0 1 1	0 0 0
	174470	MRY	1 1 1 1	1 0 0	1 0 0	1 1 1	0 0 0
	171400	MLS	1 1 1 1	0 0 1	1 0 0	0 0 0	0 0 0
	170410	DRS	1 1 1 1	0 0 0	1 0 0	0 0 1	0 0 0
	175400	DLS	1 1 1 1	1 0 1	1 0 0	0 0 0	0 0 0
	170560	FXA	1 1 1 1	0 0 0	1 0 1	1 1 0	0 0 0
	171460	FMP	1 1 1 1	0 0 1	1 0 0	1 1 0	0 0 0
	170420	FDV	1 1 1 1	0 0 0	1 0 0	0 1 0	0 0 0
	174400	CMX	1 1 1 1	0 0 0	1 0 0	0 0 0	0 0 0
	170400	CMY	1 1 1 1	0 0 0	1 0 0	0 0 0	0 0 0
	170540	NDI	1 1 1 1	0 0 0	1 0 1	1 0 0	0 0 0
	171450	NRM	1 1 1 1	0 0 1	1 0 0	1 0 1	0 0 0

DETAILED LISTING OF ROUTINES AND SUBROUTINES OF BASIC INSTRUCTIONS

A complete listing of all of the routines and subroutines of basic instructions employed by the calculator and of all of the constants employed by these routines and subroutines is given below. All of these routines, subroutines, and constants are stored either in the basic ROM or in the plug-in ROM modules employed therewith. Each page within the listing is numbered at the upper left-hand corner. Each line of each page is separately numbered in the first column from the left-hand side of the page. This facilitates reference to different parts of the listing. Descriptive headings are also provided throughout the listing to identify routines, subroutines, groups of constants, different portions of the ROM, the plug-in ROM modules, etc. Each instruction of each routine or subroutine and each constant stored in the ROM or plug-in ROM modules is represented in octal form by six digits in the third column from the left-hand side of the page, and the address of the ROM location in which each such instruction or constant is stored is represented in octal form by five digits in the second column from the left-hand side of the page.

Mnemonic labels serving as symbolic addresses or names are given in the fourth column from the left-hand side of the page for most of the constants and many of the instructions to facilitate references to these constants and instructions and associated instructions. The mnemonic code of each basic instruction and of each pseudo instruction is given in the fifth column from the left-hand side of the

page. As noted above, each basic instruction is employed as a step in a routine or subroutine of one or more basic instructions and therefore has an address in the ROM. Pseudo instructions such as ORG, EQU, etc. which appear (and are recognizable as not being one of the 71 basic machine instructions listed above) are used for control of the Assembler, which translates the symbolic/mnemonic coding of the fourth, fifth, and sixth columns into the address and contents of ROM registers which appear in the second and third columns. (See chapter 4 of the Hewlett-Packard "Assembler Programmer's Reference Manual" of April, 1970.) They are not employed as steps in the routines and subroutines performed by the calculator and therefore have no addresses in the ROM. Mnemonic operand codes are given in the sixth column from the left-hand side of the page, and descriptive comments are given to the right of the sixth column. The format, assembly, and use of the listing is explained in greater detail in the above-mentioned Hewlett-Packard "Assembler Programmer's Reference Manual".

In addition, cross-reference symbol tables are included directly below each group of routines and subroutines for providing alphabetical listing of each of the mnemonic labels and operands. The number contained in the first column to the right of each mnemonic in the cross-reference table represents the line in the associated routine or subroutine listing at which that mnemonic appears as a label in column four. Subsequent columns beyond the first column to the right of each mnemonic in the cross-reference table represent the line in the associated routine or subroutine listing at which that mnemonic appears as an operand in column six.

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```
0001                    ASMB,A,L,C
0003* MAIN SYSTEM FIRMWARE LISTING 3—27—72
0004*
0005  00000                     ORG 0
0006*
0007  00000  164121              JMP  START,I  START OF MONITOR
0008  00001  043060              OCT  43060    CONSTANT NEEDED BY PROCESSOR
0009  00002  161463              JSM  INTEL,I  INTERRUPT
0010*
0011  00003  000000  C6          OCT  0        ONE
0012  00004  010000              OCT  010000   0000
0013  00005  000000              OCT  0        0000
0014*
0015  00006  000000  C5          OCT  0000000  PI/2
0016  00007  012560              OCT  12560    1570
0017  00010  074543              OCT  074543   7963
0018  00011  023200              OCT  023200   2680
0019*
0020  00012  000001  .1          DEC  1
0021*
0022  00013  000400  C7          OCT  000400   180/PI
0023  00014  053451              OCT  053451   5729
0024  00015  053571              OCT  053571   5779
0025  00016  050450              OCT  050450   5128
0026*
0027  00017  000002  .2          DEC  2
0028  00020  000003  .3          DEC  3
0029  00021  000004  .4          DEC  4
0030  00022  000005  .5          DEC  5
0031  00023  000006  .6          DEC  6
0032  00024  000007  .7          DEC  7
0033  00025  000010  .8          DEC  8
0034  00026  000011  .9          DEC  9
0035  00027  000013  .11         DEC  11
0036  00030  000014  .12         DEC  12
0037  00031  000015  CRTN        OCT  15
0038  00031          EOL         EQU  CRTN
0039  00031          .13         EQU  CRTN
0040**********
0041* POINTERS TO FUNCTIONS CONSTANTS
0042*
0043  00027          DPERR       EQU  .11      POINTER TO 180/PI
0044  00023          PI/2        EQU  .6       POINTER TO PI/2
0045  00020          ONE         EQU  .3       POINTER TO THE CONSTANT ONE
0046*
0047**********
0048  00032  000017  .15         DEC  15
0049  00033  000020  .16         DEC  16
0050  00034  000025  .21         DEC  21
0051  00035  000026  .22         DEC  22
0052  00036  000027  .23         DEC  23
0053  00037  000034  .28         DEC  28
0054  00040  000037  .31         DEC  31
0055  00041  000040  .32         DEC  32
0056  00042  000041  .33         DEC  33
0057  00043  000042  .34         DEC  34
```

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```
0058  00044  000045  .37     DEC  37
0059  00045  000050  .40     DEC  40
0060  00046  000051  .41     DEC  41
0061  00047  000053  .43     DEC  43
0062  00050  000055  .45     DEC  45
0063  00051  000056  .46     DEC  46
0064  00052  000060  .48     DEC  48
0065  00053  000072  .58     DEC  58
0066  00054  000077  .63     DEC  63
0067  00055  000111  I        OCT  111
0068  00056  023420  .1E4    DEC  10000
0069  00057  001750  .1000   DEC  1000
0070  00060  000144  .100    DEC  100
0071  00061  000012  .10     DEC  10
0072  00061          LNFD     EQU  .10
0073  00062  100000  FLGBT    OCT  100000
0074  00063  000143  .99     DEC  99
0075  00064  100004  INTFL    OCT  100004
0076  00065  076000  OPMSK    OCT  76000
0077  00066  077777  INF      OCT  77777
0078  00067  100037  TYPFL    OCT  100037
0079  00070  101777  OPDMK    OCT  101777
0080  00071  000105  E        OCT  105
0081  00072  000106  F        OCT  106
0082  00073  000123  S        OCT  123
0083  00032          B17      EQU  .15
0084  00033          B20      EQU  .16
0085  00074  000022  B22      OCT  22
0086  00075  000023  B23      OCT  23
0087  00035          B26      EQU  .22
0088  00036          B27      EQU  .23
0089  00076  000036  B36      OCT  36
0090  00040          B37      EQU  .31
0091  00043          B42      EQU  .34
0092  00077  000044  B44      OCT  44
0093  00100  000052  B52      OCT  52
0094  00053          B72      EQU  .58
0095  00101  000100  B100     OCT  100
0096  00102  000133  B133     OCT  133
0097  00103  000140  B140     OCT  140
0098  00104  000177  B177     OCT  177
0099  00105  000377  B377     OCT  377
0100  00013          B400     EQU  C7
0101  00106  000777  B777     OCT  777
0102  00107  001000  B1000    OCT  1000
0103  00110  001400  B1400    OCT  1400
0104  00111  001740  B1740    OCT  1740
0105  00112  001760  B1760    OCT  1760
0106  00113  001774  B1774    OCT  1774
0107  00114  001775  B1775    OCT  1775
0108  00115  001777  B1777    OCT  1777
0109  00116  002000  QTOP     OCT  2000
0110  00117  002400  B2400    OCT  2400
0111  00120  003000  B3000    OCT  3000
0112  00121  004000  B4000    OCT  4000
0113  00122  006000  B6K      OCT  6000
```

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```
0114  00004          B10K    EQU  C6+1
0115  00004          RPOP    EQU  B10K
0116  00123  012000  B12K    OCT  12000
0117  00123          RBOP    EQU  B12K
0118  00124  032000  EXPOP   OCT  32000
0119  00125  050000  LBOP    OCT  50000
0120  00126  052000  LPOP    OCT  52000
0121  00127  170000  B170K   OCT  170000
0122  00130  013777  FROMA   OCT  13777
0123  00131   37777  LROMA   OCT  37777B    LAST ROM BLOCK
0124  00132  177777  M1      DEC  -1
0125  00133  177776  M2      DEC  -2
0126  00134  177775  M3      DEC  -3
0127  00135  177774  M4      DEC  -4
0128  00136  177773  M5      DEC  -5
0129  00137  177772  M6      DEC  -6
0130  00140  177767  M9      DEC  -9
0131  00141  177766  M10     DEC  -10
0132  00142  177765  M11     DEC  -11
0133  00143  177764  M12     DEC  -12
0134  00144  177763  M13     DEC  -13
0135  00145  177762  M14     DEC  -14
0136  00146  177761  M15     DEC  -15
0137  00147  177751  M23     DEC  -23
0138  00150  177747  M25     DEC  -25
0139  00151  177740  M32     DEC  -32
0140  00152  177734  M36     DEC  -36
0141  00153  177720  M48     DEC  -48
0142  00154  177700  M64     DEC  -64
0143  00155  177660  M80     DEC  -80
0144  00156  177634  M100    DEC  -100
0145  00157  177400  M256    DEC  -256
0146  00160  176000  M1024   DEC  -1024
0147  00161  154360  MAXSN   DEC  -10000   --(MAXIMUM ALLOWABLE LINE
                                            NUMBER)
0148  00162  043116  FN      ASC  1,FN
0149*
0150*   MATH CONSTANTS THAT ARE NEEDED ON BASE PAGE
0151*
0152  00163  177401  ZAP     OCT  177401
0153  00164  063440  MASK1   OCT  063440
0154  00165  061400  MASK5   OCT  061400
```

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```
0156*
0157  00166  40440  FWAM   DEF  4O44OB  FIRST WORD R/W
0158  00122         RSTKA  EQU  B1760   START OF RETURN STACK
0159  00167  02454  WRITE  DEF  WRIT    PRINTER AND DISPLAY DRIVER
0160  00170  02533  CLERA  DEF  CLEAR   CLEAR REFRESH BUFFER
0161  00116         REED   EQU  QTOP    KEYBOARD DRIVER QTOP IS=2000B
0162  00121         START  EQU  B4000
0163  00171  04741  RUNA   DEF  RUN     PHASE 2; SYMBOL TABLE
0164  00172  01012  XEC4A  DEF  XEC4    STATEMENT EXECUTION EXIT
0165  00173  04044  PEXMA  DEF  PEXMK
0166  00174  04037  RDYDA  DEF  RDYPT
0167  00122         LISTA  EQU  B6K
0168  00175  03072  TSRHA  DEF  TBSRH   TABLE SEARCH
0169  00176  07450  ELINA  DEF  OLINE   OUTPUT I/O BUFFER
0170  00177  05305  SSYMA  DEF  SSYMT
0171  00200  11433  OPCHA  DEF  OPCHK   CHECK FOR UNDEFINED OPERAND
0172  00201  10563  FORMA  DEF  FORMX   EVALUATE FORMULA
0173  00202  12040  FSCA   DEF  FSC
0174  00203  04511  ACTSA  DEF  ACTST
0175  00204  04500  DELSA  DEF  DELST
0176  00205  04355  AERRA  DEF  AERR
0177  00206  04360  ERRA   DEF  ERROR
0178  00207  000000 INTEA  BSS  1       KEYBOARD INTERRUPT LINK
0179  00210  000000 OUTIA  BSS  1       OUTPUT AN INTEGER
0180  00211  03200  .BUFA  DEF  IOBUF+  FIRST CHAR OF I/O BUFFER
                              IOBUF
0181  00212  03322  .SLBF  DEF  RBUFF+  FIRST CHAR OF REFRESH BUFFER
                              RBUFF
0182  00213  01744  AR1A   DEF  AR1
0183  00214  01754  AR2A   DEF  AR2
0184  00215  01773  TMPOP  DEF  RES     RESULT REGISTER POINTER
0185  00216  000000 .FADA  BSS  1       ADD
0186  00217  000000 .FSBA  BSS  1       SUBTRACT
0187  00220  000000 .FMPA  BSS  1       MULTPY
0188  00221  000000 .FDVA  BSS  1       DIVIDE
0189  00222  05447  ENTFA  DEF  ENTFN
0190  00223  000000 .FSR   BSS  1       SQUARE ROOT
0191  00224  000000 UPARA  BSS  1       UP ARROW
0192  00225  000000 FLTRA  BSS  1
0193  00226  000000 FLTFA  BSS  1
0194  00227  000000 FXFLA  BSS  1
0195  00230  000000 FLTSA  BSS  1
0196  00231  000000 SPLFA  BSS  1
0197  00232  000000 SNFLA  BSS  1
0198  00233  01551  BEND   DEF  RBUFF   I/O BUFFER END
0199  00233         SBUFA  EQU  BEND
0200  00234  06353  NMOTA  DEF  NMOUT   NUMBER OUTPUT ROUTINE
0201  00235  07027  FILLA  DEF  FILL    OUTPUT BLANKS
0202  00236  03442  SLEND  DEF  RBUFF+  REFRESH BUFFER END
                              RBUFF+
                              80
0203  00111         TMPA   EQU  B1740
0204  00110         BADRP  EQU  B1400   POINTER POINTER TO I/O BUFFER
0205*
0206  00123         FOPBS  EQU  B12K
0207  00237  16516  SALTA  DEF  SALT
0208  00240  05257  MDIMA  DEF  MDIM
0209  00241  10413  SYSTA  DEF  SYSTH
0210  00242  05711  DCOMA  DEF  DCOMP
0211  00243  000000 NUMCA  BSS  1
```

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```
0212   00244  000000  NUMOA   BSS  1
0213   00245  007656  GTSTA   DEF  GETST
0214   00246  012231  VAROA   DEF  VAROP
0215   00247  010112  ECALA   DEF  ECAL    EXECUTE CALC MODE
0216   00250  004625  OVCHA   DEF  OVCHK
0217   00251  004575  CLP1A   DEF  CLPR1
0218   00252  005416  ENTEA   DEF  ENTER
0219   00253  007672  CHRSA   DEF  CHRST
0220   00254  003317  XSCRA   DEF  XSCR1   SCRATCH KEYS
0221   00255  010040  XEC6A   DEF  XEC6
0222   00256  010425  FDAAA   DEF  FDATA
0223   00257  005660  FNDAA   DEF  FNDAD
0224   00260  005671  FND1A   DEF  FNDA1
0225   00261  002547  IOSTA   DEF  IOST    I/O STATUS CHECK
0226   00262  010467  INREA   DEF  INRET
0227   00263  003336  SUMPA   DEF  SUMP
0228   00264  002504  CRCKA   DEF  CRCHK   OUTPUT SUPRESSED CRLF
0229   00265  016501  IOHEA   DEF  IOHED
0230   00266  007240  QTCHA   DEF  QTCHK   CHECK FOR STRING
0231*********************************
0232*
0233   00267  000000          BSS  1       CHECKSUM WORD****************
```

PAGE 6 9830—ERROR TABLE

0235	00270	000625	E1	DEF	SYSER	ROM CONFIGURATION ERROR
0236	00271	000561		DEF	FSCE4	MEMORY OVERFLOW
0237	00272	004177		DEF	NCALC	STMT NOT ALLOWED IN CALC MODE
0238	00273	000726		DEF	SYE25	MISSING OR BAD INTEGER
0239	00274	004243	E5	DEF	NSTMT	NO STATEMENT OR COMMAND RECOGNISED
0240	00275	012134		DEF	FSCE3	UNRECOGNISED OPERAND
0241	00276	001152		DEF	NOEOF	CHARS FOLLOW STMT LOGICAL END
0242	00277	004307		DEF	SYE15	MISSING PRINT DELIMETER
0243	00300	004253		DEF	UKERR	IMPROPER TYPING AID ASSIGNMENT
0244	00301	003155	E10	DEF	KERR	KEY UNDEFINED
0245	00302	000000		BSS	1	
0246	00303	000000		BSS	1	
0247	00304	001165		DEF	SYE12	SIGN GIVEN BUT NO NUMBER
0248	00305	000511		DEF	COMCE+1	MISSING COMA
0249	00306	000522	E15	DEF	FSCE1	NO LEFT PAREN
0250	00307	000535		DEF	FSCE2	NO RIGHT PAREN
0251	00310	016432		DEF	ARRE1	MISSING SUBSCRIPT
0252	00311	012452		DEF	STRNP	STRING NOT PERMITTED
0253	00312	007660		DEF	NOST	MISSING OR BAD STRING
0254	00313	007665	E20	DEF	SYE14	NO CLOSING QUOTE
0255	00314	012433		DEF	SYNE4	MISSING OR BAD FUNCTION I.D.
0256	00315	012515		DEF	SYNE5	MISSING PARAMETER
0257	00316	003504		DEF	NDATA	MISSING OR BAD DATA ITEM
0258	00317	007723		DEF	SYNE7	MISSING THEN
0259	00320	003565	E25	DEF	MISOF	MISSING OF
0260	00321	016461		DEF	SYE13	MISSING VARIABLE
0261	00322	012464		DEF	SYNE8	MISSING FOR VARIABLE
0262	00323	012473		DEF	SYNE9	MISSING TO
0263	00324	012500		DEF	SYE10	MISSING STEP
0264	00325	012522	E30	DEF	SYNE6	MISSING ASSIGNMENT IN FOR STMT
0265	00326	004273		DEF	SYNE2	LET STMT HAS NO STORE
0266	00327	003531		DEF	FMTER	IMPROPER FORMAT SPEC
0267	00330	016436		DEF	SYNE3	MISPLACED COM STATEMENT
0268	00331	005067		DEF	CMERR	IMPROPER COM DECLARATION
0269	00332	005037	E35	DEF	MER5	ARRAY DOUBLY DEFINED
0270	00333	305372		DEF	SSYM3	PRECISION DOUBLY DEFINED
0271	00334	005353		DEF	SYME2	INCONSISTENT DIMENSIONS
0272	00335	005157		DEF	MER10	ARRAY HAS UNKNOWN DIMENSIONS
0273	00336	005276		DEF	MER9	DIMENSIONS TOO LARGE
0274	00337	011440	E40	DEF	ER8	OPERAND IS UNDEFINED
0275	00340	005421		DEF	NINIT	ARRAY OR STRING NOT INITIALIZED
0276	00341	011240		DEF	ER6	SUBSCRIPT EXCEEDS BOUNDS
0277	00342	007372		DEF	SCERR	SELECT CODE LESS THAN 1 OR GTR THAN 15
0278	00343	010224		DEF	NGOTO	LINE NOT FOUND OR IMPROPER STMT FOUND
0279	00344	007064	E45	DEF	TABER	STATEMENTS USING FORMAT CANNOT USE TAB
0280	00345	007414		DEF	FNEST	STATEMENTS USING FORMAT CANNOT BE NESTED
0281	00346	010231		DEF	ER3	IMPROPER RETURN
0282	00347	010335		DEF	BERR	IMPROPER FOR LOOP
0283	00350	010444		DEF	ER60	OUT OF DATA
0284	00351	010041	E50	DEF	MER11	LAST STMT IS NOT "END"
0285	00352	000000		BSS	1	
0286	00353	000000		BSS	1	
0287	00354	000000		BSS	1	
0288	00355	000000		BSS	1	

PAGE 7 BASE PAGE ROUTINES

```
0290*
0291*   MULTI EXIT POINT RETURNS
0292*
0293   00356  060365  RETN3   JSM  RET2    RETURN TO P+3
0294   00357  031401  RETN2   STA  RSAVE   RETURN TO P+2
0295   00360  021777          LDA  RSPTR
0296   00361  000132          ADA  M1
0297   00362  070637          ISZ  A,I      INCREMENT RETURN ADDRESS
0298   00363  021401          LDA  RSAVE    RESTORE (A)
0299   00364  170402          RET
0300*
0301   00365  031401  RET2    STA  RSAVE
0302   00366  021777          LDA  RSPTR
0303   00367  000133          ADA  M2
0304   00370  070637          ISZ  A,I      INCREMENT RETURN ADDRESS
0305   00371  021401          LDA  SRAVE    RESTORE (A)
0306   00372  170402          RET
0307*
0308   00373  024212  ICNT    LDB  .SLBF    GET SINGLE LINE CHARACTER COUNT
0309   00374  074117  WBUFF   LDA  B
0310   00375  070076          TCA
0311   00376  001400          ADA  BADDR    COMPUTE CHAR COUNT
0312   00377  170402          RET
0313*
0314*   GET A PARAMETER IN (B) FROM P+1
0315*
0316   00400  025777  GPARM   LDB  RSPTR
0317   00401  004133          ADB  M2
0318   00402  074637          ISZ  B,I
0319   00403  074537          LDB  B,I
0320   00404  065375          JMP  FIX+4
0321*
0322*   TRANSFER FROM AR2 to AR1
0323*
0324   00405  024213  XFAR1   LDB  AR1A
0325   00406  020214          LDA  AR2A
0326   00407  170004          XFR
0327   00410  004134          ADB  M3       RESTORE (B)
0328   00411  170402          RET
0329*
0330*   CONVERT AND STORE AN OPERAND VALUE
0331*
0332*     AR2=SOURCE
0333*     (A)=DESTINATION TYPE
0334*     (B)=DESTINATION ADDRESS
0335*
0336   00412  125413  RSULT   LDB  HSTPT,I
0337   00413  045413          ISZ  HSTPT
0338   00414  121413          LDA  HSTPT,I
0339   00415  045413          ISZ  HSTPT
0340   00416  070206  STORE   RAR  5         IF BIT 4=1
0341   00417  071352          SAM  XFAR1+1   IT IS FULL PRECISION
0342   00420  007062          SAR  13        NO, GET PRECISION BITS
0343   00421  071250          SZA  XFAR1+1   FULL?
0344   00422  035727          STB  MBIN2     SAVE ADDRESS
0345   00423  010012          CPA  .1        NO, SPLIT?
```

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```
0346   00424  064441           JMP  STOR2   YES
0347   00425  060405  STOR1    JSM  XFAR1   INTEGER: SAVE IN AR1
0348   00426  160225           JSM  FLTRA,I CONVERT INTEGER
0349   00427  064432           JMP  INTOV   OVERFLOW EXIT
0350   00430  135727           STB  MBIN2,I STORE INTEGER
0351   00431  064444           JMP  XFAR2   RESTORE AR2
0352   00432  160205  INTOV    JSM  AERRA,I EMIT OVERFLOW
0353   00433  177627           DEC  -105    INTEGER OVERFLOW
0354   00434  024066           LDB  INF     SBT MAXIMUM POSITIVE INTEGER
0355   00435  021744           LDA  AR1     GET MANTISSA SIGN
0356   00436  071511           SLA  STOR1+3 POSITIVE?
0357   00437  074076           TCB          NO
0358   00440  064430           JMP  STOR1+3
0359   00441  060405  STOR2    JSM  XFAR1   SAVE IN AR1
0360   00442  025727           LDB  MBIN2   RECALL ADDRESS
0361   00443  160230           JSM  FLTSA,I CONVERT TO SPLIT AND STORE
0362*
0363   00444  020213  XFAR2    LDA  AR1A
0364   00445  024214           LDB  AR2A
0365   00446  170004           XFR
0366   00447  170402           RET
0367*  STORE AN OPERAND NAME AND TYPE
0368*
0369*     (A)=ASCII CODE FOR LETTER
0370*     ENTER AT STROP+1 WITH PRE:ADJUSTED OPERAND TYPE
0371*     EXIT* (A)=COMPLETED OPERATOR—OPERAND PAIR
0372*
0373   00450  004151  STROP    ADB  M32     NUMERICALLY ADJUST OPERAND TYPE
0374   00451  000154           ADA  M64     GET 5 BIT CODE FOR OPERAND NAME
0375   00452  070544           SAL  5       COMBINE THE
0376   00453  074217           IOR  B       TWO OPERAND PARTS AND THE
0377   00454  141706           IOR  SBPTR,I   OPERATOR—OPERAND PAIR
0378*
0379*   UPDATE SYNTAX BUFFER POINTER AND CHECK FOR OVERFLOW
0380*
0381   00455  131706           STA  SBPTR,I STORE (A) BEFORE UPDATE
0382   00456  004570  SBPUD    ISZ  SBPTR   UPDATE POINTER
0383   00457  131706           STA  SBPTR,I SAVE (A)
0384   00460  170402           RET
0385*
0386*   FIND AND STORE ONE—CHARACTER OPERATORS
0387*     (A)=SOURCE CHARACTER
0388*     (B)=NUMBER OF ENTRIES TO BE SEARCHED
0389*     P+1=STARTING TABLE ADDRESS-1
0390*
0391   00461  024017  SYMC2    LDB  .2      ALTERNATE ENTRY TO SEARCH TWO
                                                                  SYMBOLS
0392   00462  064464           JMP  SYMCK
0393   00463  024012  SYMC1    LDB  .1      ALTERNATE ENTRY TO SEARCH ONE
                                                                  SYMBOL
0394*
0395   00464  035466  SYMCK    STB  LOCL1   SAVE # TO BE SEARCHED
0396   00465  031467           STA  LOCL2   SAVE SOURCE CHARACTER
0397   00466  060400           JSM  GPARM   GET STARTING ADDRESS
0398   00467  074070  SYM1     SIB  *+1     INCREMENT TABLE ADDRESS
0399   00470  074517           LDA  B,I     GET TABLE ENTRY
0400   00471  070342           SAR  8       POSITION IT
0401   00472  011467           CPA  LOCL2   MATCH SOURCE CHAR?
```

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```
0402  00473  064500          JMP  SYM2      YES
0403  00474  055466          DSZ  LOCL1     NO, CONTINUE SEARCH?
0404  00475  064467          JMP  SYM1      YES
0405  00476  021467          LDA  LOCL2     NO, RESTORE CHARACTER
0406  00477  170402          RET            RETURN TO P+2- NOT FOUND
0407  00500  020123  SYM2    LDA  FOPBS     COMPUTE
0408  00501  070076          TCA
0409  00502  074017          ADA  B           OP-CODE
0410  00503  064543          JMP  STSRH+4   SHIFT-STORE-RETURN TO P+3
0411*
0412*  CHECK FOR A COMMA
0413*
0414  00504  060463  COMCK   JSM  SYMC1     CHECK FOR
0415  00505  012001          DEF  12001B    COMMA-1
0416  00506  170402          RET            NOT FOUND — RETURN TO P+1
0417  00507  064357          JMP  RETN2     FOUND— RETURN TO P+2
0418*
0419  00510  060504  COMCE   JSM  COMCK     CHECK FOR COMMA
0420  00511  160206          JSM  ERRA,I    ERROR IF NOT FOUND
0421  00512  170402          RET
0422*
0423*  CHECK FOR LEFT PARENTHESIS
0424*
0425  00513  060461  LPCK    JSM  SYMC2     LEFT PAREN
0426  00514  012023          DEF  12023B    LBRAC-1
0427  00515  170402          RET            NO, RETURN TO P+1
0428  00516  020126          LDA  LPOP      YES, RECODE A LEFT
0429  00517  064544          JMP  STSRH+5     PAREN AND RETURN TO P+2
0430*
0431  00520  061055          JSM  GNEXT     GET NEXT CHAR
0432  00521  060513  LPCKE   JSM  LPCK      DEMAND A
0433  00522  160206  FSCE1   JSM  ERRA,I      LEFT PAREN OR BRACKET
0434  00523  170402          RET
0435*
0436*  CHECK FOR RIGHT PARENTHESIS
0437*
0438  00524  060461  RPCK    JSM  SYMC2     RIGHT PAREN
0439  00525  012003          DEF  12003B    PRAN-1
0440  00526  170402          RET            NO, RETURN TO P+1
0441  00527  020004          LDA  RPOP      YES, RECODE A RIGHT
0442  00530  060455          JSM  SBPUD-1     PAREN AND INC SBPTR
0443  00531  061055          JSM  GNEXT     GET NEXT CHAR
0444  00532  064357          JMP  RETN2     RETURN TO P+2
0445*
0446  00533  061055          JSM  GNEXT     GET NEXT CHAR
0447  00534  060524  RPCKE   JSM  RPCK      DEMAND A RIGHT
0448  00535  160206  FSCE2   JSM  ERRA,I      LEFT PAREN OR BRACKET
0449  00536  170402          RET
0450
0451*  SEARCH TABLE AND STORE OP CODE IF FOUND
0452*
0453  00537  160175  STSRH   JSM  TSRHA,I   SEARCH TABLE
0454  00540  170402          RET            NOT FOUND
0455  00541  031466          STA  LOCL1     SAVE OP CODE
0456  00542  050040          AND  B37       BET 5 BIT CODE
0457  00543  070304          SAL  10        SHIFT AND
```

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```
0458  00544  131706          STA  SBPTR,I   STORE OP CODE
0459  00545  064357          JMP  RETN2    RETURN TO P+2
0460*
0461*  SEARCH TABLE AND STORE EXPANDED OP CODE
0462*
0463  00546  160175  STEXP   JSM  TSRHA,I SEARCH TABLE
0464  00547  170402          RET
0465  00550  070544          SAL  5         ASSEMBLE AND
0466  00551  040065          IOR  OPMSK      STORE
0467  00552  064544          JMP  STSRH+5
0468*
0469*  BUMP H—STACK POINTER AND CHECK FOR OVERFLOW
0470*
0471  00553  055413  BHSTP   DSZ  HSTPT    DINC POINTER
0472  00554  025413          LDB  HSTPT
0473  00555  074076          TCB
0474  00556  005412          ADB  LSTPT
0475  00557  004017          ADB  .2
0476  00560  075012          SBM  STSRH+1 OVERLAP? RETURN IF NOT
0477  00561  160206  MERB    JSM  ERRA,I
0478*
0479  00561          FSCE4   EQU  MER8
0480*
0481*  STACK (B) ON L—STACK AND CHECK OVERFLOW
0482*
0483  00562  025421          LDB  PRADD
0484  00563  045412  SLWST   ISZ  LSTPT    INC POINTER
0485  00564  135412          STB  LSTPT,I  STORE VALUE
0486  00565  064554          JMP  BHSTP+1 CHECK FOR OVERFLOW
0487*
0488*  FETCH TOP OF L—STACK
0489*
0490  00566  031421          STA  PRADD
0491  00567  121412  UNSTK   LDA  LSTPT,I
0492  00570  055412          DSZ  LSTPT
0493  00571  170402          RET
0494*
0495*  PREPARE FOR BRANCH THROUGH TABLE
0496*
0497  00572  025421          LDB  PRADD
0498  00573  035472          STB  TEMPS
0499  00574  125472  NEXTL   LDB  TEMPS,I  READ AND SAVE
0500  00575  074073          SBP  *+1,C     CLEAR SECURITY BIT
0501  00576  035427          STB  .LNUM      CURRENT LINE NUMBER
0502  00577  025472          LDB  TEMPS     FIND ADDRESS
0503  00600  061007          JSM  NEXTA      OF NEXT STATEMENT
0504  00601  035421          STB  PRADD     SAVE IT
0505  00602  045472          ISZ  TEMPS
0506  00603  125472          LDB  TEMPS,I  READ OP CODE
0507  00604  074073          SBP  *+1,C
0508  00605  045472          ISZ  TEMPS
0509  00606  074442  NEXT1   SBR  10
0510  00607  074076          TCB            GET NEGATIVE OF OP CODE
0511  00610  035466          STB  LOCL1     SAVE —(OP CODE)
0512  00611  121472          LDA  TEMPS,I
0513  00612  050065          AND  OPMSK     GET PAGE
```

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```
0514   00613  024130  FPAGE   LDB  FROMA   GET FIRST TABLE ADDRESS
0515   00614  074457          CPA  B,I     IS THIS THE PAGE?
0516   00615  170402          RET          YES, (B) = LAST WORD OF PAGE
0517   00616  014131          CPB  LROMA   ALL ROM'S SEARCHED?
0518   00617  064622          JMP  FPAG1   YES, CHECK BINARY AREA
0519   00620  004116          ADB  QTOP    NO, CHECK NEXT ROM
0520   00621  064614          JMP  FPAGE+1
0521   00622  025403  FPAG1   LDB  MAW
0522   00623  111403          CPA  MAW,I   IS CODE IN R/W?
0523   00624  170402          RET          YES, (B) = MAW
0524   00625  160206  SYSER   JSM  ERRA,I  NO, THE PROPER BLOCK IS NOT IN
0525*
0526*
0527*
0528*   SAVE BADDR AND SBPTR
0529*
0530   00626  025400  SAVBP   LDB  BADDR
0531   00627  035715          STB  SBADR
0532   00630  025706          LDB  SBPTR
0533   00631  035716          STB  SSBPT
0534   00632  170402          RET
0535*
0536*   RESTORE BADDR AND SBPTR
0537*
0538   00633  021715  RESB1   LDA  SBADR
0539   00634  031400          STA  BADDR
0540   00635  021716          LDA  SSBPT
0541   00636  031706          STA  SBPTR
0542   00637  170402          RET
0543*
0544   00640  060633  RESBP   JSM  RESB1
0545   00641  121706          LDA  SBPTR,I  ERASE
0546   00642  050065          AND  OPMSK    OPERAND
0547   00643  131706          STA  SBPTR,I
0548   00644  170402          RET
0549*
0550*   SCRATCH SYMBOL TABLE AND INITIALIZE STACKS
0551*
0552   00645  025404  MINIT   LDB  LWAM
0553   00646  035407          STB  SYMTP
0554   00647  035406          STB  VALUE
0555   00650  064653          JMP  INITS+2
0556*
0557*   INITIALIZE STACKS FOR SYNTAX
0558*
0559   00651  020662  INITS   LDA  HFLGA
0560   00652  170000          CLR          CLEAR HALT AND TRACE FLAGS
0561   00653  025426          LDB  PBPTO   SCRATCH L-STACK
0562   00654  004132          ADB  M1
0563   00655  035412          STB  LSTPT
0564   00656  025407  INIT1   LDB  SYMTP   SCRATCH H-STACK
0565   00657  074070          SIB  *+1
0566   00660  035413          STB  HSTPT
0567   00661  164242          JMP  DCOMA,IRESET DATA POINTERS
0568   00662  001436  HFLGA   DEF  HFLG1
0569*
```

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```
0570*   SUBROUTINE TO BUILD A PROGRAM INTEGER LESS THAN 10000
0571*
0572    00663  055400            DSZ  BADDR   BACK UP POINTER
0573    00664  024161  LNUM      LDB  MAXSN   CALL PGINT WITH -10000
0574    00665  145706            ISZ  SBPTR,I FLAG FOR RESEQUENCABLE INTEGER
0575*
0576*   SUBROUTINE TO BUILD A PROGRAM INTEGER AND STORE IT
0577*     IN THE S-BUFFER AND FLAG THE PREVIOUS WORD
0578*     (B) = -(MAXIMUM ALLOWABLE INTEGER)
0579*
0580    00666  121706  PGINT     LDA  SBPTR,I SET
0581    00667  072053            SAP  *+1,S     "INTEGER
0582    00670  000020            ADA  .3          FOLLOWS"
0583    00671  060455            JSM  SBPUD-1     FLAG
0584    00672  035477            STB  TEMP4   SAVE UPPER LIMIT
0585    00673  061055            JSM  GNEXT
0586    00674  064677            JMP  INTCK+1
0587*
0588*   SUBROUTINE TO BUILD AN INTEGER AND STORE IT IN SBUFFER
0589*     (A)=FIRST CHARACTER
0590*     (B) = -(MAXIMUM ALLOWABLE INTEGER)
0591*
0592    00675  024161            LDB  MAXSN   BUILD A LINE #
0593*
0594    00676  035477  INTCK     STB  TEMP4   SAVE UPPER LIMIT
0595    00677  074742            SBR  16      INITIALIZE
0596    00700  035722            STB  INTGR     PARTIAL RESULT
0597    00701  060750            JSM  DIGCK   1ST CHAR A DIGIT?
0598    00702  064725            JMP  SYE25-1 NO
0599    00703  060750  INTC1     JSM  DIGCK   DIGIT?
0600    00704  064716            JMP  INTC2   NO
0601    00705  021722            LDA  INTGR   RECALL PARTIAL RESULT
0602    00706  035722            STB  INTGR   SAVE LATEST DIGIT
0603    00707  024061            LDB  .10     MULTIPLY PARTIAL
0604    00710  061201            JSM  IMPY    RESULT BY 10
0605    00711  001722            ADA  INTGR   ADD LATEST DIGIT
0606    00712  070552            SAM  SYE25-1 SKIP IF OVERFLOW
0607    00713  031722            STA  INTGR   STORE PARTIAL RESULT
0608    00714  061055            JSM  GNEXT   GET NEXT CHARACTER
0609    00715  064703            JMP  INTC1
0610    00716  025722  INTC2     LDB  INTGR   SKIP THROUGH LINK
0611    00717  135706            STB  SBPTR,I STORE INTEGER
0612    00720  074250            SZB  SYE25-1 IF ZERO
0613    00721  005477            ADB  TEMP4   SUBTRACT LIMIT
0614    00722  076153            SBP  SYE25-1,S SKIP IF TOO LARGE
0615    00723  025722            LDB  INTGR   RETURN WITH
0616    00724  064456            JMP  SBPUD     INTEGER IN (B); NEXT CHAR IN (A)
0617    00725  045724            ISZ  GFLAG   RETURN ON ERROR FLAG SET?
0618    00726  160206  SYE25     JSM  ERRA,I  NO
0619    00727  064357            JMP  RETN2   YES, RETURN TO P+2
0620*
0621*   GET ADDRESSES FOR SYSTEM COMMANDS
0622*
0623*     RETURN: TEMP4= ADDRESS OF FIRST LINE
0624*             (B)= ADDRESS OF LAST LINE+1
0625*
```

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```
0626   00730  074070  GETAD   SIB   *+1      ADD 1 TO SECOND TO
0627   00731  035477          STB   TEMP4      MAKE ADDRESS INCLUSIVE
0628   00732  074076          TCB             IS FIRST
0629   00733  070037          ADB   A           GREATER
0630   00734  075513          SBP   SYE25      THAN SECOND
0631   00735  061075          JSM   FNDPS      FIND ADDRESS OF FIRST
0632   00736  064740          JMP   *+2
0633   00737  064740          JMP   *+1
0634*
0635*   CALL FNDPS AND RETURN TO P+1
0636*
0637   00740  021477          LDA   TEMP4
0638   00741  035477          STB   TEMP4
0639   00742  061075  FND     JSM   FNDPS
0640   00743  170402          RET
0641   00744  170402          RET
0642   00745  170402          RET
0643*
0644*   CHECK IF CHAR IN (A) IS A DIGIT
0645*     RETURN TO P+1 IF NOT FOUND
0646*     RETURN TO P+2 IF FOUND; ASCII IN (A); DIGIT IN (B)
0647*
0648   00746  030071  DLIMT   OCT   30071    0-9
0649   00747  040532  LLIMT   OCT   40532    A-Z
0650   00750  024746  DIGCK   LDB   DLIMT    LODA LIMITS FOR DIGITS
0651   00751  064753          JMP   LIMIT     CHECK LIMITS AND RETRUN
0652*
0653*   CHECK IF CHAR IN (A) IS A LETTER
0654*     RETURN TO P+1 IF NOT FOUND
0655*     RETURN TOP+2 IF FOUND
0656*
0657   00752  024747  LETCK   LDB   LLIMT    LOAD LIMITS FOR LETTER
0658*                         ENTER INTO LIMIT DIRECTLY
0659*
0660   00753  035466  LIMIT   STB   LOCL1    SAVE LIMITS
0661   00754  074346          RBR   8
0662   00755  074342          SBR   8         GET UPPER LIMITS
0663   00756  074056          CMB
0664   00757  070037          ADB   A         CODE EXCEEDS
0665   00760  075253          SBP   FND+3     UPPER LIMIT?
0666   00761  025466          LDB   LOCL1     NO
0667   00762  074342          SBR   8         GET LOWER LIMIT
0668   00763  074076          TCB
0669   00764  070037          ADB   A         CODE LESS THAN
0670   00765  075012          SBM   FND+3     LOWER LIMIT
0671   00766  070137          LDB   A         NO, CODE IN LIMITS
0672   00767  004153          ADB   M48       YES, RETURN TO P+2
0673   00770  064357          JMP   RETN2
0674*
0675*     GET OPERAND
0676*
0677   00771  121472  GTOPP   LDA   TEMPS,I
0678   00772  050070          AND   OPDMK
0679   00773  170402          RET
0680***
0681*
```

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```
0682   00774  000000            BSS  10
0683*
0684***
0685*
0686*
0687*
0688*   COMPUTE ADDRESS OF NEXT LINE
0689*
0690   01006  035466            STB  LOCL1
0691   01007  074117  NEXTA     LDA  B        SAVE ADDRESS OF CURRENT LINE
0692   01010  070070            SIA  *+1      GET
0693   01011  070517            LDA  A,I        STATEMENT
0694   01012  050104            AND  B177         LENGTH
0695   01013  070037            ADB  A        COMPUTE ADDRESS OF NEXT LINE
0696   01014  170402            RET
0697*
0698*
0699*      THIS SUBROUTINE STORES A CHARACTER
0700*      IN A BUFFER. THE BUFFER POINTER
0701*      IS USED TO INDICATE WHERE IN THE
0702*      BUFFER THE CHARACTER IS TO BE STORED
0703*      THE BUFFER IS UNDISTURBED EXCEPT
0704*      WHERE THE POINTER POINTS.
0705*
0706*
0707*      ENTRY CONDITIONS:
0708*          (B)=BUFFER POINTER POINTER
0709*          (A)=CHARACTER TO BE STORED
0710*              RIGHT JUSTIFIED WITH LEADING 0'S
0711*
0712*
0713*
0714*
0715   01015  020041  OBLNK     LDA  .32
0716   01016  024110  ONEXT     LDB  BADRP    OPTIONAL ENTRY POINT
0717   01017  031467  OUTCR     STA  LOCL2    SAVE CHARACTER TO BE STORED
0718   01020  074517            LDA  B,I      FETCH BUFFER POINTER
0719   01021  011623            CPA  PEND     AT I/O FND?
0720   01022  170402            RET           YES
0721   01023  074637            ISZ  B,I      BUMP BUFFER POINTER
0722   01024  070137            LDB  A
0723   01025  074006            RBR  1
0724   01026  070002            SAR  1
0725   01027  070517            LDA  A,I      FETCH BUFFER WORD
0726   01030  074112            SBM  *+2
0727   01031  070346            RAR  8        SET A TO STORE IN LEFT HALF
0728   01032  050157            AND  M256
0729   01033  041467            IOR  LOCL2
0730   01034  074132            SBM  *+2,C
0731   01035  070346            RAR  8        ROTATE IF FLAG WAS SET
0732   01036  074557            STA  B,I      STORE NEW BUFFER WORD
0733   01037  170402            RET
0734*
0735*
0736*      THIS SUBROUTINE FETCHES
0737*      A CHARACTER FROM A BUFFER
```

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```
0738*
0739*
0740*     ENTRY CONDITIONS:
0741*          (B)=BUFFER POINTER POINTER
0742*
0743*
0744*     EXIT CONDITIONS:
0745*          (A)=8-BIT CHARACTER
0746*          (B)=BUFFER POINTER POINTER
0747*
0748*
0749*
0750   01040  024110          LDB  BADRP   GET NEXT CHAR FROM I/O BUFFER
0751   01041  035466  GETCH   STB  LOCL1   SAVE POINTER POINTER
0752   01042  074517          LDA  B,I     FETCH BUFFER POINTER
0753   01043  070002          SAR  1
0754   01044  070517          LDA  A,I     FETCH TWO CHARACTERS
0755   01045  074537          LDB  B,I
0756   01046  074111          SLB  GET1    TOP HALF WORD?
0757   01047  070346          RAR  8       NO, MOVE RIGHT HLAF TO LEFT
0758   01050  070342  GET1    SAR  8       TAKE TOP HALF
0759   01051  145466          ISZ  LOCL1,I BUMP POINTER
0760   01052  170402          RET          YES
0761*
0762   01053  024111  GTMP    LDB  TMPA
0763   01054  065041          JMP  GETCH
0764*
0765*
0766   01055  024110  GNEXT   LDB  BADRP   GET CHAR. AND CONVERT
0767   01056  061362          JSM  GTCON
0768   01057  011707          CPA  BLANK   BLANK?
0769   01060  065055          JMP  *-3     YES, IGNORE IT
0770   01061  170402          RET          YES, RETURN TO P+1
0771*
0772*    GET CHARACTER ROUTINES
0773*
0774   01062  020233  GFRST   LDA  SBUFA
0775   01063  031706          STA  SBPTR   INITIALIZE SYNTAX BUFFER POINTER
0776   01064  020211          LDA  .BUFA   SET BUFFER POINTER TO START
0777   01065  031400          STA  BADDR   OF I/O BUFFER
0778   01066  061055  GETSK   JSM  GNEXT   GET A CHARACTER
0779   01067  010031          CPA  EOL     END OF LINE?
0780   01070  170402          RET          YES, RETURN TO P+1
0781   01071  064357          JMP  RETN2   NO, RETURN TO P+2
0782*
0783*    FIND SEQUENTIAL POSITION OF LINE # GIVEN IN (A)
0784*
0785*      RETURN P+1:BEYOND END OF PROGRAM
0786*             P+2:BETWEEN LINES
0787*             P+3:FOUND
0788*             TEMP3=(B)=ADDRESS OF LINE OR NEXT LINE IN SEQUENCE
0789*             LSTLN=LINE NUMBER OF PREVIOUS LINE
0790*
0791   01072  120233          LDA  SBUFA,I GET SYNTAX SEQUENCE #
0792   01073  031431          STA  CLINE   SAVE FOR LIST ROUTINE
0793   01074  031427          STA  .LNUM
```

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```
0794  01075  031476  FNDPS   STA  TEMP3   SAVE SEQUENCE #
0795  01076  025424          LDB  PBUFF
0796  01077  015423  FNDP1   CPB  PBPTR   END OF PROGRAM?
0797  01100  065117          JMP  FNDP4   YES, RETURN TO P+1
0798  01101  074517          LDA  B,I     GET CURRENT #
0799  01102  070073          SAP  *+1,C   CLEAR SECURE BIT
0800  01103  070510          SZA  FNDP2   EXIT P+3 IF TYPING AID KEY
0801  01104  070076          TCA          SUBTRACT CURRENT # FROM
0802  01105  001476          ADA  TEMP3       DESIRED #
0803  01106  070412          SAM  FNDP3   CURRENT>DESIRED? IF YES, P+2
0804  01107  070330          SIA  FNDP2   EQUAL? IF YES,P+3 (A)=1
0805  01110  074517          LDA  B,I     SAVE
0806  01111  070073          SAP  *+1,C
0807  01112  031720          STA  LASTN     CURRENT LINE
0808  01113  061007          JSM  NEXTA   COMPUTE ADDRESS OF NEXT LINE
0809  01114  065077          JMP  FNDP1
0810  01115  060365  FNDP2   JSM  RET2    P+3
0811  01116  060365  FNDP3   JSM  RET2    P+2
0812  01117  035476  FNDP4   STB  TEMP3   P+1, SAVE STATEMENT ADDRESS
0813  01120  170402          RET
0814*
0815*   MOVE WORDS TO HIGHER MEMORY
0816*
0817*     TEMP2=LAST WORD+1 OF SOURCE
0818*     TEMP3=FIRST WORD OF SOURCE
0819*     TEMP4=LAST WORD+1OF DESTINATION
0820*
0821  01121  025475  MVTOH   LDB  TEMP2   FETCH SOURCE ADDRESS
0822  01122  015476          CPB  TEMP3   ALL RELOCATION DONE?
0823  01123  170402          RET
0824  01124  055477          DSZ  TEMP4   BACK UP DESTINATION POINTER
0825  01125  004132          ADB  M1      BACK UP SOURCE POINTER
0826  01126  074517          LDA  B,I     MOVE
0827  01127  131477          STA  TEMP4,I   WORD
0828  01130  065122          JMP  MVTOH+1
0829*
0830*   FETCH AN INTEGER ALLOWING ZERO
0831*
0832  01131  020132  PGIN0   LDA  M1      FLAG TO RETURN
0833  01132  031724          STA  GFLAG     ON OVERFLOW OR 0
0834  01133  060666          JSM  PGINT   FETCH INTEGER
0835  01134  170402          RET          WITHIN LIMITS
0836  01135  045706          ISZ  SBPTR   OVERFLOW OR ZERO; UPDATE POINTER
0837  01136  075710          SZB  *-2     SKIP IF ZERO
0838  01137  064726          JMP  SYE25   MUST BE OVERFLOW
0839*
0840*   FETCH A LETTER
0841*     EXIT:P+1 IF NEXT CHAR IS NOT A LETTER:CHAR IN (A)
0842*          P+2 IF LETTER; LETTER IN TEMP1; NEXT CHAR IN (A) AND TEMP2
0843*
0844  01140  061055  LTR     JSM  GNEXT
0845  01141  060752          JSM  LETCK   LETTER?
0846  01142  170402          RET          NO, RETURN TO P+1
0847  01143  031474          STA  TEMP1   YES, SAVE IT
0848  01144  061055          JSM  GNEXT
0849  01145  031475          STA  TEMP2   SAVE SECOND CHARACTER
```

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```
0850  01146  064357            JMP  RETN2     RETURN TO P+2
0851*
0852*   END AND RESTORE STATEMENT SYNTAX
0853*
0854  01147  061055  ENDS      JSM  GNEXT     CHECK FOR ADDITIONAL CHARACTERS
0855  01150  045706            ISZ  SBPTR
0856  01151  061153  EOST      JSM  EOLCK
0857  01152  160206  NOEOF     JSM  ERRA,I
0858*
0859*   SUBROUTINE TO CHECK FOR EOL
0860*
0861  01153  010031  EOLCK     CPA  EOL       EOL?
0862  01154  164203            JMP  ACTSA,I   YES, JUMP DIRECTLY TO ACTST
0863  01155  170402            RET
0864*
0865*   INPUT A CONSTANT
0866*
0867  01156  061166  CONST     JSM  GSIGN     GET SIGN
0868  01157  035721            STB  SIGN      STORE IT
0869  01160  160243            JSM  NUMCA,I   FETCH UNSIGNED NUMBER
0870  01161  065163            JMP  CONS3     NONE FOUND
0871  01162  064357            JMP  RETN2     FOUND, RETURN TO P+2
0872  01163  025721  CONS3     LDB  SIGN
0873  01164  074610            SZB  GSIGR     SKIP IF NO SIGN GIVEN
0874  01165  160206  SYE12     JSM  ERRA,I    SIGN GIVEN WITHOUT NUMBER
0875*
0876*   GET THE SIGN OF A NUMBER
0877*
0878  01166  061055  GSIGN     JSM  GNEXT
0879  01167  074742            SBR  16
0880  01170  010047            CPA  .43       "+"?
0881  01171  074230            SIB  GSIGI+1   YES
0882  01172  010050            CPA  .45       "-"?
0883  01173  024132            LDB  M1        YES
0884  01174  074210  GSIG1     SZB  GSIGR     SKIP IF NO SIGN GIVEN
0885  01175  035470            STB  L2T1      SAVE SIGN
0886  01176  061055            JSM  GNEXT     GET CHARACTER FOLLOWING SIGN
0887  01177  025470            LDB  L2T1      RECALL SIGN
0888  01200  170402  GSIGR     RET
0889*
0890*   MULTIPLY 2 INTEGERS IN (A) AND (B) AND RETURN
0891*     RESULT IN (A); IF PRODUCT > 32K, (A)<0
0892*
0893  01201  031466  IMPY      STA  MCAND     SAVE MULTIPLICAND
0894  01202  070742            SAR  16        INITIALIZE PRODUCT
0895  01203  074151  IMPY1     SLB  *+3       SKIP IF MULTIPLIER BIT IS ZERO
0896  01204  001466            ADA  MCAND     ADD MULTIPLICAND TO PRODUCT
0897  01205  071552            SAM  IMPYR     SKIP IF RESULT >32K
0898  01206  074002            SBR  1         SHIFT MULTIPLIER RIGHT
0899  01207  075450            SZB  IMPYR     RETURN IF FINISHED
0900  01210  031467            STA  PROD      SAVE PRODUCT
0901  01211  021466            LDA  MCAND     MULTIPLY
0902  01212  001466            ADA  MCAND       MULTIPLICAND
0903  01213  071252            SAM  IMPYR     SKIP IF RESULT >32K
0904  01214  031466            STA  MCAND       BY 2
0905  01215  021467            LDA  PROD      RECALL PRODUCT
```

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```
0906   01216  065203            JMP  IMPY1
0907   01200         IMPYR      EQU  GSIGR
0908*
0909*   EVALUATE FORMULA AND FETCH RESULT TO AR2
0910*
0911   01217  160201  FETCH     JSM  FORMA,I  EVALUATE FORMULA
0912   01220  160200            JSM  OPCHA,I  GET ADDRESS OF RESULT
0913   01221  045413            ISZ  HSTPT
0914   01222  045413            ISZ  HSTPT    REMOVE FROM STACK
0915   01223  074117            LDA  B
0916   01224  064445            JMP  XFAR2+1  TRANSFER TO AR2
0917*
0918*   SUBROUTINE TO LEAVE KEY DEFINITION MODE
0919*
0920   01225  021422  LDEF      LDA  UKPTR
0921   01226  070410            SZA  *+8
0922   01227  021425            LDA  PBUFO
0923   01230  031424            STA  PBUFF      RESTORE PBUFF
0924   01231  021426            LDA  PBPTO
0925   01232  031423            STA  PBPTR      RESTORE PBPTR
0926   01233  070742            SAR  16
0927   01234  031422            STA  UKPTR      CLEAR USER KEY FLAG
0928   01235  031432            STA  DRQST    CLEAR DATA REQUEST FLAG
0929   01236  170402            RET
0930*
0931*
0932************************************
0933*
0934*   MATH ROUTINES
0935*
0936*
0937*   STORE ROUTINES
0938*
0939   01237  074117  STAR2     LDA  B        ADD THE EXPONENT OF
0940   01240  001744            ADA  AR1E       AR1 AND THE B REGISTER,
0941   01241  050163            AND  ZAP        CLEAR OUT BIT5 1—7 AND
0942   01242  031754            STA  AR2E     STORE IN AR2
0943*
0944   01243  074040            ABR  2        OFFSET THE TWO ABOVE
0945   01244  021744            LDA  AR1E       QUANTITIES AND RE-ADD
0946   01245  070040            AAR  2          TO CHECK FOR A
0947   01246  074017            ADA  B          MAXIMUM EXPONENT
0948   01247  070137            LDB  A        SAVE THE SIGN OF THE EXPONENT
0949   01250  070113            SAP  *+2      IF IT IS POSITIVE
0950   01251  070076            TCA             COMPLEMENT IT
0951   01252  000164            ADA  MASK1    ADD A POSITIVE 100 TO IT
0952   01253  070312            SAM  OF       SKIP IF AN OVERFLOW HAS OCCURED
0953*
0954   01254  025755  ZONK      LDB  AR2E+1
0955   01255  076150            RZB  ZONK1
0956   01256  020214  CLAR2     LDA  AR2A     CLEAR AR2
0957   01257  170000            CLR
0958   01260  170402  ZONK1     RET
0959*
0960*
0961   01261  021754  OF        LDA  AR2E     OTHERWISE SET UP BITS 0 AND 15 OF B
```

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```
0962   01262  070111          SLA  *+2        FOR MAX OR MIN ANSWER
0963   01263  076051          SLB  *+1,S      AND ITS SIGN
0964*
0965   01264  074213          SBP  OVFW
0966*
0967   01265  160205  UNFW    JSM  AERRA,I
0968   01266  177633          DEC  -101
0969   01267  065256          JMP  CLAR2
0970*
0971   01270  061274  OVFW    JSM  STMAX
0972   01271  160205          JSM  AERRA,I
0973   01272  177634          DEC  -100
0974   01273  170402          RET
0975*
0976   01274  061256  STMAX   JSM  CLAR2
0977   01275  074352          SBM  .OVER
0978*
0979   01276  045757          ISZ  AR2E+3
0980   01277  170400          CMY
0981   01300  020165          LDA  MASK5
0982   01301  031754          STA  AR2E
0983   01302  074111          SLB  *+2
0984   01303  045754          ISZ  AR2E
0985   01304  170402  .OVER   RET
0986*
0987   01305  070742  ROUND   SAR  16         CLEAR THE A REGISTER AND
0988   01306  174470          MRY              PERFORM A RIGHT SHIFT B TIMES
0989   01307  000136          ADA  M5          IF THE LAST SHIFTED
0990   01310  070175          SEC  *+3,C       OUT DIGIT IS =>5 INCREMENT THE
0991   01311  020214          LDA  AR2A
0992   01312  170540          MDI              MANTISSA
0993   01313  170402          RET              THEN RETURN
0994*
0995*
0996**********************************
0997*
0998*
0999*
1000   01314  171400  ODGIT   MLS
1001   01315  000052          ADA  .48
1002   01316  065016          JMP  ONEXT
1003*
1004   01317  070537  SGNS    LDB  A,I         GET EXPONENT WORD
1005   01320  070070          SIA  *+1
1006   01321  070517          LDA  A,I         GET MANTISSA
1007   01322  070210          SZA  *+4         CHECK IF MANTISSA WAS ZERO
1008   01323  020012          LDA  .1
1009   01324  074111          SLB  *+2         SKIP IF SIGN IS 0
1010   01325  020132          LDA  M1          OTHERWISE SET A = -1
1011   01326  070137          LDB  A           TRANSFER A INTO B
1012   01327  170402          RET
1013*
1014   01330  031466  .NPWR    STA  LOCL1
1015   01331  021450          LDA  PMODE
1016   01332  031702          STA  NPRIN
1017   01333  021466          LDA  LOCL1
```

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```
1018   01334  164167          JMP  WRITE,I
1019*
1020   01335  035702  NPWRT   STB  NPRIN
1021   01336  164167          JMP  WRITE,I
1022*
1023   01337  035701  NDWRT   STB  NDISP
1024   01340  164167          JMP  WRITE,I
1025*
1026   01341  160170          JSM  CLERA,I
1027   01342  021450  CRLF    LDA  PMODE
1028   01343  072450          RZA  CR1
1029   01344  020031  CRLF1   LDA  CRTN
1030   01345  061353          JSM  TTY      OUTPUT CRTN
1031   01346  070742          SAR  16
1032   01347  160261          JSM  IOSTA,I  STOP KEY?
1033   01350  020040          LDA  .31      YES, SET CRLF SUPRESSED FLAG
1034   01351  031622          STA  TERM
1035   01352  020061          LDA  LNFD     OUTPUT LINE FEED
1036*
1037*  GENERAL DRIVER
1038*
1039   01353  160261  TTY     JSM  IOSTA,I  STOP KEY?
1040   01354  170402  CR1     RET           YES
1041   01355  041447          IOR  SLCOD
1042   01356  172741          STF  1
1043   01357  172141          OTA  1
1044   01360  173601          STC  1,C
1045   01361  170402          RET
1046*
1047*  CONVERT FROM LOWER CASE
1048*
1049   01362  061041  GTCON   JSM  GETCH
1050   01363  070137          LDB  A
1051   01364  050103          AND  B140
1052   01365  010103          CPA  B140
1053   01366  004151          ADB  M32
1054   01367  074117          LDA  B
1055   01370  170402          RET
1056*
1057*       TEMP1 IS POINTING AT ADDRESS OF THE VARIABLE IN SYMBOL TABLE
1058*       ON RETURN (A) = TYPE CODE
1059*                 (B) = ADDRESS
1060*
1061   01371  025474  FIX     LDB  TEMP1
1062   01372  074517          LDA  B,I
1063   01373  050040          AND  B37
1064   01374  004132          ADB  M1
1065   01375  074537          LDB  B,I
1066   01376  170402          RET
1067*
1068*********************************************
1069*
1070   01377  000000          BSS  1        CHECKSUM WORD FOR ADD.'S 1000 TO
                                                                        1377
1071*
1072*********************************************
1073*
```

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```
1075  01400                      ORG  1400B
1076  01400  000000  BADDR       BSS  1      CURRENT CHAR POINTER
1077  01401  000000  RSAVE       BSS  1       SAVE (A) IN RETN2
1078  01402  000000  OTPTR       BSS  1      REFRESH POINTER
1079  01403  000000  MAW         BSS  1      LAST WORD OF R/W MEM
1080  01404  000000  LWAM        BSS  1      LAST WORD AVAILABLE FOR USER
1081  01405  000000  FWUP        BSS  1      FIRST WORD OF COMMON OR MAINLINE
1082  01406  000000  VALUE       BSS  1      FIRST WORD -1 OF VALUE TABLE
1083  01407  000000  SYMTP       BSS  1      FIRST WORD -1 OF SYMBOL TABLE
1084  01410  000000  LSTAK       BSS  1      FIRST WORD OF OPERATOR STACK
1085  01411  000000  TSTPT       BSS  1      TEMPORARY STACK POINTER
1086  01412  000000  LSTPT       BSS  1      OPERATOR STACK POINTER
1087  01413  000000  HSTPT       BSS  1      OPERAND STACK POINTER
1088  01414  000000  DSTRT       BSS  1      DATA STATEMENT
1089  01415  000000  NXTDT       BSS  1        POINTERS
1090  01416  000000  MODE        BSS  1      PROGRAM=0; KEYBOARD=1
1091  01417  000000  PARMA       BSS  1      PARAMETER ADDRESS
1092  01420  000000  PARMN       BSS  1      PARAMETER NAME
1093  01421  000000  PRADD       BSS  1      LAST WORD+1 OF CURRENT STMT
1094  01422  000000  UKPTR       BSS  1      USER KEY POINTER
1095  01423  000000  PBPTR       BSS  1      LAST WORD OF CURRENT PROGRAM
1096  01424  000000  PBUFF       BSS  1      FIRST WORD OF CURRENT PROGRAM
1097  01425  000000  PBUFO       BSS  1      FIRST WORD OF MAINLINE
1098  01426  000000  PBPTO       BSS  1      LAST WORD+1 OF MAINLINE
1099  01427  000000  .LNUM       BSS  1      CURRENT LINE NUMBER
1100  01430  000000  LNINC       BSS  1      AUTO LINE INCREMENT
1101  01431  000000  CLINE       BSS  1      CURRENT LINE FOR LIST
1102  01432  000000  DRQST       BSS  1      INPUT STMT FLAG
1103  01433  000000  TFLAG       BSS  1      PTAPE FLAG
1104  01434  000000  UNITS       BSS  1      TRIG UNITS
1105  01435  000000  SEC         BSS  1      SECURE PROGRAM FLAG
1106  01436  000000  HFLG1       BSS  2      STOP ADDRESSES
1107  01440  000000  TFLG1       BSS  2      TRACE LIMIT ADDRESSES
1108  01442  000000  STPFL       BSS  1      STOP FLAG
1109  01443  000000  KEYFG       BSS  1      KEYBOARD FLAG
1110  01444  000000  SAVEA       BSS  1      INTERRUPT
1111  01445  000000  SAVEB       BSS  1
1112  01446  000000  ADRSS       BSS  1        TEMPORARIES
1113  01447  000000  SLCOD       BSS  1      SELECT CODE
1114  01450  000000  PMODE       BSS  1      PRINT-ALL FLAG
1115  01451  000000  CTYPE       BSS  1      KEYBOARD
1116  01452  000000  CPLAC       BSS  1        FORMAT FLAGS
1117  01453  000000  PRFLG       BSS  1      PRINT/DISP FLAG
1118  01454  000000  RCOUT       BSS  1      FORMAT
1119  01455  000000  FORMT       BSS  1
1120  01456  000000  FORMS       BSS  1
1121  01457  000000  FORME       BSS  1        STATEMENT FLAGS
1122  01460  000000  FTMP1       BSS  1      CURRENT OPERATOR CODE
1123  01461  000000  FTMP2       BSS  1      CURRENT OPERATOR PRECEDENCE
1124  01462  000000  REEDL       BSS  1       KEYBOARD DRIVER LINK
1125  01463  000000  INTEL       BSS  1       INTERRUPT LINK
1126  01464  000000              BSS  2       UNUSED
1127*
1128*   TEMPORARIES
1129*
1130  01466  000000  LOCL1       BSS  1
```

PAGE 22 9830 — BASE PAGE READ-WRITE MEMORY

```
1131  01467  000000  LOCL2   BSS  1
1132  01470  000000  L2T1    BSS  1
1133  01471  000000  L2T2    BSS  1
1134  01472  000000  TEMPS   BSS  1
1135  01473  000000  TEMP    BSS  1
1136  01473          MBOX1   EQU  TEMP
1137  01474  000000  TEMP1   BSS  1
1138  01475  000000  TEMP2   BSS  1
1139  01476  000000  TEMP3   BSS  1
1140  01477  000000  TEMP4   BSS  1
1141*
1142*  BUFFERS
1143*
1144  01500  000000  IOBUF   BSS  41      INPUT AND RECALL BUFFER
1145  01551  000000  RBUFF   BSS  41      SINGLE LINE REFRESH BUFFER
1146*
1147*  PRINT ROUTINE FLAGS
1148*
1149  01622  000000  TERM    BSS  1       CRLF FLAG
1150  01623  000000  PEND    BSS  1       BUFFER OVERFLOW FLAG
1151  01624  000000  PPFF    BSS  1       BUFFER POINTER OR TAB FLAG
1152  01625  000000  FIRST   BSS  1
1153  01626  000000          BSS  2       UNUSED
1154*
1155*  MATH TEMPORARIES
1156*
1157  01630  000000  TREGE   BSS  4
1158  01634  000000  RSLTE   BSS  4
1159*
1160*  STATEMENT SYNTAX AND EXECUTION TEMPORARIES
1161*
1162  01640  000000  ST      BSS  32
1163*
1164*  SYSTEM SYNTAX AND EXECUTION TEMPORARIES
1165*
1166  01700  000000          BSS  1       SAVED FOR PROCESSOR
1167  01701  000000  NDISP   BSS  1
1168  01702  000000  NPRIN   BSS  1
1169  01703  000000  PLACE   BSS  1
1170  01704  000000  WIDTH   BSS  1
1171  01705  000000  FLOAT   BSS  1
1172  01706  000000  SBPTR   BSS  1
1173  01707  000000  BLANK   BSS  1
1174  01710  000000  MSFLG   BSS  1
1175  01711  000000  DFLAG   BSS  1
1176  01712  000000  PFLAG   BSS  1
1177  01713  000000  UFLAG   BSS  1
1178  01714  000000  SFLAG   BSS  1
1179  01715  000000  SBADR   BSS  1
1180  01716  000000  SSBPT   BSS  1
1181  01717  000000  NUM     BSS  1
1182  01717          OPTYP   EQU  NUM
1183  01720  000000  LASTN   BSS  1
1184  01721  000000  SIGN    BSS  1
1185  01721          MAXIN   EQU  SIGN
1186  01722  000000  EXP     BSS  1
```

PAGE 23 9830 — BASE PAGE READ-WRITE MEMORY

```
1187   Ø1722          INTGR   EQU  EXP
1188   Ø1723  ØØØØØØ  ARYAD   BSS  1
1189   Ø1724  ØØØØØØ  GFLAG   BSS  1
1190   Ø1725  ØØØØØØ  NXTST   BSS  1
1191   Ø1726  ØØØØØØ  MBIN1   BSS  1
1192   Ø1727  ØØØØØØ  MBIN2   BSS  1
1193*
1194*    ARITHMETIC REGISTERS AND RETURN STACK
1195*
1196   Ø174Ø                  ORG  174ØB
1197   Ø174Ø  ØØØØØØ  XC      BSS  4
1198   Ø1744  ØØØØØØ  AR1     BSS  4
1199   Ø175Ø  ØØØØØØ  YC      BSS  4
12ØØ   Ø1754  ØØØØØØ  AR2     BSS  4
12Ø1   Ø176Ø  ØØØØØØ  RSTAK   BSS  11          RETURN STACK
12Ø2   Ø1773  ØØØØØØ  RES     BSS  4           RESULT REGISTER
12Ø3   Ø1777  ØØØØØØ  RSPTR   BSS  1     RETURN STACK POINTER
```

PAGE 24 #Ø1 EQUATES

```
12Ø5   Ø1466          MCAND   EQU  LOCL1
12Ø6   Ø1467          PROD    EQU  LOCL2
12Ø7   Ø1744          AR1E    EQU  AR1
12Ø8   Ø1754          AR2E    EQU  AR2
12Ø9   Ø173Ø          COML    EQU  MBIN2+1
121Ø   Ø1731          TYPE    EQU  MBIN2+2
1211   Ø164Ø          TEPPP   EQU  ST
1212   Ø1641          SPRDD   EQU  ST+1
1213   Ø1642          SAVE    EQU  ST+2
1214   Ø1453          ARW     EQU  PRFLG
1215   Ø174Ø          TMP     EQU  XC
1216   Ø1741          TMP1    EQU  XC+1
1217   Ø1742          TMP2    EQU  XC+2
1218   Ø1743          TMP3    EQU  XC+3
1219   Ø175Ø          TMP4    EQU  YC
122Ø   Ø1751          TMP5    EQU  YC+1
1221   Ø17Ø6          TMP6    EQU  SBPTR
1222   Ø1752          TMP6A   EQU  YC+2
1223   Ø146Ø          TMP7    EQU  FTMP1
1224   Ø1474          TMP9    EQU  TEMPS+2
1225   Ø1475          TMP1Ø   EQU  TEMPS+3
1226   Ø1476          TMP11   EQU  TEMPS+4
1227   Ø1477          TMP12   EQU  TEMPS+5
1228   Ø1461          TMP13   EQU  FTMP2
1229   Ø1473          CCNT    EQU  TEMPS+1
123Ø   Ø17Ø4          BKPTR   EQU  WIDTH
1231   Ø1741          R       EQU  TMP1
1232   Ø1742          L       EQU  TMP2
1233   Ø1751          DIGIT   EQU  TMP5
1234   Ø1743          INDEX   EQU  TMP3
1235   Ø175Ø          RBASE   EQU  TMP4
1236*
1237*
1238   ØØØ47          PLUS    EQU  .43
1239   ØØØ5Ø          MINUS   EQU  .45
124Ø   ØØØ51          POINT   EQU  .46
1241   ØØØ52          B6Ø     EQU  .48
1242   ØØØ53          COLON   EQU  .58
1243   ØØØ77          DOLAR   EQU  B44
1244   ØØ116          B2K     EQU  QTOP
1245   ØØØØ4          XECA    EQU  B1ØK
```

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```
1248*
1249*      REED SUBROUTINE
1250*
1251*      ENTRY CONDITIONS: NONE
1252*
1253*      EXIT CONDITIONS:
1254*
1255*      AN INPUT RECORD IS IN THE I/O
1256*      BUFFER. THE LAST CHAR IS AN EOL.
1257*
1258*
1259*      IF A DELETE LINE IS HIT
1260*      RETURN TO P+1, OTHERWISE
1261*      RETURN TO P+2.
1262*
1263*
1264   02000            ORG 2000B
1265*
1266*
1267   02000  020236  REED1   LDA  SLEND
1268   02001  031623          STA  PEND
1269   02002  020062          LDA  FLGBT
1270   02003  031416          STA  MODE    SET TO PROGRAM SYNTAX
1271   02004  021433          LDA  TFLAG
1272   02005  070110          SZA  *+2     PTAPE COMMAND?
1273   02006  066617          JMP  PREED
1274   02007  031473          STA  CCNT
1275   02010  031704          STA  BKPTR
1276*    GET FIRST KEY
1277   02011  063046  REEDE   JSM  CALLK   GET FIRST KEY
1278   02012  066011          JMP  *-1
1279   02013  013127          CPA  DELIN
1280   02014  066223          JMP  DEL1
1281   02015  025430          LDB  LNINC
1282   02016  010074          CPA  B22     BACKSPACE?
1283   02017  074112          SBM  REE     YES, SKIP IF LIST INPUT
1284   02020  066032          JMP  REED7
1285   02021  055400  REE     DSZ  BADDR   YES, BACKUP POINTER
1286   02022  045623          ISZ  PEND
1287   02023  020041          LDA  .32
1288   02024  061016          JSM  ONEXT
1289   02025  055400          DSZ  BADDR   WIPE OUT LAZY-T
1290   02026  055623          DSZ  PEND    RESTORE END OF BUFFER POINTER
1291   02027  070742          SAR  16
1292   02030  031430          STA  LNINC   GET OUT OF AUTO
1293   02031  066045          JMP  REED6
1294   02032  062533  REED7   JSM  CLEAR   CLEAR THE DISPLAY
1295   02033  021430          LDA  LNINC
1296   02034  070153          SAP  REED4    LIST WAS LAST?
1297   02035  070742          SAR  16
1298   02036  031430          STA  LNINC   GET OUT OF AUTO
1299   02037  070210  REED4   SZA  REED6-2 AUTO LINE?
1300   02040  025427          LDB  .LNUM   YES OUTPUT #
1301   02041  160210          JSM  OUTIA,I
1302   02042  045400          ISZ  BADDR   OUTPUT A BLANK
1303   02043  021751          LDA  TMP5
```

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```
1304  02044  066047          JMP  REEDG
1305*  GET NEXT KEY
1306  02045  063046  REED6   JSM  CALLK   GET NEXT KEY
1307  02046  066045          JMP  *-1
1308  02047  010074  REEDG   CPA  B22     BACKSPACE?
1309  02050  066707          JMP  BKSP
1310  02051  010075          CPA  B23     FORWARD?
1311  02052  066725          JMP  FORWD   YES
1312  02053  012436          CPA  B152    CLEAR?
1313  02054  067665          JMP  ECLR    YES
1314  02055  010027          CPA  .11     EXECUTE KEY?
1315  02056  045416          ISZ  MODE    YES
1316  02057  050103          AND  MSK65
1317  02060  072510          RZA  REED2   BITS 5&6=0?
1318  02061  021751          LDA  TMP5    YES
1319  02062  000141          ADA  M10
1320  02063  070413          SAP  REED2+1 DEF KEY?
1321  02064  025706          LDB  TMP6
1322  02065  074210          SZB  *+4
1323  02066  021751          LDA  TMP5
1324  02067  040101          IOR  B100    SET SHIFT BIT FOR DEF-KEYS
1325  02070  031751          STA  TMP5
1326  02071  067131          JMP  KEYPR
1327  02072  010103  REED2   CPA  MSK65   BITS 5&6=1?
1328  02073  066103          JMP  REED3   YES
1329  02074  021706          LDA  TMP6    NO
1330  02075  070610          SZA  REED5   SHIFTED?
1331  02076  021751          LDA  TMP5
1332  02077  060752          JSM  LETCK   YES, LOWER CASE LETTER?
1333  02100  066103          JMP  REED3   NO
1334  02101  040041          IOR  .32     CONVERT CODE
1335  02102  066110          JMP  REED5-1
1336  02103  026412  REED3   LDB  VALUP
1337  02104  063071          JSM  TBSR1   CODE IN VALUE TABLE?
1338  02105  066124          JMP  REEDD   NO
1339  02106  010022          CPA  .5      ENTER EXPONENT?
1340  02107  000101          ADA  B100    YES, FORM ASCII E
1341  02110  031751          STA  TMP5
1342*
1343*  ALL CONVERSIONS COMPLETE
1344  02111  021751  REED5   LDA  TMP5
1345  02112  010031          CPA  CRTN
1346  02113  066172          JMP  EOLL    EXECUTE OR STORE
1347  02114  025704          LDB  BKPTR
1348  02115  074210          SZB  REED9   CURSOR?
1349  02116  027122          LDB  BKPTA   YES
1350  02117  061017          JSM  OUTCR   REPLACE CHARACTER
1351  02120  066730          JMP  FORWD+3 SCROLL IF NECESSARY
1352  02121  061016  REED9   JSM  ONEXT   PUT CHAR AT END OF LINE
1353  02122  062737          JSM  LEFT    SCROLL IF NECESSARY
1354  02123  066045          JMP  REED6
1355*
1356  02124  026373  REEDD   LDB  EXPTB   SEARCH FOR MULTI-CHAR KEY
1357  02125  063071          JSM  TBSR1   FOUND?
1358  02126  066213          JMP  REED8   NO
1359  02127  031751          STA  TMP5
```

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```
1360  02130  062521          JSM  CLRST    CLEAR FLAG IF "STOP"
1361  02131  062533          JSM  CLEAR
1362  02132  026443          LDB  COMTA
1363  02133  021751          LDA  TMP5
1364  02134  162441          JSM  MOUTA,I  OUTPUT FROM SYSTEM COMMAND
                                                                    TABLE
1365  02135  066045          JMP  REED6
1366  02136  062533  PRALL   JSM  CLEAR    CLEAR BUFFER
1367  02137  021450          LDA  PMODE
1368  02140  070130          SIA  *+2
1369  02141  070742          SAR  16
1370  02142  031450          STA  PMODE
1371  02143  026444          LDB  OFFA     GET ADDRESS OF "OFF"
1372  02144  072110          RZA  *+2      ON?
1373  02145  004020          ADB  .3       YES, GET ADDRESS OF "ON"
1374  02146  020020          LDA  .3
1375  02147  061335          JSM  NPWRT
1376  02150  066011          JMP  REEDE    GET FIRST KEY AGAIN
1377*
1378*   STEP AND CONT EXECUTION
1379*
1380  02151  031442  STEP    STA  STPFL    SET POSITIVE NON-ZERO
1381  02152  070742          SAR  16
1382  02153  025421  CONT    LDB  PRADD
1383  02154  074273          SBP  CONT1,C  HAS AN EDIT OCCURRED?
1384  02155  072110          RZA  CONTK    YES, LINE ≠ GIVEN?
1385  02156  074517          LDA  B,I       NO, EXECUTE FROM BEGINNING
1386  02157  031725  CONTK   STA  NXTST    YES, EXECUTE FROM BEGINNING
1387  02160  164004          JMP  XECA,I
1388  02161  070250  CONT1   SZA  *+5       LINE ≠ GIVEN?
1389  02162  061075          JSM  FNDPS    YES, FIND ADDRESS
1390  02163  164174          JMP  RDYDA,I
1391  02164  066165          JMP  *+1
1392  02165  035421          STB  PRADD    STORE ADDRESS
1393  02166  062533          JSM  CLEAR
1394  02167  031416          STA  MODE     SET TO PROGRAM EXECUTION
1395  02170  025421          LDB  PRADD
1396  02171  164255          JMP  XEC6A,I  CONTINUE EXECUTION
1397*
1398*   PROCESS EXEC OR STORE
1399  02172  045623  EOLL    ISZ  PEND     GUARANTEE ROOM FOR EOL
1400  02173  061016          JSM  ONEXT
1401  02174  024233          LDB  BEND
1402  02175  035477          STB  TEMP4
1403  02176  024233          LDB  SBUFA
1404  02177  035476          STB  TEMP3
1405  02200  004046          ADB  .41
1406  02201  061122          JSM  MVTOH+1  MOVE INPUT RECORD TO I/O BUFF
1407  02202  060373          JSM  ICNT
1408  02203  000132          ADA  M1
1409  02204  070250          SZA  REEDT    SKIP IF NULL RECORD
1410  02205  025450          LDB  PMODE
1411  02206  076150          RZB  REEDT
1412  02207  024211          LDB  .BUFA
1413  02210  061337          JSM  NDWRT
1414  02211  062502  REEDT   JSM  CRC
1415  02212  064357          JMP  RETN2
```

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```
1416*
1417   Ø2213  Ø13124  REED8   CPA  B33       DIVIDE?
1418   Ø2214  Ø22437          LDA  B57       YES, GET ASCII
1419   Ø2215  Ø26361          LDB  EDIT2
142Ø   Ø2216  Ø63Ø72          JSM  TBSRH     CODE IN EDIT TABLE?
1421   Ø2217  Ø66110          JMP  REED5-1   NO
1422   Ø222Ø  ØØ244Ø          ADA  BEEB
1423   Ø2221  Ø7Ø737          JMP  A,I
1424*
1425*   DELETE LINE
1426   Ø2222  17Ø4Ø2  DEL2    RET
1427   Ø2223  Ø2143Ø  DEL1    LDA  LNINC
1428   Ø2224  Ø71713          SAP  DEL2
1429   Ø2225  Ø21431          LDA  CLINE
143Ø   Ø2226  13Ø233          STA  SBUFA,I
1431   Ø2227  Ø7Ø742          SAR  16
1432   Ø223Ø  Ø3143Ø          STA  LNINC
1433   Ø2231  164Ø4Ø          JMP  DELSA,I
1434*
1435*   RECALL
1436*
1437   Ø2232  Ø62533  EREC    JSM  CLEAR
1438   Ø2233  Ø55473          DSZ  CCNT      SET RECALL FLAG
1439   Ø2234  Ø24211          LDB  .BUFA
144Ø   Ø2235  Ø3574Ø  RSLT1   STB  TMP       GET STARTING ADDRESS OF IO BUFF
1441   Ø2236  Ø66Ø45          JMP  REED6
1442*
1443*   INITIALIZE VARIABLES
1444*
1445   Ø2237  Ø2ØØ56  INITV   LDA  .1E4
1446   Ø224Ø  164171          JMP  RUNA,I    RUN 1ØØØØ
1447*   RESULT KEY
1448   Ø2241  Ø2Ø1Ø1  RSLT    LDA  B1ØØ      CODE FOR @
1449   Ø2242  Ø257Ø6          LDB  TMP6
145Ø   Ø2243  Ø7411Ø          SZB  *+2       SHIFTED?
1451   Ø2244  Ø66110          JMP  REED5-1   YES
1452   Ø2245  Ø26445          LDB  RESA
1453   Ø2246  Ø2ØØ2Ø  RFNX1   LDA  .3
1454   Ø2247  Ø31473          STA  CCNT      COUNT=3
1455   Ø225Ø  Ø66235          JMP  RSLT1
1456*
1457*
1458   Ø2251  Ø66136  PAL     JMP  PRALL
1459   Ø2252  Ø66151  STPL    JMP  STEP
```

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```
1461*
1462*   FETCH EXECUTION
1463*
1464   Ø2253  ØØØ132  EFET    ADA  M1
1465   Ø2254  Ø31431          STA  CLINE
1466*
1467*   THIS ROUTINE LISTS ONE LINE
1468*   OF THE PROGRAM. THE FIRST
1469*   LINE TO BE LISTED IS THE FIRST
147Ø*   LINE OF THE PROGRAM.
1471*
1472*
1473   Ø2255  Ø62353  DNARW  JSM  SAROW   CHECK FOR NULL PROGRAM
1474   Ø2256  Ø74310         SZB  U4      SKIP IF TYPING AID KEY
1475   Ø2257  Ø7ØØ7Ø         SIA  *+1
1476   Ø226Ø  Ø61Ø75         JSM  FNDPS   FIND LINE
1477   Ø2261  Ø66277         JMP  U3      PAST END OF PROGRAM
1478   Ø2262  Ø663Ø1         JMP  U5-1    BETWEEN LINES
1479   Ø2263  Ø663Ø1         JMP  U5-1
148Ø*
1481*   THIS ROUTINE LISTS ONE LINE
1482*   OF THE PROGRAM. THE FIRST LINE
1483*   TO BE LISTED IS THE LAST LINE
1484*   OF THE PROGRAM.
1485*
1486*
1487   Ø2264  Ø21424  U4      LDA  PBUFF   GET FIRST LINE
1488   Ø2265  Ø663Ø2         JMP  U5
1489   Ø2266  Ø62353  UPARW  JSM  SAROW   CHECK FOR NULL PROG
149Ø   Ø2267  Ø7565Ø         SZB  U4      SKIP IF TYPING AID
1491   Ø227Ø  Ø7211Ø         RZA  U1      CLINE =Ø?
1492   Ø2271  Ø2ØØ56         LDA  .1E4    YES, FIND LAST LINE OF PROG
1493   Ø2272  Ø61Ø75  U1      JSM  FNDPS   FIND LINE
1494   Ø2273  Ø66277         JMP  U3      PAST END OF PROG
1495   Ø2274  Ø66275         JMP  *+1     BETWEEN LINES
1496   Ø2275  Ø1542Ø         CPB  PBUFF   FIRST LINE?
1497   Ø2276  Ø663Ø1         JMP  U5-1     YES
1498   Ø2277  Ø2172Ø  U3      LDA  LASTN   GET PREVIOUS LINE
1499   Ø23ØØ  Ø6Ø742         JSM  FND
15ØØ   Ø23Ø1  Ø74117         LDA  B       GET ADDRESS IN (A)
15Ø1   Ø23Ø2  Ø74742  U5      SBR  16
15Ø2   Ø23Ø3  Ø3545Ø         STB  ARW     FLAG LIST ROUTINE
15Ø3   Ø23Ø4  Ø3546Ø         STB  TMP7
15Ø4   Ø23Ø5  167120         JMP  LISTR,I
15Ø5*
15Ø6*   INSERT AND DELETE CHARACTER
15Ø7*
15Ø8   Ø23Ø6  Ø66Ø45         JMP  REED6
15Ø9   Ø23Ø7  Ø257Ø4  INSRT   LDB  BKPTR
151Ø   Ø231Ø  Ø7571Ø         SZB  INSRT-1 ANY BACKSPACE YET?
1511   Ø2311  Ø254ØØ         LDB  BADDR
1512   Ø2312  Ø217Ø6         LDA  TMP6
1513   Ø2313  Ø7Ø71Ø         SZA  INSØ    SHIFT FLAG SET?
1514*   DELETE
1515   Ø2314  Ø554ØØ         DSZ  BADDR   YES, DINC END OF LINE POINTER
1516   Ø2315  Ø257Ø4         LDB  BKPTR
```

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```
1517  02316  035740          STB  TMP      SET POINTER TO CURSOR CHARACTER
1518  02317  025740  DELC1   LDB  TMP
1519  02320  015400          CPB  BADDR    LAST CHAR?
1520  02321  066347          JMP  INS2+1   YES, OUTPUT A BLANK
1521  02322  045740          ISZ  TMP
1522  02323  061053          JSM  GTMP     GET CHARACTER
1523  02324  055740          DSZ  TMP
1524  02325  055740          DSZ  TMP
1525  02326  024111          LDB  TMPA     STORE SHIFTED LEFT ONE
1526  02327  061017          JSM  OUTCR
1527  02330  066317          JMP  DELC1
1528*   INSERT
1529  02331  014236  INS0    CPB  SLEND
1530  02332  066045          JMP  REED6     LINE FULL
1531  02333  004132          ADB  M1
1532  02334  035740  INS1    STB  TMP
1533  02335  061053          JSM  GTMP     GET CHARACTER
1534  02336  025740          LDB  TMP
1535  02337  015704          CPB  BKPTR    AT CURSOR POSITION?
1536  02340  066346          JMP  INS2     YES
1537  02341  024111          LDB  TMPA   NO, MOVE RIGHT 1 PLACE
1538  02342  061017          JSM  OUTCR
1539  02343  025740          LDB  TMP
1540  02344  004134          ADB  M3       BACK UP POINTER TO NEXT
1541  02345  066334          JMP  INS1       CHAR LEFT
1542  02346  045400  INS2    ISZ  BADDR    UPDATE END OF LINE POINTER
1543  02347  020041          LDA  .32
1544  02350  024111          LDB  TMPA
1545  02351  061017          JSM  OUTCR    INSERT A BLANK
1546  02352  066045          JMP  REED6
1547*
1548*   SUBROUTINE FOR UP AND DOWN ARROW ROUTINES
1549*
1550  02353  021424  SAROW   LDA  PBUFF
1551  02354  011423          CPA  PBPTR
1552  02355  164174          JMP  RDYDA,I  NULL PROGRAM ABORT
1553  02356  021431          LDA  CLINE
1554  02357  125424          LDB  PBUFF,I
1555  02360  170402          RET
```

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```
1557*
1558*     THIS SECTION CONTAINS TABLES,
1559*     POINTERS USED IN THE ABOVE ROUTINE
1560*
1561*
1562*
1563*
1564  02361  004744  EDIT2    DEF  *+*+2
1565  02362  012643           DEF  12600B-EEB+UPARW
1566  02363  012232           DEF  12200B-EEB+DNARW
1567  02364  015214           DEF  15200B-EEB+INITV
1568  02365  065616           DEF  65600B-EEB+RSLT
1569  02366  006627           DEF  6600B-EEB+STPL
1570  02367  017664           DEF  17600B-EEB+INSRT
1571  02370  071600           DEF  71600B-EEB+DEL1
1572  02371  070226           DEF  70200B-EEB+PAL
1573  02372  010307           DEF  10300B-EEB+EREC
1574  02223         EEB       EQU  DEL1
1575*
1576*
1577*     EXPANDING DEY TABLE
1578*
1579*
1580  02373  004770  EXPTB     DEF  *+*+2
1581  02374  007601  OCT      7601        RUN
1582  02375  014600  OCT      14600        STORE
1583  02376  014220  OCT      14220       LOAD
1584  02377  017207  OCT      17207       NORMAL
1585  02400  006212  OCT      6212        CONTINUE
1586  02401  007226  OCT      7226        TRACE
1587  02402  077637  OCT      77637       STOP
1588  02403  017216  OCT      17216       NORMAL
1589  02404  010604  OCT      10604       FETCH
1590  02405  072214  OCT      72214       FIXED
1591  02406  072615  OCT      72615       FLOAT
1592  02407  005203  OCT      5203        LIST
1593  02410  073202  OCT      73202       SCRATCH
1594  02411  073705  OCT      73705       AUTO
1595*
1596*
1597*     KEY VALUE TABLE
1598*
1599  02412  005026  VALUP     DEF  *+*+2
1600  02413  005615  OCT      5615        EOL
1601  02414  071215  OCT      71215       STORE
1602  02415  020240  OCT      20240       BLANK
1603  02416  030641  OCT      30641       !
1604  02417  032244  OCT      32244       $
1605  02420  032645  OCT      32645       %
1606  02421  067605  OCT      67605       E
1607  02422  031643  OCT      31643       #
1608  02423  031242  OCT      31242       "
1609  02424  033246  OCT      33246       &
1610  02425  033647  OCT      33647       '
1611  02426  034250  OCT      34250       (
1612  02427  034651  OCT      34651       )
```

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```
1613   02430  027677   OCT     27677      ?
1614   02431  026274           OCT   26274      <
1615   02432  027276           OCT   27276      >
1616   02433  035252   OCT     35252        *
1617   02434  035653   OCT     35653        +
1618   02435  030355   OCT     30355        -
1619*
1620*
1621*
1622   00103          MSK65    EQU   B140
1623   02436  000152  B152     OCT   152
1624   02437  000057  B57      OCT   57
1625   02440  002223  BEEB     DEF   EEB
1626   02441  006306  MOUTA    DEF   MCOUT
1627   02442  003402  LPTR     DEF   RBUFF+RBUFF+48
1628   02443  007062  COMTA    DEF   LBL1+LBL1+20
1629   02444  005117  OFFA     DEF   *+*+7
1630   02445  005114  RESA     DEF   *+*+2
1631   02446  051105           ASC   4,RESOFFON
       02447  051517
       02450  043106
       02451  047516
1632   02452  020040  TOBLN    OCT   20040
1633*
1634*
1635   02453  000000           BSS   1            *****CHECKSUM*****
```

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```
1637*   WRITE SUBROUTINE
1638*
1639*   ENTRY CONDITIONS:
1640*
1641*           (A)=CHARACTER COUNT
1642*           (B)=POINTER TO FIRST CHAR
1643*           NPRIN≠Ø FOR PRINT ABORT
1644*           NDISP≠Ø   PRINT ONLY
1645*
1646*
1647   Ø2454  Ø7Ø41Ø  WRIT    SZA  RIT3L     SKIP IF NULL COUNT
1648   Ø2455  Ø31741         STA  TMP1
1649   Ø2456  Ø3574Ø         STB  TMP       INITIALIZE POINTER
165Ø   Ø2457  Ø61Ø53  RITE1   JSM  GTMP      GET CHARACTER
1651   Ø246Ø  Ø1ØØ27         CPA  .11       EXECUTE?
1652   Ø2461  Ø2Ø1ØØ         LDA  B52       YES, CHANGE TO * FOR KEY
1653   Ø2462  Ø257Ø1         LDB  NDISP
1654   Ø2463  Ø1ØØ31         CPA  CRTN      CRTN CHARACTER?
1655   Ø2464  Ø66476  RIT3L   JMP  RITE3     YES, ABORT
1656   Ø2465  Ø7631Ø         RZB  RITE2-1   DISPLAY DISABLED?
1657   Ø2466  Ø7Ø15Ø         SZA  RITE4     NO, NULL?
1658   Ø2467  Ø61Ø16         JSM  ONEXT     OUTPUT TO DISPLAY BUFFER
1659   Ø247Ø  Ø21467         LDA  LOCL2     RECALL CHARACTER
166Ø   Ø2471  Ø2572Ø  RITE4   LDB  NPRIN
1661   Ø2472  Ø7611Ø         RZB  RITE2     PRINT DISABLED?
1662   Ø2473  Ø61353         JSM  TTY       NO, PRINT CHAR
1663   Ø2474  Ø55741  RITE2   DSZ  TMP1      MORE CHARACTERS?
1664   Ø2475  Ø66457         JMP  RITE1     YES
1665   Ø2476  Ø7Ø742  RITE3   SAR  16        RESET FLAGS
1666   Ø2477  Ø317Ø2         STA  NPRIN
1667   Ø25ØØ  Ø317Ø1         STA  NDISP
1668   Ø25Ø1  17Ø4Ø2  RETA    RET
1669*
167Ø   Ø25Ø2  Ø2545Ø  CRC     LDB  PMODE
1671   Ø25Ø3  Ø74358         SZB  CRC1      PRINT ALL?
1672   Ø25Ø4  Ø2545Ø  CRCHK   LDB  PMODE
1673   Ø25Ø5  Ø74158         SZB  CRC2      PRINT ALL?
1674   Ø25Ø6  Ø25453         LDB  PRFLG
1675   Ø25Ø7  Ø74352         SBM  CTERM
1676   Ø251Ø  Ø25622  CRC2    LDB  TERM
1677   Ø2511  Ø7541Ø         SZB  RETA
1678   Ø2512  172ØØØ  CRC1    SFC  Ø         WAIT UNTIL "STOP" KEY
1679   Ø2513  Ø66512         JMP  *-1         IS RELEASED
168Ø   Ø2514  Ø62521         JSM  CLRST     CLEAR "STOP" FLAG
1681   Ø2515  Ø61344         JSM  CRLF1
1682*
1683   Ø2516  Ø74742  CTERM   SBR  16
1684   Ø2517  Ø3562Ø         STB  TERM
1685   Ø252Ø  17Ø4Ø2         RET
1686*
1687   Ø2521  Ø2544Ø  CLRST   LDB  STPFL
1688   Ø2522  Ø14Ø4Ø         CPB  .31       SET FROM KEYBOARD?
1689   Ø2523  Ø66525         JMP  *+2       YES, CLEAR IT
169Ø   Ø2524  17Ø4Ø2         RET
1961   Ø2525  Ø74742         SBR  16
1692   Ø2526  Ø3544Ø         STB  STPFL
```

PAGE 34 KEYBOARD ENTRY AND DISPLAY

```
1693   02527  035433          STB  TFLAG
1694   02530  170402          RET
1695*
1696*
1697   02531  027117  GTMP2   LDB  TMP2A
1698   02532  065041          JMP  GETCH
1699*
1700*
1701*    THIS SUBROUTINE CLEARS THE DISPLAY
1702*
1703   02533  070742  CLEAR   SAR  16
1704   02534  031704          STA  BKPTR
1705   02535  020212          LDA  .SLBF
1706   02536  031402          STA  OTPTR
1707   02537  031400          STA  BADDR
1708   02540  031625          STA  FIRST
1709   02541  024233          LDB  BEND
1710   02542  022452          LDA  TOBLN
1711   02543  074557  CLE1    STA  B,I
1712   02544  017123          CPB  ENDW
1713   02545  066476          JMP  RITE3
1714   02546  077670          RIB  CLE1      NO
1715*
1716*    I/O STATUS CHECK ROUTINE
1717*
1718   02547  025442  IOST    LDB  STPFL
1719   02550  014040          CPB  .31       STOP FLAG?
1720   02551  170402          RET            YES
1721   02552  025447          LDB  SLCOD     NO
1722   02553  172741          STF  1         TURN INTERRUPT OFF
1723   02554  176141          OTB  1
1724   02555  172741          STF  1         GET STATUS IN I/O REG
1725   02556  177241          LIB  1,C       TURN INTERRUPT ON
1726   02557  074406          RBR  9
1727   02560  075353          SBP  IOST      DEVICE BUSY?
1728   02561  064357          JMP  RETN2     NO
```

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```
1730*
1731*
1732*     THIS SUBROUTINE REFRESHES
1733*     THE SINGLE LINE DISPLAY
1734*
1735  02562  021402  REFRS  LDA  OTPTR
1736  02563  031740         STA  TMP
1737  02564  000033         ADA  .16
1738  02565  031742         STA  TMP2
1739  02566  074742         SBR  16
1740  02567  035741  RE1    STB  TMP1
1741  02570  024111         LDB  TMPA
1742  02571  061362         JSM  GTCON
1743  02572  070304  RE3    SAL  10
1744  02573  031743         STA  TMP3
1745  02574  027117         LDB  TMP2A
1746  02575  061362         JSM  GTCON
1747  02576  050054  RE4    AND  .63
1748  02577  070604         SAL  4
1749  02600  041743         IOR  TMP3
1750  02601  041741         IOR  TMP1      FORM OUTPUT WORD
1751  02602  173750         CLF  8         TURN DISPLAY OFF
1752  02603  173741         CLF  1         INTERRUPT ON
1753  02604  025443         LDB  KEYFG
1754  02605  172741         STF  1         INTERRUPT OFF
1755  02606  074353         SBP  RE2       INTERRUPT OCCURRED?
1756  02607  025741         LDB  TMP1
1757  02610  014033         CPB  .16
1758  02611  066615         JMP  RE2
1759  02612  074070         SIB  *+1
1760  02613  172150         OTA  8
1761  02614  066567         JMP  RE1
1762  02615  173741  RE2    CLF  1
1763  02616  170402         RET            TURN INTERRUPT ON
```

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```
1765*
1766*     PTAPE COMMAND EXECUTION
1767*
1768*     THIS ROUTINE READS PROGRAMS FROM
1769*     THE PHOTOREADER. 10 OR MORE NULLS
1770*     CONSTITUTE LEADER OR TRAILER WHICH
1771*     ARE THE PROGRAM DELIMITERS.
1772*
1773*     INPUT CODES:
1774*
1775*       DATA  64 ASCII SET
1776*
1777*       CONTROL
1778*
1779*         176  ALT MODE=DELETE LINE
1780*         33   ESC MODE=DELETE LINE
1781*         137  LEFT ARROW=DELETE CHAR
1782*         177  RUBOUT= IGNORE
1783*         15   CRTN= IGNORE
1784*         12   LNFD= END OF RECORD
1785*     RETURN TO:
1786*
1787*         P+1 IF NULL RECORD
1788*         P+2 OTHERWISE
1789  02617  070204  PREED  SAL  12
1790  02620  031447         STA  SLCOD
1791  02621  020211         LDA  .BUFA
1792  02622  031400         STA  BADDR
1793  02623  020132         LDA  M1
1794  02624  031751         STA  TMP5    CLEAR DELETE LINE FLAG
1795  02625  020141         LDA  M10
1796  02626  031741         STA  TMP1    SET FEED HOLE COUNTER
1797*
1798*
1799*     GENERAL INPUT ROUTINE
1800*
1801  02627  062547  P1     JSM  IOST    STOP KEY?
1802  02630  066704         JMP  P7      YES
1803  02631  020121         LDA  B4000   GET INPUT STATUS BIT
1804  02632  061355         JSM  CR1+1   CALL FOR INPUT
1805  02633  062547         JSM  IOST
1806  02634  066704  P4     JMP  P7      STOP
1807  02635  074117         LDA  B
1808  02636  070306         RAR  7
1809  02637  050104         AND  B177
1810  02640  072310         RZA  P3      NULL?
1811  02641  045741         ISZ  TMP1    10 FEED HOLES?
1812  02642  066627         JMP  P1      NO
1813  02643  021742         LDA  TMP2
1814  02644  071413         SAP  P4      TRAILER?
1815  02645  066625         JMP  P1-2    NO, LEADER
1816  02646  031742  P3     STA  TMP2    RESET LEADER FLAG
1817  02647  010104         CPA  B177    RUBOUT?
1818  02650  066625         JMP  P1-2    YES
1819  02651  010031         CPA  CRTN    CRTN?
1820  02652  066625         JMP  P1-2    YES, IGNORE
```

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```
1821  02653  013126        CPA  B137     LEFT ARROW?
1822  02654  066700        JMP  P5       YES, BACKSPACE
1823  02655  010061        CPA  LNFD     LINE FEED?
1824  02656  020031        LDA  E0L      YES, CHANGE TO END OF LINE
                                                        CHARACTER
1825  02657  013124        CPA  B33      ESCAPE MODE?
1826  02660  066624        JMP  P1-3     YES, SET DELETE FLAG
1827  02661  013125        CPA  B176     ALT MODE?
1828  02662  066624        JMP  P1-3     YES, DELETE
1829  02663  061016        JSM  ONEXT
1830  02664  021467        LDA  LOCL2
1831  02665  010031        CPA  EOL      END OF RECORD?
1832  02666  066673        JMP  P2       YES
1833  02667  025400        LDB  BADDR
1834  02670  017130        CPB  IOEND    FULL?
1835  02671  055400  P6    DSZ  BADDR
1836  02672  066625        JMP  P1-2
1837  02673  020127  P2    LDA  B170K
1838  02674  031447        STA  SLCOD    SET TO STANDARD PRINTER
1839  02675  045751        ISZ  TMP5     CHECK DELETE FLAG
1840  02676  170402        RET           DELETE
1841  02677  064357        JMP  RETN2    ACCEPT
1842  02700  025400  P5    LDB  BADDR
1843  02701  014211        CPB  .BUFA    BUFFER EMPTY?
1844  02702  066625        JMP  P1-2     YES, IGNORE
1845  02703  066671        JMP  P6       NO, BACKSPACE
1846  02704  020031  P7    LDA  EOL
1847  02705  061016        JSM  ONEXT    PUT EOL CHAR IN BUFFER
1848  02706  164174        JMP  RDYDA,I  EXIT PTAPE MODE
```

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```
1850*
1851*     BACKSPACE
1852*
1853   02707  021704  BKSP    LDA  BKPTR
1854   02710  072350          RZA  BK2      FIRST BACKSPACE?
1855   02711  021400          LDA  BADDR    YES
1856   02712  010212          CPA  .SLBF    NULL RECORD?
1857   02713  066045          JMP  REED6    YES
1858   02714  021400          LDA  BADDR
1859   02715  031704          STA  BKPTR
1860   02716  066723          JMP  BK1-1    PUT POINTER AT LAST CHAR
1861   02717  010212  BK2     CPA  .SLBF    ALREADY AT FIRST CHAR?
1862   02720  066045          JMP  REED6    YES
1863   02721  011402          CPA  OTPTR    LEFTMOST ON SCREEN?
1864   02722  055402          DSZ  OTPTR    YES, SCROLL
1865   02723  055704          DSZ  BKPTR    BACKSPACE CURSOR
1866   02724  066045  BK1     JMP  REED6
1867*
1868*     FORWARD SPACE
1869*
1870   02725  021704  FORWD   LDA  BKPTR
1871   02726  070310          SZA  FW1      SKIP IF NO BACKSPACE HAS OCCURRED
1872   02727  045704          ISZ  BKPTR
1873   02730  021402          LDA  OTPTR
1874   02731  000041          ADA  .32
1875   02732  011704          CPA  BKPTR    ON RIGHT OF SCREEN?
1876   02733  011400          CPA  BADDR    YES, LINE FULL?
1877   02734  066045  FW1     JMP  REED6
1878   02735  045402          ISZ  OTPTR    NO, SCROLL
1879   02736  066045          JMP  REED6
1880*
1881*     LEFT SUBROUTINE
1882*
1883*     SHIFT THE 32 CHARACTER DISPLAY LEFT
1884*
1885   02737  021400  LEFT    LDA  BADDR    IS THE LAST CHAR
1886   02740  000151          ADA  M32          ALREADY TO THE LEFT OF
1887   02741  070076          TCA
1888   02742  001402          ADA  OTPTR        THE END OF DISPLAY?
1889   02743  070113          SAP  *+2
1890   02744  045402          ISZ  OTPTR    NO, SCROLL
1891   02745  170402          RET
1892*
1893*     RIGHT SUBROUTINE
1894*
1895*     SHIFT THE 32 CHARACTER DISPLAY RIGHT
1896*     ONE POSITION. IF THE FIRST CHARACTER
1897*     IS IN THE LEFTMOST POSITION, ABORT.
1898*
1899   02746  021402  RIGHT   LDA  OTPTR
1900   02747  010212          CPA  .SLBF
1901   02750  170402          RET
1902   02751  055402          DSZ  OTPTR    NO
1903   02752  170402          RET
```

PAGE 39 KEYBOARD ENTRY AND DISPLAY

```
1905*      KEYIN SUBROUTINE
1906*
1907*      THIS SUBROUTINE SCANS ALL
1908*      INPUT DEVICES SEARCHING FOR
1909*      AN INPUT CODE. IT REFRESHES
1910*      THE DISPLAY WHILE WAITING
1911*      EXIT WITH CODE IN (A)
1912*
1913  02753  074742  KEYIN   SBR  16
1914  02754  021400         LDA  BADDR
1915  02755  011704         CPA  BKPTR     CURSOR PAST END?
1916  02756  035704         STB  BKPTR     YES, CLEAR POINTER
1917  02757  021473  KEYN7   LDA  CCNT
1918  02760  072110         RZA  *+2
1919  02761  067002         JMP  KEYN1
1920  02762  061053         JSM  GTMP      GET CHARACTER
1921  02763  031751         STA  TMP5      SAVE UNCONVERTED CHAR
1922  02764  070550         SZA  KEYN1-3   EMPTY BUFFER?
1923  02765  061363         JSM  GTCON+1   CONVERT
1924  02766  011751         CPA  TMP5      DID CONVERSION OCCURR?
1925  02767  066771         JMP  *+2       NO
1926  02770  043121         IOR  B200      YES, SET SHIFT BIT
1927  02771  025473         LDB  CCNT
1928  02772  010031         CPA  EOL       END OF LINE?
1929  02773  074212         SBM  *+4       RECALL MODE?
1930  02774  055473         DSZ  CCNT      NO, DINC POINTER
1931  02775  170402         RET
1932  02776  170402         RET            RETURN WITH CHAR IN (A)
1933  02777  074742         SBR  16
1934  03000  035473         STB  CCNT      RESET POINTER
1935  03001  066756         JMP  KEYN7-1
1936  03002  031750  KEYN1   STA  TMP4      SET CURSOR COUNTER TO ZERO
1937  03003  063024         JSM  KEYN6
1938  03004  025704         LDB  BKPTR
1939  03005  074250         SZB  KEYN3     CURSOR?
1940  03006  027122         LDB  BKPTA     YES
1941  03007  061041         JSM  GETCH
1942  03010  031751         STA  TMP5      SAVE CHAR AT CURSOR POSITION
1943  03011  055704         DSZ  BKPTR
1944  03012  025443  KEYN3   LDB  KEYFG
1945  03013  074612         SBM  KEYN2     HAS KEY INPUT OCCURRED?
1946  03014  021704         LDA  BKPTR     YES
1947  03015  070250         SZA  KEYN5     CURSOR?
1948  03016  021751         LDA  TMP5      YES, RESTORE CHARACTER
1949  03017  027122         LDB  BKPTA
1950  03020  061017         JSM  OUTCR
1951  03021  055704         DSZ  BKPTR
1952  03022  021443  KEYN5   LDA  KEYFG
1953  03023  050105         AND  B377
1954  03024  024132  KEYN6   LDB  M1
1955  03025  035443         STB  KEYFG     RESET KEY OCCURRED FLAG
1956  03026  170402         RET
1957  03027  025704  KEYN2   LDB  BKPTR
1958  03030  074610         SZB  KEYN4     CURSOR?
1959  03031  025750         LDB  TMP4      YES
1960  03032  004132         ADB  M1
```

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```
1961  Ø3Ø33  Ø14136            CPB  M5
1962  Ø3Ø34  Ø24Ø61            LDB  .1Ø
1963  Ø3Ø35  Ø3575Ø            STB  TMP4
1964  Ø3Ø36  Ø21751            LDA  TMP5
1965  Ø3Ø37  Ø74113            SBP  *+2
1966  Ø3Ø4Ø  Ø2ØØ37            LDA  .28
1967  Ø3Ø41  Ø27122            LDB  BKPTA
1968  Ø3Ø42  Ø61Ø17            JSM  OUTCR    REPLACE CHARACTER WITH CURSOR
1969  Ø3Ø43  Ø557Ø4            DSZ  BKPTR
197Ø  Ø3Ø44  Ø62562  KEYN4    JSM  REFRS
1971  Ø3Ø45  Ø67Ø12            JMP  KEYN3
1972*
1973*   CALL KEYIN AND EXECUTE RIGHT AND LEFT ARROWS
1974*
1975*   P+1=ARROW; P+2=OTHERWISE
1976  Ø3Ø46  Ø62753  CALLK     JSM  KEYIN
1977  Ø3Ø47  Ø74742            SBR  16
1978  Ø3Ø5Ø  Ø7Ø346            RAR  8
1979  Ø3Ø51  Ø7Ø133            SAP  *+2,C    SHIFTED?
198Ø  Ø3Ø52  Ø24132            LDB  M1       YES
1981  Ø3Ø53  Ø357Ø6            STB  TMP6
1982  Ø3Ø54  Ø7Ø346            RAR  8
1983  Ø3Ø55  Ø31751            STA  TMP5
1984  Ø3Ø56  Ø1ØØ36            CPA  B27      RIGHT ARROW
1985  Ø3Ø57  Ø66746            JMP  RIGHT    YES
1986  Ø3Ø6Ø  Ø1ØØ35            CPA  B26
1987  Ø3Ø61  Ø66737            JMP  LEFT     LEFT ARROW
1988  Ø3Ø62  Ø64357            JMP  RETN2
```

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```
1990*
1991*      TABLE SEARCH ROUTINE
1992*
1993*
1994*      THIS SUBROUTINE COMPARES THE
1995*      INPUT STRING WITH STRINGS IN
1996*      A TABLE. IF A SUCCESSFUL COMPARE
1997*      IS MADE AN 6-BIT CODE IS RETURNED
1998*
1999*      ENTRY CONDITIONS:
2000*           (A)=FIRST CHARACTER OF INPUT STRING
2001*           (B)=POINTER TO FIRST CHAR OF TABLE
2002*
2003*      EXIT CONDITIONS:
2004*           IF MATCH, RETURN TO P+2 WITH CODE
2005*           IN A OTHERWISE RETURN TO P+1
2006*
2007*
2008  03063  062531  TBS6    JSM  GTMP2
2009  03064  070306          RAR  7
2010  03065  070511          SLA  TBS5     OP CODE?
2011  03066  070402          SAR  9        YES, RIGHT JUSTIFY
2012  03067  050054          AND  .63
2013  03070  064357          JMP  RETN2
2014  03071  021751  TBSR1   LDA  TMP5
2015  03072  031750  TBSRH   STA  TMP4      SAVE INPUT CHAR
2016  03073  035742          STB  TMP2     INITIALIZE TABLE POINTER
2017  03074  025400          LDB  BADDR
2018  03075  035752          STB  TMP6A    SAVE INPUT POINTER
2019  03076  067101          JMP  TBS2
2020  03077  055742  TBS5    DSZ  TMP2
2021  03100  061055          JSM  GNEXT    FETCH NEXT INPUT CHAR
2022  03101  031743  TBS2    STA  TMP3     STORE CHARACTER
2023  03102  062531          JSM  GTMP2
2024  03103  011743          CPA  TMP3     CHARACTERS MATCH?
2025  03104  067063          JMP  TBS6     YES, CONTINUE
2026  03105  025752          LDB  TMP6A    NO, RESTORE BADDR
2027  03106  035400          STB  BADDR
2028  03107  062531          JSM  GTMP2
2029  03110  070306          RAR  7
2030  03111  071711          SLA  *-2      CHAR IS OP CODE?
2031  03112  070153          SAP  TBS4      LAST ENTRY?
2032  03113  021750          LDA  TMP4      RESTORE FIRST CHARACTER
2033  03114  170402          RET            RETURN TO P+1
2034  03115  021750  TBS4    LDA  TMP4
2035  03116  067101          JMP  TBS2      CONTINUE
```

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```
2037*
2038*      CONSTANTS, TEMPORARIES, ETC.
2039*      USED IN ABOVE ROUTINES
2040*
2041*
2042   03117  001742  TMP2A    DEF  TMP+2
2043   03120  006006  LISTR    DEF  LIST1
2044   03121  000200  B200     OCT  200
2045   03122  001704  BKPTA    DEF  BKPTR
2046   03123  001621  ENDW     DEF  RBUFF+40
2047   03124  000033  B33      OCT  33
2048   03125  000176  B176     OCT  176
2049   03126  000137  B137     OCT  137
2050   03127  000163  DELIN    OCT  163
2051   03130  003321  IOEND    DEF  IOBUF+IOBUF+81
```

PAGE 43 DEFINE-A-KEY-ROUTINES

```
2053*
2054*      DEFINE-A-KEY-ROUTINES
2055*
2056*    THE FIRST WORD OF EACH DEFINITION CONTAINS THE
2057*    KEYCODE OF THAT KEY.  THE SECOND WORD CONTAINS THE LENGTH
2058*    OF THE DEFINITION PLUS 1. WHILE IN DEFINITION MODE
2059*    "UKPTR" POINTS TO THE LENGTH WORD.
2060*
2061   03131  060626  KEYPR    JSM  SAVBP      SAVE BADDR
2062   03132  020212           LDA  .SLBF
2063   03133  031400           STA  BADDR
2064   03134  061055           JSM  GNEXT      SET UP FOR TABLE SEARCH
2065   03135  027152           LDB  KTBA
2066   03136  160175           JSM  TSRHA,I    SEARCH TABLE
2067   03137  067153           JMP  RCAL       NOT FOUND
2068   03140  074742           SBR  16
2069   03141  035432           STB  DRQST
2070   03142  050024           AND  .7
2071   03143  003145           ADA  JTBA       A-REG HAS OPCODE
2072   03144  070737           JMP  A,I
2073*
2074   03145  103145  JTBA     DEF  JTBL-1,I
2075   03146  003253  JTBL     DEF  XRUN   RUN
2076   03147  003310           DEF  XSCR   SCRATCH
2077   03150  003330           DEF  XLST   LIST
2078   03151  003261           DEF  XKEY   FETCH
2079*
2080   03152  007155  KTBA     DEF  KTBL+KTBL+1
```

PAGE 44 DEFINE-A-KEY-ROUTINES

```
2082  03153  060633  RCAL   JSM  RESB1    RESTORE BADDR
2083  03154  063346         JSM  HUNT     FIND THE LOCATION
2084  03155  160206  KERR   JSM  ERRA,I   NOT FOUND, ERROR
2085  03156  074517         LDA  B,I
2086  03157  031466         STA  LOCL1    SAVE LENGTH WORD
2087  03160  070744         SAL  1
2088  03161  000136         ADA  M5       ASSUME ODD COUNT
2089  03162  070113         SAP  *+2      NULL DEFINITION?
2090  03163  066045         JMP  REED6    YES, IGNORE
2091  03164  031473         STA  CCNT     SAVE CHARACTER COUNT
2092  03165  035470         STB  L2T1     SAVE LOCATION
2093  03166  074070         SIB  *+1
2094  03167  074517         LDA  B,I      LOOK AT LINE #
2095  03170  074070         SIB  *+1
2096  03171  070110         SZA  *+2      IS THIS A TYPING AID?
2097  03172  067222         JMP  RFNX     NO
2098  03173  074744         SBL  1        YES
2099  03174  035740         STB  TMP      SAVE CHARACTER POINTER
2100  03175  074002         SBR  1
2101  03176  005466         ADB  LOCL1
2102  03177  004134         ADB  M3
2103  03200  074517         LDA  B,I      LOOK AT LAST WORD
2104  03201  050105         AND  B377
2105  03202  070450         SZA  *+9
2106*
2107  03203  045473         ISZ  CCNT     CORRECT COUNT
2108  03204  010100         CPA  ASTR1    CHECK FOR *
2109  03205  067207         JMP  *+2
2110  03206  066045         JMP  REED6
2111  03207  074517         LDA  B,I
2112  03210  050157         AND  M256
2113  03211  040027         IOR  AIEX1    IEX CODE
2114  03212  067220         JMP  *+6
2115*
2116  03213  074517         LDA  B,I
2117  03214  013362         CPA  ASTR2    CHECK FOR*
2118  03215  067217         JMP  *+2
2119  03216  066045         JMP  REED6
2120  03217  023363         LDA  AIEX2    IEX CODE
2121  03220  074557         STA  B,I
2122  03221  066045         JMP  REED6
2123*
2124  03222  074517  RFNX   LDA  B,I      CHECK FOR LEGITIMATE FUNCTION
2125  03223  050065         AND  K1       (076000)
2126  03224  010004         CPA  K2       (010000)
2127  03225  076130         RIB  *+2
2128  03226  067246         JMP  RRUN     NOT DEF
2129  03227  074517         LDA  B,I
2130  03230  053357         AND  K3       (176037)
2131  03231  013360         CPA  K4       (012037)
2132  03232  067234         JMP  *+2
2133  03233  067246         JMP  RRUN     NOT DEF
2134  03234  020162         LDA  FN
2135  03235  031754         STA  AR2      "FN"
2136  03236  074517         LDA  B,I
2137  03237  070202         SAR  5        EXTRACT THE LETTER
```

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```
2138  03240  050040          AND  .31
2139  03241  040101          IOR  B100
2140  03242  070404          SAL  8
2141  03243  031755          STA  AR2+1     "X("
2142  03244  027361          LDB  ALCL1     GET POINTER
2143  03245  066246          JMP  RFNX1     SET UP COUNT
2144*
2145  03246  061225  RRUN    JSM  LDEF      LEAVE DEF MODE
2146  03247  025470          LDB  L2T1        YES, CAN RUN
2147  03250  063336          JSM  SUMP
2148  03251  070742          SAR  16
2149  03252  066157          JMP  CONTK     CONTINUE FROM BEGINNING OF KEY
2150*
2151  03253  061225  XRUN    JSM  LDEF      INSURE NOT IN KEY MODE
2152  03254  063346          JSM  HUNT
2153  03255  067155          JMP  KERR      KEY UNDEFINED
2154  03256  063336          JSM  SUMP      SET UP PROGRAM POINTERS
2155  03257  070742          SAR  16
2156  03260  164171          JMP  RUNA,I    RUN
2157*
2158*
2159  03261  061225  XKEY    JSM  LDEF        INSURE NOT IN DEFINITION MODE
2160  03262  063346          JSM  HUNT        FIND THE LOCATION
2161  03263  063270          JSM  NEWK        NOT FOUND, NEW KEY REQUIRED
2162  03264  063336          JSM  SUMP
2163  03265  060651          JSM  INITS       INITIALIZE STACKS
2164  03266  070742          SAR  16
2165  03267  066254          JMP  EFET+1    FETCH FIRST LINE
2166*
2167  03270  160242  NEWK    JSM  DCOMA,I   DECOMPILE PROGRAM
2168  03271  021405          LDA  FWUP      ADD A NEW KEY TO DEFINITION AREA
2169  03272  031476          STA  TEMP3
2170  03273  020017          LDA  .2
2171  03274  160250          JSM  OVCHA,I     CHECK FOR OVERFLOW
2172  03275  061121          JSM  MVTOH       MOVE CORE
2173  03276  021751          LDA  TMPS
2174  03277  131405          STA  FWUP,I      STORE NEW KEY
2175  03300  045405          ISZ  FWUP
2176  03301  025405          LDB  FWUP
2177  03302  045405          ISZ  FWUP        UPDATE FWUP
2178  03303  020012          LDA  .1
2179  03304  074557          STA  B,I         INITIALIZE LENGTH WORD
2180  03305  045424          ISZ  PBUFF
2181  03306  045424  NEWK1   ISZ  PBUFF       UPDATE PBUFF
2182  03307  170402          RET
```

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```
2184*
2185*  SCRATCH A KEY
2186*
2187   03310  061225  XSCR    JSM  LDEF       INSURE NOT IN DEFINITION MODE
2188   03311  160242          JSM  DCOMA,IDECOMPILE
2189   03312  063346          JSM  HUNT       FIND THE LOCATION
2190   03313  164174          JMP  RDYDA,I    NOT FOUND, IGNORE
2191   03314  074117          LDA  B
2192   03315  070437          ADB  A,I        END OF AREA
2193   03316  000132          ADA  M1         START OF AREA
2194   03317  031477  XSCR1   STA  TEMP4
2195   03320  160251          JSM  CLP1A,I    CLOSE UP AREA
2196   03321  021405          LDA  FWUP
2197   03322  074017          ADA  B
2198   03323  031405          STA  FWUP       UPDATE FWUP
2199   03324  005424          ADB  PBUFF
2200   03325  035424          STB  PBUFF      UPDATE PBUFF
2201   03326  060651          JSM  INITS    INITIALIZE STACKS
2202   03327  164174          JMP  RDYDA,I  RETURN TO MONITOR
2203*
2204*  LIST A DEFINITION
2205*
2206   03330  063346  XLST    JSM  HUNT       FIND THE LOCATION
2207   03331  067615          JMP  XLST1+1 NOT FOUND
2208   03332  074117          LDA  B
2209   03333  070437          ADB  A,I        END OF AREA
2210   03334  070070          SIA  *+1        START OF AREA
2211   03335  067614          JMP  XLST1    LIST DEFINITION
2212*
2213*  SET UP MISCELLANEOUS POINTERS
2214*
2215   03336  021424  SUMP    LDA  PBUFF
2216   03337  031425          STA  PBUFO      SAVE OLD PBUFF
2217   03340  035422          STB  UKPTR
2218   03341  035424          STB  PBUFF
2219   03342  074517          LDA  B,I
2220   03343  070037          ADB  A
2221   03344  035423          STB  PBPTR      ESTABLISH NEW PBPTR
2222   03345  067306          JMP  NEWK1
```

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```
2224*
2225*  SUBROUTINE TO FIND A DEFINED KEY AREA
2226*
2227*  RETURN TO P+1 IF NOT FOUND
2228*  RETURN TO P+2 IF FOUND WITH B-REG = ADDRESS OF LENGTH WORD
2229*
2230  03346  024166  HUNT   LDB  FWAM    START SEARCHING AT FWAM
2231  03347  015405  HUN1   CPB  FWUP
2232  03350  170402         RET          UNDEFINED
2233  03351  074517         LDA  B,I
2234  03352  074070         SIB  *+1     EXTRACT THIS KEYCODE
2235  03353  011751         CPA  TMP5    AND COMPARE WITH DESIRED
2236  03354  064357         JMP  RETN2    FOUND IT
2237  03355  074437         ADB  B,I
2238  03356  067347         JMP  HUN1
2239*
2240*  CONSTANTS
2241*
2242  00065         K1     EQU  OPMSK   (076000)
2243  00004         K2     EQU  B10K    (010000)
2244  03357  176037 K3     OCT  176037
2245  03360  012037 K4     OCT  012037
2246  03361  003730 ALCL1  DEF  AR2+AR2
2247  00100         ASTR1  EQU  B52
2248  03362  025000 ASTR2  OCT  025000
2249  00027         AIEX1  EQU  .11
2250  03363  005400 AIEX2  OCT  005400
```

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```
2252*
2253*  NON-FORMULA OPERATORS
2254*
2255   Ø3364  Ø52110  FOP13   ASC  2,THEN
       Ø3365  Ø42516
2256   Ø3366  150117          OCT  150117   THEN;2Ø
2257   Ø3367  Ø43321          OCT  Ø43321   OF;21
2258   Ø337Ø  Ø4320Ø  FTABL   OCT  43200   F;3
2259   Ø3371  Ø4270Ø          OCT  42704   E;4;EOT
226Ø   Ø3372  Ø4120Ø          OCT  41206   B;6
2261   Ø3373  Ø5420Ø          OCT  54207   X;7
2262   Ø3374  Ø2771Ø          OCT  27710   /;1Ø;EOT
2263   Ø3375  Ø27311          OCT  27311   .;11;EOT
2264   Ø3376  Ø51524  FOPST   ASC  2,STEP
       Ø3377  Ø4252Ø
2265   Ø34ØØ  156524          OCT  156524   STEP 35
2266   Ø34Ø1  Ø47736          OCT  Ø47736   TO;36
2267   Ø34Ø2  Ø47522  OR      ASC  1,OR
2268   Ø34Ø3  113101          OCT  113101   OR;26
2269   Ø34Ø4  Ø47104          ASC  1,ND
227Ø   Ø34Ø5  153516          OCT  153516   AND;27
2271   Ø34Ø6  Ø47524          ASC  1,OT
2272   Ø34Ø7  154Ø76  GTE     OCT  154Ø76   NOT;3Ø
2273   Ø341Ø  Ø36631          OCT  Ø36631   >=;31
2274   Ø3411  Ø36Ø75          ASC  1,<=
2275   Ø3412  115Ø74          OCT  115Ø74   <=;32
2276   Ø3413  Ø3732Ø          OCT  Ø3732Ø   <>;2Ø
2277*
2278*  SYSTEM COMMAND JUMP TABLE
2279*
228Ø   Ø3414  ØØ4322          ABS  FLT-*
2281   Ø3415  ØØ4322          ABS  FIXED-*
2282   Ø3416  ØØØ437          ABS  PTAPE-*
2283   Ø3417  176534  LBL1    ABS  CONT-*
2284   Ø342Ø  ØØ1237          ABS  DELET-*
2285   Ø3421  ØØ1244          ABS  RENUM-*
2286   Ø3422  ØØ4335          ABS  NORML-*
2287   Ø3423  ØØ4331          ABS  TRACE-*
2288   Ø3424  ØØØ151          ABS  AUTO-*
2289   Ø3425  176626          ABS  EFET-*
229Ø   Ø3426  ØØØ155          ABS  LISTC-*
2291   Ø3427  ØØ1212          ABS  SCRAT-*
2292   Ø343Ø  ØØ1311          ABS  RUN-*
2293*
2294*  SYSTEM COMMAND NAME TABLE
2295*
2296   Ø3431  Ø51105  CMD13   ASC  1,RE
2297   Ø3432  Ø4721Ø          OCT  4721Ø   REN;ØØ1ØØØ
2298   Ø3433  Ø4210Ø          ASC  1,DE
2299   Ø3434  Ø46271          OCT  Ø46271   DELETE;111ØØ1
23ØØ   Ø3435  Ø5Ø124          ASC  1,PT
23Ø1   Ø3436  Ø4Ø653          OCT  4Ø653   PTAPE;1Ø11Ø11
23Ø2   Ø3437  Ø43111          ASC  1,FI
23Ø3   Ø344Ø  Ø54214          OCT  54214   FIXED;ØØ11ØØ
23Ø4   Ø3441  Ø43114          ASC  1,FL
23Ø5   Ø3442  Ø52215          OCT  52215   FLOAT;ØØ11Ø1
```

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```
2306  03443  052122          ASC  2,TRAC
      03444  040503
2307  03445  042666          OCT  42666     TRACE; 110110
2308  03446  047117          ASC  3,NORMAL
      03447  051115
      03450  040514
2309  03451  103503          OCT  103503    NORMAL; 000111
2310  03452  047516          ASC  1,ON
2311  03453  052252          OCT  52252     CONT; 101010
2312  03454  051524          ASC  2,STOP
      03455  047520
2313  03456  137501          OCT  137501    STOP; 111111 (NO JUMP)
2314  03457  052524          ASC  1,UT
2315  03460  047605          OCT  47605     AUTO 000101
2316  03461  051524          ASC  2,STOR
      03462  047522
2317  03463  042600          OCT  42600     STORE; 000000 (NO JUMP)
2318  03464  046117          ASC  2,LOAD
      03465  040504
2319  03466  110114  KTBL    OCT  110114    LOAD; 010000 (NO JUMP)
2320  03467  044523          ASC  1,IS
2321  03470  052203          OCT  52203     LIST; 000011
2322  03471  051125          ASC  1,RU
2323  03472  047241          OCT  047241    RUN; 100001
2324  03473  051503          ASC  3,SCRATC
      03474  051101
      03475  052103
2325  03476  044202          OCT  44202     SCRATCH; 000010
2326  03477  043105          ASC  2,FETC
      03500  052103
2327  03501  044344          OCT  44344     FETCH; 100100
```

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```
2329*
2330*   DATA STATEMENT SYNTAX
2331*
2332   Ø3502  Ø4570Ø  DATAS   ISZ   SBPTR
2333   Ø3503  Ø61156          JSM   CONST   LOOK FOR A NUMBER
2334   Ø3504  16Ø2Ø6  NDATA   JSM   ERRA,I  NOT FOUND
2335   Ø3505  16Ø244          JSM   NUMOA,IFOUND; STORE IN SYNTAX BUFFER
2336   Ø3506  Ø6Ø5Ø4  DATA2   JSM   COMCK   COMMA?
2337   Ø3507  Ø65151          JMP   EOST    NO
2338   Ø3510  Ø675Ø2          JMP   DATAS
2339*
2340*   FORMAT STATEMENT SYNTAX
2341*
2342   Ø3511  Ø61Ø55  FMTS    JSM   GNEXT   GET FIRST CHAR OF NEXT SPEC
2343   Ø3512  Ø6Ø75Ø          JSM   DIGCK   DIGIT?
2344   Ø3513  Ø67521          JMP   FMTF    NO
2345   Ø3514  Ø3572Ø          STB   GFLAG   YES, SET FOR ERROR ON OVERFLOW
2346   Ø3515  Ø554ØØ          DSZ   BADDR   FETCH AND
2347   Ø3516  Ø24161          LDB   MAXSN     STORE
2348   Ø3517  Ø6Ø666          JSM   PGINT   REPEAT FIELD
2349   Ø352Ø  Ø67522          JMP   *+2
2350   Ø3521  Ø457Ø6  FMTF    ISZ   SBPTR   MOVE TO NEW WORD
2351   Ø3522  Ø27552          LDB   FADD    LOOK FOR
2352   Ø3523  Ø6Ø546          JSM   STEXP     "F" OR "E"
2353   Ø3524  Ø67537          JMP   FMTB    NOT FOUND
2354   Ø3525  Ø24161          LDB   MAXSN   FOUND; FETCH AND
2355   Ø3526  Ø6Ø666          JSM   PGINT   STORE FIELD WIDTH
2356   Ø3527  Ø27553          LDB   .ADD    LOOK FOR
2357   Ø353Ø  Ø6Ø546          JSM   STEXP
2358   Ø3531  16Ø2Ø6  FMTER   JSM   ERRA,I  NOT FOUND
2359   Ø3532  Ø24161  FMTD    LDB   MAXSN
2360   Ø3533  Ø61131          JSM   PGINØ   FETCH DIGIT FIELD, ALLOW Ø
2361   Ø3534  Ø6115Ø  FMTC    JSM   EOLCK   EOL?
2362   Ø3535  Ø6Ø51Ø          JSM   COMCE   NO, DEMAND A COMMA
2363   Ø3536  Ø67511          JMP   FMTS    GET NEXT SPEC
2364   Ø3537  Ø27554  FMTB    LDB   BADD
2365   Ø354Ø  Ø6Ø546          JSM   STEXP   SEARCH FOR "B", "X", OR "/"
2366   Ø3541  Ø67545          JMP   FMTQT   NOT FOUND
2367   Ø3542  Ø61Ø55          JSM   GNEXT   FOUND
2368   Ø3543  Ø457Ø6          ISZ   SBPTR
2369   Ø3544  Ø67534          JMP   FMTC    DEMAND COMMA OR EOL
2370   Ø3545  Ø1ØØ43  FMTQT   CPA   B42     QUOTE?
2371   Ø3546  Ø6755Ø          JMP   *+2
2372   Ø3547  Ø67531          JMP   FMTER   NO
2373   Ø355Ø  16Ø245          JSM   GTSTA,I  YES, GET QUOTE FIELD
2374   Ø3551  Ø67534          JMP   FMTC
2375   Ø3552  ØØ676Ø  FADD    DEF   FTABL+FTABL
2376   Ø3553  ØØ6772  .ADD    DEF   FTABL+FTABL+1Ø
2377   Ø3554  ØØ6764  BADD    DEF   FTABL+FTABL+4
2378*
2379*   GOTO AND GOSUB STATEMENT SYNTAX
2380*
2381   Ø3555  Ø6Ø626  GOTOS   JSM   SAVBP   SAVE BADDR AND SBPTR
2382   Ø3556  Ø5572Ø          DSZ   GFLAG   SET TO RETURN ON ERROR FROM INTCK
2383   Ø3557  Ø6Ø664          JSM   LNUM    LOOK FOR A LINE NUMBER
2384   Ø356Ø  Ø67572          JMP   GOTO3   FOUND
```

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```
2385   03561  060640  GOTO1   JSM  RESBP   RESTORE POINTERS
2386   03562  160202          JSM  FSCA,I  FETCH FORMULA
2387   03563  027574          LDB  OFA
2388   03564  060546          JSM  STEXP   STORE "OF" AS EXPANDED OPERATOR
2389   03565  160206  MISOF   JSM  ERRA,I  NOT FOUND
2390   03566  060664  GOTO2   JSM  LNUM    FETCH LINE NUMBER
2391   03567  061153          JSM  EOLCK   EOL?
2392   03570  060510          JSM  COMCE   DEMAND A COMMA
2393   03571  067566          JMP  GOTO2
2394   03572  061153  GOTO3   JSM  EOLCK   EOL?
2395   03573  067561          JMP  GOTO1   NO, TRY FOR A FORMULA INSTEAD
2396   03574  006755  OFA     DEF  FOP13+FOP13+5
2397*
2398*    AUTO SYSTEM COMMAND
2399*
2400   03575  063647  AUTO    JSM  GETLN   GET OPTIONAL PARAMETERS
2401   03576  020061          LDA  .10
2402   03577  024061          LDB  .10
2403   03600  031427          STA  .LNUM   SET INITIAL LINE NUMBER
2404   03601  035430          STB  LNINC   SET INCREMENT
2405   03602  164173          JMP  PEXMA,I
2406*
2407*    LIST EXECUTION
2408*
2409   03603  061055  LISTC   JSM  GNEXT   GET NEXT CHARACTER
2410   03604  013627          CPA  B43     "#"?
2411   03605  067623          JMP  LSTC2   YES
2412   03606  055400          DSZ  BADDR   RESET POINTER
2413   03607  063647  LSTC1   JSM  GETLN   GET OPTIONAL LINE #'S
2414   03610  070742          SAR  16
2415   03611  024056          LDB  .1E4
2416   03612  060730          JSM  GETAD   GET ADDRESSES
2417   03613  021477          LDA  TEMP4
2418   03614  160122  XLST1   JSM  LISTA,I  LIST
2419   03615  160170          JSM  CLERA,I CLEAR BUFFER
2420   03616  025412          LDB  LSTPT
2421   03617  074076          TCB
2422   03620  005413          ADB  HSTPT   COMPUTE WORDS BETWEEN STACKS
2423   03621  160210          JSM  OUTIA,I PUT IN BUFFER
2424   03622  164173          JMP  PEXMA,I
2425   03623  060664  LSTC2   JSM  LNUM    FETCH SELECT CODE
2426   03624  074204          SBL  12
2427   03625  035447          STB  SLCOD
2428   03626  067607          JMP  LSTC1
2429   03627  000043  B43     OCT  43
2430*
2431*    STOP STATEMENT SYNTAX
2432*
2433   03630  065147          JMP  ENDS
2434   03631  021416  STOPS   LDA  MODE
2435   03632  071711          SLA  STOPS-1 SKIP IF PROG
2436   03633  063647          JSM  GETLN   GET PARAMETERS
2437   03634  020056          LDA  .1E4
2438   03635  024056          LDB  .1E4    SET DEFAULT PARAMETERS
2439   03636  060741          JSM  FND-1   FIND ADDRESS OF FIRST
2440   03637  015423          CPB  PBPTR   PAST END OF PROG?
```

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```
2441   Ø364Ø  Ø74742          SBR  16        YES, CLEAR FLAG
2442   Ø3641  Ø35436          STB  HFLG1
2443   Ø3642  Ø6Ø74Ø          JSM  FND-2     FIND ADDRESS OF SECOND
2444   Ø3643  Ø15423          CPB  PBPTR
2445   Ø3644  Ø74742          SBR  16
2446   Ø3645  Ø35437          STB  HFLG1+1
2447   Ø3646  164174          JMP  RDYDA,I
2448*
2449*
2450*   SUBROUTINE TO BUILD AND STORE N>Ø LINE NUMBERS
2451*     RETURN TO: P+1*NONE GIVEN
2452*                P+2:1 GIVEN (A)=NUMBER
2453*                P+3:2 GIVEN (A)=FIRST, (B)=SECOND
2454*     NUMBERS ARE STORED SEPARATED BY COMMAS IN S-BUFFER
2455*
2456   Ø3647  Ø61Ø66  GETLN   JSM  GETSK    GET NEXT CHAR
2457   Ø365Ø  17Ø4Ø2          RET           NONE GIVEN
2458   Ø3651  Ø6Ø75Ø          JSM  DIGCK    DIGIT?
2459   Ø3652  Ø67647          JMP  GETLN    NO, IGNOR IT
246Ø   Ø3653  Ø6Ø663          JSM  LNUM-1   BUILD FIRST INTEGER
2461   Ø3654  Ø3572Ø          STB  LASTN    SAVE 1ST #
2462   Ø3655  Ø1ØØ31          CPA  EOL      END OF LINE?
2463   Ø3656  Ø67662          JMP  GETL2    YES,RETURN TO P+2
2464   Ø3657  Ø6Ø365          JSM  RET2     INCREMENT RETURN ADDRESS
2465   Ø366Ø  Ø6Ø51Ø          JSM  COMCE    FIND AND RECORD A COMMA
2466   Ø3661  Ø6Ø664          JSM  LNUM     GET NEXT LINE NUMBER
2467   Ø3662  Ø2172Ø  GETL2   LDA  LASTN    MOVE TO (A)
2468   Ø3663  Ø64357  GETLR   JMP  RETN2    RETURN TO P+2 OR P+3
2469*
247Ø   Ø3664  ØØØØØØ          BSS  1        *******CHECKSUM*******
2471*
2472*   CLEAR ROUTINE
2473*
2474   Ø3665  Ø7Ø742  ECLR     SAR  16
2475   Ø3666  Ø3143Ø          STA  LNINC    CLEAR AUTO MODE
2476   Ø3667  17Ø4Ø2          RET           RETURN TO P+1
2477*   3677 IS LAST
2478*   MATH TABLES HERE
```

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```
2480*
2481   04000                ORG  4000B
2482*
2483   04000  020116 ENTRY  LDA  QTOP    CLEAR THE BASE PAGE
2484   04001  170000        CLR
2485   04002  000135        ADA  M4
2486   04003  073710        RZA  *-2
2487   04004  024066        LDB  INF     DETERMINE THE
2488   04005  004160 MAWCK  ADB  M1024
2489   04006  074577        STB  B,I
2490   04007  074477        CPB  B,I     LAST WORD OF R/W
2491   04010  066012        JMP  *+2     YES, IT WAS
2492   04011  066005        JMP  MAWCK   CHECK NEXT PAGE
2493*
2494*
2495   04012  074557        STA  B,I     INITIALIZE LAST WORD
2496   04013  035403        STB  MAW
2497   04014  004132        ADB  M1      SET THE POINTER
2498   04015  035404        STB  LWAM      TO THE LAST AVAILABLE WORD
2499   04016  024116        LBD  REED
2500   04017  035462        STB  REEDL   INITIALIZE KEYBOARD LINK
2501   04020  024207        LDB  INTEA
2502   04021  035463        STB  INTEL   INITIALIZE INTERRUPT LINK
2503   04022  020026        LDA  .9
2504   04023  031452        STA  CPLAC   SET DECIMAL SETTING TO 9
2505   04024  031451        STA  CTYPE   SET MODE TO "FLOAT"
2506   04025  045434        ISZ  UNITS   INITIALIZE TO RADIANS
2507   04026  045450        ISZ  PMODE   INITIALIZE TO NORMAL
2508   04027  020166 KILLK  LDA  FWAM    INITIALIZE START OF
2509   04030  031405        STA  FWUP      USER PROGRAM(SCRATCH KEYS)
2510   04031  020112 KILLP  LDA  RSTKA   INITIALIZE RETURN
2511   04032  031777        STA  RSPTR     POINTER
2512   04033  062734        JSM  SCRP    INITIALIZE PROGRAM POINTERS
2513   04034  061233        JSM  LDEF+6  RESET USER KEY POINTER
2514   04035  060645 KILLV  JSM  MINIT   INITIALIZE SYMBOL TABLE
2515   04036  060651        JSM  INITS   INITIALIZE STACKS AND FLAGS
2516   04037  070742 RDYPT  SAR  16
2517   04040  031433        STA  TFLAG   CLEAR PTAPE FLAG
2518   04041  031430        STA  LNINC   SET TO MANUAL
2519*
2520   04042  160170        JSM  CLERA,I CLEAR DISPLAY
2521   04043  031622        STA  TERM    RESET CRLF FLAG
2522   04044  070742 PEXMK  SAR  16
2523   04045  031701        STA  NDISP
2524   04046  031702        STA  NPRIN
2525   04047  021432 PEXM2  LDA  DRQST
2526   04050  070510        SZA  PEXM3   SKIP IF NOT DATA REQUEST
2527   04051  020012        LDA  .1
2528   04052  026267        LDB  QMRKA     PRINT A ?
2529   04053  061330        JSM  .NPWR
2530   04054  066100        JMP  PEXM1
2531*  PTAPE SYSTEM COMMAND
2532   04055  031433 PTAPE  STA  TFLAG   STORE DEVICE CODE
2533   04056  072110        R2A  *+2
2534   04057  064726        JMP  SYE25   SELECT CODE NOT GIVEN
2535   04060  020132        LDA  M1
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```
2536  04061  031742          STA  TMP2    SET FLAG FOR LEADER
2537  04062  070742  PEXM3   SAR  16
2538  04063  031442          STA  STPFL   CLEAR THE STEP-STOP FLAG
2539  04064  020127          LDA  B170K
2540  04065  031447          STA  SLCOD   SET TO STANDARD PRINTER
2541  04066  021400          LDA  BADDR
2542  04067  010212          CPA  .SLBF   BLANK SCREEN?
2543  04070  066072          JMP  *+2     YES
2544  04071  066100          JMP  PEXM1
2545  04072  026264          LDB  LTADD   GET ADDRESS OF LAZY-T
2546  04073  021422          LDA  UKPTR
2547  04074  070170          SIA  *+3     SKIP IF NOT KEY MODE (A)=1
2548  04075  004134          ADB  M3      GET ADDRESS OF KEY-LAZY-T
2549  04076  020021          LDA  .4
2550  04077  061335          JSM  NPWRT   WRITE ON DISPLAY
2551*
2552  04100  024112  PEXM1   LDB  RSTKA
2553  04101  035777          STB  RSPTR   RESET STACK
2554  04102  020041  ALNUM   LDA  .32
2555  04103  031707          STA  BLANK   SET TO IGNOR BLANKS
2556  04104  021430          LDA  LNINC
2557  04105  070410          SZA  GTRC1   SKIP IF MANUAL
2558  04106  021701          LDA  NDISP
2559  04107  072350          RZA  GTRC1+1 SKIP IF MESSAGE ON SCREEN
2560  04110  160170          JSM  CLERA,I CLEAR OFF LAZY-T
2561  04111  025427          LDB  .LNUM
2562  04112  160210          JSM  OUTIA,I PUT LINE # IN BUFFER
2563  04113  045400          ISZ  BADDR   OUTPUT A SPACE
2564  04114  066116          JMP  *+2
2565  04115  031427  GTRC1   STA  .LNUM   SET LINE # IF MANUAL
2566  04116  161462  GTRCD   JSM  REEDL,I READ RECORD
2567  04117  066042          JMP  PEXMK-2 NULL RECORD
2568  04120  061062          JSM  GFRST   GET FIRST CHAR IN (A)
2569  04121  066042          JMP  PEXMK-2 NULL RECORD
2570  04122  074742          SBR  16
2571  04123  035724          STB  GFLAG   SET FLAG FOR INTEGER ERROR
2572  04124  025432          LDB  DRQST
2573  04125  074730          SIB  CKRCD   SKIP IF NOT DATA REQUEST
2574  04126  035642          STB  SAVE    SAVE RETURN ADDRESS
2575  04127  074742          SBR  16
2576  04130  035432          STB  DRQST   CLEAR THE INPUT FLAG
2577  04131  035416          STB  MODE    SET TO PROGRAM EXECUTION MODE
2578  04132  160237          JSM  SALTA,I STATEMENT GIVEN?
2579  04133  066260          JMP  GTRC2   NO
2580  04134  020127  GTRC3   LDA  B170K   YES
2581  04135  031447          STA  SLCOD   SET TO STANDARD PRINTER
2582  04136  022270          LDA  CALSN
2583  04137  031416          STA  MODE    SET TO CALC SYNTAX MODE
2584  04140  061062          JSM  GFRST
2585  04141  000000          NOP          *** CHECKSUM
2586  04142  066154          JMP  SYNTX
2587  04143  025416  CKRCD   LDB  MODE
2588  04144  074111          SLB  *+2     SKIP IF EOL
2589  04145  066154          JMP  SYNTX   EXECUTE: DONT ALLOW LINE #
2590  04146  010100          CPA  STAR    FIRST CHAR AN "*"?
2591  04147  066251          JMP  UKDEF   YES
```

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```
2592  04150  060675          JSM  INTCK-1   BUILD A LINE #
2593  04151  035427          STB  .LNUM     STORE LINE #
2594*                        (A) CONTAINS NEXT CHAR
2595  04152  010031          CPA  EOL       END OF LINE?
2596  04153  066500          JMP  DELST     YES, DELETE LINE FROM CODE
2597*
2598  04154  025426  SYNTX    LDB  PBPTO     GET MAINLINE END POINTER
2599  04155  015424          CPB  PBUFF     NULL PROGRAM?
2600  04156  062734          JSM  SCRP      YES, INSURE NO SPURIOUS COMMON
                                                                    EXISTS
2601  04157  024026          LDB  .9        SET STORE FLAG FALSE
2602  04160  035710          STB  MSFLG       (DONT RECOGNISE ASSIGNMENT)
2603  04161  025413          LDB  HSTPT     INITIALIZE
2604  04162  004132          ADB  M1          THE S-STACK
2605  04163  035472          STB  TEMPS         POINTER
2606  04164  074742          SER  16
2607  04165  035711          STB  DFLAG     CLEAR DEFINE FLAG
2608  04166  035714          STB  SFLAG
2609  04167  160237  STMT     JSM  SALTA,I   SEARCH TABLES FOR STATEMENT
2610  04170  066201          JMP  CMND      NOT FOUND
2611  04171  045706          ISZ  SBPTR
2612  04172  135706          STB  SBPTR,I   STORE THE PAGE
2613  04173  025416          LDB  MODE
2614  04174  074211          SLB  STMT1     SKIP IF PROGRAM MODE
2615  04175  070304          SAL  10        SHIFT OP CODE
2616  04176  070112          SAM  STMT1     SKIP IF STMT TYPE IS ALLOWED
2617  04177  062360  NCALC    JSM  ERROR     STMT NOT ALLOWED IN CALC
2618  04200  165473  STMT1    JMP  TEMP,I    BRANCH TO CODE FOR STATEMENT
2619  04201  024132  CMND     LDB  M1        SEARCH TABLES FOR
2620  04202  160237          JSM  SALTA,I     SYSTEM COMMAND
2621  04203  066221          JMP  ILET      NOT FOUND
2622  04204  074742  CMNDF    SBR  16
2623  04205  035431          STB  CLINE     RESET POINTER FOR LIST
2624  04206  035430          STB  LNINC     RESET AUTO
2625  04207  035416          STB  MODE      SET TO PROG
2626  04210  035442          STB  STPFL     CLEAR "STEP" FLAG
2627  04211  070142          SAR  4         GET # OF PARAMETERS ALLOWED
2628  04212  070210          SZA  JCMND     BRANCH IMMEDIATELY
2629  04213  162733          JSM  GETLA,I   GET LINE # PARAMETERS
2630  04214  070742          SAR  16        NONE GIVEN, ASSUME 0
2631  04215  024056          LDB  .1E4      ONLY ONE GIVEN; ASSUME INFINITY
2632  04216  161473  JCMND    JSM  TEMP,I    BRANCH TO COMMAND EXECUTION
2633*   ALL COMMAND JUMP TO PEXMK OR RDYPT EXCEPT FETCH
2634*     WHICH JUMPS TO READ; THE FOLLOWING TWO INSTRUCTIONS
2635*     ARE RETURN EXITS FOR READ
2636  04217  066042          JMP  PEXMK-2
2637  04220  066120          JMP  GTRCD+2
2638*
2639  04221  070742  ILET     SAR  16        GET SPEICAL CHAR FOR IMPLIED LET
2640  04222  066164          JMP  STMT-3      FIND BLOCK FOR IMPLIED LET
2641*
2642  04223  055400  ILETS    DSZ  BADDR
2643  04224  061055          JSM  GNEXT       RECALL CHARACTER
2644  04225  055400          DSZ  BADDR
2645  04226  060752          JSM  LETCK       LETTER?
2646  04227  066234          JMP  ILET1+1      NO, TRY IMPLIED DISP
2647  04230  060626          JSM  SAVBP       SAVE POINTERS
```

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```
2648  04231  062274          JSM  LETSN   TRY "LET" SNTAX
2649  04232  066244          JMP  NSTMT+1 OK, CHECK FOR EOL
2650  04233  060640  ILET1   JSM  RESBP   RESTORE POINTERS
2651  04234  020125          LDA  PRTOP   STORE CODE FOR
2652  04235  055706          DSZ  SBPTR
2653  04236  131706          STA  SBPTR,I   IMPLIED LET
2654  04237  045706          ISZ  SBPTR
2655  04240  025416          LDB  MODE
2656  04241  074111          SLB  NSTMT   SKIP IF PROG
2657  04242  062315          JSM  PRNTS   TRY "PRINT" SYNTAX
2658  04243  062360  NSTMT   JSM  ERROR   NO STATEMENT TYPE CAN BE FOUND
2659  04244  061153          JSM  EOLCK   END OF LINE?
2660  04245  021416          LDA  MODE    NO
2661  04246  070111          SLA  *+2
2662  04247  066233          JMP  ILET1   TRY PRINT SYNTAX IF CALC MODE
2663  04250  065152          JMP  NOEOF
2664*
2665  04251  021422  UKDEF   LDA  UKPTR   IN KEY DEFINITION MODE?
2666  04252  072110          RZA  *+2
2667  04253  160206  UKERR   JSM  ERRA,I  NO, DEFINITION NOT ALLOWED
2668  04254  074742          SBR  16
2669  04255  135706          STB  SBPTR,I SET A 0 LINE NUMBER
2670  04256  160253          JSM  CHRSA,I ACCEPT AN ASCII STRING
2671  04257  066520          JMP  ACTKY   ACCEPT DEFINITION
2672*
2673  04260  024132  GTRC2   LDB  M1
2674  04261  160237          JSM  SALTA,I SYSTEM COMMAND IN "INPUT"?
2675  04262  165642          JMP  SAVE,I  NO, RETURN DATA TO INPUT STMT
2676  04263  066134          JMP  GTRC3   YES, ABORT INPUT
2677*
2678  04264  010555  LTADD   DEF  *+*+*5
2679  04265  045505          ASC  1,KE
2680  04266  054437          OCT  54437   Y,LAZY-T
2681  04267  000131  QMRKA   DEF  .63+.63+1
2682  04270  100001  CALSN   OCT  100001
2683  00116          IMPOP   EQU  QTOP    OP CODE 1
2684  00125          PRTOP   EQU  LBOP    OP CODE 24
2685  00100          STAR    EQU  B52
2686  00123          STDPG   EQU  RBOP
2687*
2688*   LET STATEMENT SYNTAX
2689*
2690  04271  062274  LETS    JSM  LETSN
2691  04272  065151          JMP  EOST
2692  04273  160206  SYNE2   JSM  ERRA,I
2693*
2694*   LET SYNTAX SUBROUTINE
2695*   EXIT P+1; STORE OCCURRED
2696*        P+2; NO STORE OCCURRED
2697*
2698  04274  055710  LETSN   DSZ  MSFLG   ENABLE ASSIGNMENT
2699  04275  160202          JSM  FSCA,I  GET FORMULA
2700  04276  025714          LDB  SFLAG
2701  04277  014133          CPB  M2      DID A STORE OCCUR
2702  04300  170402          RET          YES
2703  04301  064357          JMP  RETN2   NO
```

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```
2704*
2705*   WRITE AND PRINT STATEMENT SYNTAX
2706*
2707  04302  160265  RITE   JSM  IOHEA,I   GET DEVICE AND FORMAT
2708  04303  060534        JSM  RPCKE      GET RIGHT PAREN
2709  04304  055400        DSZ  BADDR
2710  04305  055706        DSZ  SBPTR
2711*
2712  04306  062315  PRINS  JSM  PRNTS     CHECK SYNTAX (TO ACTST IF OK)
2713  04307  160206  SYE15  JSM  ERRA,I    IMPROPER SYNTAX
2714*
2715*   PRINT STATEMENT SYNTAX SUBROUTINE
2716*
2717  04310  010043  PRIN1  CPA  B42        QUOTE?
2718  04311  066325        JMP  PRIN2+4     YES
2719  04312  060461        JSM  SYMC2
2720  04313  012001        DEF  COMMA-1     COMMA OR SEMICOLON?
2721  04314  066321        JMP  PRIN2       NO
2722  04315  024132  PRNTS  LDB  M1
2723  04316  035712        STB  PFLAG      ENABLE FORMULA AND TAB
2724  04317  061066        JSM  GETSK
2725  04320  065150        JMP  EOST-1
2726  04321  010043  PRIN2  CPA  B42        QUOTE?
2727  04322  066324        JMP  *+2         YES
2728  04323  066334        JMP  PRIN3       NO
2729  04324  045706        ISZ  SBPTR
2730  04325  160245        JSM  GTSTA,I     RECORD STRING CONSTANT
2731  04326  061153        JSM  EOLCK       EOL?
2732  04327  074742        SBR  16
2733  04330  135706        STB  SBPTR,I     CLEAR OUT NEXT WORD
2734  04331  024132        LDB  M1
2735  04332  035712        STB  PFLAG      ENABLE FORMULA
2736  04333  066310        JMP  PRIN1
2737  04334  045712  PRIN3  ISZ  PFLAG      TAB OR FORMULA PERMITTED?
2738  04335  170402        RET             NO, RETURN, IMPROPER SYNTAX
2739  04336  026354        LDB  TABA
2740  04337  160175        JSM  TSRHA,I     LOOK FOR "TAB"
2741  04340  066350        JMP  PRIN4       NO
2742  04341  070544        SAL  5
2743  04342  040067        IOR  TYPFL      SET PRE-DEFINED FUNCTION FLAGS
2744  04343  060454        JSM  SBPUD-2     STORE CODE FOR TAB
2745  04344  024123        LDB  RBOP
2746  04345  135706        STB  SBPTR,I
2747  04346  160202        JSM  FSCA,I      GET TAB FORMULA
2748  04347  066352        JMP  PRIN5
2749  04350  055400  PRIN4  DSZ  BADDR      BACK UP POINTER
2750  04351  160202        JSM  FSCA,I      FETCH FORMULA
2751  04352  061153  PRIN5  JSM  EOLCK       EOL?
2752  04353  066310        JMP  PRIN1       NO
2753  04354  023773  TABA   DEF  TAB+TAB+1
```

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```
2755*
2756*   OUTPUT ERROR # GIVEN IN P+1
2757*
2758   04355  060405  AERR    JSM  XFAR1    SAVE AR2 IN AR1
2759   04356  060400          JSM  GPARM    GET ERROR # IN (B)
2760   04357  066370          JMP  ERR1
2761*
2762*   OUTPUT ERROR # FROM ERROR TABLE
2763*
2764   04360  055777  ERROR   DSZ  RSPTR
2765   04361  121777          LDA  RSPTR,I  ERROR SOURCE IN (A)
2766   04362  026476          LDB  ERBS     TABLE ADDRESS IN (B)
2767   04363  074070          SIB  *+1      INC ADDRESS
2768   04364  074457          CPA  B,I      MATCH?
2769   04365  074076          TCB           YES
2770   04366  075653          SBP  *-3      CONTINUE IF NO MATCH
2771   04367  006476          ADB  ERBS     COMPUTE NEGATIVE OF ERROR #
2772   04370  035706  ERR1    STB  SBPTR    SAVE -(ERROR #)
2773   04371  021450          LDA  PMODE
2774   04372  072350          RZA  ERR2
2775   04373  021433          LDA  TFLAG
2776   04374  070250          SZA  ERR2     SKIP IF NOT PTAPE
2777   04375  020060          LDA  .100
2778   04376  024211          LDB  .BUFA
2779   04377  061337          JSM  NDWRT    PRINT LINE IF PTAPE AND P-ALL
2780   04400  061344          JSM  CRLF1
2781   04401  021416  ERR2    LDA  MODE
2782   04402  070112          SAM  *+2      SKIP IF SYNTAX MODE
2783   04403  160264          JSM  CRCKA,I  TERMINATE CURRENT LINE
2784   04404  160170          JSM  CLERA,I  CLEAR BUFFER
2785   04405  035622          STB  TERM     SET UNTERMINATED FLAG
2786   04406  020127          LDA  B170K
2787   04407  031447          STA  SLCOD    SET TO STANDARD PRINTER
2788   04410  020023          LDA  .6
2789   04411  026464          LDB  EMSGA
2790   04412  061335          JSM  NPWRT    PUT "ERROR" IN BUFFER
2791   04413  025706          LDB  SBPTR
2792   04414  074076          TCB
2793   04415  160210          JSM  OUTIA,I  OUTPUT POSITIVE ERROR #
2794   04416  025427          LDB  .LNUM    IS A LINE NUMBER
2795   04417  074310          SZB  ERR3       APPLICABLE
2796   04420  020026          LDA  .9
2797   04421  026465          LDB  LMSGA
2798   04422  061335          JSM  NPWRT    PUT "IN LINE" IN BUFFER
2799   04423  025427          LDB  .LNUM
2800   04424  160210          JSM  OUTIA,I  OUTPUT LINE #
2801   04425  045400  ERR3    ISZ  BADDR
2802   04426  045400          ISZ  BADDR    OUTPUT 2 BLANKS
2803   04427  021433          LDA  TFLAG
2804   04430  072110          RZA  *+2
2805   04431  072053          SAP  *+1,S    SET TO "PRINT" IF PTAPE
2806   04432  031453          STA  PRFLG    SET "DISP"FLAG
2807   04433  160176          JSM  ELINA,I  OUTPUT ERROR
2808   04434  160264          JSM  CRCKA,I  GIVE CRLF IF P-ALL OR PTAPE
2809   04435  025706  ERR4    LDB  SBPTR    RECALL -(ERROR #)
2810   04436  014132          CPB  M1       ERROR 1?
```

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```
2811   04437  066445          JMP  ERN1       YES
2812   04440  004063          ADB  .99
2813   04441  074313          SBP  ERR5       SKIP IF NON-RECOVERABLE
2814   04442  035442          STB  STPFL      SET TO STOP AT END OF LINE
2815   04443  035622          STB  TERM       SET UNTERMINATED LINE FLAG
2816   04444  064444          JMP  XFAR2      RESTORE AR2 AND RETURN
2817*
2818   04445  035421  ERN1    STB  PRADD      SET TO ABORT DECOMPILE
2819   04446  035416          STB  MODE       SET TO SCRATCH SYMTAB
2820   04447  021432  ERR5    LDA  DRQST
2821   04450  070110          SZA  *+2        IN "INPUT" STATEMENT?
2822   04451  165432          JMP  DRQST,I    YES, RETURN
2823   04452  021416          LDA  MODE       FIND OUT WHERE ERROR OCCURRED
2824   04453  010132          CPA  M1         MFASE?
2825   04454  066460          JMP  ERET-2     YES
2826   04455  070210          SZA  ERET-1     SKIP IF PROGRAM EXECUTION
2827   04456  070212          SAM  ERET       SKIP IF SYNTAX PHASE
2828   04457  166477          JMP  CALXA,I    MUST HAVE BEEN CALC EXECUTION
2829   04460  060645          JSM  MINIT      SCRATCH INCOMPLETE SYMTAB
2830   04461  060653          JSM  INITS+2    SCRATCH STACKS AND RESET
                                                          PROGRAM POINTER
2831   04462  045701  ERET    ISZ  NDISP      SET TO NOT DISPLAY AUTO #
2832   04463  066047          JMP  PEXM2
2833   04464  011154  EMSGA   DEF  ERRM+ERRM     POINTER TO "ERROR"
2834   04465  011162  LMSGA   DEF  ERRM+ERRM+6   POINTER TO " IN LINE "
2835   04466  042522  ERRM    ASC  8,ERROR   IN LINE
       04467  051117
       04470  051040
       04471  020111
       04472  047040
       04473  046111
       04474  047105
       04475  020040
2836   04476  000267  ERBS    DEF  E1-1
2837   04360          MERR    EQU  ERROR      MFASE ERROR
2838   04477  010070  CALXA   DEF  CALEX
```

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```
2840*   DELETE STATEMENT FROM PROGRAM
2841*
2842   04500  160242  DELST   JSM  DCOMA,I  DECOMPILE
2843   04501  061072          JSM  FNDPS-3   FIND STATEMENT TO BE DELETED
2844   04502  066506          JMP  EDITR     DOESNT EXIST
2845   04503  066506          JMP  EDITR
2846   04504  070110          SZA  EDITR     SKIP IF TYPING AID KEY
2847   04505  062571          JSM  CLPRG     CLOSE UP PROGRAM
2848   04506  060651  EDITR   JSM  INITS      INITIALIZE STACK POINTERS
2849   04507  062723          JSM  INCLN     INCREMENT LINE NUMBER
2850   04510  066042          JMP  PEXMK-2
2851*
2852*   ACCEPT STATEMENT
2853*
2854   04511  020112  ACTST   LDA  RSTKA
2855   04512  031777          STA  RSPTR     RESET RETURN STACK
2856   04513  021416          LDA  MODE
2857   04514  070073          SAP  *+1,C     SWITCH OUT OF
2858   04515  031416          STA  MODE        SYNTAX MODE
2859   04516  070110          SZA  *+2
2860   04517  164247          JMP  ECALA,I   JUMP TO CALC EXECUTION
2861   04520  160242  ACTKY   JSM  DCOMA,I  DECOMPILE
2862   04521  020233          LDA  SBUFA
2863   04522  070076          TCA            COMPUTE LENGTH
2864   04523  001706          ADA  SBPTR       OF STATEMENT
2865   04524  031473          STA  TEMP      SAVE LENGTH IN TEMP
2866   04525  025551          LDB  RBUFF     READ LINE #
2867   04526  074450          SZB  ACCS1     SKIP IF TYPING AID DEFINITION
2868   04527  041552          IOR  RBUFF+1   MERGE INTO OP-CODE WORD
2869   04530  031552          STA  RBUFF+1
2870   04531  061072          JSM  FNDPS-3   FIND ADDRESS IN PROGRAM
2871   04532  066565          JMP  ACCS4     APPEND
2872   04533  066565          JMP  ACCS4     INSERT
2873   04534  070150          SZA  ACCS1     SKIP IF REPLACING TYPING AID KEY
2874   04535  061007          JSM  NEXTA     NO, COMPUTE LENGTH AND END OF
                                                                  STATEMENT
2875   04536  066544          JMP  ACCS3
2876   04537  021424  ACCS1   LDA  PBUFF     SET POINTERS TO
2877   04540  031476          STA  TEMP3       REPLACE
2878   04541  070076          TCA
2879   04542  001423          ADA  PBPTR         ENTIRE PROGRAM
2880   04543  025423          LDB  PBPTR
2881   04544  070076  ACCS3   TCA            COMPARE
2882   04545  001473          ADA  TEMP          LENGTHS
2883   04546  070250          SZA  ACCS2     EQUAL
2884   04547  070112          SAM  *+2
2885   04550  066566          JMP  ACCS4+1   OLD LINE IS SHORTER
2886   04551  021473          LDA  TEMP      LONGER
2887   04552  062573          JSM  CLPRG+2   CLOSE UP PROGRAM
2888*    MOVE FROM S-BUFFER INTO PROGRAM
2889   04553  024233  ACCS2   LDB  SBUFA     INITIALIZE POINTER
2890   04554  074517          LDA  B,I
2891   04555  131476          STA  TEMP3,I     WORD
2892   04556  045476          ISZ  TEMP3
2893   04557  055473          DSZ  TEMP      FINISHED?
2894   04560  077630          RIB  ACCS2+1   NO
2895   04561  121424          LDA  PBUFF,I   YES
```

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```
2896  04562  072110          RZA  *+2       Ø LINE NUMBER?
2897  04563  061225          JSM  LDEF      YES, END KEY DEFINITION
2898  04564  066506          JMP  EDITR     NO
2899*    INSERT STATEMENT
2900  04565  021473  ACCS4   LDA  TEMP
2901  04566  062625          JSM  OVCHK     CHECK FOR OVERFLOW
2902  04567  061121          JSM  MVTOH     MOVE PROGRAM UP
2903  04570  066553          JMP  ACCS2
2904*
2905*   CLOSE UP PROGRAM
2906*     ADDRESS OF LINE BEING CHANGED IS IN TEMP3
2907*
2908  04571  061007  CLPRG   JSM  NEXTA     GET ADDRESS OF FIRST WORD MOVED
2909  04572  070742          SAR  16
2910  04573  001476          ADA  TEMP3     SKIP (A) LOCATIONS FORM TEMP3
2911  04574  031477          STA  TEMP4       AND SAVE DESTINATION ADDRESS
2912*   TEMP4= DESTINATION ADDR OF FIRST WORD
2913*   PBPTO= SOURCE ADDRESS OF LAST WORD +1
2914*   (B)= SOURCE ADDRESS OF FIRST WORD
2915  04575  015426  CLPR1   CPB  PBPTO     ALL OF PROGRAM MOVED?
2916  04576  066603          JMP  CLPR2     YES
2917  04577  074517          LDA  B,I       MOVE WORD FROM SOURCE
2918  04600  131477          STA  TEMP4,I     TO DESTINATION ADDRESS
2919  04601  045477          ISZ  TEMP4     INC DESTINATION AND
2920  04602  077570          RIB  CLPR1       SOURCE ADDRESSES THEN JUMP
2921  04603  021477  CLPR2   LDA  TEMP4     RECALL NEW PBPTO
2922  04604  074076          TCB            COMPUTE NET CHANGE
2923  04605  070037          ADB  A           IN PROGRAM LENGTH
2924  04606  031426          STA  PBPTO     STORE NEW END OF MAINLINE
2925  04607  021423          LDA  PBPTR
2926  04610  074017          ADA  B
2927  04611  031423          STA  PBPTR     UPDATE END OF CURRENT PROGRAM
2928  04612  021422          LDA  UKPTR     GET KEY DEFINITION FLAG
2929  04613  070450          SZA  OVCHK-1   RETURN IF NOT IN KEY DEFINITION
2930  04614  070517          LDA  A,I
2931  04615  074017          ADA  B
2932  04616  131422          STA  UKPTR,I   UPDATE KEY LENGTH
2933  04617  021425          LDA  PBUFO
2934  04620  074017          ADA  B
2935  04621  031425          STA  PBUFO     UPDATE MAINLINE PBUFF
2936  04622  005405          ADB  FWUP
2937  04623  035405          STB  FWUP      UPDATE END OF KEY AREA POINTER
2938  04624  170402          RET
2939*
2940*   CHECK FOR PROGRAM SPACE OVERFLOW
2941*     (A)= NEW WORD REQUIREMENT
2942  04625  025426  OVCHK   LDB  PBPTO     SET SOURCE ADDRESS
2943  04626  035475          STB  TEMP2       FRO PROGRAM RELOCATION
2944  04627  031711          STA  DFLAG     SAVE COUNT
2945  04630  070037          ADB  A         SET DESTINATION
2946  04631  035477          STB  TEMP4       ADDRESS
2947  04632  001426          ADA  PBPTO     COMPUTE NEW END OF MAINLINE
2948  04633  074076          TCB            ENOUGH SPACE FOR
2949  04634  005407          ADB  SYMTP       PROGRAM
2950  04635  074113          SBP  *+2         BUFFER: SKIP IF YES
2951  04636  064561          JMP  FSCE4     NO, SYNTAX OVERFLOW
```

PAGE 62 9830—UPDATE PROGRAM

```
2952  04637  025711          LDB  DFLAG     RECALL COUNT
2953  04640  066606          JMP  CLPR2+3
```

PAGE 63 9830 — SYSTEM COMMANDS

```
2955*
2956*   SCRATCH SYSTEM COMMAND
2957*
2958   04641  061055  SCRAT   JSM  GNEXT      GET NEXT CHAR
2959   04642  000154          ADA  M64
2960   04643  010012          CPA  .1         "A"?
2961   04644  066000          JMP  ENTRY      YES, SCRATCH ALL
2962   04645  010027          CPA  .11        "K"?
2963   04646  066652          JMP  SCRK       YES, SCRATCH KEYS
2964   04647  010035          CPA  .22        "V"?
2965   04650  066035          JMP  KILLV      YES, SCRATCH VARIABLES
2966   04651  066031          JMP  KILLP      OTHERWISE SCRATCH PROGRAM
2967   04652  061225  SCRK    JSM  LDEF       INSURE NOT IN KEY MODE
2968   04653  063711          JSM  DCOMP
2969   04654  020166          LDA  FWAM
2970   04655  025405          LDB  FWUP
2971   04656  164254          JMP  XSCRA,I    SCRATCH ALL KEYS
2972*
2973*   DELETE SYSTEM COMMAND
2974*
2975   04657  060730  DELET   JSM  GETAD      GET ADDRESSES
2976   04660  035476          STB  TEMP3      SAVE SOURCE ADDRESS
2977   04661  160242          JSM  DCOMA,I    DECOMPILE
2978   04662  025476          LDB  TEMP3
2979   04663  062575          JSM  CLPR1      CLOSE UP PROGRAM
2980   04664  066036          JMP  RDYPT-1    RE INITIALIZE
2981*
2982*   RENUMBER SYSTEM COMMAND
2983*
2984   04665  162733  RENUM   JSM  GETLA,I    GET OPTIONAL PARAMETERS
2985   04666  020061          LDA  .10
2986   04667  024061          LDB  .10
2987   04670  013470          STA  L2T1       SAVE STARTING LINE NUMBER
2988   04671  035471          STB  L2T2       SAVE INCREMENT
2989   04672  063675          JSM  COMPL      CONVERT OT ADDRESS FORMAT
2990   04673  025471          LDB  L2T2
2991   04674  035430          STB  LNINC      SET LINE INCREMENT
2992   04675  024133          LDB  M2         SET FLAG
2993   04676  035471          STB  L2T2         FOR 1ST PASS
2994   04677  021470  RENM1   LDA  L2T1       SET STARTING
2995   04700  031427          STA  .LNUM        LINE NUMBER
2996   04701  025424          LDB  PBUFF      INITIALIZE PROGRAM
2997   04702  035472  RENM2   STB  TEMPS        POINTER
2998   04703  015423          CPB  PBPTR      END OF PROGRAM
2999   04704  066720          JMP  RENM4      YES
3000   04705  121472          LDA  TEMPS,I
3001   04706  070610          SZA  RENM4+2    SKIP IF TYPING AID
3002   04707  050062          AND  FLGBT      GET SECURITY BIT
3003   04710  041427          IOR  .LNUM      MERGE IN NEW LINE #.
3004   04711  024132          LDB  M1
3005   04712  015471          CPB  L2T2       SECOND PASS?
3006   04713  131472          STA  TEMPS,I    YES, STORE NEW LINE #.
3007   04714  025472  RENM3   LDB  TEMPS      COMPUTE ADDRESS
3008   04715  061007          JSM  NEXTA        OF NEXT LINE
3009   04716  062723          JSM  INCLN      NO, INCREMENT .LNUM
3010   04717  066702          JMP  RENM2
```

```
3011   04720  045471  RENM4   ISZ   L2T2      FIRST PASS?
3012   04721  066677          JMP   RENM1     YES, NOW DO SECOND PASS
3013   04722  066036          JMP   RDYPT-1   DECOMPILE AND RETURN
3014*
3015*    INCREMENT LINE NUMBER
3016*
3017   04723  021430  INCLN   LDA   LNINC
3018   04724  001427          ADA   .LNUM
3019   04725  031427          STA   .LNUM     UPDATE LINE NUMBER
3020   04726  000161          ADA   MAXSN     GREATER THAN 9999?
3021   04727  070452          SAM   INCLR     RETURN IF LESS THAN 9999
3022   04730  070742          SAR   16
3023   04731  031430          STA   LNINC     SET TO MANUAL
3024   04732  064726          JMP   SYE25     JUMP TO IMPROPER INTEGER ERROR
3025   04733  003647  GETLA   DEF   GETLN
3026*
3027*    INITIALIZE PROGRAM POINTERS
3028*
3029   04734  025405  SCRP    LDB   FWUP
3030   04735  035424          STB   PBUFF
3031   04736  035423          STB   PBPTR
3032   04737  035426          STB   PBPTO
3033   04740  170402  INCLR   RET
```

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```
3035*
3036*   RUN SYSTEM COMMAND
3037*    (A)=STARTING LINE NUMBER
3038*
3039   04741  031725  RUN     STA  NXTST    SAVE STARTING LINE NUMBER
3040   04742  060645          JSM  MINIT    SCRATCH OLD SYMTAB
3041   04743  070742          SAR  16
3042   04744  031455          STA  FORMT    CLEAR THE FORMAT FLAG
3043   04745  031432          STA  DRQST
3044   04746  020012          LDA  .1
3045   04747  031434          STA  UNITS    SET TO RADIANS
3046   04750  021424          LDA  PBUFF
3047   04751  011423          CPA  PBPTR    NULL PROGRAM?
3048   04752  164174          JMP  RDYDA,I  YES
3049   04753  125424          LDB  PBUFF,I
3050   04754  075710          SZB  *-2      TYPING AID KEY?
3051   04755  031421          STA  PRADD    INITIALIZE PROGRAM POINTER
3052   04756  021405          LDA  FWUP
3053   04757  031730          STA  COML     INITIALIZE COMMON POINTER
3054   04760  045412          ISZ  LSTPT    SET L-STACK POINTER = PBPTR
3055   04761  020132          LDA  M1       FLAG ERROR ROUTINE
3056   04762  031416          STA  MODE       TO SCRATCH SYMTAB
3057*
3058*   SKIP TO BEGINNING OF NEXT STATEMENT
3059*
3060   04763  025421  MSKIP   LDB  PRADD
3061   04764  021407          LDA  SYMTP    GET POINTER FOR MILOP
3062   04765  015423          CPB  PBPTR    END OF PROGRAM?
3063   04766  067122          JMP  M1LOP    YES
3064   04767  063601          JSM  NXTOP    FETCH 1ST OPERAND IN NEXT
                                                          STATEMENT
3065   04770  066763          JMP  MSKIP    END OF STATEMENT
3066   04771  067106          JMP  MLOP2    INTEGER, SKIP IT
3067   04772  031473  MSTND   STA  MBOX1    VARIABLE OPERAND, SAVE IT
3068   04773  024132          LDB  M1
3069   04774  035474          STB  MBOX1+1  INITIALIZE DIMENSIONS TO
                                                          UNDEFINED
3070   04775  063234          JSM  FNTYP    FIND OPERAND TYPE
3071   04776  067106          JMP  MLOP2    FUNCTION
3072   04777  020132          LDA  M1       STRING
3073   05000  025731  MLOP7   LDB  TYPE
3074   05001  014020          CPB  MDMA     DIM?
3075   05002  074742  MLP72   SBR  16       YES, SET (B)=0
3076   05003  014017          CPB  MCOMA    COM?
3077   05004  067112          JMP  MLP71
3078   05005  070153          SAP  *+3      SKIP IF SIMPLE VARIABLE
3079   05006  076150          RZB  MLOP5    ARRAY, SKIP IF NOT DIM OR COM
3080   05007  067017          JMP  MLOP8
3081   05010  076310          RZB  ML2L     SKIP IF NOT DIM OR COM
3082*
3083*    PROCESS VARIABLE
3084   05011  063306  MLOP5   JSM  SSYMT+1  SEARCH SYMBOL TABLE
3085   05012  067043          JMP  MLOP9    NOT FOUND
3086   05013  021731          LDA  TYPE     FOUND
3087   05014  010017          CPA  MCOMA    COM STMT?
3088   05015  067037          JMP  MER5     YES, DOUBLE DEFINITION
3089   05016  067106  ML2L    JMP  MLOP2    NO, PROCESS NEXT WORD
3090*    COM OR DIM
```

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```
3091*   (A)=-1 FOR 1 DIM OR STRING, -2 FOR 2 DIM
3092    05017  045472  MLOP8   ISZ   TEMPS
3093    05020  045472         ISZ   TEMPS
3094    05021  125472         LDB   TEMPS,I    READ FIRST DIMENSION
3095    05022  004132         ADB   M1         OFFSET BY 1
3096    05023  074404         SBL   8          PLACE IT IN LEFT HALF WORD
3097    05024  010132         CPA   M1         2 DIMENSIONS
3098    05025  067032         JMP   *+5        NO, SET SECOND DIM TO 1
3099    05026  045472         ISZ   TEMPS
3100    05027  045472         ISZ   TEMPS
3101    05030  105472         ADB   TEMPS,I    ADD SECOND DIMENSION INTO
                                                        RIGHT HALF
3102    05031  004132         ADB   M1         OFFSET SECOND DIM
3103    05032  035474         STB   MBOX1+     STORE PACKED DIMENSIONS
3104    05033  063306         JSM   SSYMT+1    SEARCH SYMBOL TABLE
3105    05034  067043         JMP   MLOP9      NOT FOUND
3106    05035  004132         ADB   M1         FOUND, (B)=ADDRESS
3107    05036  074637         ISZ   B,I        ALREADY DIMENSIONED?
3108    05037  062360  MER5   JSM   MERR       YES
3109    05040  021474         LDA   MBOX1+1    STORE DIMENSIONS
3110    05041  074557         STA   B,I
3111    05042  067106         JMP   MLOP2
3112*     ENTER NEW SYMBOL INTO TABLE
3113    05043  063404  MLOP9  JSM   ESYMT      ENTER INTO SYMBOL TABLE
3114    05044  021731         LDA   TYPE
3115    05045  010017         CPA   MCOMA      COM STMT?
3116    05046  067050         JMP   MCOM1      YES
3117    05047  067106         JMP   MLOP2      NO
3118*     ALLOCATE SPACE FOR COMMON VARIABLE
3119    05050  021473  MCOM1  LDA   MBOX1      SET SIGN BIT IN
3120    05051  072053         SAP   *+1,S        SYMBOL TABLE TO
3121    05052  074557         STA   B,I            INDICATE COMMON
3122    05053  025474         LDB   MBOX1+1    RECALL DIMENSIONS
3123    05054  063257         JSM   MDIM       COMPUTE NUMBER OF WORDS
                                                        NEEDED
3124    05055  025730         LDB   COML       GET OLD COMMON POINTER
3125    05056  074017         ADA   B
3126    05057  031730         STA   COML       UPDATE COMMON POINTER
3127    05060  021424         LDA   PBUFF
3128    05061  045422         ISZ   UKPTR
3129    05062  055422         DSZ   UKPTR      KEY MODE?
3130    05063  021425         LDA   PBUFO      YES, GET FIRST WORD OF MAINLINE
3131    05064  070056         CMA              MAXIMUM COMMON EXCEEDED?
3132    05065  001730         ADA   COML
3133    05066  070112         SAM   *+2
3134    05067  062360  CMERR  JSM   MERR       YES, TOO MUCH COMMON IN KEY
3135    05070  021474         LDA   MBOX1+1    READ DIMENSIONS
3136    05071  010132         CPA   M1         SIMPLE VARIABLE?
3137    05072  067103         JMP   MCOM2      YES
3138    05073  064557         STA   B,I        STORE FORMAL DIMENSIONS
3139    05074  074070         SIB   *+1
3140    05075  021473         LDA   MBOX1
3141    05076  070206         RAR   5          IF BIT 4=1, IT MUST
3142    05077  070212         SAM   MCOM2        BE A STRING VARIABLE
3143    05100  021474         LDA   MBOX1+1    NO, MUST BE AN ARRAY
3144    05101  074557         STA   B,I        STORE ACTUAL DIMENSIONS
3145    05102  074070         SIB   *+1        POINT TO FIRST VARIABLE OF ARRAY
3146    05103  021407  MCOM2  LDA   SYMTP
```

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```
3147  05104  070070          SIA  *+1
3148  05105  070577          SIB  A,I          STORE ADDRESS IN SYMTAB
3149  05106  063620  MLOP2   JSM  WXTP1        GET NEXT OPERAND OF STMT
3150  05107  066763          JMP  MSKIP        END OF STMT
3151  05110  067106          JMP  MLOP2        INTEGER, SKIP IT
3152  05111  066772          JMP  MSTND        VARIABLE OPERAND
3153*   CHECK FOR LEGAL COM
3154  05112  125424  MLP71   LDB  PBUFF,I
3155  05113  074073          SBP  *+1,C
3156  05114  015427          CPB  .LNUM        IS THIS THE FIRST LINE?
3157  05115  067002          JMP  MLP72        YES
3158  05116  164330          JMP  E30+3,I      NO, MISPLACED COM
3159*
3160*   MFASE PART TWO
3161*
3162*   MOVE SYMTAB TO LOW MEMORY
3163  05117  070537  M5LOP   LDB  A,I          MOVE SYMBOL
3164  05120  135412          STB  LSTPT,I        TABLE WORD
3165  05121  045412          ISZ  LSTPT        INC DESTINATION POINTER
3166  05122  011406  M1LOP   CPA  VALUE       ALL OF TABLE MOVED?
3167  05123  067125          JMP  *+2          YES
3168  05124  073570          RIA  M5LOP        INC SOURCE POINTER
3169  05125  070742          SAR  16
3170  05126  031427          STA  .LNUM        CLEAR LINE #
3171  05127  025412          LDB  LSTPT
3172  05130  020062          LDA  FLGBT        SET ALL PROSPECTIVE
3173  05131  074557          STA  B,I
3174  05132  015406          CPB  VALUE          VALUE TABLE WORDS
3175  05133  067135          JMP  *+2
3176  05134  077670          RIB  *-3              TO UNDEFINED VALUE
3177*   DURING THIS SECTION USE LSTAK AS SYMTAB POINTER
3178*     AND HSTPT AS VALUE TABLE POINTER
3179  05135  035413          STB  HSTPT        INITIALIZE VALUE TABLE POINTER
3180  05136  021412          LDA  LSTPT
3181  05137  031410          STA  LSTAK        INITIALIZE SYMBOL TABLE POINTER
3182*
3183  05140  025410  M2LOP   LDB  LSTAK
3184  05141  015426          CPB  PBPTO        MORE SYMBOLS?
3185  05142  067216          JMP  M4LOP        NO
3186  05143  055410          DSZ  LSTAK        YES, MOVE TO NEXT SYMBOL
3187  05144  121410          LDA  LSTAK,I      READ SYMBOL
3188  05145  055410          DSZ  LSTAK
3189  05146  070233          SAP  *+4,C        DEFINED IN COM?
3190  05147  004132          ADB  M1
3191  05150  074557          STA  B,I          YES, CLEAR FLAG
3192  05151  067140          JMP  M2LOP        BYPASS ALLOCATION PHASE
3193  05152  031473          STA  MBOX1        NO, SAVE SYMBOL
3194  05153  063234          JSM  FNTYP        FIND VARIABLE TYPE
3195  05154  067140          JMP  M2LOP        FUNCTION
3196  05155  067160          JMP  *+3          STRING
3197  05156  010134          CPA  M3           ARRAY OF UNKNOWN DIMENSIONS?
3198  05157  062360  MER10   JSM  MERR         YES
3199  05160  031474          STA  MBOX1+1      SAVE TYPE FLAG
3200  06161  125410          LDB  LSTAK,I      READ DIMENSIONS
3201  05162  014132          CPB  M1           DIMENSIONED?
3202  05163  067165          JMP  *+2          NO
```

```
3203  Ø5164  Ø67173          JMP  M3LOP     YES
3204  Ø5165  Ø74742          SBR  16        LOAD STD DIM FOR STRING
3205  Ø5166  Ø7Ø213          SAP  M3LOP-1   SKIP IF SIMPLE VARIABLE OR STRING
3206  Ø5167  Ø27233          LDB  84ØØ      LOAD STD DIMENSION FOR 1 DIM
3207  Ø517Ø  Ø1Ø133          CPA  M2        2 DIMENSIONS?
3208  Ø5171  ØØ4Ø26          ADB  .9        YES, CORRECT FOR 2 DIMS
3209  Ø5172  135414          STB  LSTAK,I
3210  Ø5173  Ø21473  M3LOP   LDA  MBOX1     RECALL SYMBOL
3211  Ø5174  Ø63257          JSM  MDIM      COMPUTE STORAGE REQUIRED
3212  Ø5175  Ø7ØØ76          TCA
3213  Ø5176  Ø25413          LDB  HSTPT     MOVE VALUE TABLE POINTER
3214  Ø5177  Ø63556          JSM  MOVCK+1     AND CHECK FOR OVERFLOW
3215  Ø52ØØ  Ø21474          LDA  MBOX1+1   RECALL TYPE FLAG
3216  Ø52Ø1  Ø25413          LDB  HSTPT     GET NEW VALUE TABLE POINTER
3217  Ø52Ø2  Ø74Ø7Ø          SIB  *+1
3218  Ø52Ø3  Ø1ØØ76          CPA  B36       STRING?
3219  Ø52Ø4  Ø67211          JMP  M6LOP     YES
3220  Ø52Ø5  Ø7Ø353          SAP  M6LOP+3   SKIP IF SIMPLE VARIABLE
3221  Ø52Ø6  121414          LDA  LSTAK,I   GET DIMENSIONS AND STORE
3222  Ø52Ø7  Ø74557          STA  B,I         IN VALUE TABLE
3223  Ø521Ø  Ø7413Ø          SIB  *+2       INC POINTER
3224  Ø5211  121414  M6LOP   LDA  LSTAK,I   GET STRING DIMENSIONS
3225  Ø5212  Ø74557          STA  B,I       STORE DIMENSION
3226  Ø5213  Ø74Ø7Ø          SIB  *+1         IN VALUE TABLE
3227  Ø5214  135414          STB  LSTAK,I   STORE VALUE ADDRESS IN SYMTAB
3228  Ø5215  Ø6714Ø          JMP  M2LOP
3229*   CLEAN UP FOR EXECUTION
3230  Ø5216  Ø21413  M4LOP   LDA  HSTPT
3231  Ø5217  Ø31406          STA  VALUE     SET VALUE TABLE POINTER
3232  Ø522Ø  Ø25412          LDB  LSTPT     MOVE SYMBOL
3233  Ø5221  Ø15426          CPB  PBPTO
3234  Ø5222  Ø6723Ø          JMP  *+6
3235  Ø5223  ØØ4132          ADB  M1
3236  Ø5224  Ø74517          LDA  B,I         TABLE BACK
3237  Ø5225  131413          STA  HSTPT,I
3238  Ø5226  Ø55413          DSZ  HSTPT         TO HIGH
3239  Ø5227  Ø67221          JMP  M4LOP+3       MEMORY
3240  Ø523Ø  Ø21413          LDA  HSTPT
3241  Ø5231  Ø31407          STA  SYMPT     SET SYMBOL TABLE POINTER
3242  Ø5232  164ØØ4          JMP  XECA,I    MFASE COMPLETE
3243*
3244  Ø5233  ØØ44ØØ  B44ØØ   OCT  44ØØ
3245*   DETERMINE THE TYPE OF AN OPERAND GIVEN IN (A)
3246*
3247*        RETURN P+1:  FUNCTION
3248*                 P+2:  STRING
3249*                 P+3:  NUMERIC VARIABLE
3250*                       (A)=POSITIVE IF SIMPLE VARIABLE
3251*                          =-1 IF SINGLE DIM ARRAY
3252*                          =-2 IF DOUBLE DIM
3253*                          =-3 IF UNKNOWN DIM
3254*
3255*                         (B)=4 IF FULL PRECISION
3256*                            =2 IF SPLIT PRECISION
3257*                            =1 IF INTEGER
3258*
```

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```
3259  05234  050040  FNTYP   AND  B37      ISOLATE TYPE
3260  05235  010076          CPA  B36      STRING?
3261  05236  064357          JMP  RETN2    YES
3262  05237  074742          SBR  16
3263  05240  010040          CPA  B37      FUNCTION?
3264  05241  170432          RET           YES
3265  05242  024021          LDB  .4       SET TO FULL PRECISION
3266  05243  070146          RAR  4
3267  05244  070171          SLA  *+3,C    NUMBERED VARIABLE
3268  05245  070546          RAR  12       YES
3269  05246  064356          JMP  RETN3
3270  05247  070133          SAP  *+2,C    INTEGER?
3271  05250  004134          ADB  M3       YES
3272  05251  070646          RAR  14
3273  05252  070131          SLA  *+2,C    SPLIT PRECISION?
3274  05253  004133          ADB  M2       YES
3275  05254  070646          RAR  14       RECALL NUMBER OF DIMENSIONS
3276  05255  070076          TCA           NEGATE
3277  05256  064356          JMP  RETN3
3278*
3279*   COMPUTE STORAGE NEEDED BY A VARIABLE
3280*
3281*     (A)=SYMBOL
3282*     (B)=PACKED DIMENSIONS FOR ARRAY OR STRING
3283*
3284*     STORAGE NEEDED:  STRING=(DIM1+1)/2+1
3285*                      ARRAY=DIM1*DIM2* # OF WORDS/ELEM +2
3286*                      SIMPLE VARIABLE: # OF WORDS
3287*
3288*     EXIT (A)= STORAGE NEEDED
3289  05257  035470  MDIM    STB  L2T1
3290  05260  063234          JSM  FNTYP
3291  05261  067277          JMP  MDIM2    FUNCTION (B)=0
3292  05262  067301          JMP  MDIM1    STRING
3293  05263  070613          SAP  MDIM2    ARRAY?
3294  05264  021470          LDA  L2T1
3295  05265  050105          AND  B377     MULTIPLY SECOND DIMENSION
3296  05266  070070          SIA  *+1
3297  05267  061201          JSM  IMPY     BY THE NUMBER OF WORDS PER
                                                              ELEMENT
3298  05270  025470          LDB  L2T1
3299  05271  074342          SBR  8
3300  05272  074070          SIB  *+1
3301  05273  061201          JSM  IMPY     MULTIPLY BY SECOND DIMENSION
3302  05274  000017          ADA  .2       ADD WORDS FOR DIMENSIONS
3303  05275  070153          SAP  MDIM2+1  GREATER THAN 32K?
3304  05276  062360  MER9    JSM  MERR     YES, DIMENSIONS TOO LARGE
3305  05277  074117  MDIM2   LDA  B        MOVE RESULT TO (A)
3306  05300  170402          RET
3307  05301  074342  MDIM1   SBR  8
3308  05302  004017          ADB  .2       ADD 2 TO FORMAL DIMENSION
3309  05303  074002          SBR  1        DIVIDE BY 2
3310  05304  077570          RIB  MDIM2    INCREMENT AND JUMP
```

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```
3312*
3313*   SEARCH SYMBOL TABLE
3314*
3315*     RETURN P+1 IF NOT FOUND
3316*            P+2 IF FOUND: ADDRESS IN B
3317*
3318*     IF BIT 4=1 THEN SYMBOL AND TYPE MUST MATCH EXACTLY
3319*
3320*     AN UNSPECIFIED PRECISION VARIABLE MATCHES A SPECIFIED PRECISION
3321*       AND THE SPECIFIED PRECISION IS INSERTED IN THE TABLE
3322*
3323*     AN ARRAY WITH UNSPECIFIED NUMBER OF DIMENSIONS MATCHES A
3324*       SPECIFIED ARRAY AND THE DIMENSION NUMBER IS PUT IN THE TABLE
3325*
3326*     AN INCONSISTENCY IN DIMENSIONS OR PRECISION CAUSES AN ERROR
3327*
3328  05305  031473  SSYMT  STA  MBOX1
3329  05306  021473         LDA  MBOX1   (A)=SYMBOL TO BE FOUND
3330  05307  050020         AND  .3
3331  05310  031466         STA  STMP2   SAVE SIMPLE/ARRAY TYPE
3332  05311  021473         LDA  MBOX1
3333  05312  050030         AND  .12
3334  05313  031467         STA  STMP3   SAVE PRECISION TYPE
3335  05314  021473         LDA  MBOX1   RECALL VARIABLE
3336  05315  024112         LDB  B1760   GET MASK TO MASK OFF PRECISION
3337  05316  070146         RAR  4
3338  05317  070111         SLA  *+2     BIT 4=1?
3339  05320  024115         LDB  B1777   YES, DONT MASK OFF ANY BITS
3340  05321  070546         RAR  12      RESTORE VARIABLE
3341  05322  074257         AND  B       MASK
3342  05323  035470         STB  MASK    STORE MASK
3343  05324  031471         STA  STMP1   STORE PART OF SYMBOL TO MATCH
3344  05325  014115         CPB  B1777   MUST MATCH WHOLE SYMBOL?
3345  05326  067373         JMP  SVALU-1 YES, SEARCH AND RETURN FROM SVALU
3346  05327  063373         JSM  SVALU-1 NO, SEARCH FOR NAME ONLY
3347  05330  170402         RET          NOT FOUND
3348  05331  021466  SSYM1  LDA  STMP2   SEARCHING FOR
3349  05332  072350         RZA  SSYM4   SIMPLE VARIABLE?
3350  05333  074517         LDA  B,I     YES, SIMPLE
3351  05334  050020         AND  .3        VARIABLE
3352  05335  070410         SZA  SM2L    FOUND?
3353  05336  063402  SSYM6  JSM  SVAL1   NO, CONTINUE SEARCH
3354  05337  170402         RET
3355  05340  067331         JMP  SSYM1
3356*   SEARCHING FOR AN ARRAY
3357*
3358  05341  074517  SSYM4  LDA  B,I
3359  05342  050020         AND  .3
3360  05343  071550         SZA  SSYM6   ARRAY FOUND? SKIP IF NO
3361  05344  011466         CPA  STMP2   DO DIMENSIONS MATCH?
3362  05345  067361  SM2L   JMP  SSYM2   YES, NOW CHECK PRECISION
3363  05346  010020         CPA  .3      NO, TABLE VARIABLE UNSPECIFIED?
3364  05347  067354         JMP  SSYM5   YES
3365  05350  021466         LDA  STMP2   NO, SEARCH
3366  05351  010020         CPA  .3        VARIABLE UNSPECIFIED?
3367  05352  067361         JMP  SSYMP2  YES, OK
```

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```
3368  05353  062360  SYME2   JSM  MERR    NO, INCONSISTENT DIMENSIONS
3369  05354  074517  SSYM5   LDA  B,I     INSERT
3370  05355  050135          AND  M4
3371  05356  041466          IOR  STMP2     DIMENSION NUMBER
3372  05357  074557          STA  B,I
3373  05360  067361          JMP  SSYM2     INTO TABLE
3374*   PROPER TYPE FOUND, NOW CHECK FOR PROPER PRECISION
3375*
3376  05361  021467  SSYM2   LDA  STMP3
3377  05362  070350          SZA  SSYM3-1   SEARCH VARIABLE UNSPECIFIED?
3378  05363  074517          LDA  B,I       NO
3379  05364  050030          AND  .12
3380  05365  072250          RZA  SSYM3     TABLE VARIABLE UNSPECIFIED?
3381  05366  021467          LDA  STMP3     YES
3382  05367  074617          IOR  B,I
3383  05370  074557          STA  B,I       INSERT SPECIFICATION IN TABLE
3384  05371  064357          JMP  RETN2     FOUND
3385  05372  062360  SSYM3   JSM  MERR      PRECISION DOUBLY DEFINED
3386*
3387*   SEARCH SYMBOL TABLE FOR A MATCH — (B),I AND MASK=STMP1
3388*
3389*     RET P+1 IF NO MATCH FOUND
3390*         P+2 IF MATCH FOUND, (B)=ADDRESS
3391  05373  025406          LDB  VALUE
3392  05374  015407  SVALU   CPB  SYMTP     ALL TABLE SEARCHED?
3393  05375  170402          RET            YES, NO MATCH FOUND
3394  05376  074517          LDA  B,I       NO, READ TABLE ENTRY
3395  05377  051470          AND  MASK      GET THE BITS TO BE COMPARED
3396  05420  011471          CPA  STMP1     MATCH?
3397  05401  064357          JMP  RETN2     YES, RET P+2, (R)=ADDRESS
3398  05402  004133  SVAL1   ADB  M2        UPDATE TABLE POINTER
3399  05403  067374          JMP  SVALU
3400  01470          MASK    EQU  L2T1
3401  01471          STMP1   EQU  L2T2
3402  01466          STMP2   EQU  LOCL1
3403  01467          STMP3   EQU  LOCL2
3404*
3405*   ENTER 2 WORDS GIVEN IN MBOX1 AND MBOX1+1 INTO SYMBOL TABLE
3406*
3407  05404  020133  ESYMT   LDA  M2        MOVE H-STOCK
3408  05405  025407          LDB  SYMTP
3409  05406  063555          JSM  MOVCK     DOWN BY 2 WORDS
3410  05407  074070          SIB  *+1       ((B)=NEW SYMTP)
3411  05410  021474          LDA  MBOX1+1   TRANSFER WORDS INTO SYMTAB
3412  05411  074557  ESYM1   STA  B,I
3413  05412  074070          SIB  *+1
3414  05413  021473          LDA  MBOX1
3415  05414  074557          STA  B,I
3416  05415  170402          RET
3417*
3418*   ENTER A SIMPLE VARIABLE INTO SYMTAB AND VALUE TABLE
3419*
3420  05416  021473  ENTER   LDA  MBOX1
3421  05417  063234          JSM  FNTYP     FIND OPERAND TYPE
3422  05420  067437          JMP  ENTE1     FUNCTION
3423  05421  160206  NINIT   JSM  ERRA,I    STRING, NOT INITIALIZED
```

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```
3424   05422  071752          SAM  *-1        SIMPLE VARIABLE?
3425   05423  025406          LDB  VALUE      YES
3426   05424  020137          LDA  M6         NO, MOVE SYMTAB AND H-STACK
3427   05425  063555          JSM  MOVCK        DOWN BY 6 WORDS
3428   05426  000135          ADA  M4         COMPUTE ADDRESS OF VARIABLE
3429   05427  031474          STA  MBOX1+1
3430   05430  070137          LDB  A
3431   05431  020062          LDA  FLGBT
3432   05432  074557          STA  B,I        SET TO UNDEFINED
3433   05433  004133          ADB  M2         COMPUTE ADDRESS OF
3434   05434  063410          JSM  ESYMT+4      SYMTAB ENTRY AND ENTER
3435   05435  035406          STB  VALUE      UPDATE VALUE TABLE POINTER
3436   05436  170402          RET
3437*    SEARCH FOR A FUNCTION NOT FOUND IN SYMTAB
3438*
3439   05437  025406  ENTE1   LDB  VALUE      OPEN UP 2 WORD SPACE
3440   05440  020133          LDA  M2
3441   05441  063555          JSM  MOVCK
3442   05442  025406          LDB  VALUE
3443   05443  004132          ADB  M1
3444   05444  035750          STB  YC         SET UP ADDRESS POINTER
3445   05445  070742          SAR  16         INITIALIZE ADDRESS WORD TO 0
3446   05446  063411          JSM  ESYM1      MAKE SYMTAB ENTRY
3447*
3448*    SEARCH FOR FUNCTION WHICH HAS 0 ADDRESS
3449   05447  063513  ENTFN   JSM  SSTT       SAVE PROGRAM POINTERS
3450   05450  025424          LDB  PBUFF
3451   05451  063524          JSM  SERFN      SEARCH CURRENT PROGRAM FIRST
3452   05452  024166          LDB  FWAM       NOT FOUND
3453*    SEARCH FIRST LINE OF EACH KEY
3454   05453  015405  ENTE3   CP8  FWUP       END OF KEY AREA?
3455   05454  067503          JMP  ENTE5      YES, NOT FOUND
3456   05455  074070          SIB  *+1
3457   05456  074517          LDA  B,I
3458   05457  074070          SIB  *+1
3459   05460  010012          CPA  .1         NULL KEY?
3460   05461  067453          JMP  ENTE3      YES
3461   05462  035472          STB  TEMPS
3462   05463  121472          LDA  TEMPS,I
3463   05464  004132          ADB  M1
3464   05465  070610          SZA  ENTE4+2    TYPING AID KEY?
3465   05466  060602          JSM  NEXT1-4    NO, GET PAGE AND OP CODE
3466   05467  001466          ADA  LOCL1
3467   05470  013554          CPA  DEFOP      DEF STMT?
3468   05471  067473          JMP  *+2        YES
3469   05472  067477          JMP  ENTE4      NO
3470   05473  121472          LDA  TEMPS,I
3471   05474  050115          AND  B1777
3472   05475  011473          CPA  MBOX1      IS IT THE FUNCTION WE WANT?
3473   05476  067536          JMP  SERF1      YES
3474   05477  025472  ENTE4   LDB  TEMPS      NO
3475   05500  004134          ADB  M3
3476   05501  074437          ADB  B,I        FIND NEXT KEY
3477   05502  067453          JMP  ENTE3
3478*    SEARCH MAINLINE LAST
3479   05503  021422  ENTE5   LDA  UKPTR
```

```
3480   05504  070250          SZA  ENTE6     KEY MODE?
3481   05505  025426          LDB  PBPTO
3482   05506  035423          STB  PBPTR
3483   05507  025425          LDB  PBUFO     YES, SERCH MAINLINE
3484   05510  063524          JSM  SERFN
3485   05511  063543  ENTE6   JSM  RSTT      NOT FOUND, UNDEFINED
3486   05512  164337          JMP  E40,I
3487*
3488*   SUBROUTINE TO SAVE PROGRAM POINTERS
3489*
3490   05513  025421  SSTT    LDB  PRADD
3491   05514  035741          STB  XC+1
3492   05515  025472          LDB  TEMPS
3493   05516  035740          STB  XC
3494   05517  025427          LDB  .LNUM
3495   05520  035742          STB  XC+2
3496   05521  025423          LDB  PBPTR
3497   05522  035743          STB  XC+3
3498   05523  170402  SERFR   RET
3499*
3500*   SUBROUTINE TO SEARCH A PROGRAM FOR A FUNCTION DEF
3501*
3502*   (B)=ADDRESS OF FIRST WORD OF PROGRAM
3503*   RETURN IF NOT FOUND
3504*   RETURN TO SECOND RETURN ON STACK IF FOUND; STORE ADDRESS IN XC+3,I
3505*
3506   05524  035421  SERFN   STB  PRADD
3507   05525  023554          LDA  DEFOP
3508   05526  160241          JSM  SYTSA,I   SEARCH FOR DEF STMT
3509   05527  075613          SBP  SERFR     FOUND?
3510   05530  121472          LDA  TEMPS,I   YES
3511   05531  050115          AND  B1777
3512   05532  011473          CPA  MBOX1     IS IT THE FN WE WANT?
3513   05533  067535          JMP  *+2       YES
3514   05534  067525          JMP  SERFN+1
3515   05535  055777          DSZ  RSPTR     FOUND, DINK RETURN OFF STACK
3516   05536  025472  SERF1   LDB  TEMPS
3517   05537  004133          ADB  M2
3518   05540  135750          STB  YC,I      STORE ADDRESS IN SYMTAB
3519   05541  025750          LDB  YC
3520   05542  074070          SIB  *+1       GET SYMBOL TABLE ADDRESS
3521*
3522   05543  021740  RSTT    LDA  XC        RESTORE PROGRAM POINTERS
3523   05544  031472          STA  TEMPS
3524   05545  021741          LDA  XC+1
3525   05546  031421          STA  PRADD
3526   05547  021742          LDA  XC+2
3527   05550  031427          STA  .LNUM
3528   05551  021743          LDA  XC+3
3529   05552  031423          STA  PBPTR
3530   05553  170402          RET
3531*
3532   05554  011774  DEFOP   OCT  11774
3533*
3534*   MOVE H-STACK DOWN AND CHECK FOR OVERFLOW
3535*
```

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```
3536*      MOVE DOWN —(A) WORDS
3537*      (B)= ADDRESS OF LAST WORD MOVED
3538*
3539  05555  074070  MOVCK  SIB  *+1
3540  05556  031726         STA  MBINI    SAVE SPACE REQUIREMENT
3541  05557  035466         STB  LOCL1    SAVE LAST WORD + 1
3542  05560  001413         ADA  HSTPT    COMPUTE NEW HSTPT
3543  05561  070137         LDB  A
3544  05562  060555         JSM  BHSTP+2  CHECK FOR OVERFLOW
3545  05563  070137         LDB  A
3546  05564  021413         LDA  HSTPT    GET OLD HSTPT
3547  05565  035413         STB  HSTPT    STOKE NEW HSTPT
3548  05566  035727         STB  MBIN2    STORE SOURCE POINTER
3549  05567  011466  MOVC1  CPA  LOCL1    ALL WORDS MOVED?
3550  05570  067575         JMP  MOVC2    YES
3551  05571  070537         LDB  A,I      MOVE
3552  05572  135727         STB  MBIN2,I    WORD
3553  05573  045727         ISZ  MBIN2
3554  05574  073570         RIA  MOVC1    UPDATE POINTERS
3555  05575  025407  MOVC2  LDB  SYMTP
3356  05576  005726         ADB  MBIN1
3557  05577  035407         STB  SYMTP    UPDATE SYMBOL TABLE POINTER
3558  05600  170402  NXTPR  RET
3559*    ROUTINE TO FETCH THE NEXT OPERAND FROM THE PROGRAM
3560*      TEMPS POINTS TO CURRENT WORD OF CODE; PRADD POINTS TO END OF LINE
3561*      CONSTANTS; STRING CONSTANTS; NON-RESEQUENCEABLE INTEGERS ARE
                                                                    SKIPPE
3562*      EXIT P+1: END OF LINE
3563*           P+2: RESEQUENCABLE INTEGER FOUND
3564*           P+3: VARIABLE OPERAND FOUND
3565  05601  060572  NXTOP  JSM  NEXTL-2    COMPUTE END OF CURRENT LINE
3566  05602  005466         ADB  LOCL1     ADD OP-CODE AND
3567  05603  007772         ADB  MREM      CONSTANT TO PAGE TO GET
3568  05604  035731         STB  TYPE        UNIQUE VALUE FOR STATEMENT
                                                                    TYPE
3569  05605  055472         DSZ  TEMPS
3570  05606  121472         LDA  TEMPS,I
3571  05607  050107         AND  B1000     GET ASCII FLAG
3572  05610  073410         RZA  NXTPR     ASCII?
3573  05611  067620         JMP  NXTP1
3574*    PROCESS A STRING CONSTANT
3575  05612  125472  NXTP2  LDB  TEMPS,I   COMPUTE
3576  05613  074070         SIB  *+1
3577  05614  074404         SBL  8           LENGTH OF
3578  05615  074402         SBR  9             STRING
3579  05616  005472         ADB  TEMPS     SKIP TO
3580  05617  035472         STB  TEMPS       END OF CONSTANT
3581*    PROCESS NEXT WORD: RE-ENTER ROUTINE HERE AFTER
3582*      PROCESSING A VARIABLE OPERAND
3583  05620  045472  NXTP1  ISZ  TEMPS     SET TO NEXT WORD
3584  05621  021472         LDA  TEMPS
3585  05622  011421         CPA  PRADD     END OF CURRENT STMT?
3586  05623  170402         RET            YES
3587  05624  070517         LDA  A,I       READ CURRENT WORD
3588  05625  070452         SAM  NXTP3     SKIP IF SIGN BIT SET
3589  05626  050065         AND  OPMSK
3590  05627  010116         CPA  QIOP      QUOTE OPERATOR?
3591  05630  067612         JMP  NXTP2     YES, PROCESS STRING CONSTANT
```

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```
3592  05631  010065          CPA  OPMSK   MULTI-CHARACTER-NON-FORMULA
                                                          OPERATOR?
3593  05632  067620  NXT1L   JMP  NXTP1   YES, NO OPERAND IN THIS WORD
3594  05633  060771          JSM  GTOPP   GET OPERAND
3595  05634  071210          SZA  NXTP1   SKIP IF NULL
3596  05635  064356          JMP  RETN3   RETURN TO P+3 WITH OPERAND
                                                              IN (A)
3597*   PROCESS WORD WITH SIGN BIT SET
3598  05636  05016   NXTP3   AND  B777    GET TYPE AND CHARACTER COUNT
                                                          IF CONSTANT
3599  05637  070137          LDB  A
3600  05640  050040          AND  B37     ISOLATE THE TYPE
3601  05641  010021          CPA  .4      RESEQUENCABLE INTEGER?
3602  05642  067654          JMP  NXTP4   YES
3603  05643  071350          SZA  NXT1L   SKIP IF PARAMETER
3604  05644  000135          ADA  M4
3605  05645  071253          SAP  NXT1L   SKIP IF PARAMETER OR FUNCTION
3606  05646  074202          SBR  5       COMPUTE NUMBER OF
3607  05647  004022          ADB  .5        WORDS TO SKIP IF
3608  05650  074042          SBR  2           CONSTANT
3609  05651  010132          CPA  M1      INTEGER?
3610  05652  024012          LDB  .1      YES, SKIP 1 WORD
3611  05653  067616          JMP  NXTP1-2
3612  05654  045472  NXTP4   ISZ  TEMPS   READ THE
3613  05655  121472          LDA  TEMPS,I   INTEGER
3614  05656  064357          JMP  RETN2   RETURN TO P+2 WITH INTEGER
                                                              IN (A)
3615*
3616*   ROUTINE TO FIND ALL RESEQUENCABLE LINE NUMBER REFERENCES IN A
                                                              PROGRAM
3617*     EXIT: P+1 END OF PROGRAM FOUND
3618  05657  067620          JMP  NXTP1   NO
3619*           (A)=LINE NUMBER
3620*           (TEMPS)=ADDRESS OF LINE NUMBER
3621*
3622  05660  031421  FNDAD   STA  PRADD   SAVE STARTING ADDRESS
3623  05661  070517          LDA  A,I     TYPING AID KEY?
3624  05662  070150          SZA  FNDA2+2 RETURN IF YES
3625  05663  021421  FNDA2   LDA  PRADD
3626  05664  011423          CPA  PBPTR   END OF PROGRAM?
3627  05665  170402          RET          YES
3628  05666  063601          JSM  NXTOP   NO, CONTINUE SEARCH
3629  05667  067663          JMP  FNDA2   END OF STATEMENT
3630  05670  064357          JMP  RETN2   LINE NUMBER FOUND
3631  05671  063620  FNDA1   JSM  NXTP1   CONTINUE SEARCH
3632  05672  067663          JMP  FNDA2
3633  05673  064357          JMP  RETN2
3634  05674  067671          JMP  FNDA1
3635*
3636*   ROUTINE TO CONVERT ALL STATEMENT REFERENCES INTO ADDRESS FORMAT
3637*     THE ADDRESS OF A STATEMENT REPLACES THE LINE NUMBER AND
3638*     THE SIGN BIT IS SET
3639*
3640  05675  021424  COMPL   LDA  PBUFF   INITIALIZE TO START OF PROGRAM
3641  05676  063660          JSM  FNDAD   FIND FIRST LINE #
3642  05677  170402          RET
3643  05700  070312          SAM  COMP1
3644  05701  061075          JSM  FNDPS
3645  05702  067703          JMP  *+1
3646  05703  164343          JMP  E45-1,I NOT IN PROGRAM
3647  05704  076053          SBP  *+1,S   FOUND SET SIGN BIT
```

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```
3648  Ø57Ø5  135472          STB  TEMPS,I  REPLACE LINE NUMBER
3649  Ø57Ø6  Ø63671  COMP1   JSM  FNDA1    CONTINUE SEARCH
3650  Ø57Ø7  17Ø4Ø2          RET
3651  Ø571Ø  Ø677ØØ          JMP  COMPL+3
3652*
3653*   ROUTINE TO CONVERT ALL STATEMENT REFERENCES INTO LINE NUMBER FORMAT
3654*
3655  Ø5711  Ø25424  DCOMP   LDB  PBUFF
3656  Ø5712  Ø35415          STB  NXTDT    RESET DATA POINTERS
3657  Ø5713  Ø35414          STB  DSTRT
3658  Ø5714  Ø7Ø742          SAR  16
3659  Ø5715  Ø3142Ø          STA  PARMN    CLEAR PARAMETER NAME
3660  Ø5716  Ø76Ø53          SBP  *+1,S    SET DECOMPILE FLAG
3661  Ø5717  Ø6351Ø  DCOM1   JSM  SSTT+1   SAVE POINTERS
3662  Ø572Ø  Ø21421          LDA  PRADD
3663  Ø5721  Ø7Ø113          SAP  *+2      ALREADY DECOMPILED?
3664  Ø5722  Ø6775Ø          JMP  DCOMF    YES, DECOMPILE FUNCTIONS ONLY
3665  Ø5723  Ø2Ø166          LDA  FWAM
3666  Ø5724  Ø114Ø5  DCMP5   CPA  FWUP     END OF KEY AREA?
3667  Ø5725  Ø67764          JMP  DCMP4    YES, NOW DECOMPILE MAINLINE
3668  Ø5726  Ø7ØØ7Ø          SIA  *+1
3669  Ø5727  Ø7Ø137          LDB  A
3670  Ø573Ø  Ø7Ø437          ADB  A,I
3671  Ø5731  Ø7ØØ7Ø          SIA  *+I      COMPUTE START AND END OF KEY
3672  Ø5732  Ø35423  DCMP6   STB  PBPTR
3673  Ø5733  Ø6366Ø          JSM  FNDAD    FIND ADDRESS WORDS
3674  Ø5734  Ø67744          JMP  DCMP2    END OF THIS PROGRAM
3675  Ø5735  Ø7Ø233  DCMP1   SAP  DCMP3,C  SKIP IF ALREADY DECOMPILED
3676  Ø5736  Ø7Ø517          LDA  A,I      READ LINE NUMBER
3677  Ø5737  Ø7ØØ73          SAP  *+1,C    CLEAR SECURE BIT
3678  Ø574Ø  131472          STA  TEMPS,I  STORE LINE #
3679  Ø5741  Ø63671  DCMP3   JSM  FNDA1    FIND NEXT ADDRESS
3680  Ø5742  Ø67744          JMP  DCMP2
3681  Ø5743  Ø6773Ø          JMP  DCMP1
3682*   END OF CURRENT PROGRAM
3683  Ø5744  Ø21423  DCMP2   LDA  PBPTR
3684  Ø5745  Ø11426          CPA  PBPTO    END OF MAINLINE?
3685  Ø5746  Ø6775Ø          JMP  DCOMF    YES
3686  Ø5747  Ø6772Ø          JMP  DCMP5    NO, CONTINUE KEYS
3687*   DECOMPILE FUNCTIONS IN SYMTAB BY SETTING THEIR ADDRESSES TO Ø
3688  Ø575Ø  Ø6354Ø  DCOMF   JSM  RSTT     RESTORE PROGRAM POINTERS
3689  Ø5751  Ø24Ø4Ø  DCMF1   LDB  B37
3690  Ø5752  Ø3547Ø          STB  MASK     SET UP MASK FOR FUNCTION TYPE
3691  Ø5753  Ø35471          STB  STMP1
3692  Ø5754  Ø2546Ø          LDB  VALUE
3693  Ø5755  Ø6337Ø  DCMF2   JSM  SVALU    SEARCH SYMTAB FOR FUNCTION
3694  Ø5756  17Ø4Ø2          RET           END OF TABLE
3695  Ø5757  ØØ4132          ADB  M1
3696  Ø576Ø  Ø7Ø742          SAR  16
3697  Ø5761  Ø7455Ø          STA  B,I      SET ADDRESS TO ZERO
3698  Ø5762  ØØ4132          ADB  M1
3699  Ø5763  Ø6775Ø          JMP  DCMF2    FIND NEXT FUNCTION
3700*
3701*   END OF KEY AREA
3702  Ø5764  Ø2142Ø  DCMP4   LDA  PBUFO
3703  Ø5765  Ø2542Ø          LDB  UKPTR
```

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```
3704   05766  076110          RZB  *+2        KEY MODE?
3705   05767  021424          LDA  PBUFF      NO, START OF MAINLINE IS IN PBUFF
3706   05770  025426          LDB  PBPTO      GET END OF MAINLINE
3707   05771  067732          JMP  DCMP6
3708*
3709*
3710   00020          MDMA     EQU  .3         TYPE CODE FOR DIM
3711   00017          MCOMA    EQU  .2
3712   00012          MDEFA    EQU  .1
3713   05772  164006  MREM     ABS  5-13777B   OP CODE 5 ON STANDARD PAGE
3714*
3715   05773  000000          BSS  1          CHECKSUM WORD**********
```

PAGE 78 LIST ROUTINE

```
3717*
3718*       THIS SUBROUTINE LISTS ALL OR
3719*       A PORTION OF THE PROGRAM.
3720*
3721*       ENTRY CONDITIONS:
3722*            (A)=FWA OF LIST
3723*            (B)=LWA+1 OF LIST
3724*            PBUFF=FWA OF PROGRAM
3725*            PBPTR=LWA+1 OF PROGRAM
3726*
3727  06000                ORG    6000B
3728  06000  031453  LIST       STA  ARW     SET FLAT FOR LIST
3729  06001  035460             STB  TMP7    SAVE ENDING ADDRESS
3730  06002  074057             CPA  B       NULL LIST?
3731  06003  066005             JMP  *+2     YES
3732  06004  061344             JSM  CRLF1
3733  06005  021453             LDA  ARW
3734  06006  031472  LIST1      STA  TEMPS   SAVE STARTING ADDRESS
3735  06007  031476             STA  TMP11   SET FLAG FOR BLANK AFTER MCOUT
3736  06010  070742             SAR  16
3737  06011  031432             STA  DRQST   CLEAR INPUT MODE
3738*   LIST NEXT LINE
3739  06012  160170  L1         JSM  CLERA,I CLEAR BUFFER
3740  06013  025472             LDB  TEMPS
3741  06014  015460             CPB  TMP7    FINISHED
3742  06015  170402             RET          YES
3743  06016  062036             JSM  LISTS   NO, PUT NEXT LINE IN BUFFER
3744  06017  025453             LDB  ARW
3745  06020  076350             RZB  L100    UP OR DOWN ARROW?
3746  06021  020040             LDA  .31     YES
3747  06022  045623             ISZ  PEND    GUARANTEE ROOM FOR LAZY-T
3748  06023  061016             JSM  ONEXT   OUTPUT LAZY-T
3749  06024  020132             LDA  M1
3750  06025  031430             STA  LNINC   FLAG REED FOR LIST
3751  06026  165462             JMP  REEDL,I
3752  06027  060373  L100       JSM  ICNT    COMPUTE COUNT
3753  06030  061337             JSM  NDWRT   OUTPUT TO PRINTER
3754  06031  061344             JSM  CRLF1
3755  06032  021442             LDA  STPFL
3756  06033  010040             CPA  .31     STOP KEY HIT?
3757  06034  167517             JMP  CRCIA,I YES, ABORT
3758  06035  066012             JMP  L1
3759*
3760*   SUBROUTINE TO PUT NEXT LINE IN BUFFER
3761*
3762  06036  061007  LISTS      JSM  NEXTA   FIND END OF LINE
3763  06037  035475             STB  TMP10   SAVE END OF STMT
3764  06040  020236             LDA  SLEND
3675  06041  031623             STA  PEND    SET END OF BUFFER POINTER
3676  06042  125472             LDB  TEMPS,I
3767  06043  074073             SBP  *+1,C   CLEAR SECURE BIT
3768  06044  035431             STB  CLINE
3769  06045  076650             RZB  LLL     TYPING AID KEY?
3770  06046  020100             LDA  B52     YES, OUTPUT AN *
3771  06047  061016             JSM  ONEXT
3772  06050  025460             LDB  TMP7
```

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```
3773  Ø6Ø51  Ø35475          STB  TMP1Ø     SET UP END OF LINE POINTER
3774  Ø6Ø52  Ø55472          DSZ  TEMPS
3775  Ø6Ø53  121472          LDA  TEMPS,I
3776  Ø6Ø54  ØØØ133          ADA  M2
3777  Ø6Ø55  Ø7Ø744          SAL  1         GET CHARACTER COUNT
3778  Ø6Ø56  Ø25472          LDB  TEMPS
3779  Ø6Ø57  ØØ4Ø17          ADB  .2
3780  Ø6Ø6Ø  Ø74744          SBL  1         GET STARTING ADDRESS
3781  Ø6Ø61  Ø66276          JMP  L28—3     OUTPUT STRING
3782*   OUTPUT STMT NUMBER AND TYPE
3783  Ø6Ø62  16Ø21Ø  LLL      JSM  OUTIA,I
3784  Ø6Ø63  Ø61Ø15          JSM  OBLNK
3785  Ø6Ø64  121472          LDA  TEMPS,I
3786  Ø6Ø65  Ø7Ø213          SAP  *+4       SECURE?
3787  Ø6Ø66  Ø2Ø1ØØ          LDA  B52       YES, OUTPUT A "*"
3788  Ø6Ø67  Ø61Ø16          JSM  ONEXT
3789  Ø6Ø7Ø  Ø66277          JMP  L28—2
3790  Ø6Ø71  Ø6Ø6Ø2          JSM  NEXT1—4   NO, GET PAGE AND TYPE
3791  Ø6Ø72  Ø35474          STB  TMP9      STORE LAST ADDRESS OF PAGE
3792  Ø6Ø73  Ø55472          DSZ  TEMPS
3793  Ø6Ø74  121472          LDA  TEMPS,I
3794  Ø6Ø75  Ø45472          ISZ  TEMPS
3795  Ø6Ø76  Ø5Ø1Ø7          AND  B1ØØØ    GET ASCII FLAG
3796  Ø6Ø77  Ø31461          STA  TMP13
3797  Ø61ØØ  Ø21466          LDA  LOCL1     RECALL OP CODE
3798  Ø61Ø1  Ø1Ø132          CPA  M1        IMPLIED LET?
3799  Ø61Ø2  Ø66117          JMP  L23       YES
3800  Ø61Ø3  Ø7ØØ76          TCA            GET OP-CODE
3801  Ø61Ø4  ØØ4132          ADB  M1        GET STMT NAME TABLE ADDRESS
3802  Ø61Ø5  Ø74437          ADB  B,I
3803  Ø61Ø6  Ø74744          SBL  1         COMPUTE TABLE ADDRESS
3804*   OUTPUT MULTI-CHARACTER OPERATOR
3805  Ø61Ø7  Ø623Ø6  L6       JSM  MCOUT     OUTPUT NAME
3806  Ø611Ø  Ø21461          LDA  TMP13
3807  Ø6111  Ø7Ø11Ø          SZA  *+2       ASCII FORMAT?
3808  Ø6112  Ø66266          JMP  L25       YES
3809  Ø6113  Ø21476          LDA  TMP11
3810  Ø6114  Ø7Ø11Ø          SZA  *+2
3811  Ø6115  Ø61Ø15          JSM  OBLNK
3812  Ø6116  Ø35476          STB  TMP11     RESET BLANK FLAG
3813*   OUTPUT NEXT OPERAND
3814  Ø6117  121472  L23      LDA  TEMPS,I
3815  Ø612Ø  Ø5ØØ67          AND  TYPFL     ISOLATE OPERAND TYPE
3816  Ø6121  Ø7Ø472          SAM  L4,C      SKIP IF CONSTANT OR FUNCTION
3817  Ø6122  Ø31477          STA  TMP12     SAVE TYPE
3818  Ø6123  121472          LDA  TEMPS,I
3819  Ø6124  Ø5ØØ65          AND  OPMSK     WAS THE PREVIOUS OURATOR
3820  Ø6125  Ø1ØØ65          CPA  OPMSK       EXPANDED?
3821  Ø6126  Ø66152          JMP  L11       YES SKIP THIS FIELD
3822  Ø6127  Ø623Ø2          JSM  GTOPD
3823  Ø613Ø  Ø71710          SZA  *—2       SKIP IF NULL OPERAND
3824  Ø6131  Ø66221          JMP  L15
3825*   OUTPUT CONSTANT
3826  Ø6132  Ø1ØØ4Ø  L4       CPA  .31       PREDEFINED FUNCTION?
3827  Ø6133  Ø66255          JMP  L9        YES
3828  Ø6134  ØØØ132          ADA  M1
```

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```
3829  Ø6135  Ø317Ø5          STA  FLOAT    SAVE FIX/FLOAT FLAG (Ø=FIX)
383Ø  Ø6136  ØØØ133          ADA  M2
3831  Ø6137  Ø7Ø313          SAP  L12      SKIP IF INTEGER
3832  Ø614Ø  16Ø232          JSM  SNFLA,I  CONVERT
3833  Ø6141  Ø2Ø133          LDA  M2
3834  Ø6142  Ø317Ø3          STA  PLACE    DECIMAL PLACES NOT SPECIFIED
3835  Ø6143  Ø62353          JSM  NMOUT    OUTPUT NUMBER FROM AR2
3836  Ø6144  Ø66152          JMP  L11
3837*   OUTPUT INTEGER
3838  Ø6145  Ø4572   L12     ISZ  TEMPS
3839  Ø6146  125472          LDB  TEMPS,I  GET INTEGER
384Ø  Ø6147  Ø74133          SBP  *+2,C    COMPILED FORMAT?
3841  Ø615Ø  Ø74537          LDB  B,I      YES, READ LINE #
3842  Ø6151  16Ø21Ø          JSM  OUTIA,I  OUTPUT INTEGER
3843*   *CHECK FOR END OF STATEMENT
3844  Ø6152  Ø45472  L11     ISZ  TEMPS
3845  Ø6153  Ø21472          LDA  TEMPS
3846  Ø6154  Ø11475          CPA  TMP1Ø
3847  Ø6155  17Ø4Ø2          RET
3848*   OUTPUT NEXT OPERATOR
3849  Ø6156  121472          LDA  TEMPS,I
385Ø  Ø6157  Ø5ØØ65          AND  OPMSK
3851  Ø616Ø  Ø7Ø442          SAR  1Ø
3852  Ø6161  Ø7Ø51Ø          SZA  L13      SKIP IF NULL OPERATOR
3853  Ø6162  Ø1ØØ12          CPA  .1       QUOTE?
3854  Ø6163  Ø66213          JMP  L29      YES
3855  Ø6164  Ø24Ø34          LDB  .21
3856  Ø6165  Ø6Ø753          JSM  LIMIT    SINGLE CHARACTER OPERATOR?
3857  Ø6166  Ø66174          JMP  L3       NO
3858  Ø6167  ØØØ123          ADA  FOPBS
3859  Ø617Ø  Ø7Ø517          LDA  A,I
386Ø  Ø6171  Ø7Ø342          SAR  8        GET ASCII FROM TABLE
3861  Ø6172  Ø61Ø16          JSM  ONEXT
3862  Ø6173  Ø66117  L13     JMP  L23      GO OUTPUT NEXT OPERAND
3863*   OUTPUT MULTI-CHAR OPERATOR
3864  Ø6174  Ø317Ø3  L3      STA  PLACE    SAVE OPERAND IN TEMP
3865  Ø6175  Ø1ØØ4Ø          CPA  .31      EXPANDED OP?
3866  Ø6176  Ø623Ø2          JSM  GTOPD    YES, GET OP CODE
3867  Ø6177  Ø317Ø4          STA  WIDTH    SAVE
3868  Ø62ØØ  Ø7Ø142          SAR  4
3869  Ø62Ø1  Ø31476          STA  TMP11    SET FLAG FOR BLANK
387Ø  Ø62Ø2  Ø7Ø11Ø          SZA  *+2      OUTPUT BLANK IF
3871  Ø62Ø3  Ø61Ø15          JSM  OBLNK      OP > 17B
3872  Ø62Ø4  Ø217Ø3          LDA  PLACE
3873  Ø62Ø5  Ø2413Ø          LDB  FROMA    GET STANDARD PAGE
3874  Ø62Ø6  Ø1ØØ4Ø          CPA  .31      EXPANDED OP?
3875  Ø62Ø7  Ø25474          LDB  TMP9     YES, GET PAGE FOR STMT
3876  Ø621Ø  Ø217Ø4          LDA  WIDTH
3877  Ø6211  ØØ4135          ADB  M4
3878  Ø6212  Ø661Ø5          JMP  L6-2     COMPUTE TABLE ADDR AND OUTPUT
3879*   OUTPUT QUOTE FIELD
388Ø  Ø6213  Ø2ØØ43  L29     LDA  .34
3881  Ø6214  Ø61Ø16          JSM  ONEXT
3882  Ø6215  Ø62647          JSM  QUOTE
3883  Ø6216  Ø2ØØ43          LDA  .34
3884  Ø6217  Ø61Ø16          JSM  ONEXT
```

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```
3885   06220  066153          JMP  L11+1
3886*   OUTPUT OPERAND NAME AND TYPE
3887   06221  021477  L15     LDA  TMP12
3888   06222  010040          CPA  .31        FUNCTION?
3889   06223  062251          JSM  L16        YES
3890   06224  062302  L8      JSM  GTOPD
3891   06225  000101          ADA  B100
3892   06226  061016          JSM  ONEXT      OUTPUT LETTER NAME
3893   06227  025477          LDB  TMP12
3894   06230  014040          CPB  .31        FUNCTION?
3895   06231  066152          JMP  L11        YES
3896   06232  020077          LDA  DOLAR
3897   06233  014076          CPB  B36        STRING
3898   06234  066241          JMP  L19        YES
3899   06235  074146          RBR  4
3900   06236  074251          SLB  L20        LETTER AND DIGIT?
3901   06237  021477          LDA  TMP12      YES, OUTPUT DIGIT
3902   06240  040052          IOR  .48
3903   06241  061016  L19     JSM  ONEXT
3904   06242  066152          JMP  L11
3905   06243  074642  L20     SBR  14
3906   06244  075710          SZB  *-2        LETTER ONLY?
3907   06245  020055          LDA  I          NO
3908   06246  075551          SLB  L19        INTEGER?
3909   06247  020073          LDA  S          NO — SPLIT
3910   06250  066241          JMP  L19
3911*   OUTPUT "FN"
3912   06251  020072  L16     LDA  F
3913   06252  061016          JSM  ONEXT      OUTPUT F
3914   06253  023522          LDA  N
3915   06254  065016          JMP  ONEXT      OUTPUT N AND RETURN TO L8
3916*   OUTPUT PRE-DEFINED FUNCTION NAME
3917   06255  062302  L9      JSM  GTOPD      GET OP-CODE
3918   06256  031467          STA  LOCL2
3919   06257  060605          JSM  NEXT1-1    GET PAGE
3920   06260  004134          ADB  M3
3921   06261  074437          ADB  B,I
3922   06262  021467          LDA  LOCL2
3923   06263  074744          SBL  1          COMPUTE TABLE ADDRESS
3924   06264  062306          JSM  MCOUT
3925   06265  06617           JMP  L23
3926*   OUTPUT REM STATEMENT
3927   06266  021472  L25     LDA  TEMPS
3928   06267  070076          TCA
3929   06270  001475          ADA  TMP10
3930   06271  070744          SAL  1
3931   06272  000132          ADA  M1         COMPUTE CHARACTER COUNT
3932   06273  025472          LDB  TEMPS
3933   06274  074744          SBL  1
3934   06275  074070          SIB  *+1        COMPUTE STARTING ADDRESS
3935   06276  062651          JSM  STOUT      OUTPUT STRING TO BUFFER
3936   06277  025475          LDB  TMP10
3937   06300  035472          STB  TEMPS
3938   06301  170402  L28     RET             LINE COMPLETE
3939*
3940*   GET OPERAND NAME
```

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```
3941*
3942   Ø63Ø2  121472  GTOPD  LDA  TEMPS,I
3943   Ø63Ø3  Ø5Ø115         AND  B1777
3944   Ø63Ø4  Ø7Ø2Ø2         SAR  5
3945   Ø63Ø5  17Ø4Ø2         RET
```

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```
3947*
3948*      THIS SUBROUTINE SEARCHES THE
3949*      MULTIPLE CHARACTER OP CODE
395Ø*      TABLE. IT RETURNS WITH THE
3951*      ASCII STRING IN THE SYNTAX
3952*      BUFFER.
3953*
3954*      ENTRY CONDITIONS
3955*
3956*           (A)=OP CODE
3957*           (B)=POINTER TO FIRST
3958*                CHARACTER OF TABLE
3959*
396Ø*
3961   Ø63Ø6  Ø31741  MCOUT  STA  TMP1   SAVE CODE
3962   Ø63Ø7  Ø3574Ø         STB  TMP
3963   Ø631Ø  Ø7Ø742  MC1    SAR  16
3964   Ø6311  Ø31743         STA  TMP3   COUNT=Ø
3965   Ø6312  Ø61Ø53  MC4    JSM  GTMP
3966   Ø6313  Ø7Ø3Ø6         RAR  7
3967   Ø6314  Ø7Ø331         SLA  MC2,C  OP CODE?
3968   Ø6315  Ø7Ø4Ø2         SAR  9      YES
3669   Ø6316  Ø5ØØ4Ø         AND  .31
397Ø   06317  Ø11741         CPA  TMP1   MATCH?
3971   Ø632Ø  Ø66324         JMP  MC3    YES
3972   Ø6321  Ø6631Ø         JMP  MC1
3973   Ø6322  Ø45743  MC2    ISZ  TMP3
3974   Ø6323  Ø66312         JMP  MC4
3975   Ø6324  Ø21743  MC3    LDA  TMP3   GET COUNT
3976   Ø6325  Ø25743         LDB  TMP3
3977   Ø6326  Ø74Ø56         CMB
3978   Ø6327  ØØ574Ø         ADB  TMP    COMPUTE STARTING ADDRESS
3979   Ø633Ø  Ø66651         JMP  STOUT
```

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```
3981*
3982*       THIS SUBROUTINE ROUNDS THE NUMBER
3983*       IN AR2. IF OVERFLOW OCCURS BUMP THE
3984*       EXPONENT AND SHIFT A ONE IN AS THE
3985*       MSD. B HAS THE LEADING ZERO COUNT
3986*       FOR THE ROUNDING CONSTANT.
3987*
3988*
3989   06331  021744  RND2    LDA  AR1
3990   06332  031754          STA  AR2
3991   06333  170402          RET
3992   06334  061256  RND     JSM  CLAR2
3993   06335  020022          LDA  .5
3994   06336  174470          MRY                 ROUND OFF LSD-1
3995   06337  170560          FXA
3996   06340  170002          MOV                 SET A=E
3997   06341  071410          SZA  RND2
3998   06342  024012          LDB  .1
3999   06343  174470          MRY                 SHIFT IN A ONE
4000   06344  020013          LDA  B400
4001   06345  001744          ADA  AR1
4002   06346  031754          STA  AR2            BUMP EXPONENT
4003   06347  070340          AAR  8
4004   06350  010060          CPA  .100           EXPONENT OVERFLOW?
4005   06351  064444          JMP  XFAR2
4006   06352  055777          DSZ  RSPTR
4007*
4008*
4009*
4010*       NUMOUT ROUTINE
4011*
4012*       THIS ROUTINE OUTPUTS A NORMALIZED
4013*       NUMBER FROM AR2 INTO A BUFFER/
4014*
4015*       PLACE=DIGITS FOLLOWING DECIMAL POINT
4016*       PLACE=—1 STANDARD FORMAT
4017*       PLACE=—2 LIST NUMBER
4018*       WIDTH=FIELD WIDTH
4019*       BADDR=OUTPUT BUFFER POINTER
4020*       FLOAT=1 SPECIFIES FLOATING POINT
4021*
4022*
4023   06353  060405  NMOUT   JSM  XFAR1
4024   06354  024012          LDB  .1
4025   06355  035751          STB  DIGIT          INITIALIZE
4026   06356  171400  NM3     MLS                 SHIFT NEXT DIGIT
4027   06357  070450          SZA  NM1            DIGIT IS ZERO?
4028   06360  021703          LDA  PLACE
4029   06361  070070          SIA  *+1
4030   06362  072250          RZA  NM2            STANDARD FORMAT?
4031   06363  014027          CP8  .11
4032   06364  066374          JMP  NM4
4033   06365  014030          CPB  .12
4034   06366  066374          JMP  NM4
4035   06367  035751  NM2     STB  DIGIT
4036   06370  074070  NM1     SIB  *+1
```

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```
4037  06371  014031          CPB  .13        LAST DIGIT?
4038  06372  066374          JMP  *+2         YES
4039  06373  066356          JMP  NM3         NO
4040  06374  060444  NM4     JSM  XFAR2
4041  06375  021705          LDA  FLOAT
4042  06376  072110          RZA  *+2         FIXED OR FLOAT?
4043  06377  066467          JMP  OFXD        FIXED
4044*
4045*
4046*       OUTPUT A FLOATING POINT NUMBER
4047*       THE NUMBER WILL HAVE THE FORM:
4048*
4049*       SX.XXXXXXXXXESXX
4050*
4051  06400  025703  OFLT    LDB  PLACE
4052  06401  021416          LDA  MODE
4053  06402  070151          SLA  *+3         SKIP IF PROG OR LIST
4054  06403  035741          STB  R
4055  06404  066433          JMP  FLT2+1
4056  06405  074513          SBP  FLT1        STANDARD FORMAT?
4057  06406  014132          CPB  M1          LIST NUMBER?
4058  06407  066414          JMP  FLT7        NO
4059  06410  021751          LDA  DIGIT       YES
4060  06411  000132          ADA  M1
4061  06412  031741          STA  R           R=DIGIT—1
4062  06413  066435          JMP  FLT5
4063  06414  024022  FLT7    LDB  .5          STD PRINTOUT——FLOAT 5
4064  06415  035741  FLT11   STB  R
4065  06416  066432          JMP  FLT2
4066  06417  035741  FLT1    STB  R
4067  06420  076110          RZB  *+2         ANY RIGHT DIGITS?
4068  06421  004132          ADB  M1          NO, ALLOW ONE LESS CHARACTER
4069  06422  004024          ADB  .7
4070  06423  074076          TCB
4071  06424  005704          ADB  WIDTH
4072  06425  074213          SBP  FLT4
4073  06426  020077  FLT3    LDA  DOLAR       NO
4074  06427  025704          LDB  WIDTH
4075  06430  067475          JMP  MOUT
4076  06431  063474  FLT4    JSM  MOUT—1
4077  06432  025741  FLT2    LDB  R
4078  06433  004017          ADB  .2
4079  06434  062334          JSM  RND         ROUND THE NUMBER
4080  06435  062637  FLT5    JSM  OSIGN
4081  06436  061314          JSM  ODGIT       OUTPUT A DIGIT FROM AR2
4082  06437  021741          LDA  R
4083  06440  070310          SZA  FLT8        ANY RIGHT DIGITS?
4084  06441  020051          LDA  POINT
4085  06442  061016          JSM  ONEXT       YES, OUTPUT DECIMAL POINT
4086  06443  061314  FLT6    JSM  ODGIT
5087  06444  055741          DSZ  R           DINC R
4088  06445  066443          JMP  FLT6
4089  06446  020071  FLT8    LDA  E
4090  06447  061016          JSM  ONEXT
4091  06450  025754          LDB  AR2
4092  06451  074340          ABR  8           GET EXPONENT
```

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```
4093  06452  020047          LDA  PLUS
4094  06453  074153          SPB  FLT10     NEGAIVE EXPONENT?
4095  06454  020050          LDA  MINUS     YES
4096  06455  074076          TCB
4097  06456  035743  FLT10   STB  INDEX     SAVE EXPONENT
4098  06457  061016          JSM  ONEXT
4099  06460  025743          LDB  INDEX
4100  06461  004141          ADB  M10
4101  06426  074153          SBP  FLT9      EXPONENT LT 10?
4102  06463  020052          LDA  B60
4103  06464  061016          JSM  ONEXT
4104  06465  025743  FLT9    LDB  INDEX
4105  06466  164210          JMP  OUTIA,I   OUTPUT EXPONENT
```

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```
4107*
4108*       OUTPUT A FIXED POINT NUMBER
4109*       IF IT WILL FIT IN \E SPECIFIED
4110*       FIELD. THE NORMALIZED NUMBER IS
4111*       IN REGISTER AR1.
4112*
4113*
4114  06467  021754  OFXD   LDA  AR2
4115  06470  070340         AAR  8
4116  06471  070070         SIA  *+1
4117  06472  031742         STA  L
4118  06473  074742         SBR  16
4119  06474  035750         STB  RBASE
4120  06475  070076         TCA
4121  06476  070152         SAM  RL4
4122  06477  035742         STB  L
4123  06500  031750         STA  RBASE
4124  06501  001751  RL4    ADA  DIGIT
4125  06502  070113         SAP  *+2        DIGIT GE EXP?
4126  06503  070742         SAR  16         NO. R=0
4127  06504  031741         STA  R          R=DIGIT+RBASE-L
4128  06505  025703  RL3    LDB  PLACE
4129  06506  014133         CPB  M2         LIST NUMBER?
4130  06507  066567         JMP  NN2        YES
4131  06510  074313         SBP  N2         STANDARD FORMAT?
4132  06511  025741         LDB  R          YES
4133  06512  014027         CPB  .11        11 RIGHT DIGITS?
4134  06513  004133         ADB  M2         YES, USE ONLY 9
4135  06514  014061         CPB  .10        10 RIGHT DIGITS?
4136  06515  004132         ADB  M1         YES, USE ONLY 9
4137  06516  035741  N2     STB  R
4138  06517  074076         TCB
4139  06520  005750         ADB  RBASE
4140  06521  074076         TCB
4141  06522  005742         ADB  L
4142  06523  004143         ADB  M12
4143  06524  074353         SBP  N1
4144  06525  004031         ADB  .13
4145  06526  062334  N4     JSM  RND        ROUND THE NUMBER
4146  06527  066533         JMP  N1
4147  06530  025754  N6     LDB  AR2
4148  06531  074112         SBM  N1         L GE 0?
4149  06532  045742         ISZ  L          YES, BUMP L
4150  06533  021416  N1     LDA  MODE
4151  06534  025754         LDB  AR2
4152  06535  074340         ABR  8
4153  06536  070311         SLA  NN3        CALC MODE?
4154  06537  004143         ADB  M12        YES
4155  06540  074513         SBP  NN         OVERFLOW?
4156  06541  005703         ADB  PLACE      NO
4157  06542  004030         ADB  .12
4158  06543  074313         SBP  N7         UNDERFLOW?
4159  06544  021703  NN3    LDA  PLACE
4160  06545  070313         SAP  NN1        STANDARD FORMAT?
4161  06546  004141         ADB  M10
4162  06547  074153         SBP  NN         EXPONENT GT 9?
```

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```
4163  06550  004030          ADB  .12
4164  06551  074713  N7      SBP  NN2        OVERFLOW?
4165  06552  066400  NN      JMP  OFLT       YES
4166  06553  025741  NN1     LDB  R
4167  06554  074130          SIB  *+2        R=0?
4168  06555  004012          ADB  .1         NO, B=R+2
4169  06556  021742          LDA  L          YES, B=R+1
4170  06557  070130          SIA  *+2        L=0?
4171  06560  000132          ADA  M1         NO
4172  06561  070037          ADB  A          YES, USE L=1
4173  06562  074076          TCB
4174  06563  005704          ADB  WIDTH
4175  06564  075312          SBM  NN         NUMBER FITS IN FIELD?
4176  06565  035461          STB  TMP13
4177  06566  063474          JSM  MOUT-1
4178  06567  062637  NN2     JSM  OSIGN
4179  06570  021742          LDA  L
4180  06571  025742          LDB  L
4181  06572  004144          ADB  M13
4182  06573  074112          SBM  NN10       MORE THAN 12 DIGITS?
4183  06574  020030          LDA  .12        YES, USE ONLY 12
4184  06575  031461  NN10    STA  TMP13
4185  06576  070510          SZA  NN4
4186  06577  061314  NN5     JSM  ODGIT
4187  06600  055461          DSZ  TMP13      LAST LEFT DIGIT?
4188  06601  066577          JMP  NN5        NO
4189  06602  025742          LDB  L
4190  06603  004143          ADB  M12
4191  06604  074312          SBM  NN4+2
4192  06605  074250          SZB  NN4+2
4193  06606  020052          LDA  B60
4194  06607  063475          JSM  MOUT       FILL WITH ZEROES
4195  06610  020052  NN4     LDA  B60
4196  06611  061016          JSM  ONEXT
4197  06612  021741          LDA  R
4198  06613  072110          RZA  *+2
4199  06614  066636  NN11    JMP  NN6
4200  06615  020051          LDA  POINT
4201  06616  061016          JSM  ONEXT
4202  06617  025750          LDB  RBASE
4203  06620  074117          LDA  B
4204  06621  070076          TCA
4205  06622  001741          ADA  R
4206  06623  070153          SAP  *+3
4207  06624  070742          SAR  16
4208  06625  025741          LDB  R
4209  06626  031741          STA  R          R=R-RBASE
4210  06627  020052          LDA  B60
4211  06630  063475          JSM  MOUT       FILL WITH ZEROES
4212  06631  021741  NN7     LDA  R
4213  06632  070210          SZA  NN6
4214  06633  061314          JSM  ODGIT
4215  06634  055741          DSZ  R          LAST RIGHT DIGIT?
4216  06635  066631          JMP  NN7        NO
4217  06636  170402  NN6     RET             YES, DONE
4218*
```

PAGE 89 OUTPUT TO BUFFER ROUTINES

```
4220*
4221*      THIS SUBROUTINE OUTPUTS THE MANTISSA SIGN
4222*
4223*      MANTISSA NEGATIVE - - - - UNCONDITIONALLY OUTPUT -
4224*
4225*      MANTISSA POSITIVE
4226*           LIST NUMBER - - - - - - OUTPUT NOTHING
4227*           OTHERWISE - - - - - - - - OUTPUT BLANK
4228*
4229*
4230   06637  021754  OSIGN   LDA  AR2
4231   06640  070151           SLA  OSI        MANTISSA POSITIVE?
4232   06641  020050           LDA  MINUS      NO
4233   06642  065016           JMP  ONEXT
4234   06643  021703  OSI      LDA  PLACE
4235   06644  010133           CPA  M2         LIST NUMBER?
4236   06645  170402           RET             YES
4237   06646  065015           JMP  OBLNK
```

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```
4239*
4240*      OUTPUT A QUOTE STRING
4241*
4242   06647  063261  QUOTE    JSM  OTCH1      GET CHAR COUNT AND ADDRESS
4243   06650  000000           BSS  1          CHECKSUM WORD****(QTCH1
                                                          RETURNS TO P+2)
4244*
4245*
4246*      OUTPUT ANY STRING
4247*
4248*      ENTRY CONDITIONS:
4249*
4250*           A=NUMBER OF CHARACTERS
4251*           B=POINTER FIRST CHAR
4252*
4253   06651  031466  STOUT    STA  LOCL1      SAVE COUNT
4254   06652  070742           SAR  16
4255   06653  031701           STA  NDISP      ENABLE DISPLAY
4256   06654  020012           LDA  .1
4257   06655  065332           JMP  .NPWR+2    DISABLE PRINT
```

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```
4259*
4260*   SUBROUTINE TO PLACE NEXT PRINT FIELD IN BUFFER
4261*
4262*     RETURN P+1: END OF LINE (B)=0 FOR CRLF NOT SUPPRESSED
4263*             P+2: ITEM IN BUFFER (BADDR)=BUFFER POINTER
4264*
4265*
4266  06656  063227  PRINN  JSM  CKEOL     END OF LINE?
4267  06657  074742         SBR  16        YES CRLF NOT SUPPRESSED
4268  06660  170402         RET            YES CRLF SUPPRESSED
4269  06661  063004         JSM  PFOR1     SET UP 72 CHAR LINE
4270  06662  063240         JSM  QTCHK     QUOTE FIELD NEXT?
4271  06663  066674         JMP  PR5       NO
4272  06664  021471  QOV    LDA  L2T2      RECALL COUNT
4273  06665  003523         ADA  M72
4274  06666  070113         SAP  *+2       MORE THAN 72 CHARS?
4275  06667  070742         SAR  16        NO
4276  06670  070076         TCA
4277  06671  001471         ADA  L2T2      TRUNCATE TO 72
4278  06672  062651         JSM  STOUT     OUTPUT STRING
4279  06673  066731         JMP  PR7
4280  06674  121472  PR5    LDA  TEMPS,I
4281  06675  050070         AND  OPDMK
4282  06676  012732         CPA  TABOP     TAB?
4283  06677  067040         JMP  ETAB      YES
4284  06700  021453         LDA  PRFLG
4285  06701  010132         CPA  M1
4286  06702  066706         JMP  *+4       KEYBOARD "LET"
4287  06703  062773         JSM  PFORM
4288  06704  061220         JSM  FETCH+1   EVALUATE EXPRESSION
4289  06705  066707         JMP  *+2
4290  06706  062773         JSM  PFORM     EVALUATE "LET"
4291  06707  025622         LDB  TERM
4292  06710  076150         RZB  *+3       CRLF GIVEN IN FUNCTION?
4293  06711  160170         JSM  CLERA,I   YES
4294  06712  035622         STB  TERM
4295  06713  066721         JMP  PR6       NO
4296*   BUFFER OVERFLOW
4297  06714  025742  POV    LDB  TMP2
4298  06715  074110         SZB  *+2
4299  06716  066664         JMP  QOV       OVERFLOW DURING STRING
4300  06717  020215         LDA  TMPOP     NO, RESTORE AR2
4301  06720  060445         JSM  XFAR2+1
4302  06721  024132  PR6    LDB  M1
4303  06722  021416         LDA  MODE
4304  06723  070150         SZA  PR11      SKIP IF PROG MODE
4305  06724  025452         LDB  CPLAC
4306  06725  021451         LDA  CTYPE     SET UP CALC FORMAT FLAGS
4307  06726  063065  PR11   JSM  GNUM1     PUT NUMBER IN BUFFER
4308  06727  074742         SBR  16
4309  06730  035742         STB  TMP2      SET FLAG FOR NUMBER
4310  06731  063052  PR7    JSM  OVCK      CHECK FOP OVERFLOW
4311  06732  100077  TABOP  OCT  100077    (OVCK RETURNS TO P+2)
4312  06733  075052         SBM  POV       SKIP IF OVERFLOW
4313  06734  021472         LDA  TEMPS
4314  06735  011421         CPA  PRADD     END OF LINE?
```

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```
4315  06736  064357          JMP  RETN2    YES RETURN TO P+2
4316  06737  121472          LDA  TEMPS,I  NO, GET NEXT OPERATOR
4317  06740  070073          SAP  *+1,C
4318  06741  070442          SAR  10
4319  06742  000133          ADA  M2       SET UP COMMA:SEMICOLON FLAG
4320  06743  063027          JSM  FILL     OUTPUT TRAILING BLANKS
4321  06744  064357          JMP  RETN2
4322*
4323*
4324*   PRINT DISP AND WRITE(N,*) ROUTINE
4325*
4326  06745  020146  EPRIN   LDA  M15      SET UP SELECT CODE 15
4327  06746  070076  EDISP   TCA          NEG=DISP, -1=LET
4328  06747  031453          STA  PRFLG    SELECT CODE=PRINT OR WRITE
4329  06750  025416  EWRI1   LDB  MODE
4330  06751  076150          RZB  *+3      SKIP IF KEYBOARD MODE
4331  06752  021622          LDA  TERM
4332  06753  072150          RZA  *+3      SKIP IF BUFFER IS PARTIALLY FILLED
4333  06754  160170          JSM  CLERA,I  INITIALIZE BUFFER
4334  06755  035622          STB  TERM     INITIALIZE CRLF SUPPRESSED FLAG
4335  06756  063227          JSM  CKEOL    NULL LIST?
4336  06757  066765          JMP  PR2-1
4337  06760  066765          JMP  PR2-1    YES, GIVE CRLF
4338  06761  062656  PR3     JSM  PRINN    OUTPUT NEXT FIELD TO BUFFER
4339  06762  066766          JMP  PR2      END OF LINE
4340  06763  063450          JSM  OLINE    PRINT THE LATEST FIELD
4341  06764  066761          JMP  PR3
4342*
4343  06765  074742          SBR  16
4344  06766  035622  PR2     STB  TERM     SET CRLF SUPRESSED FLAG
4345  06767  076150          RZB  PR17     SKIP IF SUPPRESSED
4346  06770  063007          JSM  PRCHK    DISP?
4347  06771  061344          JSM  CRLF1    OUTPUT A CRLF
4348  06772  164172  PR17    JMP  XEC4A,I
4349*
4350*   SAVE PRINT FLAGS AND CALL FORMX
4351*
4352  06773  025453  PFORM   LDB  PRFLG
4353  06774  060563          JSM  SLWST
4354  06775  025447          LDB  SLCOD
4355  06776  060563          JSM  SLWST
4356  06777  160201          JSM  FORMA,I  EVALUATE FORMULA
4357  07000  060567          JSM  UNSTK
4358  07001  031447          STA  SLCOD    RESTORE SELECT CODE
4359  07002  060567          JSM  UNSTK
4360  07003  031453          STA  PRFLG    RESTORE PRINT FLAG
4361  07004  023521  PFOR1   LDA  LN72
4362  07005  031623          STA  PEND     SET UP 72 CHAR LINE
4363  07006  170402          RET
```

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```
4365  07007  025450  PRCHK   LDB  PMODE
4366  07010  074310          SZB  PRCHR  PRINT ALL?
4367  07011  025453          LDB  PRFLG  NO
4368  07012  074213          SBP  PRCHR  PRINT STMT?
4369  07013  064357          JMP  RETN2  NO
4370*     THIS SUBROUTINE FILLS A COMMA
4371*     OR SEMICOLON FIELD WITH BLANKS/
4372*     IF THE CURRENT LINE IS OVERFLOWED
4373*     IT IS OUTPUT AND A CRLF IS DONE/
4374*
4375*     ENTRY CONDITIONS:
4376*
4377*          A=0 IF COMMA FIELD
4378*          TMP2≠0 IF QUOTE FIELD WAS PRINTED
4379*
4380  07014  021742  FILL1   LDA  TMP2
4381  07015  070110          SZA  *+2        SKIP IF NUMERIC
4382  07016  170402  PRCHR   RET
4383  07017  061015          JSM  OBLNK      INSURE AT LEAST 1 BLANK
4384  07020  025625          LDB  FIRST      NO
4385  07021  074076          TCB
4386  07022  005400          ADB  BADDR      GET OUTPUT COUNT
4387  07023  004137          ADB  M6
4388  07024  074512          SBM  FILL2
4389  07025  004134          ADB  M3
4390  07026  067024          JMP  *-2
4391  07027  073250  FILL    RZA  FILL1      COMMA FIELD?
4392  07030  063014          JSM  FILL1      YES, FIRST OUTPUT ";" SPACING
4393  07031  025400          LDB  BADDR
4394  07032  007520          ADB  MSLPT      GET OUTPUT COUNT
4395  07033  075150          SZB  PRCHR      SKIP IF EXACT
4396  07034  004146          ADB  M15
4397  07035  075713          SBP  *-2
4398  07036  074076  FILL2   TCB
4399  07037  067474          JMP  MOUNT-1    OUTPUT BLANKS
4400*
4401*
4402*     TAB EXECUTION
4403*
4404*
4405  07040  045472  ETAB    ISZ  TEMPS
4406  07041  062773          JSM  PFORM
4407  07042  061220          JSM  FETCH+1
4408  07043  160226          JSM  FLTFA,I    TRUNCATE TO INTEGER
4409  07044  064357          JMP  RETN2      OVERFLOW
4410  07045  075752          SBM  *-1        NEGATIVE NUMBER?
4411  07046  074076          TCB
4412  07047  005400          ADB  BADDR      COMPUTE # OF BLANKS NEEDED
4413  07050  007520          ADB  MSLPT
4414  07051  063036          JSM  FILL2
4415  07052  025400  OVCK    LDB  BADDR
4416  07053  015623          CPB  PEND       OVERFLOW?
4417  07054  067056          JMP  ET1        YES
4418  07055  064357          JMP  RETN2
4419  07056  160170  ET1     JSM  CLERA,I
4420  07057  063007          JSM  PRCHK      PRINT?
```

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```
4421   07060  061344          JSM   CRLF1   YES
4422   07061  024062          LDB   FLGBT   SET (B) NEGATIVE FOR OVERFLOW
4423   07062  035622          STB   TERM    SET CRLF SUPRESSED FLAG
4424   07063  064357          JMP   RETN2
4425*
4426   07064  160206  TABER   JSM   ERRA,I  ERROR IF CALLED FROM WRITE STMT
4427*
4428*
4429   07065  035703  GNUM1   STB   PLACE
4430   07066  031705          STA   FLOAT
4431   07067  024215  GNUM    LDB   TMPOP
4432   07070  060406          JSM   XFAR1+1 SAVE RESULT
4433   07071  066353          JMP   NMOUT   PUT NUMBER IN BUFFER
```

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```
4435*
4436*    WRITE STATEMENT EXECUTION
4437*
4438   07072  023447  EWRIT   LDA  FMTOP
4439   07073  063366          JSM  SFMT    SET UP DEVICE AND FORMAT CODES
4440   07074  066750          JMP  EWRI1   NO FORMAT SPECIFIED
4441   07075  063227          JSM  CKEOL   NULL LIST?
4442   07076  000000          BSS  1       ***CHECKSUM***IMPOSSIBLE STATE
4443   07077  035472          STB  TEMPS   YES, SET TEMPS=PRADD
4444   07100  063303  WRIT2   JSM  TYPEC   GET NEXT FORMAT SPEC
4445   07101  067113          JMP  WRITN   END OF FORMAT
4446   07102  067122          JMP  WRITQ   QUOTE FIELD
4447   07103  074742          SBR  16      SET FLAG FOR FIXED
4448   07104  060563          JSM  SLWST   STACK FLAG: 0=F, +=E, -=B
4449   07105  067125          JMP  WRITF   (CODE 5 IS NOT USED)
4450   07106  077713          SBP  *-2,S   SET B FLAG
4451   07107  067117          JMP  WRITX   X;
4452*    END OF FORMAT STATEMENT
4453   07110  063356          JSM  FSPR    /:UPDATA FORMAT POINTER
4454   07111  061344  WRITS   JSM  CRLF1   /
4455   07112  067100          JMP  WRIT2
4456   07113  075713  WRITN   SBP  WRITS   ANY NUMERIC SPECS FOUND?
4457   07114  074742          SBR  16
4458   07115  035455          STB  FORMT   CLEAR FORMAT NESTING FLAG
4459   07116  066750          JMP  EWRI1   NO, GO TO STANDARD FORMAT
4460*    X FIELD
4461   07117  063356  WRITX   JSM  FSPR    UPDATE FORMAT POINTER
4462   07120  020012          LDA  .1
4463   07121  027124          LDB  BLNKA
4464*    QUOTE FIELD
4465   07122  061337  WRITQ   JSM  NDWRT   OUTPUT TO PRINTER
4466   07123  067100          JMP  WRIT2
4467   07124  000103  BLNKA   DEF  .32+.32+1
4468*
4469*    OUTPUT F,E, OR B FIELD
4470   07125  025466  WRITF   LDB  LOCL1
4471   07126  060563          JSM  SLWST   STACK FORMAT STMT POINTER
4472   07127  063227  WRIT4   JSM  CKEOL   END OF WRITE STMT?
4473   07130  074742          SBR  16      YES, CRLF NOT SUPRESSED
4474   07131  067222          JMP  WRIT8-2 YES
4475   07132  063240          JSM  QICHK   QUOTE NEXT IN WRITE?
4476   07133  067136          JMP  WRIT5   NO
4477   07134  061337          JSM  NDWRT   YES, PRINT IT
4478   07135  067127          JMP  WRIT4
4479   07136  062773  WRIT5   JSM  PFORM   SAVE FLAGS AND
4480   07137  061220          JSM  FETCH+1 EVALUATE FORMULA
4481   07140  060567          JSM  UNSTK   RECALL FORMAT STMT POINTER
4482   07141  031466          STA  LOCL1
4483   07142  060567          JSM  UNSTK   RECALL E,F, OR B FLAG
4484   07143  031705          STA  FLOAT
4485   07144  070252          SAM  WRITB   SKIP IF B
4486   07145  045466          ISZ  LOCL1
4487   07146  121466          LDA  LOCL1,I GET FIELD WIDTH SPEC
4488   07147  045466          ISZ  LOCL1
4489   07150  045466          ISZ  LOCL1
4490   07151  025456  WRITB   LDB  FORMS
```

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```
4491  07152  074073            SBP  *+1,C
4492  07153  035456            STB  FORMS   SET NUMERIC SPEC FOUND FLAG
4493  07154  125466            LDB  LOCL1,I GET DECIMAL SPEC
4494  07155  063356            JSM  FSPR    UPDATE FORMAT POINTERS
4495  07156  031704            STA  WIDTH
4496  07157  070353            SAP  WRIT7   SKIP IF E OR F
4497*   OUTPUT B FIELD CHARACTER
4498  07160  160225            JSM  FLTRA,I CONVERT TO ROUNDED INTEGER
4499  07161  074742            SBR  16      OVERFLOW: USE 0
4500  07162  074117            LDA  B
4501  07163  050105            AND  B377    MASK TO 8 BITS
4502  07164  061353            JSM  TTY     OUTPUT SINGLE CHAR
4503  07165  067216            JMP  WRIT6
4504*   OUTPUT E OR F NUMBER
4505  07166  035703  WRIT7     STB  PLACE
4506  07167  021412            LDA  LSTPT   START TEMP BUFFER
4507  07170  070070            SIA  *+1
4508  07171  070744            SAL  1
4509  07172  031400            STA  BADDR     ABOVE LOW STACK
4510  07173  031706            STA  SBPTR
4511  07174  021413            LDA  HSTPT
4512  07175  070744            SAL  1
4513  07176  031623            STA  PEND    SET END OF BUFFER AT H-STACK
4514  07177  021416            LDA  MODE
4515  07200  031641            STA  ST+1
4516  07201  070742            SAR  16
4517  07202  031416            STA  MODE    SET FOR PROGRAM FORMAT
4518  07203  063067            JSM  GNUM    OUTPUT NUMBER TO BUFFER
4519  07204  021641            LDA  ST+1
4520  07205  031416            STA  MODE
4521  07206  021400            LDA  BADDR
4522  07207  011623            CPA  PEND    OVERFLOW?
4523  07210  064561            JMP  MER8
4524  07211  025706            LDB  SBPTR
4525  07212  060374            JSM  WBUFF   COMPUTER CHAR COUNT
4526  07213  061337            JSM  NDWRT   PRINT THE BUFFER
4527  07214  025625            LDB  FIRST
4528  07215  035400            STB  BADDR   RESET BADDR
4529  07216  063227  WRIT6     JSM  CKEOL   END OF STMT?
4530  07217  074742            SBR  16      YES, CRLF NOT SUPRESSED
4531  07220  067224            JMP  WRIT8   YES
4532  07221  067100            JMP  WRIT2   NO
4533*   END OF WRITE STMT
4534  07222  055412            DSZ  LSTPT
4535  07223  055412            DSZ  LSTPT   UNSTACK FLAGS
4536  07224  070742  WRIT8     SAR  16
4537  07225  031455            STA  FORMT   SET FORMAT COMPLETE FLAG
4538  07226  066767            JMP  PR2+1
```

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```
4540*
4541*   CHECK FOR END OF OUTPUT LIST
4542*     P+1: TEMPS=PRADD
4543*     P+2: NULL OPERAND AND TEMPS+1=PRADD
4544*     P+3: ALL OTHER
4545*
4546   07227  025472  CKEOL   LDB  TEMPS
4547   07230  015421          CPB  PRADD   END OF STMT?
4548   07231  170402          RET
4549   07232  060771          JSM  GTOPP
4550   07233  072210          RZA  CKEO1   NULL OPERAND?
4551   07234  074070          SIB  *+1     YES
4552   07235  015421          CPB  PRADD   TEMPS+1=PRADD?
4553   07236  064357          JMP  RETN2    YES
4554   07237  064356  CKEO1   JMP  RETN3   NO
4555*
4556*   CHECK TO SEE IF NEXT OPERATOR IS A QUOTE FIELD
4557*     P+1: QUOTE NOT NEXT
4558*     P+2: QUOTE NEXT; (A)=LENGTH; (B)=POINTER; TEMPS UPDATED
4559*
4560   07240  121472  QTCHK   LDA  TEMPS,I
4561   07241  050065          AND  OPMSK   CURRENT OPERATOR
4562   07242  010116          CPA  QTOP      A QUOTE?
4563   07243  067261          JMP  QTCH1   YES
4564   07244  060771          JSM  GTOPP
4565   07245  072410          RZA  QTCH3   NULL OPERAND?
4566   07246  045472          ISZ  TEMPS   YES, GET NEXT OPERATOR
4567   07247  121472          LDA  TEMPS,I
4568   07250  050065          AND  OPMSK
4569   07251  010116          CPA  QTOP    QUOTE?
4570   07252  067261          JMP  QTCH1   YES
4571   07253  055472          DSZ  TEMPS   NO, RESTORE TEMPS
4572   07254  170402          RET          RETURN P+1
4573   07255  050040  QTCH3   AND  B37
4574   07256  010076          CPA  B36     STRING VARIABLE?
4575   07257  067276          JMP  QTCH2   YES
4576   07260  170402          RET          NO, RET P+1
4577   07261  121472  QTCH1   LDA  TEMPS,I
4578   07262  050104          AND  B177    GET CHAR COUNT
4579   07263  031471          STA  L2T2    SAVE
4580   07264  045472          ISZ  TEMPS
4581   07265  025472          LDB  TEMPS
4582   07266  074744          SBL  1       GET STARTING CHARADDRESS
4583   07267  035742          STB  TMP2    SAVE
4584   07270  070037          ADB  A
4585   07271  074070          SIB  *+1
4586   07272  074002          SBR  1
4587   07273  035472          STB  TEMPS   POINT TEMPS PAST END OF STRING
4588   07274  025742          LDB  TMP2
4589   07275  064357          JMP  RETN2
4590   07276  020121  QTCH2   LDA  SBLOC
4591   07277  060613          JSM  FPAGE   FIND STRING BLOCK PAGE
4592   07300  074117          LDA  B
4593   07301  050065          AND  OPMSK   GET STARTING ADDRESS OF PAGE
4594   07302  070737          JMP  A,I     JUMP TO STRING PAGE
4595   00121          SBLOC   EQU  B4000   OP CODE 2
```

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```
4597*
4598*   SUBROUTINE TO GET NEXT FORMAT SPEC
4599*
4600   07303  021454  TYPEC   LDA  RCOUT
4601   07304  072450          RZA  FSP1
4602   07305  025455          LDB  FORMT
4603   07306  015457          CPB  FORME
4604   07307  067353          JMP  FSPN
4605*   SET UP NEW REPEAT COUNT
4606   07310  121455          LDA  FORMT,I
4607   07311  045455          ISZ  FORMT
4608   07312  070253          SAP  FSP2
4609   07313  121455          LDA  FORMT,I
4610   07314  045455          ISZ  FORMT
4611   07315  000132  FSP1    ADA  M1
4612   07316  031454          STA  RCOUT
4613*   GET FORMAT SPEC; (FORMT) POINTS TO TYPE WORD
4614   07317  121455  FSP2    LDA  FORMT,I
4615   07320  050065          AND  OPMSK   READ TYPE
4616   07321  025777          LDB  RSPTR
4617   07322  004132          ADB  M1
4618   07323  035401          STB  RSAVE   SAVE ADDRESS OF RETURN
4619   07324  025455          LDB  FORMT
4620   07325  035466          STB  LOCL1
4621   07326  010116          CPA  QTOP    QUOTE FIELD?
4622   07327  067340          JMP  FSPQ    YES
4623   07330  121455          LDA  FORMT,I
4624   07331  070202          SAR  5
4625   07332  050040          AND  B37
4626   07333  070137          LDB  A
4627   07334  105401          ADB  RSAVE,I
4628   07335  004132          ADB  M1
4629   07336  135401  BASE    STB  RSAVE,I
4630   07337  170402          RET          RETURN TO P+(OP CODE)
4631   07340  121466  FSPQ    LDA  LOCL1,I
4632   07341  050104          AND  B177    GET CHAR COUNT
4633   07342  031467          STA  LOCL2   SAVE
4634   07343  074070          SIB  *+1
4635   07344  074744          SBL  1       COMPUTE STARTING CHARACTER
                                                              ADDRESS
4636   07345  074017          ADA  B
4637   07346  000132          ADA  M1
4638   07347  070002          SAR  1
4639   07350  031466          STA  LOCL1   COMPUTE AND SAVE ENDING WORD
                                                              ADDRESS
4640   07351  145401          ISZ  RSAVE,I SET TO RETURN TO P+2
4641   07352  067357          JMP  FSPR+1
4642*   END OF FORMAT STMT
4643   07353  025456  FSPN    LDB  FORMS   RESET TO START OF SMT
4644   07354  035455          STB  FORMT
4645   07355  170402          RET
4646*
4647*
4648*
4649   07356  031467  FSPR    STA  LOCL2   SAVE (A)
4650   07357  021454          LDA  RCOUT
4651   07360  072210          RZA  FSPR1   END OF REPEAT COUNT?
4652   07361  021466          LDA  LOCL1   YES, UPDATE
```

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```
4653  07362  070070          SIA  *+1
4654  07363  031455          STA  FORMT    FORMAT POINTER
4655  07364  021467  FSPR1   LDA  LOCL2   RESTORE (A)
4656  07365  170402          RET
```

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```
4658*
4659*   SET UP FORMAT STMT POINTERS FOR WRITE OR ENTER
4660*
4661  07366  031640  SFMT    STA  ST       SAVE FORMAT OP CODE
4662  07367  045472          ISZ  TEMPS
4563  07370  061217          JSM  FETCH    EVALUATE SELECT CODE
4664  07371  160225          JSM  FLTRA,I  CONVERT TO INTEGER
4665  07372  160206  SCERR   JSM  ERRA,I   OVERFLOW
4666  07373  074117          LDA  B
4667  07374  075710          SZB  *-2
4668  07375  074142          SBR  4
4669  07376  077610          RZB  *-4      CHECK FOR 1<SC<15
4670  07377  031453          STA  PRFLG    SAVE SELECT CODE
4671  07400  070204          SAL  12
4672  07401  031447          STA  SLCOD
4673  07402  035454  PLOTE   STB  RCOUT    SET REPEAT COUNT TO 0
4674  07403  125472          LDB  TEMPS,I
4675  07404  045472          ISZ  TEMPS
4676  07405  074152          SBM  *+3      FORMAT SPECIFIED
4677  07406  045472          ISZ  TEMPS
4678  07407  170402          RET           NO, RETURN P+1
4679  07410  121472          LDA  TEMPS,I  YES
4680  07411  070673          SAP  SFMT2,C
4681  07412  025455  SFMT1   LOB  FORMT    ERROR IF STATEMENTS USING
4682  07413  074110          SZB  *+2      FORMATS NESTED?
4683  07414  160206  FNEST   JSM  ERRA,I   YES
4684  07415  070137          LDB  A
4685  07416  000017          ADA  .2
4686  07417  031455          STA  FORMT    SET CURRENT FMT SPEC POINTER
4687  07420  072053          SAP  *+1,S    SET FLAG ---NO NUMERIC SPEC YET
4688  07421  031456          STA  FORMS
4689  07422  061007          JSM  NEXTA
4690  07423  035457          STB  FORME    SET POINTER TO END OF FMT STMT
4691  07424  045472          ISZ  TEMPS
4692  07425  064357          JMP  RETN2
4693*   FIND AND VERIFY FORMAT STMT
4694  07426  061075  SFMT2   JSM  FNDPS    FIND STATEMENT
4695  07427  067430          JMP  *+
4696  07430  164343  NOFMT   JMP  E45--1,I  NOT FOUND
4697  07431  076053          SBP  *+1,S    SET FLAG
4698  07432  135472          STB  TEMPS,I  STORE ADDRESS IN PLACE OF STMT #
4699  07433  021476          LDA  TEMP3
4700  07434  070070          SIA  *+1
4701  07435  070537          LDA  A,I      GET OP CODE
4702  07436  070070          SIA  *+1
4703  07437  070517          LDA  A,I      GET PAGE
4704  07440  050065          AND  OPMSK
4705  07441  074442          SBR  10
4706  07442  070037          ADB  A        COMBINE
4707  07443  021476          LDA  TEMP3    RECALL STMT ADDRESS
4708  07444  015640          CPB  ST       IS THIS A FORMAT STMT?
4709  07445  067412          JMP  SFMT1    YES
4710  07446  067430          JMP  NOFMT    NO, ERROR
4711*
4712  07447  012025  FMTOP   OCT  12025
```

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```
4714*     THIS ROUTINE TAKES A RECORD FROM
4715*     THE REFRESH BUFFER AND OUTPUTS IT
4716*     ON THE PRINTER.
4717*
4718*
4719  07450  021625  OLINE   LDA  FIRST
4720  07451  070076          TCA
4721  07452  001400          ADA  BADDR   GET CHAR COUNT
4722  07453  073410          SZA  OLI     BUFFER EMPTY?
4723  07454  063007          JSM  PRCHK   PRINT?
4724  07455  067457          JMP  *+2     YES
4725  07456  067464          JMP  OL2     NO
4726  07457  025625          LDB  FIRST   YES
4727  07460  061337          JSM  NDWRT
4728  07461  021400  OL3     LDA  BADDR
4729  07462  031625          STA  FIRST
4730  07463  170402  OL1     RET
4731  07464  024030  OL2     LDB  .12
4732  07465  035705          STB  FLOAT   SAVE COUNT
4733  07466  163516  EW2     JSM  REFRA,I
4734  07467  025443          LDB  KEYFG   HAS A KEY BEEN ENTERED?
4735  07470  075453          SBP  OL3
4736  07471  055705          DSZ  FLOAT
4737  07472  067466          JMP  EW2
4738  07473  067461          JMP  OL3
4739*
4740*     THIS ROUTINE OUTPUTS THE CODE.
4741*     IN A B TIMES
4742*
4743*
4744  07474  020041          LDA  .32
4745  07475  074412  MOUT    SBM  MO1     COUNT NEGATIVE
4746  07476  074350          SZB  MO1     OR ZERO?
4747  07477  035740          STB  TMP     NO, SAVE COUNT
4748  07500  031752          STA  TMP6A
4749  07501  021752          LDA  TMP6A
4750  07502  061016  MO2     JSM  ONEXT
4751  07503  055740          DSZ  TMP
4752  07504  067501          JMP  MO2-1
4753  07505  170402  MO1     RET          YES
```

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```
4755*
4556*   WAIT EXECUTION
4757*
4758   07506  061217  EWAIT   JSM  FETCH    GET COUNT
4759   07507  160226          JSM  FLTFA,I  CONVERT TO INTEGER
4760   07510  164172  EW1     JMP  XEC4A,I  OVERFLOW
4761   07511  075752          SBM  EW1
4762   07512  074142          SBR  4        DIVIDE BY 16
4763   07513  075650          SZB  EW1
4764   07514  063465          JSM  EW2—1    REFRESH DISPLAY
4765   07515  164172          JMP  XEC4A,I

4767   07516  002562  REFRA   DEF  REFRS
4768   07517  002512  CRCIA   DEF  CRC1
4769   072520 174456  MSLPT   ABS  —RBUFF—RBUFF
4770   07521  003433  LN72    DEF  RBUFF+RBUFF+73
4771   07522  000116  N       OCT  116
4772   07523  177670  M72     DEC  —72
```

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```
4774*
4775*   STATEMENT SYNTAX JUMP TABLE
4776*
4777    07524  174556          ABS  RITE-*
4778    07525  171422          ABS  ENDS-*    GRAD
4779    07526  171421          ABS  ENDS-*    DEG
4780    07527  171420          ABS  ENDS-*    RAD
4781    07530  174541          ABS  LETS-*
4782    07531  173760          ABS  FMTS-*
4783    07532  174554          ABS  PRINS-*   DISP
4784    07533  006725          ABS  READS-*   INPUT
4785    07534  006732          ABS  RSTRS-*
4786    07535  174551          ABS  PRINS-*
4787    07536  006722          ABS  READS-*
4788    07537  173743          ABS  DATAS-*
4789    07540  002741          ABS  WAITS-*
4790    07541  174070          ABS  STOPS-*
4791    07542  171405          ABS  ENDS-*
4792    07543  002761          ABS  RETNS-*
4793    07544  174011          ABS  GOTOS-*   GOSUB
4794    07545  000147          ABS  NEXTS-*
4795    07546  002714          ABS  FORS-*
4796    07547  000151          ABS  IFS-*
4797    07550  174005          ABS  GOTOS-*
4798    07551  006721          ABS  REMS-*
4799    07552  002731          ABS  DEFS-*
4800    07553  006660          ABS  COMS-*
4801    07554  006702          ABS  DIMS-*    DIM
4802    07555  174446          ABS  ILETS-*
4803*
4804*   STATEMENT NAME TABLE
4805*
4806    07556  000241  SYN13   OCT  00241     IMPLIED LET OP CODE 100001
4807    07557  046105          ASC  1,LE
4808    07560  052266          OCT  52266     LET; OP CODE 110110
4809    07561  042111          ASC  1,DI
4810    07562  046602          OCT  046602    DIM;000010
4811    07563  041517          ASC  1,CO
4812    07564  046603          OCT  046603    COM;000011
4813    07565  042105          ASC  1,DE
4814    07566  043204          OCT  043204    DEF;000100
4815    07567  051105          ASC  1,RE
4816    07570  046645          OCT  046645    REM;100101
4817    07571  043517          ASC  2,GOTO
        07572  052117
4818    07573  123111          OCT  123111    GOTO;100110
4819    07574  043247          OCT  043247    IF;100111
4820    07575  047105          ASC  2,NEXT
        07576  054124
4821    07577  104507          OCT  104507    NEXT;001001
4822    07600  047523          ASC  2,OSUB
        07601  052502
4823    07602  105122          OCT  105122    GOSUB;001010
4824    07603  042524          ASC  2,ETUR
        07604  052522
4825    07605  047213          OCT  047213    RETURN;001011
```

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```
4826  Ø76Ø6  Ø42516        ASC  1,EN
4827  Ø76Ø7  Ø42254        OCT  Ø42254     END;1Ø11ØØ
4828  Ø7610  Ø51524        ASC  2,STOP
      Ø7611  Ø4752Ø
4829  Ø7612  126527        OCT  126527     STOP;1Ø11Ø1
4830  Ø7613  Ø4Ø511        ASC  1,AI
4831  Ø7614  Ø52216        OCT  Ø52216     WAIT;ØØ1111Ø
4832  Ø7615  Ø4211Ø        ASC  2,DATA
      Ø7616  Ø5211Ø
4833  Ø7617  1Ø7522        OCT  1Ø7522     DATA;ØØ1111
4834  Ø762Ø  Ø425Ø1        ASC  1,EA
4835  Ø7621  Ø4222Ø        OCT  Ø4222Ø     READ; Ø1ØØØØ
4836  Ø7622  Ø5Ø122        ASC  2,PRIN
      Ø7623  Ø4516
4837  Ø7624  Ø52261        OCT  Ø52261     PRINT;11ØØØ1
4838  Ø7625  Ø42111        ASC  2,DISP
      Ø7626  Ø5152Ø
4839  Ø7627  132111        OCT  132111     DISP; 11Ø1ØØ
4840  Ø763Ø  Ø4712Ø        ASC  2,NPUT
      Ø7631  Ø2524
4841  Ø7632  111Ø6        OCT  111Ø6      INPUT; Ø1ØØ11
4842  Ø7633  Ø4752Ø        ASC  2,ORMA
      Ø7634  Ø4651Ø
4843  Ø7635  Ø52225        OCT  52225      FORMAT; Ø1Ø1Ø1
4844  Ø7636  Ø43117        ASC  1,FO
4845  Ø7637  Ø5121Ø        OCT  5121Ø      FOR; ØØ1ØØØ
4846  Ø764Ø  Ø511Ø5        ASC  3,RESTOR
      Ø7641  Ø5152Ø
      Ø7642  Ø4752Ø
4847  Ø7643  Ø4266Ø        OCT  42662      RESTORE; 11ØØ1Ø
4848  Ø7644  Ø511Ø1        ASC  1,RA
4849  Ø7645  Ø42267        OCT  42267      RAD; 11Ø111
4850  Ø7646  Ø42Ø5        ASC  1,DE
4851  Ø7647  Ø4367Ø        OCT  4367Ø      DEG; 111ØØØ
4852  Ø765Ø  Ø4352Ø        ASC  2,GRAD
      Ø7651  Ø4Ø5Ø4
4853  Ø7652  134527        OCT  134527     GRAD; 111ØØ1
4854  Ø7653  Ø51111        ASC  2,RITE
      Ø7654  Ø5215
4855  Ø7655  175ØØØ        OCT  175ØØØ     WRITE; 111Ø1Ø
```

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```
4857*    FETCH A STRING CONSTANT
4858*
4859*      START STRING IN NEXT WORK OF SYNTAX BUFFER, THEN RECORD
4860*        OPENING QUOTE AND THE STRING LENGTH. EXIT WITH NEXT CHAR IN (A)
4861*      EXIT TO ERROR IF NO OPENING QUOTE
4862*      EXIT TO ERROR IF NO CLOSING QUOTE
4863*      ENTER AT GETST+3, IF OPENING QUOTE ALREADY FOUND
4864*
4865   07656  010043  GETST   CPA  B42       OPENING QUOTE?
4866   07657  067661          JMP  *+2       YES
4867   07660  160206  NOST    JSM  ERRA,I    NO
4868   07661  025706          LDB  SBPTR     SAVE INITIAL SYNTAX
4869   07662  035470          STB  L2T1        BUFFER POINTER
4870   07663  074742          SBR  16        SET TO START STORING IN LEFT HALF
4871   07664  063672          JSM  CHRST     GET STRING
4872   07665  160206  SYE14   JSM  ERRA,I      NO CLOSING QUOTE
4873   07666  020116          LDA  QTOP      STORE OPENING QUOTE
4874   07667  001474          ADA  TEMP1       AND THE
4875   07670  131470          STA  L2T1,I        STRING LENGTH
4876   07671  065055          JMP  GNEXT     GET NEXT CHAR AND RETURN
4877*
4878*    PROCESS A CHARACTER STRING
4879*
4880*      (A)=STRING TERMINATOR
4881*      (B)=CHARACTER POINTER; 1=START IN RIGHT HALF OF CURRENT WORD
4882*          0=START IN LEFT OF NEXT WORD
4883*      EXIT:P+1 ON END OF LINE
4884*           P+2 ON TERMINATOR CHAR FOUND
4885*           (A)=NEXT CHARACTER
4886*           TEMP1=CHAR COUNT BIASED BY (B) ON ENTRY
4887*           SBPTR=NEXT WORD NOT IN STRING
4888*
4889   07672  031475  CHRST   STA  TEMP2     RECORD TERMINATOR CHARACTER
4890   07673  035474  CHRS1   STB  TEMP1     SAVE CHARACTER FLAG AND
                                                          COUNTER
4891   07674  061040          JSM  GETCH-1   GET CHARACTER
4892   07675  010031          CPA  EOL
4893   07676  067713          JMP  CHRS3+1   EOL
4894   07677  011475          CPA  TEMP2     TERMINATOR?
4895   07700  067712          JMP  CHRS3     YES
4896   07701  025474          LDB  TEMP1
4897   07702  074251          SLB  CHRS2     SELECT WORD HALF
4898   07703  141706          IOR  SBPTR,I   RIGHT HALF, MERGE
4899   07704  131706          STA  SBPTR,I     WITH PREVIOUS CHAR
4900   07705  077330          RIB  CHRS1     ADVANCE COUNT
4901   07706  067673          JMP  CHRS1     JUMP ON 0 COUNT
4902   07707  045706  CHRS2   ISZ  SBPTR     LEFT HALF, ADVANCE POINTER
4903   07710  070404          SAL  8         POSITION CHAR
4904   07711  067704          JMP  *-5
4905   07712  060365  CHRS3   JSM  RET2      SET TO RETURN TO P+2
4906   07713  064456          JMP  SBPUD     ADVANCE POINTER
4907*
4908*    NEXT STATEMENT SYNTAX
4909*
4910   07714  160246  NEXTS   JSM  VAROA,I   FETCH SIMPLE VARIABLE
4911   07715  164322          JMP  E25+2,I
4912   07716  164322          JMP  E25+2,I   NOT FOUND
```

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```
4913   Ø7717  Ø65151            JMP  EOST
4914*
4915*   IF STATEMENT SYNTAX
4916*
4917   Ø772Ø  16Ø2Ø2  IFS       JSM  FSCA,I   GET DECISION FORMULA
4918   Ø7721  Ø27726             LDB  THENA    DEMAND "THEN"
4919   Ø7722  Ø6Ø546             JSM  STEXP      AND STORE AS EXPANDED OPERATOR
4920   Ø7723  16Ø2Ø6  SYNE7     JSM  ERRA,I   NOT FOUND
4921   Ø7724  Ø6Ø664             JSM  LNUM     DEMAND A SEQUENCE NUMBER
4922   Ø7725  Ø65151             JMP  EOST
4923   Ø7726  ØØ675Ø  THENA     DEF  FOP13+FOP13
4924*
4925*   INITIALIZE THE TRIG UNITS
4926*
4927   Ø7727  Ø24Ø12  ERAD      LDB  .1
4928   Ø773Ø  Ø35434             STB  UNITS
4929   Ø7731  164172             JMP  XEC4A,I
4930   Ø7732  Ø74742  EDEG      SBR  16
4931   Ø7733  Ø6773Ø             JMP  ERAD+1
4932   Ø7734  Ø24Ø17  EGRAD     LDB  .2
4933   Ø7735  Ø6773Ø             JMP  ERAD+1
4934*
4935*   FLOAT AND FIXED SYSTEM COMMAND EXECUTION
4936*   (A)=Ø
4937*
4938   Ø7736  Ø72Ø51  FLT       SLA  *+1,S    SET TO NON ZERO FOR FLOAT
4939   Ø7737  Ø31451  FIXED     STA  CTYPE    SET TO ZERO FOR FIXED
4940   Ø774Ø  Ø61Ø66             JSM  GETSK    PARAMETER GIVEN?
4941   Ø7741  164174             JMP  RDYDA,I NO
4942   Ø7742  Ø6Ø75Ø             JSM  DIGCK    DIGIT?
4943   Ø7743  Ø6774Ø             JMP  FIXED+1 NO, IGNORE IT
4944   Ø7744  Ø554ØØ             DSZ  BADDR    YES, RESET POINTER
4945   Ø7745  Ø24143             LDB  M12
4946   Ø7746  Ø61131             JSM  PGINØ    GET DIGIT FIELD, ALLOW Ø
4947   Ø7747  Ø35452             STB  CPLAC
4948   Ø775Ø  164174             JMP  RDYDA,I
4949*
4950*   TRACE SYSTEM COMMAND EXECUTION
4951*
4952   Ø7751  Ø24Ø62  TRAC2     LDB  FLGBT
4953   Ø7752  Ø35441             STB  TFLG1+1 SET — (MAXIMUM UPPER LIMIT)
4954   Ø7753  Ø7633Ø             RIB  TRAC3    SET MAXIMUM (UPPER—LOWER LIMIT)
4955   Ø7754  Ø7165Ø  TRACE     SZA  TRAC2    ANY PARAMETERS?
4956   Ø7755  Ø6Ø73Ø             JSM  GETAD    FIND ADDRESSES
4957   Ø7756  Ø74Ø76             TCB
4958*   NORMAL:  (B)=Ø; CLEAR TRACE FLAG
4959   Ø7757  Ø35441  NORML     STB  TFLG1+1 STORE — (UPPER LIMIT)
4960   Ø776Ø  ØØ5477             ADB  TEMP4
4961   Ø7761  Ø74Ø76  TRAC3     TCB
4962   Ø7762  Ø3544Ø             STB  TFLG1    STORE (UPPER LIMIT—LOWER LIMIT)
4963   Ø7763  164174             JMP  RDYDA,I
4964*
4965*
4966*   EXECUTE READ
4967*
4968   Ø7764  16Ø2Ø1  EREAD     JSM  FORMA,I GET VARIABLE ADDRESS IN HSTPT
```

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```
4969   Ø7765   16Ø256          JSM   FDAAA,I FIND DATA AND SAVE IN AR2
497Ø   Ø7766   Ø6Ø412          JSM   RSULT   STORE DATA
4971   Ø7767   Ø21421         LDA   PRADD
4972   Ø777Ø   Ø11472         CPA   TEMPS   MORE VARIABLES TO COME?
4973   Ø7771   164172          JMP   XEC4A,I NO: RETURN
4974   Ø7772   Ø67764          JMP   EREAD   YES: LOOP
```

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```
4976*
4977   10000                    ORG  10000B
4978*
4979*  INITIALIZATION
4980*
4981   10000  020112  XEC       LDA  RSTKA
4982   10001  031777            STA  RSPTR     GUARANTEE EMPTY STACK
4983   10002  060653            JSM  INITS+2   RESET STACK POINTERS
4984   10003  062162            JSM  ESTAC     START NEW STACKS
4985   10004  031416            STA  MODE      SET TO PROG (0)
4986   10005  021725  XEC3      LDA  NXTST     GET STARTING STATEMENT NUMBER
4987   10006  061075            JSM  FNDPS     FIND STARTING ADDRESS
4988   10007  066066            JMP  EEND+1     BEYOND END OF PROG
4989   10010  066011            JMP  *+1       BETWEEN LINES
4990   10011  035421  ERTN1     STB  PRADD
4991*  PROCEED TO XEC4
4992*
4993*  EXECUTE NEXT PROGRAM STATEMENT
4994*
4995   10012  024062  XEC4      LDB  FLGBT
4996   10013  021443            LDA  KEYFG
4997   10014  050104            AND  B177      MASK OFF SHIFT BIT
4998   10015  035443            STB  KEYFG      RESET KEY FLAG
4999   10016  000145            ADA  M14
5000   10017  072210            RZA  *+4       TRACE KEY?
5001   10020  020066            LDA  INF       YES, SET ALL TRACE
5002   10021  031440            STA  TFLG1
5003   10022  066025            JMP  XEC7
5004   10023  074742            SBR  16
5005   10024  010033            CPA  B20       NORMAL KEY?
5006   10025  035441  XEC7      STB  TFLG1+1   YES, CLEAR TRACE
5007   10026  025416            LDB  MODE
5008   10027  074110            SZB  *+2       KEYBOARD EXECUTION?
5009   10030  066070            JMP  CALEX     YES, EXIT
5010   10031  025442            LDB  STPFL
5011   10032  076150            RZB  XEC5      SKIP IF STOP; STEP; OR ERROR
5012   10033  025421            LDB  PRADD
5013   10034  015436            CPB  HFLG1
5014   10035  066151  XEC5      JMP  STOPE
5015   10036  015437            CPB  HFLG1+1
5016   10037  066151            JMP  STOPE     HALT IF ADDRESS=FLAG
5017   10040  015423  XEC6      CPB  PBPTR     PAST END OF PROGRAM?
5018   10041  160206  MER11     JSM  ERRA,I    YES, IMPROPER TERMINATION
5019   10042  005441            ADB  TFLG1+1   ADD —(UPPER LIMIT)
5020   10043  074313            SBP  XEC8      SKIP IF NOT IN TRACE LIMITS
5021   10044  005440            ADB  TFLG1     ADD (UPPER LIMIT —(LOWER LIMIT))
5022   10045  074212            SBM  XEC8
5023   10046  062136            JSM  PLINE     OUTPUT LINE ≠ TO BUFFER
5024   10047  061337            JSM  NDWRT     PRINT ON PRINTER
5025   10050  061344            JSM  CRLF1
5026   10051  060572  XEC8      JSM  NEXTL-2   FIND OP-CODE AND PAGE
5027   10052  004135  XEC9      ADB  M4        GET JUMP TABLE STARTING ADDRESS
5028   10053  005466            ADB  LOCL1     ADD IN —(OP CODE)
5029   10054  074437            ADB  B,I       ADD RELATIVE JUMP ADDRESS
5030   10055  074737            JMP  B,I       JUMP TO STATEMENT EXECUTION
5031*
```

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```
5032*    EXECUTE LET OR IMPLIED LET STATEMENT
5033*
5034   10056  026063  ELET    LDB  DISPA    GET JUMP ADDRESS FOR DISP EXEC
5035   10057  021416          LDA  MODE     GET CALC/PROG FLAG
5036   10060  073610          RZA  ELET-2   SKIP IF CALC MODE
5037   10061  062563          JSM  FORMX    PROG— EVALUATE FORMULA
5038   10062  066012          JMP  XEC4
5039   10063  013747  DISPA   DEF  DISP
5040*
5041*********************************
5042*
5043   10064  000000          BSS  1        CHECKSUM WORD
5044*
5045*********************************
5046*
5047*
5048*    END EXECUTION
5049*
5050   10065  061225  EEND    JSM  LDEF
5051   10066  060653          JSM  INITS+2  RESET POINTERS AND STACKS
5052   10067  066106          JMP  ESTOP
5053*
5054*    EXIT FOR CALC MODE
5055*
5056   10070  021421  CALEX   LDA  PRADD
5057   10071  071652          SAM  EEND+1   SKIP IF DECOMPILED
5058   10072  000020          ADA  .3
5059   10073  031412          STA  LSTPT    RESET STACK POINTER
5060   10074  060567          JSM  UNSTK
5061   10075  060566          JSM  UNSTK-1  RESTORE PROGRAM POINTER
5062   10076  031411          STA  TSTPT    RESTORE T-STACK POINTER
5063   10077  060567          JSM  UNSTK
5064   10100  031410          STA  LSTAK    RESTORE
5065   10101  060567          JSM  UNSTK
5066   10102  031412          STA  LSTPT      L-STACK POINTERS
5067   10103  121413          LDA  HSTPT,I
5068   10104  045413          ISZ  HSTPT
5069   10105  071713          SAP  *-2
5070   10106          ESTOP   EQU  *
5071   10106  160264  CALX2   JSM  CRCKA,I  YES, PROVIDE CR—LF IF NEEDED
5072   10107  070742          SAR  16
5073   10110  031430          STA  LNINC    GET OUT OF AUTO
5074   10111  164173          JMP  PEXMA,I
5075*
5076*    INITIALIZATION FOR KEYBOARD EXECUTION
5077*
5078   10112  025412  ECAL    LDB  LSTPT
5079   10113  035472          STB  TEMPS    SAVE ORIGINAL STACK POINTER
5080   10114  020233          LDA  SBUFA
5081   10115  011706  ECAL1   CPA  SBPTR    TRANSFER SYNTAX
5082   10116  066122          JMP  ECAL2      BUFFER INTO
5083   10117  070537          LDB  A,I          STACK AREA
5084   10120  060563          JSM  SLWST
5085   10121  073630          RIA  ECAL1
5086   10122  025472  ECAL2   LDB  TEMPS
5087   10123  060563          JSM  SLWST    STACK OLD LSTPT
```

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```
5088   10124  021412          LDA  LSTPT    GET NEW END OF LINE POINTER
5089   10125  025410          LDB  LSTAK
5090   10126  060563          JSM  SLWST    STACK LSTPT
5091   10127  025411          LDB  TSTPT
5092   10130  060563          JSM  SLWST    STACK TSTPT
5093   10131  060562          JSM  SLWST-1  STACK OLD PRADD
5094   10132  031421          STA  PRADD    SET PRADD TO END OF BUFFER
5095   10133  062162          JSM  ESTAC    SET UP NEW STACKS
5096   10134  060602          JSM  NEXT1-4  GET PAGE AND OP CODE
5097   10135  066052          JMP  XEC9
5098*
5099*   PRINT CURRENT LINE NUMBER FOR TRACE AND STOP
5100*
5101   10136  160264  PLINE   JSM  CRCKA,I  GIVE CRLF IF PRINT
5102   10137  160170          JSM  CLERA,I  CLEAR BUFFER
5103   10140  025421          LDB  PRADD
5104   10141  015423          CPB  PBPTR    PAST END OF PROG?
5105   10142  066146          JMP  *+4      YES, DONT PRINT LINE #
5106   10143  125421          LDB  PRADD,I
5107   10144  074073          SBP  *+1,C
5108   10145  160210          JSM  OUTIA,I  OUTPUT CURRENT LINE #
5109   10146  020053          LDA  COLON
5110   10147  061016          JSM  ONEXT    OUTPUT A:
5111   10150  064373          JMP  ICNT     COMPUTE CHAR COUNT
5112*
5113*   STOP EXECUTION
5114*
5115   10151  074412  STOPE   SBM  STP1     SKIP IF ERROR MESSAGE
5116   10152  062136          JSM  PLINE    OUTPUT LINE # AND COMPUTE COUNT
5117   10153  031466          STA  LOCL1    SAVE COUNT
5118   10154  021450          LDA  PMODE
5119   10155  072210          RZA  STP1     PRINT IF PRINT-ALL
5120   10156  035701          STB  NDISP
5121   10157  061332          JSM  .NPWR+2
5122   10160  061344          JSM  CRLF1
5123   10161  066106  STP1    JMP  ESTOP    RETURN TO MONITOR
5124*
5125*
5126*   INITIALIZE STACKS FOR EXECUTION
5127*
5128   10162  025412  ESTAC   LDB  LSTPT    START AT OLD LSTPT
5129   10163  004134          ADB  M3
5130   10164  035411          STB  TSTPT    OFFSET T-STACK POINTER BY 4
5131   10165  004033          ADB  .16
5132   10166  035410          STB  LSTAK    ALLOW 12 WORDS FOR T-STACK
5133   10167  035412          STB  LSTPT
5134   10170  060553          JSM  BHSTP
5135   10171  074742          SBR  16
5136   10172  135410          STB  LSTAK,I
5137   10173  035432          STB  DRQST
5138   10174  024132          LDB  M1
5139   10175  135413          STB  HSTPT,I
5140   10176  164170          JMP  CLERA,I  INITIALIZE THE PRINT BUFFER
5141*
5142*   EXECUTE IF STATEMENT
5143*
```

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```
5144  10177  061217  EIF     JSM  FETCH    EVALUATE FORMULA AND RETURN
                                                              RESULT
5145  10200  021755          LDA  AR2+1    GET FIRST WORD OF MANTISSA
5146  10201  070250          SZA  EGOS4    SKIP IF FALSE
5147  10202  062217  EGOS1   JSM  EADD     GET ADDRESS
5148  10203  025416          LDB  MODE
5149  10204  076150          RZB  EGOS4+1  SKIP IF KEYBOARD MODE
5150  10205  031421          STA  PRADD    STORE IN PROGRAM POINTER
5151  10206  066012  EGOS4   JMP  XEC4
5152  10207  025421          LDB  PRADD
5153  10210  004020          ADB  .3       GET ADDRESS OF OLD PRADD
5154  10211  035466          STB  LOCL1
5155  10212  125466          LDB  LOCL1,I  GET OLD PRADD
5156  10213  074113          SBP  *+2
5157  10214  072053          SAP  *+1,S    SAVE DECOMPILE FLAG
5158  10215  131466          STA  LOCL1,I
5159  10216  066012          JMP  XEC4
5160*
5161*   SUBROUTINE TO GET ADDRESS
5162*
5163  10217  045472  EADD    ISZ  TEMPS
5164  10220  121472          LDA  TEMPS,I  GET LINE # OR ADDRESS
5165  10221  070372          SAM  EADD1,C   ADDRESS FORMAT?
5166  10222  061075          JSM  FNDPS    NO, GET ADDRESS
5167  10223  066224          JMP  *+1
5168  10224  160206  NGOTO   JSM  ERRA,I   NOT FOUND
5169  10225  074117          LDA  B        MOVE ADDRESS TO (A)
5170  10226  076053          SBP  *+1,S
5171  10227  135472          STB  TEMPS,I  STORE COMPILED FORMAT
5172  10230  170402  EADD1   RET           ADDRESS IN (A)
5173*
5174*   EXECUTE RETURN
5175*
5176  10231  160206  ER3     JSM  ERRA,I   INCORRECT RETURN STATEMENT
5177  10232  125412  ERTRN   LDB  LSTPT,I  GET TOP OF RETURN STACK
5178  10233  055412          DSZ  LSTPT
5179  10234  075650          SZB  ER3      SKIP IF NO RETURN
5180  10235  021472          LDA  TEMPS
5181  10236  070070          SIA  *+1
5182  10237  011421          CPA  PRADD    RETURN A FORMULA?
5183  10240  066243          JMP  *+3      NO
5184  10241  075413          SBP  ER3      YES, FUNCTION RETURN ALLOWED?
5185  10242  067106          JMP  RETNN    YES, EXECUTE
5186  10243  060771          JSM  GTOPP    GET NEXT OPERAND
5187  10244  073650          RZA  *-3      RETURN AND SINGLE VARIABLE?
5188  10245  075212          SBM  ER3      NO, GOSUB RETURN ALLOWED?
5189  10246  066011          JMP  ERTN1    YES, SET RETURN ADDRESS
5190*
5191*        FOR STATEMENT
5192*
5193  10247  011767  NOPCD   OCT  11767    ENCODED OP CODE FOR "NEXT"
5194*
5195  10250  060771  EFOR    JSM  GTOPP    GET FOR-VARIABLE
5196  10251  160177          JSM  SSYMA,I      FIND IT IN SYMBOL TABLE
5197  10252  160252          JSM  ENTEA,I  NOT FOUND — ENTER IT
5198  10253  035474          STB  TEMP1    SAVE ABS ADDRESS ALSO
5199  10254  021487          LDA  SYMTP
```

```
5200  10255  070076          TCA
5201  10256  070037          ADB  A        COMPUTE REALTIVE ADDRESS
5202  10257  020141          LDA  M10      MOVE HSTPT TO LOWER
5203  10260  001413          ADA  HSTPT    ADDRESS TO ACCOMMODATE
5204  10261  031413          STA  HSTPT    THE NEW FOR VAR.
5205  10262  031476          STA  TEMP3    SAVE IT FOR MVTOH IF NEEDED.
5206  10263  135413          STB  HSTPT,I  SAVE RELATIVE SYMBOL TABLE
                                                              POINTER
5207*
5208  10264  060554          JSM  BHSTP+1  OVERLAY?
5209*
5210  10265  000061  EFOR2   ADA  .10
5211  10266  070537          LDB  A,I      LOAD THE REALTIVE SYMBOL TABLE
                                                              POINTER
5212  10267  074512          SBM  EFOR1    IF MINUS MEANS BOOTTOM OF HIGH
                                                              STACK
5213  10270  031475          STA  TEMP2    SAVE THIS ADDRESS FOR MVTOH IF
                                                              NEEDED
5214  10271  115413          CPB  HSTPT,I  IS THIS F.V. THE SAME ?
5215  10272  066274          JMP  *+2      YES — GO DELETE IT
5216  10273  066265          JMP  EFOR2    NO — LOOP BACK FOR NEXT ONE
5217*
5218  10274  000061          ADA  .10      SET UP LAST WORD OF DESTINATION
5219  10275  031477          STA  TEMP4
5220  10276  061121          JSM  MVTOH    DELETE IT AND MOVE REST TO HIGHER
                                                              MEMORY
5221  10277  025477          LDB  TEMP4
5222  10300  035413          STB  HSTPT    RESET HSTPT
5223*
5224  10301  160201  EFOR1   JSM  FORMA,I
5225*
5226  10302  061371          JSM  FIX      GET (A) AND (B) FIXED UP
5227  10303  060416          JSM  STORE      STORE AR2 IN INITIAL VALUE TABLE
5228*
5229  10304  061217          JSM  FETCH    GET ENDING LIMIT
5230  10305  025413          LDB  HSTPT    TRANSFER END LIMIT
5231  10306  074070          SIB  *+1      TO HSTPT+1 THUR +4
5232  10307  060406          JSM  XFAR1+1
5233*
5234  10310  020020          LDA  ONE
5235  10311  060445          JSM  XFAR2+1  SET AR2=1
5236  10312  021472          LDA  TEMPS      IS THERE A STEP SIZE?
5237  10313  011421          CPA  PRADD
5238  10314  066316          JMP  *+2      NO, LEAVE 1 IN AR2
5239  10315  061217          JSM  FETCH    YES — GET IT
5240  10316  025413          LDB  HSTPT    TRANSFER STEP
5241  10317  004022          ADB  .5       SIZE
5242  10320  060406          JSM  XFAR1+1     TO HSTPT+4
5243*
5244  10321  004021          ADB  .4       STORE NEXT
5245  10322  021421          LDA  PRADD          EXECUTABLE
5246  10323  074557          STA  B,I          LINE ADDRESS IN HSTPT+9
5247*
5248*    FIND THE CORRESPONDING NEXT STATEMENT (TEMPS AND PRADD
5249*    WILL BE UP-DATED ACCORDINGLY), THEN CHECK IF THE "FOR"
5250*    LIMITS ARE CORRECT FOR LOOPING. IF NOT — ERASE FOR IMFORMATION
5251*    AND JMP TO XEC4 TO CONTINUE AFTER THE "NEXT" STATEMENT.
5252*    IF THE "FOR" LOOP WAS VALID, LOAD HSTPT+9 (THE ADDRESS FOLLOWING
5253*    THE "FOR" STATEMENT) AND EXECUTE FROM THERE (XEC4+1).
5254*
5255*
```

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```
5256   10324  022247          LDA  NOPCD     LOAD SEARCH CODE
5257   10325  062413          JSM  SYTSH     FIND A NEXT STATEMENT
5258   10326  074373          SBP  BERR,C    B IS NEGATIVE IF FOUND
5259   10327  062405          JSM  TEST      GO CHECK IF SAME VARIABLE
5260   10330  075613          SBP  *-4       LOOP BACK UNLESS FOUND
5261*
5262   10331  061371          JSM  FIX       GET A AND B REG FIXED FOR
5263   10332  063444          JSM  OPCH1       FOR CONVERTING INT, SPLIT, OR
                                                              FULL TO FULL
5264   10333. 035475          STB  TEMP2
5265   10334  066361          JMP  FTEST       CHECK IF LOOP IS VALID
5266*
5267   10335  160206  BERR    JSM  ERRA,I    NO CORRESPONDING "NEXT" OR
                                                          INCORRECT NESTING
5268*
5269*      NEXT STATEMENT
5270*
5271*
5272   10336  125413  ENEXT   LDB  HSTPT,I     RECOVER SYMBOL TABLE ADDRESS
5273   10337  075712          SBM  BERR      ERROR BOTTOM OF STACK
5274   10340  005407          ADB  SYMTP
5275   10341  035474          STB  TEMP1     COMPUTE ABS ADDRESS OF VARIABLE
5276   10342  062405          JSM  TEST
5277   10343  074252          SBM  *+5       IF B IS -, GET OUT OF LOOP
5278   10344  020061          LDA  .10       IF + THE VARIABLE WASN'T FOUND
5279   10345  001413          ADA  HSTPT     SO DINC THE HSTPT
5280   10346  031413          STA  HSTPT     AND LOOP BACK
5281   10347  066336          JMP  ENEXT
5282*
5283*    TEMP1 IS POINTING AT SYMBOL IN SYMBLAOL TABLE
5284*    HSTPT+1 = ENDING LIMIT
5285*    HSTPT+5 = STEP SIZE
5286*
5287*
5288   10350  061371          JSM  FIX       FIX A AND B FOR
5289   10351  063444          JSM  OPCH1     CONVERT INT OR SPLIT TO FULL
5290   10352  021413          LDA  HSTPT       ON RETURN (B) IS POINTING AT
                                                                  NUMBER
5291   10353  000022          ADA  .5          LOAD (A) WITH STEP SIZE ADDRESS
5292   10354  160216          JSM  .F  ,DA,I   *
5293*
5294   10355  063454          JSM  OPC1        SAVE AR2 AT 1470B
5295   10356  035475          STB  TEMP2     SAVE 1470B IN TEMP2
5296*
5297   10357  061371          JSM  FIX       FIX (A) AND (B) FOR .XFR
5298   10360  060416          JSM  STORE         STORE ANSWER BACK IN VALUE
                                                                  TABLE
5299*
5300   10361  025413  FTEST   LDB  HSTPT
5301   10362  074070          SIB  *+1         (B) = ADDRESS OF END LIMIT
5302   10363  021413          LDA  HSTPT       GET SIGN
5303   10364  000022          ADA  .5              OF STEP
5304   10365  070517          LDA  A,I               SIZE
5305   10366  070151          SLA  *+3
5306   10367  021475          LDA  TEMP2     STEP SIZE IS -, F.V.—END LIMIT → AR2
5307   10370  066373          JMP  *+3
5308   10371  074117          LDA  B         STEP SIZE IS +, END LIMIT—F.V. → AR2
5309   10372  025475          LDB  TEMP2
5310   10373  160217          JSM  .FSBA,I
5311*
```

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```
5312  10374  021413          LDA  HSTPT   (A) IS POINTING AT NEXT
5313  10375  000026          ADA  .9      EXECUTABLE LINE ADDRESS
5314  10376  025754          LDB  AR2     TEXT AR2 FOR + RESULT
5315  10377  074211          SLB  *+4
5316*
5317  10400  070070          SIA  *+1     AR2 WAS NEGATIVE, ERASE
5318  10401  031413          STA  HSTPT    "FOR" LOOP INFORMATION
5319  10402  066012          JMP  XEC4       AND EXECUTE LINE AFTER "NEXT"
5320*
5321  10403  070537          LDB  A,I     AR2 WAS POSITIVE OR 0,
5322  10404  066011          JMP  ERTN1   EXECUTE STMT AFTER "FOR"
```

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```
5324*
5325*     SUBROUTINES FOR "FOR" AND "NEXT" STATEMENTS.
5326*
5327  10405  061371  TEST    JSM  FIX     RETURN WITH TYPE CODE OF F.V.
5328  10406  141472          IOR  TEMPS,I IN A. IOR IN THE F.V. AND PAGE
5329  10407  050115          AND  B1777   REMOVE PAGE.
5330  10410  111474          CPA  TEMP1,I DO THE VARIABLES AGREE?
5331  10411  076053          SBP  *+1,S   THEY WERE THE SAME, FLAG B
5332  10412  170402          RET          DID NOT AGREE B IS +.
5333*
5334*     CALLING SEQUENCE FOR SYTSH
5335*
5336*       LDA OP CODE (PAGE-OP CODE)
5337*       JSM SYTSH (TEMPS IS POINTING AT LINE #.)
5338*  ON RETURN
5339*         (B)=-, OP CODE FOUND PRADD IS POINTING AT NEXT LINE #.
5340*                                TEMPS IS POINTING AT PRADD+2
5341*           (B)=+ ERROR RETURN - OP CODE NOT FOUND
5342*
5343  10413  031475  SYTSH   STA  TEMP2   SAVE SEARCH CODE
5344  10414  025421          LDB  PRADD
5345  10415  015423          CPB  PBPTR   CHECK IF END OF PROGRAM
5346  10416  170402          RET          YES — RETURN WITH (B) +.
5347  10417  035472          STB  TEMPS   NO — SET TEMPS=PRADD
5348  10420  060577          JSM  NEXTL+3 LOOK AT THE NEXT STATEMENT.
5349  10421  001466          ADA  LOCL1   ENCODE PAGE AND OP CODE
5350  10422  011475          CPA  TEMP2   WAS IT =TO TEMP2(SEARCH CODE)?
5351  10423  077553          SBP  *-5,S   YES, RETURN WITH (B) NEGATIVE
5352  10424  066414          JMP  SYTSH+1 NO — LOOP BACK.
```

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```
5354*
5355*
5356*    FIND THE NEXT DATA ITEM AND MOVE IT TO AR2
5357*     NXTDT MUST BE POINTING AT THE NEXT DATA ITEM OR
5358*     EQUAL TO DISTRT. IF EQUAL TO DSTRT FDATA WILL SEARCH
5359*     FOR THE NEXT DATA STATEMENT.
5360*
5361   10425  062437  FDATA   JSM  SWITH    SAVE TEMPS, TEMPS = NXTDT
5362   10426  021421         LDA  PRADD
5363   10427  031642         STA  SAVE
5364   10430  025472         LDB  TEMPS
5365   10431  015414         CPB  DSTRT     IF NXTDT(TEMPS) AND DSTRT ARE =:
5366   10432  066445         JMP  .FDA1     GO FIND NEXT DATA STATEMENT
5367   10433  160232         JSM  SNFLA,I   OR CONVERT SYNTAX TO FULL
5368   10434  045472         ISZ  TEMPS
5369   10435  021642         LDA  SAVE
5370   10436  031421         STA  PRADD
5371   10437  021472  SWITH  LDA  TEMPS
5372   10440  025415         LDB  NXTDT
5373   10441  031415         STA  NXTDT
5374   10442  035472         STB  TEMPS
5375   10443  170402         RET
5376*
5377   10444  160206  ER60    JSM  ERRA,I    OUT OF DATA
5378   10445  035421  .FDA1   STB  PRADD
5379   10446  022454         LDA  DATCD     LOAD "DATA" STATEMENT SEARCH
                                                                    CODE
5380   10447  062413         JSM  SYTSH     FIND NEXT DATA STATEMENT
5381   10450  075613         SBP  ER60      IF (B) WAS +, NO MORE DATA FOUND
5382   10451  025421         LDB  PRADD
5383   10452  035414         STB  DSTRT
5384   10453  066430         JMP  FDATA+3   DATA WAS FOUND GO CHECK IF ANY
                                                                    DATA WITH IT
5385*
5386   10454  011761  DATCD  OCT  11761
```

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```
5388*
5389*   EXECUTE INPUT   *
5390*
5391   10455  021622  EINPT   LDA  TERM
5392   10456  072110         RZA  *+2
5393   10457  160170         JSM  CLERA,I
5394   10460  021472         LDA  TEMPS
5395   10461  000133         ADA  M2
5396   10462  031641         STA  SPRDD    SAVE START OF INPUT STATEMENT
5397   10463  021641         LDA  SPRDD    SET PRADD TO START OF
5398   10464  031421         STA  PRADD      INPUT STATEMENT
5399   10465  020262         LDA  INREA    SET UP RETURN
5400   10466  031432         STA  DRQST    SET DATA REQUEST FLAG
5401   10467  164173  INRET  JMP  PEXMA,I  CALL FOR DATA
5402   10470  055400         DSZ  BADDR
5403   10471  025641         LDB  SPRDD
5404   10472  061007         JSM  NEXTA    SET PRADD BACK TO END
5405   10473  035421         STB  PRADD      OF INPUT STATEMENT
5406   10474  021472         LDA  TEMPS
5407   10475  031640         STA  TEPPP    SAVE START OF VARIABLE
5408   10476  160201  .EIN1  JSM  FORMA,I  GET THE ADDRESS OF THE VARIABLE
                                                              IN HSTPT
5409   10477  024017         LDB  .2
5410   10500  035706         STB  SBPTR    AIM SBPTR AT ROM
5411   10501  026532         LDB  INCHA
5412   10502  035432         STB  DRQST    SET FLAG IN CASE OF ERROR
5413   10503  061156         JSM  CONST    BUILD A NUMBER IN AR2
5414   10504  066520         JMP  INCHT-1  NO NUMBER FOUND, RESTORE
                                                              H-STACK
5415   10505  070742         SAR  16
5416   10506  031432         STA  DRQST    CLEAR FLAG
5417   10507  060412         JSM  RSULT    SAVE AR2 AT HSTPT,I
5418   10510  025472         LDB  TEMPS
5419   10511  015421         CPB  PRADD    END OF STATEMENT?
5420   10512  066530         JMP  CXEC4    YES
5421   10513  035640         STB  TEPPP    RESET THE TEMPORARY POINTER
5422   10514  055400         DSZ  BADDR    NO — DINC BADR TO LOOK AT THE
                                                              LAST CHAR
5423   10515  061066         JSM  GETSK    GET LAST CHAR.
5424   10516  066526         JMP  INCH1
5425   10517  066476         JMP  .EIN1    P+2 RETURN — OTHER CHAR'S
5426*
5427   10520  160170         JSM  CLERA,I
5428   10521  021640  INCHT  LDA  TEPPP
5429   10522  031472         STA  TEMPS    RESTORE VARIABLE POINTER
5430   10523  045413         ISZ  HSTPT
5431   10524  045413         ISZ  HSTPT
5432   10525  066463         JMP  INRET-4
5433*
5434   10526  160170  INCH1  JSM  CLERA,I
5435   10527  066463         JMP  INRET-4
5436*
5437   10530  160170  CXEC4  JSM  CLERA,I
5438   10531  066012         JMP  XEC4
5439*
5440   10532  010521  INCHA  DEF  INCHT
5441*
5442*   EXECUTE RESTORE STATEMENT
5443*
```

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```
5444  10533  125472  ERSTR   LDB  TEMPS,I
5445  10534  021424          LDA  PBUFF
5446  10535  074113          SBP  *+2        LINE GIVEN?
5447  10536  062217          JSM  EADD       YES, GET ADDRESS
5448  10537  031415          STA  NXTDT      SET UP DATA POINTERS
5449  10540  031414          STA  DSTRT
5450  10541  066012          JMP  XEC4
```

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```
5452*
5453*   EVALUATE ARGUEMENT OF FUNCTION
5454*
5455   10542  024032  EVARG   LDB  B17        INITIALIZE OPERATOR STACK
5456   10543  066564          JMP  FORMX+1      FOR FUNCTION
5457*
5458*   EVALUATE A FORMULA
5459*
5460*
5461*   STACK A CONSTANT
5462   10544  050040  FORM6   AND  B37
5463   10545  010040          CPA  B37          PRE-DEFINED FUNCTION?
5464   10546  066664          JMP  FORM7        YES
5465   10547  055413          DSZ  HSTPT        BUMP STACK POINTER
5466   10550  063406          JSM  RSCHK        ALLOT SPACE ON T-STACK
5467   10551  160232          JSM  SNFLA,I      CONVERT TO FLOATING
5468   10552  045472  FORST   ISZ  TEMPS
5469   10553  074742          SBR  16
5470   10554  135413          STB  HSTPT,I      STORE FULL PRECISION TYPE
5471   10555  060553          JSM  BHSTP
5472   10556  025411          LDB  TSTPT
5473   10557  135413          STB  HSTPT,I      STORE ADDRESS OF T-STACK
5474   10560  020214          LDA  AR2A
5475   10561  170004          XFR               TRANSFER RESULT TO T-STACK
5476   10562  066616  FOR2L   JMP  FORM2
5477*
5478*
5479   10563  074742  FORMAX  SBR  16           INITIALIZE
5480   10564  060563          JSM  SLWST          OPERATOR STACK
5481*   PROCESS NEXT OPERAND
5482   10565  121472  FORM1   LDA  TEMPS,I      FETCH OPERAND
5483   10566  050070          AND  OPDMK
5484   10567  070113          SAP  *+2
5485   10570  066544          JMP  FORM6        CONSTANT OR FUNCTION
5486   10571  045472          ISZ  TEMPS        SET FOR NEXT WORD OF FORMULA
5487   10572  071410          SZA  FOR2L        SKIP IF NULL OPERAND
5488   10573  055413          DSZ  HSTPT        BUMP POINTER
5489   10574  025420          LDB  PARMN        GET PARAMETER NAME
5490   10575  074504          SBL  6
5491   10576  074242          SBR  6            MASK OFF PRECISION
5492   10577  074057          CPA  B            IS THIS OPERAND THE PARMETER
5493   10600  067116          JMP  FPARM        YES
5494*   STACK NON-FUNCTION VARIABLE OPERAND ADDRESS
5495   10601  160177          JSM  SSYMA,I      SEARCH FOR VARIABLE IN SYMTAB
5496   10602  160252          JSM  ENTEA,I      NOT FOUND, ENTER IT
5497   10603  074517          LDA  B,I
5498   10604  050040          AND  B37          FETCH TYPE
5499   10605  004132          ADB  M1
5500   10606  035750          STB  YC           SAVE ADDRESS-ADDRESS
5501   10607  125750          LDB  YC,I         READ ADDRESS
5502   10610  010040          CPA  B37
5503   10611  066725          JMP  FORM8        IT WAS A USER DEFINED FUNCTION
5504   10612  131413  FORMP   STA  HSTPT,I      SAVE TYPE ON H-STACK
5505   10613  074117          LDA  B            GET ADDRESS OF OPERAND
5506   10614  060553          JSM  BHSTP        BUMP POINTER
5507   10615  131413          STA  HSTPT,I      STORE ADDRESS ON OPERAND STACK
```

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```
5508*   PROCESS NEXT OPERATOR
5509    10616  021472  FORM2   LDA  TEMPS      END OF
5510    10617  011421          CPA  PRADD        STATEMENT?
5511    10620  066631          JMP  FORM3       YES, FORCE END OF FORMULA
5512    10621  121472          LDA  TEMPS,I     EXTRACT
5513    10622  070073          SAP  *+1,C
5514    10623  070442          SAR  10             NEXT
5515    10624  070137          LDB  A                OPERATOR
5516    10625  000135          ADA  M4          OP CODE LESS THAN 4?
5517    10626  070152          SAM  FORM3       IF YES, NON FORMULA OPERATOR
5518    10627  000147          ADA  M23         NO, GREATER THAN B32?
5519    10630  070112          SAM  *+2         NON-FORMULA OPERATOR?
5520    10631  024012  FORM3   LDB  .1          YES, USE CODE FOR QUOTE
5521    10632  035460          STB  FTMP1       SAVE CURRENT OP-CODE
5522    10633  004123          ADB  FOPBS       ADD OP CODE TO TABLE ADDRESS
5523    10634  074517          LDA  B,I         GET AND MASK
5524    10635  050040          AND  B37           PRECEDENCE
5525    10636  031461          STA  FTMP2       SAVE PRECEDENCE OF CURRENT OP
5526*   STACK PRESENT OR EXECUTE PREVIOUS OPERATOR
5527    10637  121412  FORM4   LDA  LSTPT,I     DOES OPERATOR ON
5528    10640  050040          AND  B37           TOP OF OPERATOR
5529    10641  070056          CMA                  STACK HAVE
5530    10642  001461          ADA  FTMP2             HIGHER
5531    10643  070412          SAM  FORM5               PRECEDENCE?
5532    10644  025461  FORM9   LDB  FTMP2       NO, STACK CURRENT OPERATOR
5533    10645  014033          CPB  B20         LEFT PAREN OR BRACKET?
5534    10646  024012          LDB  .1          YES, STACK PRECEDENCE OF 1
5535    10647  021460          LDA  FTMP1       COMBINE
5536    10650  070304          SAL  10            PRECEDENCE
5537    10651  070037          ADB  A               WITH OP-CODE
5538    10652  066564          JMP  FORM1-1       AND STACK IT
5539    10653  121412  FORM5   LDA  LSTPT,I
5540    10654  055412          DSZ  LSTPT
5541    10655  070442          SAR  10          COMPUTE JUMP ADDRESS
5542    10656  003135          ADA  ARBAS         FOR OPERATOR
5543*   AT THIS POINT (HSTPT,I)= ADDRESS OF THE TOP OPERAND
5544*     (HSTPT+1,I)= THE TYPE OF THE TOP OPERAND
5545    10657  070737          JMP  A,I         BRANCH TO ROUTINE
5546*
5547*   EVALUATE NON-ARGUEMENT FUNCTION
5548    10660  055413  FOR72   DSZ  HSTPT
5549    10661  060553          JSM  BHSTP       PLACE DUMMY ON STACK
5550    10662  045472          ISZ  TEMPS       POINT TO NEXT OPERATOR
5551    10663  066707          JMP  FOR71
5552*   EVALUATE PRE-DEFINED FUNCTION
5553    10664  025777  FORM7   LDB  RSPTR
5554    10665  004132          ADB  M1          TAKE RETURN ADDRESS OF
5555    10666  074537          LDB  B,I           FORMX OFF STACK AND
5556    10667  055777          DSZ  RSPTR
5557    10670  060563          JSM  SLWST           SAVE ON LOW STACK
5558    10671  125472          LDB  TEMPS,I     GET OP CODE
5559    10672  074544          SBL  5
5560    10673  060604          JSM  NEXT1-2     CONFIGURE OP CODE AND GET PAGE
5561    10674  004134          ADB  M3
5562    10675  074437          ADB  B,I         GET TABLE STARTING ADDRESS
5563    10676  005466          ADB  LOCL1       ADD -(OP CODE)
```

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```
5564  10677  074437          ADB  B,I        GET ACTUAL JUMP ADDRESS
5565  10700  060563          JSM  SLWST      STACK JUMP ADDRESS
5566  10701  021466          LDA  LOCL1
5567  10702  000036          ADA  .23
5568  10703  070113          SAP  *+2        ARGUEMENT REQUIRED?
5569  10704  066660          JMP  FOR72      NO
5570  10705  062542          JSM  EVARG      EVALUATE ARGUEMENT
5571  10706  063433          JSM  OPCHK      VERIFY RESULT
5572  10707  063405  FOR71   JSM  RSCHK-1    ALLOT SPACE ON T-STACK
5573  10710  125412          LDB  LSTPT,I
5574  10711  055412          DSZ  LSTPT      REMOVE ADDRESS FROM STACK
5575  10712  074717          JSM  B,I        BRANCH TO ROUTINE
5576*   RECORD RESULT OF FUNCTION
5577*
5578*   FUNCTIONS RETURN HERE WITH RESULT IN AR2
5579  10713  045413  FOR10   ISZ  HSTPT      POP ARGUEMENT BUT LEAVE STACK
                                                                  BUMPED1
5580  10714  121412          LDA  LSTPT,I    UNSTACK RETURN ADDRESS
5581  10715  055412          DSZ  LSTPT
5582  10716  025777          LDB  RSPTR      GET RETURN ADDRESS
5583  10717  045777          ISZ  RSPTR
5584  10720  070173          SAP  *+3,C      MORE ADDRESSES TO COME?
5585  10721  074557          STA  B,I        YES
5586  10722  066714          JMP  FOR10+1    GET NEXT RETURN ADDRESS
5587  10723  074557          STA  B,I        NO
5588  10724  066553          JMP  FORST+1
5589*   EVALUATE PROGRAMMER DEFINED FUNCTION
5590  10725  076110  FORM8   RZB  *+2        ADDRESS =0?
5591  10726  160222          JSM  ENTFA,I    YES, FIND FUNCTION
5592  10727  074742          SBR  16         FLAG FIRST RETURN, SIGN=0
5593  10730  021777  FMX80   LDA  RSPTR
5594  10731  000132          ADA  M1
5595  10732  070437          ADB  A,I      COMBINE RETURN ADDRESS WITH
                                                                      FLAG
5596  10733  055777          DSZ  RSPTR
5597  10734  060563          JSM  SLWST      STACK ON L-STACK
5598  10735  021777          LDA  RSPTR
5599  10736  010112          CPA  RSTKA      ALL OF STACK MOVED?
5600  10737  066742          JMP  *+3        YES
5601  10740  024062          LDB  FLGBT
5602  10741  066730          JMP  FMX80
5603  10742  020132          LDA  M1
5604  10743  131413          STA  HSTPT,I    FLAG STACK FOR "FOR" LOOPS
5605  10744  025411          LDB  TSTPT
5606  10745  060563          JSM  SLWST      SAVE T-STACK POINTER
5607  10746  125750          LDB  YC,I
5608  10747  060563          JSM  SLWST      SAVE FUNCTION ADDRESS
5609  10750  062542          JSM  EVARG      EVALUATE ARGUEMENT
5610  10751  021472          LDA  TEMPS      SWITCH FORMULA
5611  10752  125412          LDB  LSTPT,I      POINTER TO FUNCTION FORMULA
5612  10753  035472          STB  TEMPS
5613  10754  131412          STA  LSTPT,I
5614  10755  023100          LDA  DSTRA      MOVE LSTPT UP 9 WORDS
5615  10756  024026          LDB  .9          AND TRANSFER DSTRT
5616  10757  063122          JSM  MOVST          THROUGH PBUFF
5617  10760  170004          XFR                   TO L-STACK
5618  10761  121413          LDA  HSTPT,I    GET PARAMETER ADDRESS
5619  10762  031417          STA  PARMA
```

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```
5620  10763  011411          CPA  TSTPT   IS PARAMETER ON T-STACK?
5621  10764  063406          JSM  RSCHK    YES. PROTECT IT
5622  10765  025423          LDG  PBPTR
5623  10766  074076          TCB
5624  10767  005472          ADB  TEMPS
5625  10770  074313          SBP  FMX82    SKIP IF OUTSIDE PRESENT PROGRAM
5626  10771  025424          LDB  PBUFF
5627  10772  074076          TCB
5628  10773  005472          ADB  TEMPS
5629  10774  074112          SBM  FMX82    SKIP IF OUTSIDE PRESENT PROGRAM
5630  10775  067016          JMP  FMX81
5631  10776  061225  FMX82   JSM  LDEF     INSURE NOT IN KEY MODE
5632  10777  024166          LDB  FWAM     FIND PROGRAM CONTAINING
                                                              FUNCTION
5633  11000  015405  FMX84   CPB  FWUP     END OF KEYS?
5634  11001  067013          JMP  FMX83    YES, MUST BE MAINLINE
5635  11002  074070          SIB  *+1      POINT TO LENGTH WORD
5636  11003  035474          SIB  TEMP1    SAVE START
5637  11004  074437          ADB  B,I      COMPUTE END
5638  11005  074117          LDA  B
5639  11006  070076          TCA
5640  11007  001427          ADA  TEMPS
5641  11010  071413          SAP  FMX84    FUNCTION IN THIS KEY?
5642  11011  025474          LDB  TEMP1    YES
5643  11012  160263          JSM  SUMPA,I  YES, SET UP PROGRAM POINTERS
5644  11013  025424  FMX83   LDB  PBUFF    RESET DATA STMT POINTERS
5645  11014  035414          STB  DSTRT
5646  11015  035415          STB  NXTDT
5647  11016  070742  FMX81   SAR  16
5648  11017  031416          STA  MODE     SET TO PROGRAM MODE
5649  11020  025472          LDB  TEMPS
5650  11021  061007          JSM  NEXTA
5651  11022  035421          STB  PRADD    SET POINTER TO END OF LINE
5652  11023  045413          ISZ  HSTPT
5653  11024  125413          LDB  HSTPT,I
5654  11025  074244          SBL  11       GET PRECISION OF PARAMETER
5655  11026  045413          ISZ  HSTPT    DINK PARAMETER OFF STACK
5656  11027  021472          LDA  TEMPS
5657  11030  000020          ADA  .3
5658  11031  070517          LDA  A,I      FETCH PARAMETER NAME
5659  11032  050115          AND  B1777
5660  11033  074217          IOR  B        MERGE WITH PRECISION
5661  11034  031420          STA  PARMN
5662  11035  025472          LDB  TEMPS
5663  11036  004022          ADB  .5       POINT PAST PARAMETER
5644  11037  015421          CPB  PRADD    MULTI-LINE FUNCTION?
5665  11040  067102          JMP  EVMLF    YES
5666  11041  035472          STB  TEMPS    NO
5667*
5668  11042  062563  FMX9    JSM  FORMX    EVALUATE FUNCTION FORMULA
5669  11043  121412          LDA  LSTPT,I   FETCH OLD PBUFF
5670  11044  027076          LDB  PBUFA
5671  11045  035477          STB  TEMP4    INITIALIZE TRANSFER POINTER
5672  11046  025412          LDB  LSTPT
5673  11047  074070          SIB  *+1
5674  11050  035475          STB  TEMP2
5675  11051  004141          ADB  M10
```

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```
5676  11052  035412          STB  LSTPT   RESET STACK POINTER
5677  11053  074070          SIB  *+1
5678  11054  011424          CPA  PBUFF   WAS A KEY ENTERED?
5679  11055  004017          ADB  .2      NO, DONT RESTORE DATA POINTERS
5680  11056  035476          STB  TEMP3
5681  11057  061121          JSM  MVTOH   RESTORE PROGRAM POINTERS
5682  11060  121412          LDA  LSTPT,I
5683  11061  055412          DSZ  LSTPT
5684  11062  031472          STA  TEMPS   RESTORE PROGRAM POINTER
5685  11063  121412          LDA  LSTPT,I
5686  11064  055412          DSZ  LSTPT
5687  11065  031411          STA  TSTPT   RESTORE T-STACK POINTER
5688  11066  063404          JSM  STTOP   GET ADDRESS OF RESULT
5689  11067  024214          LDB  AR2A
5690  11070  170004          XFR          TRANSFER
5691  11071  121413          LDA  HSTPT,I REMOVE ANY UNTERMINATED
5692  11072  010132          CPA  M1      "FOR" INFORMATION
5693  11073  066714          JMP  FOR10+1
5694  11074  045413          ISZ  HSTPT
5695  11075  067071          JMP  *+4
5696  11076  001425  PBUFA   DEF  PBUFF+1
5697  11077  177771  M7      DEC  -7
5698  11100  001414  DSTRA   DEF  DSTRT
5699  11101  001640  STADD   DEF  ST
5700*
5701* EVALUATE MULTI LINE FUNCTION
5702  11102  023101  EVMLF   LDA  STADD   TRANSFER FIRST 7 WORDS
5703  11103  024025          LDB  .8        OF EXECUTION TEMPORARY AREA
5704  11104  063122          JSM  MOVST       TO L-STACK
5705  11105  066012          JMP  XEC4
5706*
5707  11106  021412  RETNN   LDA  LSTPT
5708  11107  003077          ADA  M7      RESTORE EXECUTION
5709  11110  031412          STA  LSTPT
5710  11111  070070          SIA  *+1
5711  11112  027101          LDB  STADD     TEMPROARIES
5712  11113  170004          XFR
5713  11114  170004          XFR
5714  11115  067042          JMP  FMX9
5715*
5716* SET UP ADDRESS AND TYPE FOR PARAMETER
5717  11116  021420  FPRAM   LDA  PARMN  PRECISION IS STORED IN
5718  11117  070502          SAR  11        UPPER BITS
5719  11120  025417          LDB  PARMA
5720  11121  066612          JMP  FORMP
5721*
5722* TRANSFER WORDS TO LOW STOCK
5723* (A)=TRANSFER STARTING ADDRESS
5724* (B)= # OF WORDS
5725*
5726  11122  035467  MOVT    STB  LOCL2   SAVE COUNT
5727  11123  025412          LDB  LSTPT   SAVE OLD LSTPT
5728  11124  035466          STB  LOCL1
5729  11125  005467          ADB  LOCL2   ADD COUNT TO POINTER
5730  11126  035412          STB  LSTPT
5731  11127  060554          JSM  BHSTP+1 CHECK FOR OVERFLOW
```

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```
5732  11130  135412          STB  LSTPT,I  STACK NEGATIVE FLAG FOR "RETURN"
                                                                    STMT
5733  11131  025466          LDB  LOCL1
5734  11132  074070          SIB  *+1
5735  11133  170004          XFR            TRANSFER 4 WORDS
5736  11134  064446          JMP  XFAR2+2TRANSFER 3 MORE AND RETURN
```

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```
5738*
5739*  FORMULA OPERATOR JUMP TABLE
5740*
5741  11135  111136  ARBAS   DEF  *+1,I
5742  11136  011432          DEF  FORMR  EXECUTE END OF FORMULA
5743*
5744*  THE FOLLOWING 3 TABLE WORDS ARE NOT USED
5745*
5746*  QUOTE, COMMA, AND SEMI-COLON ARE END OF FORMULA OPERATORS
5747*
5748*  CALL SUBTRACT
5749*
5750  11137  063376  EFSB    JSM  BINOP
5751  11140  160217          JSM  .FSBA,I
5752  11141  067260          JMP  FOR14
5753*
5754  11142  011432          DEF  FORMR  ')'
5755  11143  011432          DEF  FORMR  ']'
5756  11144  011202          DEF  ESCMA  SUBSCRIPT COMMA
5757  11145  011171          DEF  ESTR   ASSIGNMENT EQUAL
5758  11146  000000  NOP       ************ CHECKSUM WORD ************
5759  11147  011256          DEF  EFAD
5760  11150  011137          DEF  EFSB
5761  11151  011272          DEF  EFMP
5762  11152  011275          DEF  EFDV
5763  11153  011300          DEF  EPWR
5764  11154  011333          DEF  EGTRT
5765  11155  011336          DEF  ELST
5766  11156  011352          DEF  ENEQL
5767  11157  011344          DEF  EEQL   LOGICAL EQUAL
5768  11160  011303          DEF  EUMIN  UNARY MINUS
5769  11161  010637          DEF  FORM4  UNARY PLUS
5770  11162  011317          DEF  ELBRC  '['
5771  11163  010565          DEF  FORM1  '('
5772  11164  011357          DEF  EOR
5773  11165  011366          DEF  EAND
5774  11166  011716          DEF  ENOT
5775  11167  011341          DEF  EGORE
5776  11170  011347          DEF  ELORE  '<='
```

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```
5778*
5779*   EXECUTE ASSIGNMENT EQUAL
5780*
5781   11171  025461  ESTR    LDB  FTMP2     IS NEXT OPERATOR AN
5782   11172  074150           SZB  *+3        END OF FORMULA?
5783   11173  045412           ISZ  LSTPT     NO, MULTIPLE STORE--RESTORE
5784   11174  066644           JMP  FORM9       STORE OPERATOR AND DEFER
                                                              STORE
5785   11175  055460           DSZ  FTMP1     FIRST STORE EXECUTED?
5786   11176  067200           JMP  ESTR1     NO SOURCE IS ALREADY IN AR2
5787   11177  061220           JSM  FETCH+1   POP STACK AND MOVE SOURCE TO
                                                                  AR2
5788   11200  060412  ESTR1    JSM  RSULT     POP DESTINATION AND STORE
5789   11201  066637           JMP  FORM4
5790*
5791*   EXECUTE SUBSCRIPT COMMA
5792*
5793   11202  061220  ESCMA    JSM  FETCH+1   CHECK COLUMN SUBSCRIPT
5794   11203  160225           JSM  FLTRA,I   ROUND TO INTEGER
5795   11204  067240           JMP  ER6       OVERFLOW
5796   11205  004132           ADB  M1        ADD OFFSET
5797   11206  075712           SBM  *-2       UNDERFLOW?
5798   11207  135412           STB  LSTPT,I   SAVE COLUMN SUBSCRIPT
5799   11210  061220           JSM  FETCH+1   CHECK ROW SUBSCRIPT
5800   11211  160225           JSM  FLTRA,I   ROUND TO INTEGER
5801   11212  067240           JMP  ER6
5802   11213  004132           ADB  M1
5803   11214  075712           SBM  *-2
5804   11215  035471           STB  L2T2      SAVE ROW SUBSCRIPT
5805   11216  125413           LDB  HSTPT,I     GET ACTUAL BOUNDS
5806   11217  004132           ADB  M1
5807   11220  074517           LDA  B,I
5808   11221  050105           AND  B377        EXTRACT COLUMN BOUND
5809   11222  070070           SIA  *+1
5810   11223  031470           STA  L2T1        SAVE IT
5811   11224  074537           LDB  B,I       EXTRACT ROW BOUND
5812   11225  074342           SBR  8
5813   11226  074070           SIB  *+1
5814   11227  074076           TCB
5815   11230  005471           ADB  L2T2
5816   11231  074353           SBP  ER6       ROW SUBSCRIPT LEGAL?
5817   11232  025471           LDB  L2T2      YES, RECALL ROW SUBSCRIPT
5818   11233  061201           JSM  IMPY      COMPUTE ROW DISPLACEMENT
5819   11234  025470           LDB  L2T1
5820   11235  074076           TCB
5821   11236  105412           ADB  LSTPT,I     COLUMN SUBSCRIPT LEGAL?
5822   11237  074112           SBM  *+2
5823   11240  160206  ER6      JSM  ERRA,I    NO,ERROR
5824   11241  101412           ADA  LSTPT,I     YES, ADD IN COLUMN
                                                          DISPLACEMENT
5825   11242  025413           LDB  HSTPT       FIND TYPE OF ARRAY
5826   11243  074070           SIB  *+1
5827   11244  074537           LDB  B,I
5828   11245  074042           SBR  2         FIND # OF WORDS PER ELEMENT
5829   11246  076110           RZB  *+2       FULL PRECISION?
5830   11247  070704           SAL  2         YES, MULTIPLY BY 4
5831   11250  014012           CPB  .1          SPLIT?
5832   11251  070744           SAL  1         YES, MULTIPLY BY 2
5833   11252  101413           ADA  HSTPT,I
```

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```
5834   11253  131413            STA  HSTPT,I     STORE ACTUAL ADDRESS OF
                                                  ELEMENT
5835   11254  055412            DSZ  LSTPT       UNSTACK I
5836   11255  066565            JMP  FORM1
5837*
5838*   CALL ADD
5839*
5840   11256  063376  EFAD      JSM  BINOP
5841   11257  160216            JSM  .FADA,I
5842*   PROCEED TO FOR14
5843*
5844*   OPERATORS CREATING INTERMEDIATE RESULTS RETURN HERE
5845*    WITH RESULT IN AR2
5846*
5847   11260  020214  FOR14     LDA  AR2A
5848   11261  025411            LDB  TSTPT       TRANSFER TO T-STACK
5849   11262  170004            XFR
5850   11263  021413            LDA  HSTPT
5851   11264  070070            SIA  *+1         POINT TO PRECISION WORD
5852   11265  074742            SBR  16
5853   11266  070577            STB  A,I         STORE FULL PRECISION
5854   11267  025411            LDB  TSTPT
5855   11270  135413            STB  HSTPT,I     STORE ADDRESS OF T-STACK
5856   11271  066637            JMP  FORM4
5857*
5858*   CALL MULTIPLY
5859*
5860   11272  063376  EFMP      JSM  BINOP
5861   11273  160220            JSM  .FMPA,I
5862   11274  067260            JMP  FOR14
5863*
5864*   CALL DIVIDE
5865*
5866   11275  063376  EFDV      JSM  BINOP
5867   11276  160221            JSM  .FDVA,I
5868   11277  067260            JMP  FOR14
5869*
5870*   CALL EXPONENTIAL ARROW
5871*
5872   11300  063376  EPWR      JSM  BINOP
5873   11301  160224            JSM  UPARA,I
5874   11302  067260            JMP  FOR14
5875*
5876*   CALL UNARY MINUS
5877*
5878   11303  063404  EUMIN     JSM  STTOP       FETCH TOP ELEMENT OF STACK
5879   11304  025411            LDB  TSTPT
5880   11305  170004            XFR              TRANSFER TO T-STACK
5881   11306  000133            ADA  M2
5882   11307  070517            LDA  A,I         READ FIRST WORD OF MANTISSA
5883   11310  070250            SZA  *+5           SKIP IF ZERO
5884   11311  121411            LDA  TSTPT,I
5885   11312  072111            SLA  *+2,S       REVERSE THE SIGN
5886   11313  070071            SLA  *+1,C
5887   11314  131411            STA  TSTPT,I
5888   11315  067263            JMP  FOR14+3
5889*
```

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```
5890*   EXECUTE LEFT BRACKET
5891*
5892   11316  Ø14ØØ2  SCCNT    OCT  14ØØ2
5893*
5894   11317  Ø45412  ELBRC    ISZ  LSTPT      STACK A
5895   1132Ø  Ø27316            LDB  SCCNT       SUBSCRIPT COMMA
5896   11321  Ø6Ø563            JSM  SLWST         ON OPERATOR STACK
5897   11322  Ø634Ø6            JSM  RSCHK     STACK A 1 ON
5898   11323  Ø55413            DSZ  HSTPT     OPERATOR
5899   11324  Ø6Ø553            JSM  BHSTP
5ØØØ   11325  Ø2ØØ2Ø  TRUE     LDA  ONE
5Ø1Ø   11326  Ø67261            JMP  FOR14+1     STACK A 1 ON T-STACK
5Ø2Ø*
5Ø3Ø*  COMPARE TOP OPERANDS OF STACK
5Ø4Ø*
5Ø5Ø   11327  Ø6337Ø  COMPR    JSM  BINOP       GET OPERAND ADDRESSES
5Ø6Ø   1133Ø  16Ø217            JSM  .FSBA,I     SUBTRACT ONE FROM ANOTHER
5Ø7Ø   11331  Ø2Ø214            LDA  AR2A      POINT TO RESULT IN AR2
5Ø8Ø   11332  Ø65317            JMP  SGNS      GET SGN IN (B)
5Ø9Ø*
5Ø1Ø*  EXECUTE >
5Ø11*
5Ø12   11333  Ø6332Ø  EGTRT    JSM  COMPR       COMPARE OPERANDS
5Ø13   11334  Ø74753            SBP  ENEQL+1    <?
5Ø14   11335  Ø67354            JMP  FALSE       YES
5Ø15*
5Ø16*  EXECUTE <
5Ø17*
5Ø18   11336  Ø6332Ø  ELST     JSM  COMPR       COMPARE OPERANDS
5Ø19   11337  Ø74Ø56            CMB              REVERSE COMPARISON SENSE
5Ø2Ø   1134Ø  Ø67342            JMP  *+2
5Ø21*
5Ø22*  EXECUTE >=
5Ø23*
5Ø24   11341  Ø6332Ø  EGORE    JSM  COMPR       COMPARE OPERANDS
5Ø25   11342  Ø75153            SBP  TRUE      <?
5Ø26   11343  Ø67354            JMP  FALSE       YES
5Ø27*
5Ø28*  EXECUTE =
5Ø29*
5Ø3Ø   11344  Ø6332Ø  EEQL     JSM  COMPR       COMPARE OPERANDS
5Ø31   11345  Ø75Ø1Ø            SZB  TRUE      =?
5Ø32   11346  Ø67354            JMP  FALSE       NO
5Ø33*
5Ø34*  EXECUTE <=
5Ø35*
5Ø36   11347  Ø6332Ø  ELORE    JSM  COMPR       COMPARE OPERANDS
5Ø37   1135Ø  Ø7565Ø            SBP  EEQL+1     >=?
5Ø38   11351  Ø67325  LTRUE    JMP  TRUE      NO
5Ø39*
5Ø4Ø*  EXECUTE # OR <>
5Ø41*
5Ø42   11352  Ø6332Ø  ENEQL    JSM  COMPR       COMPARE OPERANDS
5Ø43   11353  Ø7771Ø            RZB  LTRUE     #?
5Ø44   11354  Ø21411  FALSE    LDA  TSTPT     CLEAR T-STACK ENTRY
5Ø45   11355  17ØØØØ            CLR
```

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```
5946   11356  067263            JMP  FOR14+3
5947*
5948*  EXECUTE "OR"
5949*
5950   11357  063376  EOR       JSM  BINOP
5951   11360  070070            SIA  *+1
5952   11361  070517            LDA  A,I          LOOK AT FIRST OPERAND
5953   11362  073350            RZA  LTRUE        IF NON-ZERO, RESULT IS TRUE
5954   11363  074070  EOR2      SIB  *+1          LOOK AT SECOND OPERAND
5955   11364  074537            LDB  B,I
5956   11365  067353            JMP  ENEQL+1
5957*
5958*  EXECUTE "AND"
5959*
5960   11366  063376  EAND      JSM  BINOP
5961   11367  070070            SIA  *+1
5962   11370  070517            LDA  A,I          LOOK AT FIRST OPERAND
5963   11371  071150            SZA  FALSE        ZERO?
5964   11372  067363            JMP  EOR2         NO
5966*
5967*  PREPARE TO EXECUTE A BINARY OPERATOR
5968*
5969   11373  024057  BINO1     LDB  .1000
5970   11374  060406            JSM  XFAR1+1      TRANSFER TO SECOND TEMP(YC)
5971   11375  067401            JMP  BINO2
5972   11376  063433  BINOP     JSM  OPCHK
5973   11377  014111            CPB  B1740        CONVERSION TEMPORARY?
5974   11400  067373            JMP  BINO1        YES
5975   11401  035726  BINO2     STB  MBIN1        SAVE ADDRESS IN TEMPORARY
5976   11402  045413            ISZ  HSTPT          MOVE HIGH STACK POINTER
5977   11403  045413            ISZ  HSTPT          TO DELETE OPERAND
5978*   PROCEED TO STTOP
5979*
5980*   FETCH TOP OF STACK
5981*
5982   11404  063433  STTOP     JSM  OPCHK
5983   11405  035471            STB  L2T2         SAVE SECOND ADDRESS
5984*   PROCEED TO RSCHK
5985*
5986*  ALLOT SPACE FOR INTERMEDIATE RESULT
5987*
5988   11406  021411  RSCHK     LDA  TSTPT          MOVE TEMPORARY POINTER
5989   11407  000021            ADA  .4
5990   11410  031411            STA  TSTPT
5991   11411  011410            CPA  LSTAK        OVERFLOW INTO LOW STACK?
5992   11412  067414            JMP  *+2          YES
5993   11413  067430            JMP  RSCH2        NO
5994   11414  031476            STA  TEMP3
5995   11415  000025            ADA  .8
5996   11416  031410            STA  LSTAK
5997   11417  021412            LDA  LSTPT
```

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```
5998   11420  070070          SIA   *+1
5999   11421  031475          STA   TEMP2
6000   11422  000024          ADA   .7
6001   11423  031412  RSCH1   STA   LSTPT
6002   11424  070070          SIA   *+1
6003   11425  031477          STA   TEMP4
6004   11426  060554          JSM   BHSTP+1     TEST FOR OVERLAP WITH HIGH
                                                                    STACK
6005   11427  061121          JSM   MVTOH       MOVE LOW STACK UP
6006   11430  021471  RSCH2   LDA   L2T2        RECALL SECOND ADDRESS
6007   11431  025726          LDB   MBIN1       RECALL FIRST ADDRESS
6008   11432  170402  FORMR   RET
6009*
6010*  VERIFY LEGITIMACY OF OPERAND
6011*
6012   11433  125413  OPCHK   LDB   HSTPT,I      GET OPERAND ADDRESS
6013   11434  015411          CPB   TSTPT         IS IT TEMPORARY?
6014   11435  067460          JMP   OPC3          YES
6015   11436  074517          LDA   B,I           NO, GET EXPONENT WORD
6016   11437  010062          CPA   FLGBT         IS OPERAND DEFINED?
6017   11440  160206  ER8     JSM   ERRA,I      YES,ERROR
6018   11441  021413          LDA   HSTPT         YES, GET TYPE
6019   11442  070070          SIA   *+1
6020   11443  070517          LDA   A,I
6021   11444  050037  OPCH1   AND   .28         GET PRECISION BITS
6022   11445  071250          SZA   FORMR        FULL PRECISION?
6023   11446  010021          CPA   .4           NO, SPLIT?
6024   11447  067456          JMP   OPC2          YES
6025   11450  070206          RAR   5
6026   11451  071052          SAM   FORMR       NUMBERED VARIABLE?
6027   11452  074537          LDB   B,I           NO, IT MUST BE INTEGER
6028   11453  160227          JSM   FXFLA,I      RESULT IS IN AR2 NOW
6029   11454  024111  OPC1    LDB   BI740
6030   11455  064406          JMP   XFAR1+1      TRANSFER TO XC REGISTER
6031   11456  160231  OPC2    JSM   SPLFA,I      CONVERT SPLIT TO FULL PRECISION
6032   11457  067454          JMP   OPC1
6033   11460  021411  OPC3    LDA   TSTPT         DELETE TEMPORARY
6034   11461  000135          ADA   M4
6035   11462  031411          STA   TSTPT
6036   11463  170402          RET
6037*   11464 IS LAST
6038*   MATH ROUTINES HERE
```

PAGE 131 FUNCTION TABLES

```
6040   11707                    ORG  11707B
6041*
6042*  FUNCTION SYNTAX AND EXECUTION JUMP TABLE
6043*
6044   11707  000002            ABS  EPI-*
6045   11710  000003            ABS  ERES-*
6046   11711  023715  EPI       LDA  PIA
6047   11712  064445            JMP  XFAR2+1
6048   11713  020215  ERES      LDA  TMPOP
6049   11714  064445            JMP  XFAR2+1
6050   11715  003764  PIA       DEF  3764B
6051*
6052*  EXECUTE "NOT"
6053*
6054   11716  063404  ENOT      JSM  STTOP
6055   11717  070070            SIA  *+1
6056   11720  070537            LDB  A,I
6057   11721  067345            JMP  EEQL+1
6058*
6059   11722  000000            BSS  13          FUNCTION JUMP TABLE
6060   11737  175125            ABS  TABER-*     TAB
6061*
6062*  FUNCTION NAME TABLE
6063*
6064   11740  042530  FTN13     ASC  1,EX
6065   11741  050202            OCT  050202      EXP;OP CODE 2
6066   11742  046117            ASC  1,LO
6067   11743  043603            OCT  43603       LOG: OP CODE 3
6068   11744  040502            ASC  1,AB
6069   11745  051604            OCT  051604      ABS;OP CODE 4
6070   11746  051521            ASC  1,SQ
6071   11747  051205            OCT  051205      SQR;OP CODE 5
6072   11750  044516            ASC  1.IN
6073   11751  052206            OCT  052206      INT;OP CODE 6
6074   11752  051507            ASC  1,SG
6075   11753  047207            OCT  47207       SGN: 7
6076   11754  051511            ASC  1,SI
6077   11755  047210            OCT  047210      SIN; 10
6078   11756  041517            ASC  1,CO
6079   11757  051611            OCT  051611      COS; 11
6080   11760  052101            ASC  1,TA
6081   11761  047212            OCT  047212      TAN; 12
6082   11762  040524            ASC  1,AT
6083   11763  047213            OCT  047213      ATN; 13
6084   11764  046107            ASC  1,LG
6085   11765  052214            OCT  52214       LGT;14
6086   11766  040523            ASC  1,AS
6087   11767  047215            OCT  47215       ASN; 15
6088   11770  040503            ASC  1,AC
6089   11771  051616            OCT  51616       ACS; 16
6090   11772  051105            ASC  1,RE
6091   11773  051630            OCT  51630       RES; 30 (NO ARGUEMENT)
6092   11774  050111            ASC  1,PI
6093   11775  154524  TAB       OCT  154524      PI; 31 (NO ARGUEMENT)
6094   11776  040502            OCT  40502
6095   11777  140777            OCT  140777      TAB; 1
```

PAGE 132 FORMULA OPERATOR TABLE

```
6097   12000                  ORG  12000B
6098   12000  006774  STEPA   DEF  FOPST+FOPST
6099*
6100*   FORMULA OPERATOR SEARCH AND PRECEDENCE TABEL
6101*   LEFT CHAR IS ASCII; RIGHT CHAR IS PRECEDENCE
6102*
6103   12001  021000  QUOT    OCT  21000      OP CODE I
6104   12002  026000  COMMA   OCT  26000      2
6105   12003  035400  SMCLN   OCT  35400      3
6106   12004  024400  RPARN   OCT  24400      4
6107   12005  056400  RBRAC   OCT  56400      5
6108   12006  026002  SCMMA   OCT  26002      6
6109   12007  036402  ASSOP   OCT  36402      7
6110   12010  177377  M257    DEC  -257       THIS IS NOT USED AS TABLE ENTRY
6111   12011  025407  PLUSS   OCT  25407      11
6112   12012  026407  MINS    OCT  26407      12
6113   12013  025010  TIMES   OCT  25010      13
6114   12014  027410  DIV     OCT  27410      14
6115   12015  057013  EXPS    OCT  57013      15
6116   12016  037005  GTR     OCT  37005      16
6117   12017  036005  LSS     OCT  36005      17
6118   12020  021405  UNEQL   OCT  21405      20
6119   12021  036405  EQUAL   OCT  36405      21
6120   12022  026412  UNMIN   OCT  26412      22
6121   12023  025412  UPLUS   OCT  25412      23
6122   12024  055420  LBRAC   OCT  55420      24
6123   12025  024020  LPARN   OCT  24020      25
6124   12026  000003  OROP    OCT  00003      26
6125   12027  000004  ANDOP   OCT  00004      27
6126   12030  000012  NOTOP   OCT  00012      30
6127   12031  000005  GTREQ   OCT  00005      31
6128   12032  000005  LSSEQ   OCT  00005      32
6129*
6130   12033  000000          BSS  1          *******CHECKSUM*****
```

PAGE 133 SYNTAX SUBROUTINES

```
6132                    LST
6133   12034  007001   TOA      DEF  FOPST,+FOPST+5
6134   12035  007004   ORA      DEF  OR+OR
6135   12036  007013   NOTA     DEF  OR+OR+7
6136   12037  007017   GTEA     DEF  GTE+GTE+1
6137*
6138*   CHECK SYNTAX OF A FORMULA
6139*
6140*     EXIT TO ERROR ON UNRECOGNISABLE OR INCORRECT INPUT
6141*     ON EXIT (A)= NEXT CHARACTER NOT IN FORMULA
6142*               (B)= 0
6143*     IF FIRST OPERAND IS A STRING VARIABLE, EXIT TO ERROR
6144*       UNLESS STRING IS ENABLED BY SFLAG=SBPTR, THEN EXIT (B)=SFLAG=-1
6145*
6146*     MSFLG=8; LOOKING FOR "=" IN LET OR FOR STATEMENT
6147*     MSFLG=9; INTERPRET "=" AS A LOGICAL OPERATOR
6148*     IF A STORE IS FOUND, SFLAG=-2
6149*
6150   12040  020012   FSC      LDA  .1          SET LEFT PARENTHESIS
6151   12041  131472            STA  TEMPS,I       COUNT TO 0 (OFFSET BY 1)
6152   12042  020132   FSC1     LDA  M1          ENABLE UNARY
6153   12043  031713            STA  UFLAG         OPERATORS
6154*   LOOK FOR AN OPERAND
6155   12044  062231   FSC2     JSM  VAROP       LOOK FOR VARIABLE OPERAND
6156   12045  066114            JMP  FSC7        FIRST CHAR NOT A LETTER
6157   12046  066164            JMP  FSC13-3     SUBSCRIPTED OR STRING VARIABLE
6158   12047  060752            JSM  LETCK       SIMPLE VARIABLE; FOLLOWED BY
                                                                      LETTER?
6159   12050  066167            JMP  FSC13       NO
6160*   DOES "AND" OR "OR" FOLLOW SIMPLE VARIABLE?
6161   12051  062217            JSM  MCBCK       CHECK FOR "AND"OR"OR"ONLY; (B)
                                                                      =-1
6162*   CHECK FOR FUNCTION INSTEAD OF SIMPLE VARIABLE
6163   12052  062424            JSM  FNCK        "FN"?
6164   12053  066061            JMP  FSC4        NO
6165   12054  055400            DSZ  BADDR       YES
6166   12055  000154            ADA  M64         GET FUNCTION NAME
6167   12056  074742            SBR  16
6168   12057  135706            STB  SBPTR,I     CLEAR OUT NEXT WORD
6169   12060  066074            JMP  FSC3-1
6170   12061  070342   FSC4     SAR  8           RECALL LAST CHAR
6171   12062  055400            DSZ  BADDR       BACK UP TO POINT AT SECOND CHAR
6172   12063  024133            LDB  M2          SEARCH ALL TABLES FOR
6173   12064  160237            JSM  SALTA,I       A PREDEFINED FUNCTION
6174   12065  066143            JMP  FSC11       NOT FOUND
6175   12066  135706            STB  SBPTR,I     STORE TABLE CODE
6176   12067  070137            LDB  A
6177   12070  004147            ADB  M23
6178   12071  074076            TCB
6179   12072  035474            STB  TEMP1       SET NEGATIVE IF NO ARGUEMENT
6180   12073  040116            IOR  QTOP        SET FLAG FOR PRE-DEF FUNCTION
6181   12074  070544            SAL  5           POSITION OP CODE
6182*   ASSEMBLE AND STORE FUNCTION
6183   12075  040040   FSC3     IOR  B37         SET OPERAND TYPE FOR FUNCTION
6184   12076  070137            LDB  A
6185   12077  055706            DSZ  SBPTR       REPLACE
6186   12100  060641            JSM  RESBP+1       PREVIOUS OPERAND
6187   12101  074217            IOR  B               WITH FUNCTION
```

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```
6188  12102  131706          STA  SBPTR,I
6189  12103  045706          ISZ  SBPTR
6190  12104  021474          LDA  TEMP1      RECALL ARGUEMENT FLAG
6191  12105  070253          SAP  FSC31       NORMAL ARITHMETIC ARGUEMENT?
6192  12106  161473          JSM  TEMP,I     NO, JUMP THROUGH SYNTAX/EXEC
                                                TABLE
6193  12107  045706          ISZ  SBPTR      RETURN HERE IF NO ARGUEMENT
6194  12110  061055          JSM  GNEXT
6195  12111  066130          JMP  FSC8       NO, CHECK FOR EOL NEXT
6196  12112  031713  FSC31   STA  UFLAG      DISABLE UNARY OPERATORS
6197  12113  066140          JMP  FSC10
6198*   CHECK FOR LEFT PARENTHESIS
6199  12114  045706  FSC7    ISZ  SBPTR
6200  12115  060513          JSM  LPCK       CHECK FOR PAREN
6201  12116  066123          JMP  *+5        NOT FOUND
6202  12117  145472  FSC5    ISZ  TEMPS,I
6203  12120  024026  FSC6    LDB  .9         DISABLE ASSIGNMENT
6204  12121  035710          STB  MSFLG
6205  12122  066042          JMP  FSC1
6206*   CHECK FOR A NUMBER
6207  12123  074742          SBR  16         INITIALIZE
6208  12124  035721          STB  SIGN         TO POSITIVE
6209  12125  160243          JSM  NUMCA,I    FETCH AND BUILD CONSTANT
6210  12126  066133          JMP  FSC9       NOT FOUND
6211  12127  160244          JSM  NUMOA,I    STORE IN SYNTAX BUFFER
6212  12130  024026  FSC8    LDB  .9
6213  12131  035710          STB  MSFLG      DISABLE ASSIGNMENT
6214  12132  066167          JMP  FSC13
6215*   CHECK FOR A UNARY OPERATOR
6216  12133  045713  FSC9    ISZ  UFLAG      UNARY OPERATORS PERMITTED?
6217  12134  160206  FSCE3   JSM  ERRA,I     NO, UNRECOGNISED OPERNAD
6218  12135  060461          JSM  SYMC2      UNARY MINUS
6219  12136  012021          DEF  UNMIN-1      OR UNARY PLUS?
6220  12137  066134          JMP  FSCE3      NO
6221  12140  024026  FSC10   LDB  .9
6222  12141  035710          STB  MSFLG      DISABLE ASSIGNMENT
6223  12142  066044          JMP  FSC2
6224*   CHECK FOR "NOT" RATHER THAN SIMPLE VARIABLE
6225  12143  045713  FSC11   ISZ  UFLAG      "NOT" PERMITTED?
6226  12144  066212          JMP  FSC14-1    NO
6227  12145  026036          LDB  NOTA
6228  12146  060537          JSM  STSRH      SEARCH FOR 'NOT"
6229  12147  066212          JMP  FSC14-1    NOT FOUND
6230  12150  055706          DSZ  SBPTR      ERASE
6231  12151  060641          JSM  RESBP+1      SPURIOUS
6232  12152  045706          ISZ  SBPTR          OPERAND
6233  12153  066140          JMP  FSC10
6234*
6235*   CHECK FOR RIGHT PARENTHESIS
6236*
6237  12154  060524  FSC12   JSM  RPCK       RIGHT PAREN?
6238  12155  066213          JMP  FSC14      NO
6239  12156  155472          DSZ  TEMPS,I
6240  12157  066167          JMP  FSC13      ((A)=NEXT CHAR)
6241  12160  055706          DSZ  SBPTR      NO MATCHING LEFT PAREN
6242  12161  055400          DSZ  BADDR      RESTORE
6243  12162  020046          LDA  .41          PREVIOUS CONDITIONS
```

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```
6244   12163  Ø66215            JMP  FSC14+2     AND RETURN
6245*   CHECK FOR A BINARY OPERATOR
6246   12164  Ø24132            LDB  M1          STRING VARIABLE
6247   12165  Ø15714            CPB  SFLAG         JUST FOUND?
6248   12166  17Ø4Ø2            RET                YES
6249   12167  Ø1ØØ31  FSC13     CPA  EOL         END OF STMT?
6250   1217Ø  Ø66213            JMP  FSC14       YES
6251   12171  Ø31713            STA  UFLAG       DISABLE UNARY OPERATORS
6252   12172  Ø31474            STA  TEMP1       SAVE CHAR
6253   12173  Ø24132            LDB  M1
6254   12174  Ø62217            JSM  MCBCK       CHECK FOR AND, OR, >=,<=,<>
6255   12175  Ø2571Ø            LDB  MSFLG
6256   12176  Ø6Ø464            JSM  SYMCK       SEARCH FOR
6257   12177  Ø21Ø1Ø            DEF  PLUSS—1       SINGLE CHAR OPERATOR
6258   122ØØ  Ø662Ø4            JMP  *+4         NOT FOUND
6259   122Ø1  Ø1Ø124            CPA  EXPOP       EXPONENTIATION?
6260   122Ø2  Ø6614Ø            JMP  FSC1Ø       YES
6261   122Ø3  Ø6612Ø            JMP  FSC6        NO
6262   122Ø4  Ø6Ø463            JSM  SYMC1       NO, "=" ASSIGNMENT?
6263   122Ø5  Ø12ØØ6            DEF  ASSOP—1
6264   122Ø6  Ø66154            JMP  FSC12       NO
6265   122Ø7  Ø2Ø133            LDA  M2          YES, SET
6266   1221Ø  Ø31714            STA  SFLAG         STORE OCCURRED FLAG
6267   12211  Ø66Ø42            JMP  FSC1
6268*   END OF FORMULA
6269   12212  Ø61Ø55            JSM  GNEXT       RECALL CHAR
6270   12213  155472  FSC14     DSZ  TEMPS,I     ALL PARENS MATCHED?
6271   12214  Ø64535            JMP  FSCE2       MISSING RIGHT PAREN
6272   12215  Ø74742            SBR  16
6273   12216  17Ø4Ø2            RET                RETURN WITH (B)=Ø
6274*
6275*   CHECK FOR A MULTI-CHARACTER BINARY OPERATOR
6276*
6277*     (B)=-1; CHECK >=,<=,<> AS WELL AS AND, OR
6278*     EXIT TO FSC6 IF FOUND
6279*
6280   12217  135706  MCBCK     STB  SBPTR,I     SAVE FLAG
6281   1222Ø  Ø26Ø35            LDB  ORA         SEARCH FOR "AND" OR "OR"
6282   12221  Ø6Ø537            JSM  STSRH
6283   12222  Ø66225            JMP  *+3         NOT FOUND
6284   12223  Ø55777            DSZ  RSPTR       DINC STACK POINTER
6285   12224  Ø6612Ø            JMP  FSC6        RETURN
6286   12225  145706            ISZ  SBPTR,I     CHECK REST OR OPERATORS
6287   12226  17Ø4Ø2            RET                NO
6288   12227  Ø26Ø37            LDB  GTEA        CHECK FOR >=,<=,<>
6289   1223Ø  Ø66221            JMP  MCBCK+2
```

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```
6291*
6292*   SEEK A VARIABLE OPERAND
6293*         P+1: FIRST CHAR NOT A LETTER
6294*         P+2: ARRAY OR STRING VARIABLE FOUND
6295*         P+3: SIMPLE VARIABLE
6296*
6297*     (A)=NEXT CHAR FOLLOWING OPERAND
6298*     IF STRING IS FOUND AND SFLAG=SBPTR THEN SET SFLAG=-1
6299*         IF SFLAG≠SBPTR THEN STRING IS NOT PERMITTED; ERROR
6300*
6301   12231  061140  VAROP   JSM  LTR      LETTER?
6302   12232  170402          RET           NO, RETURN TO P+1
6303   12233  074742          SBR  16       INITIALIZE FOR
6304   12234  035717          STB  OPTYP      FULL PRECISION
6305   12235  010077          CPA  B44      IS NEXT CHAR "S"?
6306   12236  066275          JMP  VARO4    YES
6307   12237  060750          JSM  DIGCK    DIGIT?
6308   12240  066250          JMP  VARO1    NO
6309   12241  070137          LDB  A        YES, RESTORE ASCII
6310   12242  021474          LDA  TEMP1    RECALL LETTER
6311   12243  035474          STB  TEMP1    SAVE DIGIT
6312   12244  060450          JSM  STROP    COMBINE AND STORE OPERAND
6313   12245  061055          JSM  GNEXT
6314   12246  031475          STA  TEMP2    SAVE IT
6315   12247  064356          JMP  RETN3
6316   12250  074742  VARO1   SBR  16
6317   12251  010073          CPA  S
6318   12252  224021          LDB  .4       OPTYP=4 FOR SPLIT PRECISION
6319   12253  010055          CPA  I
6320   12254  024025          LDB  .8       OPTYP=8 FOR INTEGER
6321   12255  074350          SZB  VARO6    SKIP IF FULL PRECISION
6322   12256  055771          DSZ  DFLAG    DIM OR COM?
6323   12257  066261          JMP  *+2      NO, SPLIT OR INTEGER INT ALLOWED
6324   12260  035717          STB  OPTYP    YES, STORE OPERAND TYPE
6325   12261  045711          ISZ  DFLAG    DIM OR COM?
6326   12262  061055          JSM  GNEXT    YES GET CHAR FOLLOWING PRECISION
6327   12263  031475          STA  TEMP2    STORE CHAR
6328   12264  010045  VARO6   CPA  .40      "("
6329   12265  066275          JMP  VARO4    YES
6330   12266  010102          CPA  B133     "["?
6331   12267  066275          JMP  VARO4    YES
6332   12270  021474          LDA  TEMP1    RECALL LETTER
6333   12271  025717          LDB  OPTYP
6334   12272  060451          JSM  STROP+1  COMBINE AND STORE SIMPLE
                                                          VARIABLE
6335   12273  021475  VARO3   LDA  TEMP2    NO, RECALL NEXT CHAR
6336   12274  064356          JMP  RETN3    RETURN TO P+3
6337   12275  062436  VARO4   JSM  STRID    STORE STRING OR ARRAY OPERAND
6338   12276  062301          JSM  SBSCK    GET SUBSCRIPT
6339   12277  074742          SBR  16       NO SUBSCRIPT, SET B=0
6340   12300  064357          JMP  RETN2
```

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```
6342*
6343*    SUBSTCRIPT SYNTAX
6344*
6345*       ARYAD POINTS TO ARRAY OPERAND
6346*       EXIT TO P+1 IF FIRST CHAR ISNOT "("OR "[" OTHERWISE P+2
6347*       DFLAG=1 IF ANALYSING DIM OR COM STMT; 0 OTHERWISE
6348*       SFLAG=1 FOR STRING OPERAND
6349*
6350*       ARRAY OPERANDS ARE MARKED AS ONE OR TWO DIMENITIONAL
6351*       MEMORY REQUIREMENT IS COMPUTED FOR COM STMT
6352*
6353   12301  060513  SBSCK   JSM  LPCK      FIRST CHAR A "(" OR "["?
6354   12302  170402         RET            NO
6355   12303  020125         LDA  LBOP      YES, RECORD
6356   12304  131706         STA  SBPTR,I     A LEFT BRACKET
6357   12305  155723         DSZ  ARYAD,    SET ARRAY
6358   12306  155723         DSZ  ARYAD,I     TO / DIMENSION
6359   12307  021711         LDA  DFLAG     DIM OR COM?
6360   12310  072110         RZA  *+2
6361   12311  066363         JMP  SBSC3
6362   12312  024157         LDB  M256      ALLOW 255
6363   12313  045714         ISZ  SFLAG     STRING?
6364   12314  004132         ADB  M1        NO, ALLOW UP TO 256
6365   12315  060666         JSM  PGINT     GET AN INTEGER
6366   12316  004132         ADB  M1        OFFSET BY -1
6367   12317  074404         SBL  8
6368   12320  035474         STB  TEMP1     SAVE DIMENSION
6369   12321  025714         LDB  SFLAG
6370   12322  074450         SZB  SBSC1     SKIP IF STRING
6371   12323  060463         JSM  SYMC1     LOOK FOR A COMMA
6372   12324  012005         DEF  SCMMA-1     A COMMA
6373   12325  066333         JMP  SBSC1     NOT FOUND
6374   12326  145732         ISZ  ARYAD,I   SET TO 2 DIMENSIONS
6375   12327  026010         LDB  M257      GET SECOND
6376   12330  060666         JSM  PGINT     DIMENSION
6377   12331  004132         ADM  M1        OFFSET BY -1
6378   12332  066334         JMP  SBSC1+1
6379   12333  074742  SBSC1  SBR  16        SECOND DIM=1 OFFSET BY -1
6380   12334  005474         ADB  TEMP1     COMBINE DIMENSIONS
6381   12335  035714         STB  SFLAG     SAVE PACKED DIMENSIONS
6382   12336  060534  SBSC2  JSM  RPCKE     DEMAND ")" OR "]"
6383   12337  024123         LDB  RBOP      STORE
6384   12340  055706         DSZ  SBPTR
6385   12341  135706         STB  SBPTR,I     A RIGIT BRACKET
6386   12342  045706         ISZ  SBPTR
6387   12343  025711         LDB  DFLAG     DIM OR COM?
6388   12344  076710         RZB  SBSCR
6389*    RESTORE LOCAL QUANTITIES FOR FSC
6390   12345  045472         ISZ  TEMPS
6391   12346  024112         LDB  RSTKA     RESET
6392   12347  035777         STB  RSPTR       STACK POINTER
6393   12350  066353         JMP  FPOP1
6394   12351  135777  FPOP2  STB  RSPTR,I     STORE ON RETURN STACK
6395   12352  045777         ISZ  RSPTR
6396   12353  124572  FPOP1  LDB  TEMPS,I    GET WORD FROM S--STACK
6397   12354  045472         ISZ  TEMPS
```

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```
6398   12355  075633          SBP   FPOP2,C   IF NEGATIVE; IT MUST BE MSFLG
6399   12356  035710          STB   MSFLG     RESTORE MSFLG
6400   12357  125472          LDB   TEMPS,I
6401   12360  045472          ISZ   TEMPS
6402   12361  035713          STB   UFLAG     RESTORE UFLAG
6403   12362  064357  SBSCR.  JMP   RETN2     RETURN TO P+2
6404*    SAVE LOCAL QUANTITIES FOR FSC
6405   12363  021713  SBSC3   LDA   UFLAG
6406   12364  062416          JSM   DINCT     SAVE UFLAG ON THE S-STACK
6407   12365  021710          LDA   MSFLG
6408   12366  072053          SAP   *+1,S     SET FLAG
6409   12367  062416          JSM   DINCT     SAVE MSFLG
6410   12370  055777  FRCU1   DSZ   RSPTR
6411   12371  121777          LDA   RSPTR,I   GET RETURN ADDRESS
6412   12372  062416          JSM   DINCT     SAVE IT
6413   12373  021777          LDA   RSPTR
6414   12374  010112          CPA   RSTKA     ALL OF STACK MOVED?
6415   12375  066377          JMP   *+2       YES
6416   12376  066370          JMP   FRCU1
6417   12377  021723          LDA   ARYAD
6418   12400  062416          JSM   DINCT     SAVE ARRAY ADDRESS
6419   12401  062416          JSM   DINCT     DINK AGAIN AND CHECK OVERFLOW
6420   12402  020026          LDA   .9        DISABLE STORE MODE
6421   12403  031710          STA   MSFLG
6422   12404  062040          JSM   FSC       GET INDEX FORMULA
6423   12405  045472          ISZ   TEMPS     RESTORE
6424   12406  125472          LDB   TEMPS,I     ARRAY
6425   12407  035723          STB   ARYAD        ADDRESS
6426   12410  060463          JSM   SYMC1
6427   12411  012005          DEF   SCMMA-1   COMMA?
6428   12412  066336          JMP   SBSC2     NO
6429   12413  145723          ISZ   ARYAD,I   SET TO 2 DIMENSIONS
6430   12414  062040          JSM   FSC       GET SECOND INDEX FORMULA
6431   12415  066336          JMP   SBSC2
6432*
6433*    DECREMENT TEMPS AND CHECK FOR OVERFLOW
6434*
6435   12416  055472  DINCT   DSZ   TEMPS
6436   12417  025472          LDB   TEMPS
6437   12420  015412          CPB   LSTPT     OVERFLOW?
6438   12421  064561          JMP   FSCE4     YES
6439   12422  131472          STA   TEMPS,I   NO, SAVE (A) ON STACK
6440   12423  170402          RET
```

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```
6442*
6443*   CHECK FOR "FN" FOLLOWED BYA LETTER
6444*     EXIT P+1; NOT FOUND
6445*          P+2; FOUND, (A)=LETTER
6446*
6447   12424  025474  FNCK    LDB  TEMP1
6448   12425  074404          SBL  8
6449   12426  074217          IOR  B
6450   12427  010162          CPA  FN          "FN"?
6451   12430  066432          JMP  *+2         YES
6452   12431  170402          RET
6453   12432  061140          JSM  LTR         NEXT CHAR A LETTER?
6454   12433  160206  SYNE4   JSM  ERRA,I      NO
6455   12434  021474          LDA  TEMP1       YES, RECALL LETTER
6456   12435  064357          JMP  RETN2
6457*
6458*   RECORD A STRING OR ARRAY IDENTIFIER
6459*
6460   12436  025706  STRID   LDB  SBPTR       SET POINTER TO
6461   12437  035723          STB  ARYAD         ARRAY OR STRING OPERAND
6462   12440  010077          CPA  B44         NEXT CHAR "S"?
6463   12441  066450          JMP  STRI1       YES
6464   12442  021474          LDA  TEMP1       GET OPERAND LETTER
6465   12443  025717          LDB  OPTYP       SET THE TYPE TO FULL,SPLIT,OR
                                                                  INTEGER
6466   12444  004020          ADB  .3            WITH UNKNOWN DIMENSIONS
6467   12445  060451          JSM  STROP+1     COMBINE AND STORE
6468   12446  021475          LDA  TEMP2       RECALL FOLLOWING CHAR
6469   12447  170402          RET
6470   12450  015714  STRI1   CPB  SFLAG       STRING VARIABLE ALLOWED?
6471   12451  066453          JMP  *+2         YES
6472   12452  160206  STRNP   JSM  ERRA,I        NO
6473   12453  020132          LDA  M1          SET FLAG
6474   12454  031714          STA  FLAG          TO "STRING OCCURRED"
6475   12455  021474          LDA  TEMP1
6476   12456  024076          LDB  B36
6477   12457  035723          STB  ARYAD       POINT ADDRESS AT ROM
6478   12460  060451          JSM  STROP+1     STORE STRING OPERAND
6479   12461  065055          JMP  GNEXT       GET NEXT CHAR AND RETURN
```

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```
6481*
6482*   FOR STATEMENT SYNTAX
6483*
6484   12462  062231  FORS    JSM  VAROP     SEEK A SIMPLE VARIABLE
6485   12463  066464          JMP  SYNE8
6486   12464  160206  SYNEB   JSM  ERRA,I    NOT FOUND
6487   12465  060463          JSM  SYMC1      SEEK "="
6488   12466  012006          DEF  ASSOP-1
6489   12467  066522          JMP  SYNE6      NOT FOUND
6490   12470  062040          JSM  FSC        GET REST OF INITIAL FORMULA
6491   12471  026034          LDB  TOA        SEEK "TO"
6492   12472  060537          JSM  STSRH
6493   12473  160206  SYNE9   JSM  ERRA,I    NOT FOUND
6494   12474  062040          JSM  FSC        GET ENDING FORMULA
6495   12475  061153          JSM  EOLCK      EOL?
6496   12476  026000  FORS1   LDB  STEPA      SEEK "STEP"
6497   12477  060537          JSM  STSRH
6498   12500  160236  SYE10   JSM  ERRA,I    NOT FOUND
6499*
6500*   WAIT STATEMENT SYNTAX
6501*
6502   12501  062040  WAITS   JSM  FSC        GET FORMULA
6503   12502  065151          JMP  EOST       DEMAND END OF STMT
6504*
6505*   DEF STATEMENT SYNTAX
6506*
6507   12503  061140  DEFS    JSM  LTR
6508   12504  066433          JMP  SYNE4
6509   12505  062424          JSM  FNCK       "FN" FOLLOWED BY LETTER?
6510   12506  066433          JMP  SYNE4      NO
6511   12507  024040          LDB  B37        YES RECORD
6512   12510  060451          JSM  STROP+1      FUNCTION NAME
6513   12511  021475          LDA  TEMP2
6514   12512  060521          JSM  LPCKE      DEMAND LEFT PAREN
6515   12513  062231          JSM  VAROP      FETCH SIMPLE VARIABLE
6516   12514  066515          JMP  SYNE5
6517   12515  160206  SYNES   JSM  ERRA,I    NOT FOUND
6518   12516  060534          JSM  RPCKE      DEMAND RIGHT PAREN
6519   12517  061153          JSM  EOLCK      EOL?
6520   12520  060463          JSM  SYMCI      DEMAND
6521   12521  012006          DEF  ASSOP-1      AN "="
6522   12522  160206  SYNE6   JSM  ERRA,I
6523   12523  066501          JMP  WAITS      FETCH ASSIGNING FORMULA
6524*
6525*   RETURN STATEMENT SYNTAX
6526*
6527   12524  061066  RETNS   JSM  GETSK      RETURN A VALUE?
6528   12525  065150          JMP  EOST-1     NO
6529   12526  055400          DSZ  BADDR
6530   12527  066501          JMP  WAITS      YES, GET A FORMULA
6531*    12533 IS LAST
6532*   MATH ROUTINES HERE
```

PAGE 141 STATEMENT EXECUTION JUMP TABLE

```
6534*
6535*    EXECUTION JUMP TABLE
6536*
6537    13741                       ORG  13641B
6538    13741  173131               ABS  EWRIT-*
6539    13742  173772               ABS  EGRAD-*
6540    13743  173767               ABS  EDEG-*
6541    13744  173763               ABS  ERAD-*
6542    13745  174111               ABS  ELET-*
6543    13746  174044               ABS  XEC4-*     FORMAT
6544    13747  172777  DISP         ABS  EDISP-*
6545    13750  174505               ABS  EINPT-*
6546    13751  174562               ABS  ERSTR-*
6547    13752  172773               ABS  EPRIN-*
6548    13753  174011               ABS  EREAD-*
6549    13754  174036               ABS  XEC4-*     DATA
6550    13755  173531               ABS  EWAIT-*
6551    13756  174130               ABS  ESTOP-*
6552    13757  174106               ABS  EEND-*
6553    13760  174252               ABS  ERTRN-*
6554    13761  002577               ABS  EGOSB-*
6555    13762  174354               ABS  ENEXT-*
6556    13763  174265               ABS  EFOR-*
6557    13764  174213               ABS  EIF-*
6558    13765  002574               ABS  EGOTO-*
6559    13766  174024               ABS  XEC4-*     REM
6560    13767  174023               ABS  XEC4-*     DEF
6561    13770  174022               ABS  XEC4-*     COM
6562    13771  174021               ABS  XEC4-*     DIM
6563    13772  174064               ABS  ELET-*     IMPLIED LET



6565    13773  167371               ABS  FOP13-*    NON-FORMULA OPERATOR TABLE
6566    13774  175744               ABS  FTN13-*    FUNCTION TABLE
6567    13775  167434               ABS  CMD13-*    SYSTEM COMMAND TABLE
6568    13776  173560               ABS  SYN13-*    STATEMENT TABLE
6569    13777  012000               OCT  12000      TABLE OP-CODE
```

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```
6571   16410                    ORG  16410B
6572*
6573*   CHECK SYNTAX OF DIM AND COM STATEMENTS
6574*
6575   16410  045711  ARRYS     ISZ  DFLAG     SET DIM MODE FOR SBSCK
6576   16411  021706            LDA  SBPTR
6577   16412  031710            STA  MSFLG     SAVE POINTER
6578   16413  031714            STA  SFLAG     ENABLE STRING VARIABLES
6579   16414  160246            JSM  VAROA,I   FETCH I.D.
6580   16415  164321            JMP  E25+1,I   MISSING VARIABLE
6581   16416  074610            SZB  ARRE1     ARRAY OR STRING; DIMENSIONED?
6582   16417  031475            STA  TEMP2
6583   16420  121710            LDA  MSFLG,I   FETCH IDENTIFIER
6584   16421  025714            LDB  SFLAG     FETCH PACKED DIMENSIONS
6585   16422  160240            JSM  MDIMA,I   COMPUTE SPACE REQUIRED
6586   16423  001461            ADA  FTMP2     UPDATE
6587   16424  031461            STA  FTMP2       COMMON POINTER
6588   16425  021475            LDA  TEMP2
6589   16426  010031  ARRY1     CPA  EOL       END OF STMT?
6590   16427  170402            RET            YES
6591   16430  060510            JSM  COMCE     DEMAND A COMMA
6592   16431  066411            JMP  ARRYS+1   CONTINUE
6593   16432  160206  ARRE1     JSM  ERRA,I    NO DIMENSION ON STRING
6594*
6595*   COM STMT SYNTAX AND STORAGE ALLOCATION
6596*
6597   16433  025423  COMS      LDB  PBPTR
6598   16434  015424            CPB  PBUFF     NULL PROGRAM?
6599   16435  066437            JMP  *+2
6600   16436  160206  SYNE3     JSM  ERRA,I    NO, ILLEGAL COM
6601   16437  021422            LDA  UKPTR
6602   16440  072710            RZA  DIMS      SKIP IF KEY; NO STORAGE
                                                        ALLOCATION
6603   16441  035461            STB  FTMP2     INITIALIZE COMMON POINTER
6604   16442  062410            JSM  ARRYS       CHECK SYNTAX
6605   16443  025404            LDB  LWAM
6606   16444  004156            ADB  M100
6607   16445  074076            TCB
6608   16446  005461            ADB  FTMP2     EXCEEDED MAXIMUM
6609   16447  074112            SBM  *+2         COMMON AREA?
6610   16450  064561            JMP  FSCE4     YES
6611   16451  025461            LDB  FTMP2     MOVE PROGRAM
6612   16452  035424            STB  PBUFF       POINTERS
6613   16453  035423            STB  PBPTR
6614   16454  035426            STB  PBPTO
6615   16455  164203            JMP  ACTSA,I
6616*
6617*   DIM STMT SYNTAX
6618*
6619   16456  062410  DIMS      JSM  ARRYS     CHECK SYNTAX
6620   16457  164203            JMP  ACTSA,I
6621*
6622*   READ AND INPUT STATEMENT SYNTAX
6623*
6624   16460  160246  READS     JSM  VAROA,I   RECORD VARIABLE OPERAND
6625   16461  160206  SYE13     JSM  ERRA,I    NONE FOUND
6626   16462  066463            JMP  *+1
```

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```
6627   16463  060504          JSM  COMCK     COMMA?
6628   16464  065151          JMP  EOST      NO
6629   16465  066460          JMP  READS     YES
6630*
6631*   RESTORE STMT SYNTAX
6632*
6633   16466  061066  RSTRS   JSM  GETSK     LINE # GIVEN?
6634   16467  065150          JMP  ENDS+1    NO
6635   16470  060663          JSM  LNUM-1    YES, GET LINE #
6636   16471  065151          JMP  EOST
6637*
6638*   REM STATEMENT SYNTAX
6639*
6640   16472  020107  REMS    LDA  B1000
6641   16473  041552          IOR  RBUFF+1
6642   16474  031552          STA  RBUFF+1   SET ASCII BIT
6643   16475  020031          LDA  EOL       SET STATEMENT TERMINATOR
6644   16476  024012          LDB  .1        SET TO STORE IN LOW HALF
6645   16477  160253          JSM  CHRSA,I   RECORD REST TO STMT AS ASCII
6646   16500  164203          JMP  ACTSA,I
6647*
6648*   GET SELECT CODE AND FORMAT #
6649*
6650   16501  045706  IOHED   ISZ  SBPTR
6651   16502  060520          JSM  LPCKE-1   DEMAND LEFT BRACKET
6652   16503  160202          JSM  FSCA,I    GET SELECT CODE
6653   16504  060510          JSM  COMCE     DEMAND COMMA
6654   16505  061055          JSM  GNEXT
6655   16506  045706          ISZ  SBPTR
6656   16507  060463          JSM  SYMC1     LOOK FOR "*"
6657   16510  012012          DEF  TIMES-1
6658   16511  066514          JMP  *+3       NOT FOUND
6659   16512  045706          ISZ  SBPTR
6660   16513  065055          JMP  GNEXT
6661   16514  055706          DSZ  SBPTR
6662   16515  064663          JMP  LNUM-1
```

PAGE 144 SYNTAX

```
6664*
6665*   SEARCH ALL TABLES
6666*     (A)=FIRST CHAR  BADDR POINTS TO REST OF STRING
6667*     (B)=Ø     FOR STATEMENTS
6668*        =-1    FOR SYSTEM COMMANDS
6669*        =-2    FOR ARITHMETIC FUNCTIONS
6670*
6671   16516  ØØ4132  SALT     ADB  M1
6672   16517  Ø35473           STB  TEMP      SAVE RELATIVE ADDRESS OF TABLE
6673   1652Ø  Ø25403           LDB  MAW       GET ADDRESS OF LAST
6674   16521  Ø62531           JSM  SPAGE     SEARCH TABLE ON R/W PAGE
6675   16522  Ø24131           LDB  LROMA     GET ADDRESS OF LAST ROM PAGE
6676   16523  Ø62531  SALT1    JSM  SPAGE     SEARCH TABLE IN ROM
6677   16524  Ø25717           LDB  NUM
6678   16525  Ø1413Ø           CPB  FROMA     ALL TABLES SEARCHED?
6679   16526  17Ø4Ø2           RET            YES
6680   16527  ØØ416Ø           ADB  M1Ø24
6681   1653Ø  Ø66523           JMP  SALT1     NO, SEARCH NEXT PAGE
6682*
6683*   SEARCH TABLE ON A GIVEN PAGE
6684*     RET IF NOT FOUND
6685*     RET TO P+2 OF ROUTINE WHICH CALLED SALT IF FOUND
6686*       (A)= OP CODE
6687*       (B)= PAGE
6688*       (SBPTR,I)=SHIFTED OP CODE
6689*       (TEMP)=JUMP ADDRESS
6690*
6691   16531  Ø35717  SPAGE    STB  NUM       SAVE PAGE ADDRESS
6692   16532  Ø7453Ø           LDB  B,I       READ LAST WORD OF PAGE
6693   16533  Ø7431Ø           SZB  TSRET     RETURN IF ZERO
6694   16534  Ø25717           LDB  NUM       GET TABLE
6695   16535  ØØ5473           ADB  TEMP        STARTING
6696   16536  Ø7443Ø           ADB  B,I           ADDRESS
6697   16537  Ø7474Ø           SBL  1         POINT TO FIRST CHARACTER
6698   16538  Ø6Ø537           JSM  STSRH     SEARCH TABLE
6699   16539  17Ø4Ø2  TSRET    RET            NOT FOUND, RETURN
67ØØ   1654Ø  Ø7Ø442           SAR  1Ø
67Ø1   16541  Ø25473           LDB  TEMP
67Ø2   16542  Ø14133           CPB  M2        GET 4 BIT CODE
67Ø3   16543  Ø5ØØ32           AND  B17         FOR SYSTEM COMMANDS
67Ø4   16544  ØØ5717           ADB  NUM       GET TABLE
67Ø5   16545  Ø7443Ø           ADB  B,I         ADDRESS
67Ø6   1655Ø  Ø7ØØ76           TCA            COMPUTE AND
67Ø7   16547  Ø74Ø17           ADA  B         STORE
67Ø8   16548  Ø7Ø417           ADA  A,I         ABSOLUTE
67Ø9   16549  Ø31473           STA  TEMP          JUMP ADDRESS
67Ø1Ø  1654A  125717           LDB  NUM,I     GET OP CODE FOR THIS PAGE
6711   1654B  Ø21466           LDA  LOCL1     RECALL OP CODE
6712   1654C  Ø55777           DSZ  RSPTR     RETURN TO ROUTINE
6713   1654D  Ø64357           JMP  RETN2       WHICH CALLED SALT
```

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```
6715*
6716*   EXECUTE GOTO AND GOSUB
6717*
6718    16560  025421  EGOSB   LDB  PRADD     STACK RETURN ADDRESS
6719    16561  060563  EGOTO   JSM  SLWST     STACK GARBAGE IF GOTO
6720    16562  060771          JSM  GTOPP     GET FIRST OPERAND
6721    16563  010064          CPA  INTFL
6722    16564  066602          JMP  EGOS2     YES, SIMPLE BRANCH
6723    16565  061217          JSM  FETCH     NO, COMPUTE BRANCH INDEX
6724    16566  160225          JSM  FLTRA,I   CONVERT TO INTEGER
6725    16567  066606          JMP  EGOS3     OVERFLOW
6726    16570  004154          ADB  M64
6727    16571  074653          SBP  EGOS3     SKIP IF GREATER THAN 64
6728    16572  004054          ADB  .63        RESTORE OFFSET BY -1
6729    16573  074552          SBM  EGOS3     SKIP IF RESULT WAS NEGATIVE OR 0
6730    16574  074744          SBL  1         MULTIPLY BY 2
6731    16575  005472          ADB  TEMPS     COMPUTE
6732    16576  035472          STB  TEMPS       AND SAVE ADDRESS
6733    16577  074056          CMB
6734    16600  005421          ADB  PRADD
6735    16601  074252          SBM  EGOS3     SKIP IF BEYOND END OF STATEMENT
6736    16602  060567  EGOS2   JSM  UNSTK     UNSTACK FLAG
6737    16603  011421          CPA  PRADD     WAS IT A GOSUB?
6738    16604  045412          ISZ  LSTPT     YES, RESTORE RETURN ADDRESS ON
                                                                        STACK
6739    16605  166610          JMP  EGSIA,I   EXECUTE BRANCH
6740    16606  055412  EGOS3   DSZ  LSTPT     OUT OF BOUNDS, DELETE FROM
                                                                        STACK
6741    16607  164172          JMP  XEC4A,I
6742    16610  010202  EGSIA   DEF  EGOS1
6743*    16614B IS LAST
6744*    TAPE COMMAND SYNTAX FOLLOWS HERE
6745*
6746                            END
*   NO ERRORS*
```

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.1	0020	0345	0393	1008	2178	2527	2960	3044	3459	3610	3712
	3853	3998	4024	4168	4256	4462	4927	5520	5534	5831	6150
	6644										
.10	0071	0072	0603	1962	2401	2402	2985	2986	4135	5210	5218
	5278										
.100	0070	2777	4004								
.1000	0069	5969									
.11	0035	0043	1314	1651	2249	2962	4031	4133			
.12	0036	3333	3379	4033	4157	4163	4183	4731			
.13	0039	4037	4144								
.15	0048	0083									
.16	0049	0084	1737	1757	5131						
.1E4	0068	1445	1492	2415	2437	2438	2631				
.2	0027	0391	0475	2170	3302	3308	3711	3779	4078	4685	4932
	5409	5679									
.21	0050	3855									
.22	0051	0087	2964								
.23	0052	0088	5567								
.28	0053	1966	6021								
.3	0028	0045	0582	1373	1374	1453	3330	3351	3359	3363	3366
	3710	5058	5153	5657	6466						
.31	0054	0090	1033	1688	1719	2138	3746	3756	3826	3865	3874
	3888	3894	3969								
.32	0055	0715	1287	1334	1543	1874	2554	4467	4467	4744	
.33	0056										
.34	0057	0091	3880	3883							
.37	0058										
.4	0029	2549	3265	3601	5244	5989	6023	6318			
.40	0059	6328									
.41	0060	1405	6243								
.43	0061	0880	1238								
.45	0062	0882	1239								
.46	0063	1240									
.48	0064	1001	1241	3902							
.5	0030	1339	3607	3993	4063	5241	5291	5303	5663		
.58	0065	0094	1242								
.6	0031	0044	2788								
.63	0066	1747	2012	2681	2681	6728					
.7	0032	2070	4069	6000							
.8	0033	5703	5995	6320							
.9	0034	2503	2601	2796	3208	5313	5615	6203	6212	6221	6420
.99	0074	2812									
.ADD	2376	2356									
.BUFA	0180	0776	1412	1439	1791	1843	2778				
.EIN1	5408	5425									
.FADA	0185	5292	5841								
.FDA1	5378	5366									
.FDVA	0188	5867									
.FMPA	0187	5861									
.FSBA	0186	5310	5751	5906							
.FSR	0190										
.LNUM	1099	0501	0793	1300	2403	2561	2565	2593	2794	2799	2995
	3003	3018	3019	3156	3170	3494	3527				
.NPWR	1014	2529	4257	5121							
.OVER	0985	0977									

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BKPTR	1230	1275	1347	1509	1516	1535	1704	1853	1859	1865	1870
	1872	1875	1915	1916	1938	1943	1946	1951	1957	1969	2045
BKSP	1853	1309									
BLANK	1173	0768	2555								
BLNKA	4467	4463									
C5	0015										
C6	0011	0114									
C7	0022	0100									
CALEX	5056	2838	5009								
CALLK	1976	1277	1306								
CALSN	2682	2582									
CALX2	5071										
CALXA	2838	2828									
CCNT	1229	1274	1438	1454	1917	1927	1930	1934	2091	2107	
CHRS1	4890	4900	4901								
CHRS2	4902	4897									
CHRS3	4905	4893	4895								
CHRSA	0219	2670	6645								
CHRST	4889	0219	4871								
CKEO1	4554	4550									
CKEOL	4546	4266	4335	4441	4472	4529					
CKRCD	2587	2573									
CLAR2	0956	0969	0976	3992							
CLE1	1711	1714									
CLEAR	1703	0160	1294	1361	1366	1393	1437				
CLERA	0160	1026	2419	2520	2560	2784	3739	4293	4333	4419	5102
	5140	5393	5427	5434	5437						
CLINE	1101	0792	1429	1465	1553	2623	3768				
CLP1A	0217	2195									
CLPR1	2915	0217	2920	2979							
CLPR2	2921	2916	2953								
CLPRG	2908	2847	2887								
CLRST	1687	1360	1680								
CMD13	2296	6567									
CMERR	3134	0268									
CMND	2619	2610									
CMNDF	2622										
COLON	1242	5109									
COMCE	0419	0248	2362	2392	2465	6591	6653				
COMCK	0414	0419	2336	6627							
COML	1209	3053	3124	3126	3132						
COMMA	6104	2720									
COMP1	3649	3643									
COMPL	3640	2989	3651								
COMPR	5905	5912	5918	5924	5930	5936	5942				
COMS	6597	4800									
COMTA	1628	1362									
CONS3	0872	0870									
CONST	0867	2333	5413								
CONT	1382	2283									
CONT1	1388	1383									
CONTK	1386	1384	2149								
CPLAC	1116	2504	4305	4947							
CR1	1040	1028	1804								
CRC	1670	1414									
CRC1	1678	1671	4768								

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CRC1A	4768	3757									
CRC2	1676	1673									
CRCHK	1672	Ø228									
CRCKA	Ø228	2783	28Ø8	5Ø71	51Ø1						
CRLF	1Ø27										
CRLF1	1Ø29	1681	278Ø	3732	3754	4347	4421	4454	5Ø25	5122	
CRTN	ØØ37	ØØ38	ØØ39	1Ø29	1345	1654	1819				
CTERM	1683	1675									
CTYPE	1115	25Ø5	43Ø6	4939							
CXEC4	5437	542Ø									
DATA2	2336										
DATAS	2332	2338	4788								
DATCD	5386	5379									
DCMF1	3689										
DCMF2	3693	3699									
DCMP1	3675	3681									
DCMP2	3683	3674	368Ø								
DCMP3	3679	3675									
DCMP4	37Ø2	3667									
DCMP5	3666	3686									
DCMP6	3672	37Ø7									
DCOM1	3661										
DCOMA	Ø21Ø	Ø567	2167	2188	2842	2861	2977				
DCOMF	3688	3664	3685								
DCOMP	3655	Ø21Ø	2968								
DEFOP	3532	3467	35Ø7								
DEFS	65Ø7	4799									
DEL1	1427	128Ø	1571	1574							
DEL2	1426	1428									
DELC1	1518	1527									
DELET	2975	2284									
DELIN	2Ø5Ø	1279									
DELSA	Ø175	1433									
DELST	2842	Ø175	2596								
DFLAG	1175	26Ø7	2944	2952	6322	6325	6359	6387	6575		
DIGCK	Ø65Ø	Ø597	Ø599	2343	2458	4942	63Ø7				
DIGIT	1233	4Ø25	4Ø35	4Ø59	4124						
DIMS	6619	48Ø1	66Ø2								
DINCT	6435	46Ø6	64Ø9	6412	6418	6419					
DISP	6544	5Ø39									
DISPA	5Ø39	5Ø34									
DIV	6114										
DLIMT	Ø648	Ø65Ø									
DNARW	1473	1566									
DOLAR	1243	3896	4Ø73								
DPERR	ØØ43										
DRQST	11Ø2	Ø928	2Ø69	2525	2572	2576	282Ø	2822	3Ø43	3737	5137
	54ØØ	5412	5416								
DSTRA	5698	5614									
DSTRT	1Ø88	3657	5365	5383	5449	5645	5698				
E	ØØ8Ø	4Ø89									
E1	Ø235	2836									
E1Ø	Ø244										
E15	Ø249										
E2Ø	Ø254										
E25	Ø259	4911	4912	658Ø							

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E3Ø	Ø264	3158									
E35	Ø269										
E4Ø	Ø274	3486									
E45	Ø279	3646	4696								
E5	Ø239										
E5Ø	Ø284										
EADD	5163	5147	5447								
EADD1	5172	5165									
EAND	596Ø	5773									
ECAL	5Ø78	Ø215									
ECAL1	5Ø81	5Ø85									
ECAL2	5Ø86	5Ø82									
ECALA	Ø215	286Ø									
ECLR	2474	1313									
EDEG	493Ø	654Ø									
EDISP	4327	6544									
EDIT2	1564	1419									
EDITR	2848	2844	2845	2846	2898						
EEB	1574	1565	1566	1567	1568	1569	157Ø	1571	1572	1573	1625
EEND	5Ø5Ø	4988	5Ø57	6552							
EEQL	593Ø	5767	5937	6Ø57							
EFAD	584Ø	5759									
EFDV	5866	5762									
EFET	1464	2165	2289								
EFMP	586Ø	5761									
EFOR	5195	6556									
EFOR1	5224	5212									
EFOR2	521Ø	5216									
EFSB	575Ø	576Ø									
EGORE	5924	5775									
EGOS1	5147	6742									
EGOS2	6736	6722									
EGOS3	674Ø	6725	6727	6729	6735						
EGOS4	5151	5146	5149								
EGOSB	6718	6554									
EGOTO	6719	6558									
EGRAD	4932	6539									
EGS1A	6742	6739									
EGTRT	5912	5764									
EIF	5144	6557									
EINPT	5391	6545									
ELBRC	5894	577Ø									
ELET	5Ø34	5Ø36	6542	6563							
ELINA	Ø169	28Ø7									
ELORE	5936	5776									
ELST	5918	5765									
EMSGA	2833	2789									
ENDS	Ø854	2433	4778	4779	478Ø	4791	6634				
ENDW	2Ø46	1712									
ENEQL	5492	5766	5913	5956							
ENEXT	5272	5281	6555								
ENOT	6Ø54	5774									
ENTE1	3439	3422									
ENTE3	3454	346Ø	3477								
ENTE4	3474	3464	3469								
ENTE5	3479	3455									

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GTMP	0762	1522	1533	1650	1920	3965					
GTMP2	1697	2008	2023	2028							
GTOPD	3942	3822	3866	3890	3917						
GTOPP	0677	3594	4549	4564	5186	5195	6720				
GTR	6116										
GTRC1	2565	2557	2559								
GTRC2	2673	2579									
GTRC3	2580	2676									
GTRCD	2566	2637									
GTREQ	6127										
GTSTA	0213	2373	2730								
HFLG1	1106	0568	2442	2446	5013	5015					
HFLGA	0568	0559									
HSTPT	1087	0336	0337	0338	0339	0471	0472	0566	0913	0914	2422
	2603	3179	3213	3216	3230	3237	3238	3240	3542	3546	3547
	4511	5067	5068	5139	5203	5204	5206	5214	5222	5230	5240
	5272	5279	5280	5290	5300	5302	5312	5318	5430	5431	5465
	5470	5473	5488	5504	5507	5548	5579	5604	5618	5652	5653
	5655	5691	5694	5805	5825	5833	5834	5850	5855	5898	5976
	5977	6012	6018								
HUN1	2231	2238									
HUNT	2230	2083	2152	2160	2189	2206					
I	0067	3907	6319								
ICNT	0308	1407	3752	5111							
IFS	4917	4796									
ILET	2639	2621									
ILET1	2650	2646	2662								
ILETS	2642	4802									
IMPOP	2683										
IMPY	0893	0604	3297	3301	5818						
IMPY1	0895	0906									
IMPYR	0907	0897	0899	0903							
INCH1	5434	5424									
INCHA	5440	5411									
INCHT	5428	5414	5440								
INCLN	3017	2849	3009								
INCLR	3033	3021									
INDEX	1234	4097	4099	4104							
INF	0077	0354	2487	5001							
INIT1	0564										
INITS	0559	0555	2163	2201	2515	2830	2848	4983	5051		
INITV	1445	1567									
INREA	0226	5399									
INRET	5401	0226	5432	5435							
INS0	1529	1513									
INS1	1532	1541									
INS2	1542	1520	1536								
INSRT	1509	1510	1570								
INTC1	0599	0609									
INTC2	0610	0600									
INTCK	0594	0586	2592								
INTEA	0178	2501									
INTEL	1125	0009	2502								
INTFL	0075	6721									
INTGR	1187	0596	0601	0602	0605	0607	0610	0615			
INTOV	0352	0349									

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IOBUF	1144	0180	0180	2051	2051						
IOEND	2051	1834									
IOHEA	0229	2707									
IOHED	6650	0229									
IOST	1718	0225	1727	1801	1805						
IOSTA	0225	1032	1039								
JCMND	2632	2628									
JTBA	2074	2071									
JTBL	2075	2074									
K1	2242	2125									
K2	2243	2126									
K3	2244	2130									
K4	2245	2131									
KERR	2084	0244	2153								
KEYFG	1109	1753	1944	1952	1955	4734	4996	4998			
KEYIN	1913	1976									
KEYN1	1936	1919	1922								
KEYN2	1957	1945									
KEYN3	1944	1939	1971								
KEYN4	1970	1958									
KEYN5	1952	1947									
KEYN6	1954	1937									
KEYN7	1917	1935									
KEYPR	2061	1326									
KILLK	2508										
KILLP	2510	2966									
KILLV	2514	2965									
KTRA	2080	2065									
KTBL	2319	2080	2080								
L	1232	4117	4122	4141	4149	4179	4180	4189			
L1	3739	3758									
L100	3752	3745									
L11	3844	3821	3836	3885	3895	3904					
L12	3838	3831									
L13	3862	3852									
L15	3887	3824									
L16	3912	3889									
L19	3903	3898	3908	3910							
L20	3905	3900									
L23	3814	3799	3862	3925							
L25	3827	3808									
L28	3938	3781	3789								
L29	3880	3854									
L2T1	1132	0885	0887	2092	2146	2987	2994	3289	3294	3298	3400
	4869	4875	5810	5819							
L2T2	1133	2988	2990	2993	3005	3011	3401	4272	4277	4579	5804
	5815	5817	5983	6006							
L3	3864	3857									
L4	3826	3816									
L6	3805	3878									
L8	3890										
L9	3917	3827									
LASTN	1183	0807	1498	2461	2467						
LBLI	2283	1628	1628								
LBOP	0119	2684	6355								
LBRAC	6122										

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NEXTL	0499	3565	5026	5348							
NEXTS	4910	4794									
NGOTO	5168	0278									
NINIT	3423	0275									
NM1	4036	4027									
NM2	4035	4030									
NM3	4026	4039									
NM4	4040	4032	4034								
NMOTA	0200										
NMOUT	4023	0200	3835	4433							
NN	4165	4155	4162	4175							
NN1	4166	4160									
NN10	4184	4182									
NN11	4199										
NN2	4178	4130	4164								
NN3	4159	4153									
NN4	4195	4185	4191	4192							
NN5	4186	4188									
NN6	4217	4199	4213								
NN7	4212	4216									
NOEOF	0857	0241	2663								
NOFMT	4696	4710									
NOPCD	5193	5256									
NORML	4959	2286									
NOST	4867	0253									
NOTA	6135	6227									
NOTOP	6126										
NPRIN	1168	1016	1020	1660	1666	2524					
NPWRT	1020	1375	2550	2790	2798						
NSTMT	2658	0239	2649	2656							
NUM	1181	1182	6677	6691	6694	6704	6710				
NUMCA	0211	0869	6209								
NUMOA	0212	2335	6211								
NXTIL	3593	3603	3605								
NXTDT	1089	3656	5372	5373	5448	5646					
NXTOP	3565	3064	3628								
NXTP1	3583	3149	3573	3593	3595	3611	3618	3631			
NXTP2	3575	3591									
NXTP3	3598	3588									
NXTP4	3612	3602									
NXTPR	3558	3572									
NXTST	1190	1386	3039	4986							
OBLNK	0715	3784	3811	3871	4237	4383					
ODGIT	1000	4081	4086	4186	4214						
OF	0961	0952									
OFA	2396	2387									
OFFA	1629	1371									
OFFI	4051	4165									
OFXD	4114	4043									
OL1	4730	4722									
OL2	4731	4725									
OL3	4728	4735	4738								
OLINE	4719	0169	4340								
ONE	0045	5234	5900								
ONEXT	0716	1002	1288	1352	1400	1658	1829	1847	3748	3771	3788
	3861	3881	3884	3892	3903	3913	3915	4085	4090	4098	4103

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RBUFF	1145	0181	0181	0198	0202	0202	1627	1627	2046	2866	2868
	2869	4769	4769	4770	4770	6641	6642				
RCAL	2082	2067									
RCOUT	1118	4600	4612	4650	4673						
RDYDA	0166	1390	1552	1848	2190	2202	2447	3048	4941	4948	4963
RDYPT	2516	0166	2980	3013							
RE1	1740	1761									
RE2	1762	1755	1758								
RE3	1743										
RE4	1747										
READS	6624	4784	4787	6629							
REE	1285	1283									
REED	0161	2499									
REED1	1267										
REED2	1327	1317	1320								
REED3	1336	1328	1333								
REED4	1299	1296									
REED5	1344	1330	1335	1421	1451						
REED6	1306	1293	1299	1354	1365	1441	1508	1530	1546	1857	1862
	1866	1877	1879	2090	2110	2119	2122				
REED7	1294	1284									
REED8	1417	1358									
REED9	1352	1348									
REEDD	1356	1338									
REEDE	1277	1376									
REEDG	1308	1304									
REEDL	1124	2500	2566	3751							
REEDT	1414	1409	1411								
REFRA	4767	4733									
REFRS	1735	1970	4767								
REMS	6640	4798									
RENM1	2994	3012									
RENM2	2997	3010									
RENM3	3007										
RENM4	3011	2999	3001								
RENUM	2984	2285									
RES	1202	0184									
RESA	1630	1452									
RESB1	0538	0544	2082								
RESBP	0544	2385	2650	6186	6231						
RET2	0301	0293	0810	0811	2464	4905					
RETA	1668	1667									
RETN2	0294	0417	0444	0459	0619	0673	0781	0850	0871	1415	1728
	1841	1988	2013	2236	2468	2703	3261	3384	3397	3614	3630
	3633	4315	4321	4369	4409	4418	4424	4553	4589	4692	6340
	6403	6456	6713								
RETN3	0293	3269	3277	3596	4554	6315	6336				
RETNN	5707	5185									
RETNS	6527	4792									
RFNX	2124	2097									
RFNX1	1453	2143									
RIGHT	1899	1985									
RIT3L	1655	1647									
RITE	2707	4777									
RITE1	1650	1664									
RITE2	1663	1656	1661								

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RITE3	1665	1665	1713								
RITE4	166Ø	1657									
RL3	4128										
RL4	4124	4121									
RND	3992	4Ø79	4145								
RND2	3989	3997									
ROUND	Ø987										
RPARN	61Ø6										
RPCK	Ø438	Ø447	6237								
RPCKE	Ø447	27Ø8	6382	6518							
RPOP	Ø155	Ø441									
RRUN	2145	2128	2133								
RSAVE	1Ø77	Ø294	Ø298	Ø3Ø1	Ø3Ø5	4618	4627	4629	4640		
RSCH1	6ØØ1										
RSCH2	6ØØ6	5993									
RSCHK	5988	5466	5572	5621	5897						
RSLT	1448	1568									
RSLT1	144Ø	1445									
RSLTE	1158										
RSPTR	12Ø3	Ø295	Ø3Ø2	Ø316	2511	2553	2764	2765	2855	3515	4ØØ6
	4616	4982	5553	5556	5582	5583	5593	5596	5598	6284	6392
	6394	6395	641Ø	6411	6413	6712					
RSTAK	12Ø1										
RSTKA	Ø158	251Ø	2552	2854	4981	5599	6391	6414			
RSTRS	6633	4785									
RSTT	3522	3485	3688								
RSULT	Ø336	497Ø	5417	5788							
RUN	3Ø39	Ø163	2292								
RUNA	Ø163	1446	2156								
S	ØØ82	39Ø9	6317								
SALT	6671	Ø2Ø7									
SALT1	6676	6681									
SALTA	Ø2Ø7	2578	26Ø9	262Ø	2674	6173					
SAROW	155Ø	1473	1489								
SAVBP	Ø53Ø	2Ø61	2381	2647							
SAVE	1213	2574	2675	5363	5369						
SAVEA	111Ø										
SAVEB	1111										
SBADR	1179	Ø531	Ø538								
SBLOC	4595	459Ø									
SBPTR	1172	Ø377	Ø381	Ø382	Ø383	Ø458	Ø532	Ø541	Ø545	Ø547	Ø574
	Ø58Ø	Ø611	Ø775	Ø836	Ø855	1221	2332	235Ø	2368	2611	2612
	2652	2653	2654	2669	271Ø	2729	2733	2746	2772	2791	28Ø9
	2864	451Ø	4524	4868	4898	4899	49Ø2	5Ø81	541Ø	6168	6175
	6185	6188	6189	6193	6199	623Ø	6232	6241	628Ø	6286	6356
	6384	6385	6386	646Ø	6576	665Ø	6655	6659	6661		
SBPUD	Ø382	Ø442	Ø583	Ø616	2744	49Ø6					
SBSC1	6379	637Ø	6373	6378							
SBSC2	6382	6428	6431								
SBSC3	64Ø5	6361									
SBSCK	6353	6338									
SBSCR	64Ø3	6388									
SBUFA	Ø199	Ø774	Ø791	14Ø3	143Ø	2862	2889	5Ø8Ø			
SCCNT	5892	5895									
SCERR	4665	Ø277									
SCMMA	61Ø8	6372	6427								

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SCRAT	2958	2291									
SCRK	2967	2963									
SCRP	3029	2512	2600								
SEC	1105										
SERF1	3516	3473									
SERFN	3506	3451	3484	3514							
SERFR	3498	3509									
SFLAG	1178	2608	2700	6247	6266	6363	6369	6381	6470	6474	6578
	6584										
SFMT	4661	4439									
SFMT1	4681	4709									
SFMT2	4694	4680									
SGNS	1004	5908									
SIGN	1184	0868	0872	1185	6208						
SLCOD	1113	1041	1721	1790	1838	2427	2540	2581	2787	4354	4358
	4672										
SLEND	0202	1267	1529	3764							
SLWST	0484	4353	4355	4448	4471	5084	5087	5090	5092	5093	5480
	5557	5565	5597	5606	5608	5896	6719				
SM2L	3362	3352									
SMCLN	6105										
SNFLA	0197	3832	5367	5467							
SPAGE	6691	6674	6676								
SPLFA	0196	6031									
SPRDD	1212	5396	5397	5403							
SSBPT	1180	0533	0540								
SSTT	3490	3449	3661								
SSYM1	3348	3355									
SSYM2	3376	3362	3367	3373							
SSYM3	3385	0270	3377	3380							
SSYM4	3358	3349									
SSYM5	3369	3364									
SSYM6	3353	3360									
SSYMA	0170	5196	5495								
SSYMT	3328	0170	3084	3104							
ST	1162	1211	1212	1213	4515	4519	4661	4708	5699		
STADD	5699	5702	5711								
STAR	2685	2590									
STAR2	0939										
START	0162	0007									
STDPG	2686										
STEP	1380	1459									
STEPA	6098	6496									
STEXP	0463	2352	2357	2365	2388	4919					
STMAX	0976	0971									
STMP1	3401	3343	3396	3691							
STMP2	3402	3331	3348	3361	3365	3371					
STMP3	3403	3334	3376	3381							
STMT	2609	2640									
STMT1	2618	2614	2616								
STOPE	5115	5014	5016								
STOPS	2434	2435	4790								
STOR1	0347	0356	0358								
STOR2	0539	0346									
STORE	0340	5227	5298								
STOUT	4253	3935	3979	4278							

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CROSS-REFERENCE TABLE

STP1	5123	5115	5119								
STPFL	1108	1380	1687	1692	1718	2538	2626	2814	3755	5010	
STPL	1459	1569									
STRI1	6470	6463									
STRID	6460	6337									
STRNP	6472	0252									
STROP	0373	6312	6334	6467	6478	6512					
STSRH	0453	0410	0429	0467	0476	6228	6282	6492	6497	6698	
STTOP	5982	5688	5878	6054							
SUMP	2215	0227	2147	2154	2162						
SUMPA	0227	5643									
SVAL1	3398	3353									
SVALU	3392	3345	3346	3399	3693						
SWITH	5371	5361									
SYE10	6498	0263									
SYE12	0874	0247									
SYE13	6625	0260									
SYE14	4872	0254									
SYE15	2713	0242									
SYE25	0618	0238	0598	0606	0612	0614	0630	0838	2534	3024	
SYM1	0398	0404									
SYM2	0407	0402									
SYMC1	0393	0414	6262	6371	6426	6487	6520	6656			
SYMC2	0391	0425	0438	2719	6218						
SYMCK	0395	0392	6256								
SYME2	3368	0271									
SYMTP	1083	0553	0564	2949	3061	3146	3241	3392	3408	3555	3557
	5199	5274									
SYN13	4806	6568									
SYNE2	2692	0265									
SYNE3	6600	0267									
SYNE4	6454	0255	6508	6510							
SYNE5	6517	0256	6516								
SYNE6	6522	0264	6489								
SYNE7	4920	0258									
SYNE8	6486	0261	6485								
SYNE9	6493	0262									
SYNTX	2598	2586	2589								
SYSER	0524	0235									
SYTSA	0209	3508									
SYTSH	5343	0209	5257	5352	5380						
TAB	6093	2753	2753								
TABA	2753	2739									
TABER	4426	0279	6060								
TABOP	4311	4282									
TBS2	2022	2019	2035								
TBS4	2034	2031									
TBS5	2020	2010									
TBS6	2008	2025									
TBSR1	2014	1337	1357								
TBSRH	2015	0168	1420								
TEMP	1135	1136	2618	2632	2865	2882	2886	2893	2900	6192	6672
	6695	6701	6709								
TEMP1	1137	0847	1061	4874	4890	4896	5198	5275	5330	5636	5642
	6179	6190	6252	6310	6311	6332	6368	6380	6447	6455	6464
	6475										

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CROSS-REFERENCE TABLE

TEMP2	1138	Ø821	Ø849	2943	4889	4894	5213	5264	5295	53Ø6	53Ø9
	5343	535Ø	5674	5999	6314	6327	6335	6468	6513	6582	6588
TEMP3	1139	Ø794	Ø8Ø2	Ø812	Ø822	14Ø4	2169	2877	2891	2892	291Ø
	2976	2978	4699	47Ø7	52Ø5	568Ø	5994				
TEMP4	114Ø	Ø584	Ø594	Ø613	Ø627	Ø637	Ø638	Ø824	Ø827	14Ø2	2194
	2417	2911	2918	2919	2921	2946	496Ø	5219	5221	5671	6ØØ3
TEMPS	1134	Ø498	Ø499	Ø5Ø2	Ø5Ø5	Ø5Ø6	Ø5Ø8	Ø512	Ø677	1224	1225
	1226	1227	1229	26Ø5	2997	3ØØØ	3ØØ6	3ØØ7	3Ø92	3Ø93	3Ø94
	3Ø94	31ØØ	31Ø1	3461	3462	347Ø	3474	3492	351Ø	3516	3523
	3569	357Ø	3575	3579	358Ø	3583	3584	3612	3613	3648	3678
	3734	374Ø	3766	3774	3775	3778	3785	3792	3793	3794	3814
	3818	3838	3839	3844	3845	3849	3927	3932	3937	3942	428Ø
	4313	4316	44Ø5	4443	4546	456Ø	4566	4567	4571	4577	458Ø
	4581	4587	4662	4674	4675	4677	4679	4691	4698	4972	5Ø79
	5Ø86	5163	5164	5171	518Ø	5236	5328	5347	5364	5368	5371
	5374	5394	54Ø6	5418	5429	5444	5468	5482	5486	55Ø9	5512
	555Ø	5558	561Ø	5612	5624	5628	564Ø	5649	5656	5662	5666
	5684	6151	62Ø2	6239	627Ø	639Ø	6396	6397	64ØØ	64Ø1	6423
	6424	6435	6436	6439	6731	6732					
TEPPP	1211	54Ø7	5421	5428							
TERM	1149	1Ø34	1676	1684	2521	2785	2815	4291	4294	4331	4334
	4344	4423	5391								
TEST	5327	5259	5276								
TFLAG	11Ø3	1271	1693	2517	2532	2775	28Ø3				
TFLG1	11Ø7	4953	4959	4962	5ØØ2	5ØØ6	5Ø19	5Ø12			
THENA	4923	4918									
TIMES	6113	6657									
TMP	1215	144Ø	1517	1518	1521	1523	1524	1532	1534	1539	1649
	1736	2Ø42	2Ø99	3962	3978	4747	4751				
TMP1	1216	1231	1648	1663	174Ø	175Ø	1756	1796	1811	3961	397Ø
TMP1Ø	1225	3763	3773	3846	3929	3936					
TMP11	1226	3735	38Ø9	3812	3869						
TMP12	1227	3817	3887	3893	39Ø1						
TMP13	1228	3796	38Ø6	4716	4184	4187					
TMP2	1217	1232	1738	1813	1816	2Ø16	2Ø2Ø	2536	4297	43Ø9	438Ø
	4583	4588									
TMP2A	2Ø42	1697	1745								
TMP3	1218	1234	1744	1749	2Ø22	2Ø24	3964	3973	3975	3976	
TMP4	1219	1235	1936	1959	1963	2Ø15	2Ø32	2Ø34			
TMP5	122Ø	1233	13Ø3	1318	1323	1325	1331	1341	1344	1359	1363
	1794	1839	1921	1924	1942	1948	1964	1983	2Ø14	2173	2235
TMP6	1221	1321	1329	1449	1512	1981					
TMP6A	1222	2Ø18	2Ø26	4748	4749						
TMP7	1223	15Ø3	3729	3741	3772						
TMP9	1224	3791	3875								
TMPA	Ø2Ø3	Ø762	1525	1537	1544	1741					
TMPOP	Ø184	43ØØ	4431	6Ø48							
TOA	6133	6491									
TOBLN	1632	171Ø									
TRAC2	4952	4955									
TRAC3	4961	4954									
TRACE	4955	2287									
TREGE	1157										
TRUE	59ØØ	5925	5931	5938							
TSRET	6699	6693									
TSRHA	Ø168	Ø453	Ø463	2Ø66	2740						

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TSTPT	1Ø85	5Ø62	5Ø91	513Ø	5472	56Ø5	562Ø	5687	5848	5854	5879
	5884	5887	5944	5988	599Ø	6Ø13	6Ø33	6Ø35			
TTY	1Ø39	1Ø3Ø	1662	45Ø2							
TYPE	121Ø	3Ø73	3Ø86	3114	3568						
TYPEC	46ØØ	4444									
TYPFL	ØØ78	2743	3815								
U1	1493	1491									
U3	1498	1477	1494								
U4	1487	1474	149Ø								
U5	15Ø1	1478	1479	1488	1497						
UFLAG	1177	6153	6196	6216	6225	6251	64Ø2	64Ø5			
UKDEF	2665	2591									
UKERR	2667	Ø243									
UKPTR	1Ø94	Ø92Ø	Ø927	2217	2546	2665	2928	2932	3128	3129	3479
	37Ø3	66Ø1									
UNEQL	6118										
UNFW	Ø967										
UNITS	11Ø4	25Ø6	3Ø45	4928							
UNMIN	612Ø	6219									
UNSTK	Ø491	4357	4359	4481	4483	5Ø6Ø	5Ø61	5Ø63	5Ø65	6736	
UPARA	Ø191	5873									
UPARW	1489	1565									
UPLUS	6121										
VALUE	1Ø82	Ø554	3166	3174	3231	3391	3425	3435	3439	3442	3692
VALUP	1599	1336									
VARO1	6316	63Ø8									
VARO3	6335										
VARO4	6337	63Ø6	6329	6331							
VARO6	6328	6321									
VAROA	Ø214	491Ø	6579	6624							
VAROP	63Ø1	Ø214	6155	6484	6515						
WAITS	65Ø2	4789	6523	653Ø							
WBUFF	Ø3Ø9	4525									
WIDTH	117Ø	123Ø	3867	3876	4Ø71	4Ø74	4174	4495			
WRIT	1647	Ø159									
WRIT2	4444	4455	4466	4532							
WRIT4	4472	4478									
WRIT5	4479	4476									
WRIT6	4529	45Ø3									
WRIT7	45Ø5	4496									
WRIT8	4536	4474	4531								
WRITB	449Ø	4485									
WRITE	Ø159	1Ø18	1Ø21	1Ø24							
WRITF	447Ø	4449									
WRITN	4456	4445									
WRITQ	4465	4446									
WRITS	4454	4456									
WRITX	4461	4451									
XC	1197	1215	1216	1217	1218	3491	3493	3495	3497	3522	3524
	3526	3528									
XEC	4981										
XEC3	4986										
XEC4	4995	Ø164	5Ø38	5151	5159	5319	5438	545Ø	57Ø5	6543	6549
	6559	656Ø	6561	6562							
XEC4A	Ø164	4348	476Ø	4765	4929	4973	6741				
XEC5	5Ø14	5Ø11									

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XEC6	5Ø17	Ø221									
XEC6A	Ø221	1396									
XEC7	5ØØ6	5ØØ3									
XEC8	5Ø26	5Ø2Ø	5Ø22								
XEC9	5Ø27	5Ø97									
XECA	1245	1387	3242								
XFAR1	Ø324	Ø341	Ø343	Ø347	Ø359	2758	4Ø23	4432	5232	5242	597Ø
	6Ø3Ø										
XFAR2	Ø363	Ø351	Ø916	2816	4ØØ5	4Ø4Ø	43Ø1	5235	5736	6Ø47	6Ø49
XKEY	2159	2Ø78									
XLST	22Ø6	2Ø77									
XLST1	2418	22Ø7	2211								
XRUN	2151	2Ø75									
XSCR	2187	2Ø76									
XSCR1	2194	Ø22Ø									
XSCRA	Ø22Ø	2971									
YC	1199	1219	122Ø	1222	3444	3518	3519	55ØØ	55Ø1	56Ø7	
ZAP	Ø152	Ø941									
ZONK	Ø954										
ZONK1	Ø958	Ø955									

PAGE 170 9830 MATH ROUTINES

```
0001                        ASMB,A,L,C
0003*  MATH ROUTINES 3—20—72
0004*
0005   00000                ORG  0
0006*
0007   00000  164121         JMP  START,I  START OF MONITOR
0008   00001  043060         OCT  43060    CONSTANT NEEDED BY PROCESSOR
0009   00002  000000         BSS  1
0010*
0011   00003  000000  C6     OCT  0        ONE
0012   00004  010000         OCT  010000   0000
0013   00005  000000         OCT  0        0000
0014*
0015   00006  000000  C5     OCT  0000000  PI/2
0016   00007  012560         OCT  12560    1570
0017   00010  074543         OCT  074543   7963
0018   00011  023200         OCT  023200   2680
0019*
0020   00012  000001  .1     DEC  1
0021*
0022   00013  000400  C7     OCT  000400   180/PI
0023   00014  053451         OCT  053451   5729
0024   00015  053571         OCT  053571   5779
0025   00016  050450         OCT  050450   5128
0026*
0027   00017  000002  .2     DEC  2
0028   00020  000003  .3     DEC  3
0029   00021  000004  .4     DEC  4
0030   00022  000005  .5     DEC  5
0031   00023  000006  .6     DEC  6
0032   00024  000007  .7     DEC  7
0033   00025  000010  .8     DEC  8
0034   00026  000011  .9     DEC  9
0035   00027  000013  .11    DEC  11
0036   00030  000014  .12    DEC  12
0037   00031  000015  CRTN   OCT  15
0038   00031         EOL    EQU  CRTN
0039   00031         .13    EQU  CRTN
0040*
0041*  POINTERS TO FUNCTIONS CONSTANTS
0042*
0043   00027         DPERR  EQU  .11   POINTER TO 180/PI
0044   00023         PI/2   EQU  .6    POINTER TO PI/2
0045   00020         ONE    EQU  .3    POINTER TO THE CONSTANT ONE
0046*
0047*
0048   00032  000017  .15    DEC  15
0049   00032  000020  .16    DEC  16
0050   00034  000025  .21    DEC  21
0051   00035  000026  .22    DEC  22
0052   00036  000027  .23    DEC  23
0053   00037  000034  .28    DEC  28
0054   00040  000037  .31    DEC  31
0055   00041  000040  .32    DEC  32
0056   00042  000041  .33    DEC  33
0057   00043  000042  .34    DEC  34
```

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```
0058  00044  000045  .37     DEC  37
0059  00045  000050  .40     DEC  40
0060  00046  000051  .41     DEC  41
0061  00047  000053  .43     DEC  43
0062  00050  000055  .45     DEC  45
0063  00051  000056  .46     DEC  46
0064  00052  000060  .48     DEC  48
0065  00053  000072  .58     DEC  58
0066  00054  000077  .63     DEC  63
0067  00055  000111  I       OCT  111
0068  00056  023420  .1E4    DEC  10000
0069  00057  001750  .1000   DEC  1000
0070  00060  000144  .100    DEC  100
0071  00061  000012  .10     DEC  10
0072  00061          LNFD    EQU  .10
0073  00062  100000  FLGBT   OCT  100000
0074  00063  000143  .99     DEC  99
0075  00064  100004  INTFL   OCT  100004
0076  00065  076000  OPMSK   OCT  76000
0077  00066  077777  INF     OCT  77777
0078  00067  100037  TYPFL   OCT  100037
0079  00070  101777  OPDMK   OCT  101777
0080  00071  000105  E       OCT  105
0081  00072  000106  F       OCT  106
0082  00073  000123  S       OCT  123
0083  00032          B17     EQU  .15
0084  00033          B20     EQU  .16
0085  00074  000022  B22     OCT  22
0086  00075  000023  B23     OCT  23
0087  00035          B26     EQU  .22
0088  00036          B27     EQU  .23
0089  00076  000036  B36     OCT  36
0090  00040          B37     EQU  .31
0091  00043          B42     EQU  .34
0092  00077  000044  B44     OCT  44
0093  00100  000052  B52     OCT  52
0094  00053          B72     EQU  .58
0095  00101  000100  B100    OCT  100
0096  00102  000133  B133    OCT  133
0097  00103  000140  B140    OCT  140
0098  00104  000177  B177    OCT  177
0099  00105  000377  B377    OCT  377
0100  00013          B400    EQU  C7
0101  00106  000777  B777    OCT  777
0102  00107  001000  B1000   OCT  1000
0103  00110  001400  B1400   OCT  1400
0104  00111  001740  B1740   OCT  1740
0105  00112  001760  B1760   OCT  1760
0106  00113  001774  B1774   OCT  1774
0107  00114  001775  B1775   OCT  1775
0108  00115  001777  B1777   OCT  1777
0109  00116  002000  QTOP    OCT  2000
0110  00117  002400  B2400   OCT  2400
0111  00120  003000  B3000   OCT  3000
0112  00121  004000  B4000   OCT  4000
0113  00122  006000  B6K     OCT  6000
```

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```
0114  00004          B10K    EQU  C6+1
0115  00004          RPOP    EQU  B10K
0116  00123  012000  B12K    OCT  12000
0117  00123          RBOP    EQU  B12K
0118  00124  032000  EXPOP   OCT  32000
0119  00125  050000  LBOP    OCT  50000
0120  00126  052000  LPOP    OCT  52000
0121  00127  170000  B17OK   OCT  170000
0122  00130  013777  FROMA   OCT  13777
0123  00131  000000  LROMA   BSS  1
0124  00132  177777  M1      DEC  -1
0125  00133  177776  M2      DEC  -2
0126  00134  177775  M3      DEC  -3
0127  00135  177774  M4      DEC  -4
0128  00136  177773  M5      DEC  -5
0129  00137  177772  M6      DEC  -6
0130  00140  177767  M9      DEC  -9
0131  00141  177766  M10     DEC  -10
0132  00142  177765  M11     DEC  -11
0133  00143  177764  M12     DEC  -12
0134  00144  177763  M13     DEC  -13
0135  00145  177762  M14     DEC  -14
0136  00146  177761  M15     DEC  -15
0137  00147  177751  M23     DEC  -23
0138  00150  177747  M25     DEC  -25
0139  00151  177740  M32     DEC  -32
0140  00152  177734  M36     DEC  -36
0141  00153  177720  M48     DEC  -48
0142  00154  177700  M64     DEC  -64
0143  00155  177660  M80     DEC  -80
0144  00156  177634  M100    DEC  -100
0145  00157  177400  M256    DEC  -256
0146  00160  176000  M1024   DEC  -1024
0147  00161  154360  MAXSN   DEC  -10000  -(MAXIMUM ALLOWABLE LINE
                                           NUMBER)
0148  00162  043116  FN      ASC  1,FN
0149*
0150*  MATH CONSTANTS THAT ARE NEEDED ON BASE PAGE
0151*
0152  00163  177401  ZAP     OCT  177401
0153  00164  063440  MASK1   OCT  063440
0154  00165  061400  MASK2   OCT  061400
```

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```
0156*
0157  00166 000000 FWAM   BSS  1
0158  00112        RSTKA  EQU  B1760      START OF RETURN STACK
0159  00167 000000 WRITE  BSS  1         PRINTER AND DISPLAY DRIVER
0160  00170 000000 CLERA  BSS  1         CLEAR SCREEN
0161  00116        REED   EQU  QTOP      KEYBOARD DRIVER QTOP IS = 2000B
0162  00121        START  EQU  B4000
0163  00171 000000 RUNA   BSS  1         PHASE Z:SYMBOL TABLE AND
                                                              STORAGE
0164  00172 000000 XEC4A  BSS  1
0165  00173 000000 PEXMA  BSS  1
0166  00174 000000 RDYDA  BSS  1
0167  00122        LISTA  EQU  B6K
0168  00175 000000 TSRHA  BSS  1         TABLE SEARCH
0169  00176 000000 ELINA  BSS  1         OUTPUT I/O BUFFER
0170  00177 000000 SSYMA  BSS  1         SEARCH SYMBOL TABLE FOR SYMBOL
0171  00200 000000 OPCHA  BSS  1
0172  00201 000000 FORMA  BSS  1
0173  00202 000000 FSCA   BSS  1
0174  00203 000000 ACTSA  BSS  1
0175  00204 000000 DELSA  BSS  1
0176  00205 000000 AERRA  BSS  1         ALTERNATIVE ENTRY FOR ERROR
0177  00206 000000 ERRA   BSS  1
0178  00207 000000 INTEA  BSS  1
0179  00210 017036 OUTIA  DEF  OUTIN     OUTPUT AN INTEGER
0180  00211 000000 .BUFA  BSS  1         FIRST CHAR OF I/O BUFFER
0181  00212 000000 .SLBF  BSS  1          REFRESH BUFFER POINTER
0182  00213 001744 ARIA   DEF  AR1
0183  00214 001754 AR2A   DEF  AR2
0184  00215 000000 TMPOP  BSS  1
0185  00216 011500 .FADA  DEF  FAD
0186  00217 011466 .FSBA  DEF  FSB      SUBTRACT
0187  00220 016311 .FMPA  DEF  FMP      MULTIPLY
0188  00221 011576 .FDVA  DEF  FDV      DIVIDE
0189  00222 000000 ENTFA  BSS  1
0190  00223 016162 .FSR   DEF  FSR
0191  00224 016054 UPARA  DEF  UPARO    UP ARROW
0192  00225 017021 FLTRA  DEF  FLTRF
0193  00226 017001 FLTFA  DEF  FLTFX
0194  00227 017055 FXFLA  DEF  FXFLT
0195  00230 017121 FLTSA  DEF  FLTSP
0196  00231 016365 SPLFA  DEF  SPLFL
0197  00232 017331 SNFLA  DEF  SNFLT    SYNTAX FORMAT TO FLOATING
0198  00233 000000 BEND   BSS  1          I/O BUFFER END
0199  00233        SBUFA  EQU  BEND
0200  00234 000000 NMOTA  BSS  1          NUMBER OUTPUT ROUTINE LINK
0201  00235 000000 FILLA  BSS  1          SUPPLY NEEDED BLANKS ON
                                                              OUTPUT
0202  00236 000000 SLEND  BSS  1         REFRESH BUFFER END
0203  00111        TMPA   EQU  B1740
0204  00110        BADRP  EQU  B1400      POINTER POINTER TO I/O BUFFER
0205*
0206  00123        FOPBS  EQU  B12K
0207  00237 000000 SALTA  BSS  1
0208  00240 000000 MDIMA  BSS  1
0209  00241 000000 SYTSA  BSS  1
0210  00242 000000 DCOMA  BSS  1
0211  00243 017154 NUMCA  DEF  NUMCK
```

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```
0212   00244  017266  NUMOA  DEF  NUMOP
0213   00245  000000  GTSTA  BSS  1
0214   00246  000000  VAROA  BSS  1
0215   00247  000000  ECALA  BSS  1
0216   00250  000000  OVCHA  BSS  1
0217   00251  000000  CLPIA  BSS  1
0218   00252  000000  ENTEA  BSS  1
0219   00253  000000  CHRSA  BSS  1
0220   00254  000000  XSCRA  BSS  1
0221   00255  000000  XEC6A  BSS  1
0222   00256  000000  FDAAA  BSS  1
0223   00257  000000  FNDAA  BSS  1
0224   00260  000000  FND1A  BSS  1
0225   00261  000000  IOSTA  BSS  1
0226   00262  000000  INREA  BSS  1
0227   00263  000000  SUMPA  BSS  1
0228   00264  000000  CRCKA  BSS  1
0229   00265  000000  IOHEA  BSS  1
0230   00266  000000  QTCHA  BSS  1
0231**********************************************
0232*
0233   00267  000000         BSS  1        CHECKSUM WORD FOR FIRST 512 BLOCK
```

PAGE 175 9830——ERROR TABLE

```
0235  00270  000000  E1    BSS  1
0236  00271  000000        BSS  1
0237  00272  000000        BSS  1
0238  00273  000000        BSS  1
0239  00274  000000  E5    BSS  1
0240  00275  000000        BSS  1
0241  00276  000000        BSS  1
0242  00277  000000        BSS  1
0243  00300  000000        BSS  1
0244  00301  000000  E10   BSS  1
0245  00302  017255        DEF  NUMER
0246  00303  017172        DEF  NUMCP+1
0247  00304  000000        BSS  1
0248  00305  000000        BSS  1
0249  00306  000000  E15   BSS  1
0250  00307  000000        BSS  1
0251  00310  000000        BSS  1
0252  00311  000000        BSS  1
0253  00312  000000        BSS  1
0254  00313  000000  E20   BSS  1
0255  00314  000000        BSS  1
0256  00315  000000        BSS  1
0257  00316  000000        BSS  1
0258  00317  000000        BSS  1
0259  00320  000000  E25   BSS  1
0260  00321  000000        BSS  1
0261  00322  000000        BSS  1
0262  00323  000000        BSS  1
0263  00324  000000        BSS  1
0264  00325  000000  E30   BSS  1
0265  00326  000000        BSS  1
0266  00327  000000        BSS  1
0267  00330  000000        BSS  1
0268  00331  000000        BSS  1
0269  00332  000000  E35   BSS  1
0270  00333  000000        BSS  1
0271  00334  000000        BSS  1
0272  00335  000000        BSS  1
0273  00336  000000        BSS  1
0274  00337  000000  E40   BSS  1
0275  00340  000000        BSS  1
0276  00341  000000        BSS  1
0277  00342  000000        BSS  1
0278  00343  000000        BSS  1
0279  00344  000000  E45   BSS  1
0280  00345  000000        BSS  1
0281  00346  000000        BSS  1
0282  00347  000000        BSS  1
0283  00350  000000        BSS  1
0284  00351  000000  E50   BSS  1
0285  00352  013355        DEF  ER47   LOG OF A NEGATIVE NUMBER
0286  00353  016207        DEF  ER48   SQUARE ROOT OF A NEGATIVE NUMBER
0287  00354  016053        DEF  ER49   ZERO TO THE ZERO POWER
0288  00355  016141        DEF  ER50    NEGATIVE NUMBER RAISED TO A
                                                    NON-INTEGER
```

PAGE 176 9830——BASE PAGE READ-WRITE MEMORY

```
0290  01400                    ORG  1400B
0291  01400  000000  BADDR     BSS  1      CURRENT CHAR POINTER
0292  01401  000000  RSAVE     BSS  1          SAVE (A) FOR RETN2
0293  01402  000000  OTPTR     BSS  1      REFRESH POINTER
0294  01403  000000  MAW       BSS  1      LAST WORD OF R/W MEM
0295  01404  000000  LWAM      BSS  1      LAST WORD AVAILABLE FOR USER
0296  01405  000000  FWUP      BSS  1      FIRST WORD OF COMMON OR
                                                              MAINLINE
0297  01406  000000  VALUE     BSS  1      FIRST WORD -1 OF VALUE TABLE
0298  01407  000000  SYMTP     BSS  1      FIRST WORD -1 OF SYMBOL TABLE
0299  01410  000000  LSTAK     BSS  1      FIRST WORD OF OPERATOR STACK
0300  01411  000000  TSTPT     BSS  1      TEMPORARY STACK POINTER
0301  01412  000000  LSTPT     BSS  1      OPERATOR STACK POINTER
0302  01413  000000  HSTPT     BSS  1      OPERAND STACK POINTER
0303  01414  000000  DSTRT     BSS  1      DATA STATEMENT
0304  01415  000000  NXTDT     BSS  1        POINTERS
0305  01416  000000  MODE      BSS  1      PROGRAM=0: KEYBOARD=1
0306  01417  000000  PARMA     BSS  1      PARAMETER ADDRESS
0307  01420  000000  PARMN     BSS  1      PARAMETER NAME
0308  01421  000000  PRADD     BSS  1      LAST WORD+1 OF CURRENT STMT
0309  01422  000000  UKPTR     BSS  1      USER KEY POINTER
0310  01423  000000  PBPTR     BSS  1      LAST WORD OF CURRENT PROGRAM
0311  01424  000000  PBUFF     BSS  1      FIRST WORD OF CURRENT PROGRAM
0312  01425  000000  PBUFO     BSS  1      FIRST WORD OF MAINLINE
0313  01426  000000  PBPTO     BSS  1      LAST WORD+1 OF MAINLINE
0314  01427  000000  .LNUM     BSS  1      CURRENT LINE NUMBER
0315  01430  000000  LNINC     BSS  1      AUTO LINE INCREMENT
0316  01431  000000  CLINE     BSS  1      CURRENT LINE FOR LIST
0317  01432  000000  DRQST     BSS  1      INPUT STMT FLAG
0318  01433  000000  TFLAG     BSS  1      PTAPE FLAG
0319  01434  000000  UNITS     BSS  1      TRIG UNITS
0320  01435  000000  SEC       BSS  1      SECURE PROGRAM FLAG
0321  01436  000000  HFLG1     BSS  2      STOP ADDRESSES
0322  01440  000000  TFLG1     BSS  2      TRACE LIMIT ADDRESSES
0323  01442  000000  STPFL     BSS  1      STOP FLAG
0324  01443  000000  KEYFG     BSS  1      KEYBOARD FLAG
0325  01444  000000  SAVEA     BSS  1      INTERRUPT
0326  01445  000000  SAVEB     BSS  1
0327  01446  000000  ADRSS     BSS  1        TEMPORARIES
0328  01447  000000  SLCOD     BSS  1      SELECT CODE
0329  01450  000000  PMODE     BSS  1      PRINT-ALL FLAG
0330  01451  000000  CTYPE     BSS  1      KEYBOARD
0331  01452  000000  CPLAC     BSS  1        FORMAT FLAGS
0332  01453  000000  PRFLG     BSS  1      PRINT/DISP FLAG
0333  01454  000000  RCOUT     BSS  1      FORMAT
0334  01455  000000  FORMT     BSS  1
0335  01456  000000  FORMS     BSS  1
0336  01457  000000  FORME     BSS  1        STATEMENT FLAGS
0337  01460  000000  FTMP1     BSS  1      CURRENT OPERATOR CODE
0338  01461  000000  FTMP2     BSS  1      CURRENT OPERATOR PRECEDENCE
0339  01462  000000  REEDL     BSS  1
0340  01463  000000  INTEL     BSS  1
0341  01464  000000            BSS  2          UNUSED
0342*
0343* TEMPORARIES
0344*
0345  01466  000000  LOCL1     BSS  1
```

PAGE 177 9830 - - BASE PAGE READ-WRITE MEMORY

```
0346   01467  000000  LOCL2   BSS  1
0347   01470  000000  L2T1    BSS  1
0348   01471  000000  L2T2    BSS  1
0349   01472  000000  TEMPS   BSS  1
0350   01473  000000  .TEMP   BSS  1
0351   01473          MBOX1   EQU  .TEMP
0352   01474  000000  TEMP1   BSS  1
0353   01475  000000  TEMP2   BSS  1
0354   01476  000000  TEMP3   BSS  1
0355   01477  000000  TEMP4   BSS  1
0356*
0357*    BUFFERS
0358*
0359   01500  000000  IOBUF   BSS  41      INPUT AND RECALL BUFFER
0360   01551  000000  RBUFF   BSS  41      SINGLE LINE REFRESH BUFFER
0361*
0362*    PRINT ROUTINE FLAGS
0363*
0364   01622  000000  TERM    BSS  1       CRLF FLAG
0365   01623  000000  PEND    RSS  1       BUFFER OVERFLOW FLAG
0366   01624  000000  PPFF    BSS  1       BUFFER POINTER OR TAB FLAG
0367   01625  000000  FIRST   BSS  1
0368   01626  000000          BSS  2         UNUSED
0369*
0370*        MATH TEMPORARIES
0371*
0372   01630  000000  TREGE   BSS  4
0373   01634  000000  RSLTE   BSS  4
0374*
0375*    STATEMENT SYNTAX AND EXECUTION TEMPORARIES
0376*
0377   01640  000000  ST      BSS  32
0378*
0379*    SYSTEM SYNTAX AND EXECUTION TEMPORARIES
0380*
0381   01700  000000          BSS  1       SAVED FOR PROCESSOR
0382   01701  000000  NDISP   BSS  1
0383   01702  000000  NPRIN   BSS  1
0384   01703  000000  PLACE   BSS  1
0385   01704  000000  WIDTH   BSS  1
0386   01705  000000  FLOAT   BSS  1
0387   01706  000000  SBPTR   BSS  1
0388   01707  000000  BLANK   BSS  1
0389   01710  000000  MSFLG   BSS  1
0390   01711  000000  DFLAG   BSS  1
0391   01712  000000  PFLAG   BSS  1
0392   01713  000000  UFLAG   BSS  1
0393   01714  000000  SFLAG   BSS  1
0394   01715  000000  SBADR   BSS  1
0395   01716  000000  SSBPT   BSS  1
0396   01717  000000  NUM     BSS  1
0397   01717          OPTYM   EQU  NUM
0398   01720  000000  LASTN   BSS  1
0399   01721  000000  .SIGN   BSS  1
0400   01721          MAXIN   EQU  .SIGN
0401   01722  000000  EXP     BSS  1
```

PAGE 178 9830 - - BASE PAGE READ-WRITE MEMORY

```
0402   01722           INTGR   EQU  EXP
0403   01723  000000   ARYAD   BSS  1
0404   01724  000000   GFLAG   BSS  1
0405   01725  000000   NXTST   BSS  1
0406   01726  000000   MBINI   BSS  1
0407   01727  000000   MBIN2   BSS  1
0408*
0409*    ARITHMETIC REGISTERS AND RETURN STACK
0410*
0411   01740           ORG  1740B
0412   01740  000000   XC      BSS  4
0413   01744  000000   AR1     BSS  4
0414   01750  000000   YC      BSS  4
0415   01754  000000   AR2     BSS  4
0416   01760  000000   RSTAK   BSS  11          RETURN STACK
0417   01773  000000   RES     BSS  4           RESULT REGISTOR
0418   01777  000000   RSPTR   BSS  1       RETURN STACK POINTER
0419*
```

PAGE 179 NON-COMMON BASE PAGE ROM

```
0421  01744          AR1E    EQU  AR1
0422  01754          AR2E    EQU  AR2
0423  00136          N5      EQU  M5
0424  01237          STAR2   EQU  1237B
0425  01305          ROUND   EQU  1305B
0426  01261          OF      EQU  1261B
0427  01274          STMAX   EQU  1274B
0428*
0429  00356          RETN3   EQU  356B
0430  00357          RETN2   EQU  357B
0431  00365          RET2    EQU  365B
0432  00373          ICNT    EQU  373B
0433  00374          WBUFF   EQU  374B
0434  00400          GPARM   EQU  400B
0435  00405          XFAR1   EQU  405B
0436  00412          RSULT   EQU  412B
0437  00416          STORE   EQU  416B
0438  00425          STOR1   EQU  425B
0439  00444          XFAR2   EQU  444B
0440  00450          STROP   EQU  450B
0441  00456          SBPUD   EQU  456B
0442  00461          SYMC2   EQU  461B
0443  00463          SYMC1   EQU  463B
0444  00464          SYMCK   EQU  464B
0445  00504          COMCK   EQU  504B
0446  00510          COMCE   EQU  510B
0447  00513          LPCK    EQU  513B
0448  00521          LPCKE   EQU  521B
0449  00524          RPCK    EQU  524B
0450  00534          RPCKE   EQU  534B
0451  00535          FSCE2   EQU  535B
0452  00537          STSRH   EQU  537B
0453  00546          STEXP   EQU  546B
0454  00553          BHSTP   EQU  553B
0455  00561          MER8    EQU  561B
0456  00561          FSCE4   EQU  561B
0457  00563          SLWST   EQU  563B
0458  00567          UNSTK   EQU  567B
0459  00574          NEXTL   EQU  574B
0460  00606          NEXT1   EQU  606B
0461  00613          FPAGE   EQU  613B
0462  00626          SAVBP   EQU  626B
0463  00633          RESB1   EQU  633B
0464  00640          RESBP   EQU  640B
0465  00645          MINIT   EQU  645B
0466  00651          INITS   EQU  651B
0467  00664          LNUM    EQU  664B
0468  00666          PGINT   EQU  666B
0469  00676          INTCK   EQU  676B
0470  00726          SYE25   EQU  726B
0471  00730          GETAD   EQU  730B
0472  00742          FND     EQU  742B
0473  00750          DIGCK   EQU  750B
0474  00752          LETCK   EQU  752B
0475  00753          LIMIT   EQU  753B
0476  00771          GTOPP   EQU  771B
```

PAGE 180 NON-COMMON BASE PAGE ROM

```
0477  01007          NEXTA   EQU  1007B
0478  01015          OBLNK   EQU  1015B
0479  01016          ONEXT   EQU  1016B
0480  01017          OUTCR   EQU  1017B
0481  01041          GETCH   EQU  1041B
0482  01053          GTMP    EQU  1053B
0483  01055          GNEXT   EQU  1055B
0484  01062          GFRST   EQU  1062B
0485  01066          GETSK   EQU  1066B
0486  01075          FNDPS   EQU  1075B
0487  01121          MVTOH   EQU  1121B
0488  01131          PGIN0   EQU  1131B
0489  01140          LTR     EQU  1140B
0490  01147          ENDS    EQU  1147B
0491  01151          EOST    EQU  1151B
0492  01152          NOEOF   EQU  1152B
0493  01153          EOLCK   EQU  1153B
0494  01156          CONST   EQU  1156B
0495  01165          SYE12   EQU  1165B
0496  01166          GSIGN   EQU  1166B
0497  01201          IMPY    EQU  1201B
0498  01217          FETCH   EQU  1217B
0499  01225          LDEF    EQU  1225B
0500  01254          ZONK    EQU  1254B
0501  01256          CLAR2   EQU  1256B
0502  01314          ODGIT   EQU  1314B
0503  01317          SGNS    EQU  1317B
0504  01330          .NPWR   EQU  1330B
0505  01335          NPWRT   EQU  1335B
0506  01337          NDWRT   EQU  1337B
0507  01342          CRLF    EQU  1342B
0508  01344          CRLF1   EQU  1344B
0509  01351          TTY     EQU  1351B
0510  01362          GTCON   EQU  1362B
0511  01371          FIX     EQU  1371B
```

PAGE 181 CONSTANTS AND EQUATES FOR BOTH

```
0513                                LST
0514*       MIKE WINGERT
0515*       AND GENE BURMEISTER 8-24-71
0516*
0517*
0518************************************
0519*
0520*  BASE PAGE CONSTANTS
0521*
0522  00012          P1       EQU  .1
0523  00017          P2       EQU  .2
0524  00021          P4       EQU  .4
0525  00022          P5       EQU  .5
0526  00025          P8       EQU  .8
0527  00030          P12      EQU  .12
0528  00031          P13      EQU  CRTN
0529  00032          P15      EQU  .15
0530  00013          P256     EQU  B400
0531  00132          N1       EQU  M1
0532  00141          N10      EQU  M10
0533  00157          N256     EQU  M256
0534  00057          ATEMP    EQU  .1000      POINTER TO YC REGISTOR
0535  00004          D1000    EQU  B10K
0536*
0537************************************
0538*
0539*  SHARED READ/WRITE
0540*
0541  01701          TEMPA    EQU  1701B
0542  01466          TEMP5    EQU  LOCL1
0543*
0544*
0545************************************
0546*
0547*  R/W MEMORY AREA
0548*
0549  01702          ADR1     EQU  1702B
0550  01703          ADR2     EQU  1703B
0551  01703          ADR3     EQU  ADR2
0552  01704          TEMP     EQU  1704B      TEMPORARY
0553  01705          TABL0    EQU  TEMP+1     CORDIC CONSTANT
0554  01706          GFG      EQU  TEMP+2     G FLAG
0555  01707          SHIFT    EQU  TEMP+3     SHIFT FACTOR
0556  01710          COUNT    EQU  TEMP+4     BCD DATA STORAGE
0557  01711          RCPFG    EQU  TEMP+5     RECIPROCAL FLAG
0558  01712          FNCFG    EQU  TEMP+6     FUNCTION FLAG
0559  01713          RY1      EQU  TEMP+7     REGISTER ADDRESS STORAGE
0560  01714          SAVE     EQU  TEMP+8     TEMPORARY
0561  01715          RY2      EQU  TEMP+9     REGISTER ADDRESS STORAGE
0562  01716          SIGN     EQU  TEMP+10    EXPONENT WORD STORAGE
0563  01717          DIGIT    EQU  TEMP+11    DIGIT STACK POINTER
0564  01720          WRDN     EQU  TEMP+12    START OF DIGIT STACK
0565  01734          ADRYE    EQU  1734B
0566*
0567*
0568************************************
```

PAGE 182 CONSTANTS AND EQUATES FOR BOTH

```
Ø569*
Ø57Ø***      LABELS
Ø571*
Ø572   ØØØ23          P6       EQU  .6          +6
Ø573   ØØØ24          P7       EQU  .7          +7
Ø574   ØØØ61          P1Ø      EQU  .1Ø             +1Ø
Ø575   ØØ133          N2       EQU  M2          -2
Ø576   ØØ135          N4       EQU  M4          -4
Ø577   ØØ143          N12      EQU  M12         -12
Ø578   ØØØ62          D8ØØØ    EQU  FLGBT           BCD 8ØØØ
Ø579*
Ø58Ø*  LINKAGE TO ARITHMETIC
Ø581*
Ø582   ØØ216          ADD      EQU  .FADA       FLOATING ADD ROUTINE
Ø583   ØØ22Ø          MLT      EQU  .FMPA       FLOATING MULTIPLY ROUTINE
Ø584   ØØ221          DVD      EQU  .FDVA       FLOATING DIVIDE ROUTINE
Ø585*
Ø586*
Ø587**********************************
Ø588*
```

PAGE 183 LOG CONSTANTS AT 11600B

```
0591   03700                  ORG   3700B
0592*
0593*
0594**********************************
0595*
0596*  ROM AREA
0597*
0598   03700  000000  C1      OCT   0000000     LN(2)
0599   03701  003223          OCT   003223      0693
0600   03702  012161          OCT   012161      1471
0601   03703  100126          OCT   100126      8056
0602*
0603   03704  000000          DEC   0000        LN(1.1)
0604   03705  004523          OCT   004523      0953
0605   03706  010027          OCT   010027      1017
0606   03707  114004          OCT   114004      9804
0607*
0608   03710  000000          DEC   0000        LN(1.01)
0609   03711  004625          OCT   004625      0995
0610   03712  001460          OCT   001460      0330
0611   03713  102462          OCT   102462      8532
0612*
0613   03714  000000          DEC   0000        LN(1.001)
0614   03715  004631          OCT   004631      0999
0615   03716  050003          OCT   050003      5003
0616   03717  031410          OCT   031410      3308
0617*
0618   03720  000000          DEC   0000        LN(1.0001)
0619   03721  004631          OCT   004631      0999
0620   03722  112400          OCT   112400      9500
0621   03723  001463          OCT   001463      0333
0622*
0623   03724  000000          OCT   000000      LN(1,00001)
0624   03725  004631          OCT   004631      0999
0625   03726  114520          OCT   114520      9950
0626   03727  000003          OCT   000003      0003
0627*
0628   03730  000000  C2      OCT   0000000     LN(10)
0629   03731  021402          OCT   021402      2302
0630   03732  054120          OCT   054120      5850
0631   03733  111400          OCT   111400      9300
0632*
0633***
0634*
0635   03734  000000          DEC   0000        ARCTAN(1)
0636   03735  003605          OCT   003605      0785
0637   03736  034601          OCT   034601      3981
0638   03737  061500          OCT   061500      6340
0639*
0640   03740  000000          DEC   0000        ARCTAN(.1)
0641   03741  004626          OCT   004626      0996
0642   03742  064145          OCT   064145      6865
0643   03743  022221          OCT   022221      2491
0644*
0645   03744  000000          DEC   0000        ARC TAN (.01)
0646   03745  004631          OCT   004631      09999
```

PAGE 184 LOG CONSTANTS AT 11600B

```
0647   03746  113146          OCT   113146      9666
0648   03747  064147          OCT   064147      6867
0649*
0650   03750  000000          DEC   0000        ARCTAN(.001)
0651   03751  004631          OCT   004631      0999
0652   03752  114626          OCT   114626      9996
0653   03753  063147          OCT   063147      6667
0654*
0655   03754  000000          OCT   000000      ARCTAN(.0001)
0656   03755  004631          OCT   004631      0999
0657   03756  114631          OCT   114631      9999
0658   03757  113147          OCT   113147      9667
0659*
0660   03760  000000          OCT   000000      ARCTAN(.00001)
0661   03761  004631          OCT   004631      0999
0662   03762  114631          OCT   114631      9999
0663   03763  114627          OCT   114627      9997
0664*
0665   03764  000000  C3      OCT   0000000       PI
0666   03765  030501          OCT   030501      3141
0667   03766  054446          OCT   054446      5926
0668   03767  051540          OCT   051540      5360
0669*
0670   03770  000000  C4      OCT   0000000       2PI
0671   03771  061203          OCT   061203      6283
0672   03772  014123          OCT   014123      1853
0673   03773  003440          OCT   003440      0720
0674*
0675   03774  000400  C8      OCT   000400      200/PI
0676   03775  061546          OCT   061546      6366
0677   03776  014567          OCT   014567      1977
0678   03777  021545          OCT   021545      2365
```

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```
0681   12533                  ORG  12533B
0682*
0683   12533  003774  GPERR   DEF  C8      ADDRESS OF 200/PI
0684   00035           P22    EQU  .22
0685   00060           P100   EQU  .100
0686   00144           N13    EQU  M13
0687   00156           N100   EQU  M100
0688   12534  003730  LN10    DEF  C2      ADDRESS OF LN10
0689   12535  003764  PI      DEF  C3      ADDRESS OF PI
0690   12536  003770  TWOPI   DEF  C4      ADDRESS OF 2PI
0691   12537  001720  AWRDN   DEF  WRDN    TOP OF THE DIGIT STACK
0692   00111           ADRX   EQU  B1740   ADDRESS OF REGISTER X
0693   12540  001734  ADRY    OCT  1734    ADDRESS OF REGISTER Y
0694   12540           ADR0   EQU  ADRY    ADDRESS OF REGISTOR THETE
0695   12541  001630  TREG    DEF  TREGE   ADDRESS OF REGISTOR T
0696   12542  001634  RSLT    DEF  RSLTE   ADDRESS OF THE ORIGINAL
                                                          ARGUMENT
0697   00110           EP3    EQU  B1400     EXPONENT POSITIVE 3
0698   00013           D0100  EQU  B400      BCD 0100
0699   00033           D0010  EQU  B20       BCD 0010
0700   00121           GRAF   EQU  B4000     EXPONENT POSITIVE 8
0701   12543  176400  EN3     OCT  176400  EXPONENT NEGATIVE 3
0702   12544  172000  EN12    OCT  172000  EXPONENT NEGATIVE 12
0703   12545  003674  THETL   DEF  C1-4    ADDRESS OF LOG CONSTANT TABLE
0704   12546  003724  THETT   DEF  C2-4    ADDRESS OF TRIG CONSTANT TABLE
0705   00012           RAD    EQU  P1      RADIAN CODE
0706   00017           GRA    EQU  P2      GRAD CODE
0707*
0708*   ADDITIONAL CONSTANTS FOR MATH
0709*
0710   00117           AD5    EQU  B2400
0711   00145           N14    EQU  M14
```

PAGE 186 FUNCTIONS FOR 9830

```
0713*
0714*
0715**********************************
0716*
0717***      PROGRAM SUBROUTINES
0718*
0719*
0720**********************************
0721*
0722*  INITIALIZE ROUTINE
0723*
0724   12547  035712  INIT    STB  FNCFG    STORE THE FUNCTION FLAG
0725*
0726   12550  031703          STA  ADR2     STORE THE ADDRESS OF THE
                                                          ARGUMENT
0727   12551  121703          LDA  ADR2,I   SAVE THE ORIGINAL EXPONENT
0728   12552  031716          STA  SIGN       WORD IN SIGN
0729*
0730   12553  021703          LDA  ADR2     SAVE THE ANSWER OF THE RESULT
0731   12554  026542          LDB  RSLT
0732   12555  035703          STB  ADR2
0733   12556  170004          XFR             SO IT IS SURELY IN A R/W
                                                          TEMPORARY
0734*
0735   12557  022542  RTT     LDA  RSLT     LOAD THE ARGUMENT
0736   12560  024214          LDB  AR2A     INTO THE AR2 WORKING REGISTER
0737   12561  170004          XFR
0738*
0739   12562  066635          JMP  ZERO     JUMP TO DETERMINE IF IT IS ZERO
0740*
0741*
0742**********************************
0743*
0744*  NORMALIZE TWO ARGUMENTS
0745*
0746   12563  035702  DIV     STB  ADR1     SAVE THE ADDRESS IN B
0747   12564  062575          JSM  NORM     NORMALIZE THE NO. SPECIFIED IN
                                                                    A
0748   12565  026541          LDB  TREG     TRANSFER IT INTO
0749   12566  170004          XFR             A TEMPORARY
0750   12567  021702          LDA  ADR1     LOAD THE OTHER ADDRESS
0751   12570  062575          JSM  NORM     NORMALIZE IT
0752   12571  026542  ITR     LDB  RSLT     TRANSFER IT INTO THE
0753   12572  020214          LDA  AR2A     RESULT REGISTOR AND RET
0754   12573  170004          XFR
0755   12574  170402          RET
0756*
0757*
0758**********************************
0759*
0760*  NORMALIZE A SINGLE ARGUMENT
0761*
0762   12575  062560  NORM    JSM  RTT+1    TRANSFER THE ARGUMENT
                                                    SPECIFIED IN A IN
0763   12576  171450          NRM           NORMALIZE IT
0764   12577  074404          SBL  8        ALLIGN THE SHIFT COUNT IN B
0765   12600  074076          TCB           COMPLEMENT IT
0766   12601  005754          ADB  AR2E     ADD THE EXPONENT WORD TO IT
0767   12602  035754          STB  AR2E     RESTORE THE EXPONENT WORD
0768   12603  020214          LDA  AR2A   LOAD THE ADD. OF THE ARGUMENT
```

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```
0769   12604  170402            RET             AND RETURN
0770*
0771*
0772**********************************
0773*
0774*  REDUCE ONE NUMBER TO A FRACTIONAL PART OF ANOTHER
0775*
0776   12605  062727  FRAC      JSM  FDV1       DIVIDE THE ARGUMENT BY THE
                                                      SPECIFIED CONSTANT
0777*
0778   12606  025754            LDB  AR2E       LOAD THE EXPONENT WORD OF THE
                                                      RESULT
0779   12607  070742            SAR  16         CLEAR THE COUNT WORD
0780   12610  031710            STA  COUNT        FOR STORING THE INTEGER PART
0781   12611  074252            SBM  *+5        SKIP IF THE EXPONENT IS NEGATIVE
0782*
0783   12612  004157            ADB  N256       SUBTRACT 1 FROM THE EXPONENT
0784   12613  171400            MLS             LEFT SHIFT THE ARGUMENT
0785   12614  001710            ADA  COUNT      STORE THE LEFT
0786   12615  070604            SAL  4            SHIFTED DIGIT
0787   12616  031710            STA  COUNT        IN COUNT
0788   12617  075553            SBP  *-5        SKIP IF THE EXPONENT IS STILL
                                                      POSITIVE
0789   12620  035754            STB  AR2E       STORE THE NEW EXPONENT WORD
0790*
0791   12621  062576            JSM  NORM+1     JUMP TO NORMALIZE THE
                                                      ARGUMENT
0792*
0793   12622  021702            LDA  ADR1       MULTIPLY THIS FRACTIONAL
0794   12623  066750            JMP  .FMP-1       PART OF THE ORIGINAL SPECIFIED
                                                      CONSTANT
0795*
0796*
0797**********************************
0798*
0799*  UNNORMALIZE AN ARGUMENT
0800*
0801   12624  025754  UNRM      LDB  AR2E       LOAD THE EXPONENT WORD
0802   12625  074413            SBP  ZERO       SKIP IF THE EXPONENT IS POSITIVE
0803   12626  074340            ABR  8          ALLIGN AND COMPLEMENT
0804   12627  074076            TCB               THE EXPONENT
0805   12630  074117            LDA  B          DUPLICATE IT AND
0806   12631  000143            ADA  N12          CHECK TO SEE IF IT
0807   12632  070112            SAM  *+2          IS GREATER THAN 12
0808   12633  024031            LDB  P13        SET B=13 IF IT IS
0809*
0810   12634  061305            JSM  ROUND SHIFT AND COUNT THE ARGUMENT
```

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```
0812*
0813*
0814**********************************
0815*
0816*  DETERMINE WHETHER AN ARGUMENT IS ZERO
0817*
0818   12635  070075  ZERO    SEC  *+1,C     CLEAR THE E REGISTER
0819   12636  021755          LDA  AR2E+1    ADD THE 12 DIGITS
0820   12637  001756          ADA  AR2E+2      OF AR2 TOGETHER
0821   12640  001757          ADA  AR2E+3      IN A
0822   12641  072154          SES  *+3,S     SKIP IF THE REGISTER OVERFLOWED
                                                          AND SET E
0823   12642  072110          RZA  *+2       CLEAR E
0824   12643  070075          SEC  *+1,C     SKIP IF A IS NOT ZERO
0825   12644  025754          LDB  AR2E      LOAD THE EXPONENT WORD INTO B
0826   12645  170402          RET              AND RETURN
0827*
0828*
0829**********************************
0830*
0831*  RECIPROCATE AN ARGUMENT
0832*
0833   12646  062571  RECIP   JSM  ITR
0834   12647  020020          LDA  ONE       SET THE DIVIDEND=1
0835   12650  025703          LDB  ADR3
0836   12651  066731          JMP  .FDV+1
```

PAGE 189 FUNCTIONS FOR 9830

```
0893*
0894*
0895**********************************
0896*
0897*  INITIALIZE ROUTINE FOR THE TRIG FUNCTIONS
0898*
0899*
0900   12714  074742  STN     SBR  16      CLEAR THE 6 FLAG
0901   12715  035706          STB  GFG       AND THE TEMP
0902   12716  035704          STB  TEMP      LOCATION
0903   12717  062547          JSM  INIT    FETCH THE ARGUMENT AND
                                              INITIALIZE OTHER FLAGS
0904*
0905   12720  025434          LDB  UNITS   LOAD THE UNITS WORD
0906   12721  074250          SZB  DTOR    IF IT IS SET TO DEGREES JUMP TO
                                              CONVERT TO RAD.
0907   12722  014012          CPB  RAD     IF IT SAYS NOT RADIANS CONVERT
0908   12723  170402          RET            IT FROM GRADS TO RADIANS
0909*
0910   12724  026533  GTOR    LDB  GPERR   LOAD THE ADDRESS OF 200/PI
0911   12725  066727          JMP  DTOR+1    DIVIDE IT INTO THE ARGUMENT
0912*
0913*
0914**********************************
0915*
0916*  LINK ROUTINE TO FLOATING DIVIDE
0917*
0918   12726  024027  DTOR    LDB  DPERR   LOAD THE ADDRESS OF 180/PI
0919   12727  021703  FDV1    LDA  ADR3
0920   12730  031703  .FDV    STA  ADR2
0921   12731  160221          JSM  DVD,I   DO THE DIVIDE
0922   12732  066737          JMP  SANS    STORE THE RESULT
0923*
0924*
0925**********************************
0926*
0927*  LINK ROUTINE TO FLOATING ADD
0928*
0929   12733  022542  FADI    LDA  RSLT
0930   12734  035702  .FAD    STB  ADR1
0931   12735  031703          STA  ADR2
0932   12736  160216          JSM  ADD,I   DO THE ADD
0933   12737  020214  SANS    LDA  AR2A
0934   12740  025703          LDB  ADR3
0935   12741  170004          XFR
0936   12742  170402          RET
```

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```
0938*
0939*
0940**********************************
0941*
0942*  LINK ROUTINE TO FLOATING MULTIPLY
0943*
0944   12743  020027  RTOD    LDA  DPERR     LOAD THE ADDRESS OF 180/PI
0945   12744  026541          LDB  TREG      TRANSFER THIS QUANTITY INTO A
0946   12745  170004          XFR            TEMPORARY IN ORDER TO
0947   12746  045633          ISZ  TREGE+3   INCREMENT DIGIT 12 BY 1
0948   12747  022541          LDA  TREG      SET (A) TO THE POINTER TO TREG
0949   12750  024214          LDB  AR2A      SET B=ADD. OF AR2
0950*
0951*
0952   12751  160220  .FMP    JSM  MLT,I
0953   12752  066737          JMP  SANS      STORE THE ANSWER
0954*
0955*
0956**********************************
0957*
0958*  REGISTER TRANSFER SUBROUTINES
0959*
0960   12753  020020  OTO     LDA  ONE       SET A=THE ADDRESS OF FLOATING
                                                                      ONE
0961   12754  024213  XAR1    LDB  ARIA      TRANSFER IT INTO AR1 AND RETURN
0962   12755  170004          XFR
0963   12756  170402          RET
0964*
0965   12757  020020  OTT     LDA  ONE       SET A=THE ADDRESS OF FLOATING
                                                                      ONE
0966   12760  066560          JMP  RTT+1     TRANSFER FLOATING ONE INTO AR2
```

PAGE 191 FUNCTIONS FOR 9830

```
0968**********************************
0969*
0970***        MAIN PROGRAMS
0971*
0972************************
0973*
0974*          FIND THE SINE OF AN ARGUMENT
0975*
0976   12761  062714  SIN      JSM  STN      FETCH THE ARGUMENT AND
                                              INITIALIZE FLAGS
0977   12762  045704           ISZ  TEMP     SET TEMP=1
0978   12763  063054           JSM  TAN+1    CALCULATE THE TANGENT OF THE
                                              ARGUMENT
0979*
0980   12764  072150           RZA  *+3      SKIP IF OVERFLOW DID NOT OCCUR
0981   12765  062757           JSM  OTT      IF TAN WAS INFINITY
0982   12766  066773           JMP  .CS      SET + OR - ONE INTO AR2
0983   12767  062737           JSM  SANS
0984   12770  070742           SAR  16       LET THE FUNCTION FLAG BE 0
0985   12771  062652           JSM  SCRT     JUMP TO CALCULATE SQR(1+XX)
0986*
0987   12772  062730           JSM  .FDV     DIVIDE THE ORIGINAL NO, BY THIS
                                              QUANTITY
0988*
0989   12773  021754  .CS       LDA  AR2E     LOAD THE EXPONENT WORD WORD
                                              OF THE RESULT
0990   12774  072051           SLA  *+1,S    SET THE MANTISSA SIGN BIT
0991   12775  025711           LDB  RCPFG    LOAD THE RECIPROCAL FLAG INTO
                                              B
0992   12776  004133           ADB  N2       SUBTRACT 2 FROM IT
0993   12777  074702           SBR  15       LET BIT 0=1 IF THE RESULT WAS
                                              NEGATIVE
0994   13000  005716           ADB  SIGN     ADD THE ORIGINAL MANTISSA
                                              SIGN BIT TO THIS
0995   13001  074111           SLB  *+2      IF THE RESULTANT LOW BIT IS
0996   13002  070071           SLA  *+1,C      ZERO CLEAR THE MANTISSA SIGN
                                              BIT OF THE ANSWER
0997   13003  074742           SBR  16       SET B=0 AND JUMP
0998   13004  070112           SAM  *+2
0999   13005  035757           STB  AR2+3
1000   13006  067202           JMP  OUT        TO THE STORE ROUTINE
1001*
1002**********************************
1003*
1004*  FIND THE COSINE OF AN ARGUMENT
1005*
1006   13007  062714  COS      JSM  STN      FETCH THE ARGUMENT IN
                                              RADIANS
1007   13010  021754           LDA  AR2E     CHECK THE EXPONENT
1008   13011  070340           AAR  8
1009   13012  000142           ADA  M11      IF LESS THAN 11
1010   13013  070112           SAM  *+2      SKIP
1011   13014  066757           JMP  OTT      OTHERWISE ASSUME A FULL
                                              CIRCLE
1012   13015  024023           LDB  PI/2
1013   13016  062733           JSM  FAD1     ADD PI/2 TO THE ARGUMENT
1014   13017  066762           JMP  SIN+1    JUMP TO SINE ROUTINE
1015*
1016**************************************
1017   13020  000000           BSS  1        CHECKSUM WORD
1018*
1019**************************************
1020*
```

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```
1022
1023*
1024**********************************
1025*
1026*   FIND THE ARCCOSINE OF AN ARGUMENT
1027*
1028    13021  024132  ACS     LDB  N1      LET THE FUNCTION FLAG BE -1
1029    13022  063032          JSM  ASNS+1  JUMP TO THE ARCSINE ROUTINE
1030    13023  021706          LDA  GFG     LOAD THE ORIGINAL EXPONENT
                                            WORD
1031    13024  070211          SLA  ACSC    SKIP IF THE MANTISSA SIGN BIT
                                            IS0
1032    13025  062571          JSM  ITR     OTHERWISE FETCH ANSWER
1033    13026  026535          LDB  PI
1034    13027  062733          JSM  FADI
1035    13030  067256  ACSC    JMP  EATN    JUMP TO CONVERT TO THE
                                            PROPER UNITS
1036*
1037*
1038**********************************
1039*
1040*   SUBROUTINE FOR THE ARC ROUTINES
1041*
1042    13031  024012  ASNS    LDB  P1      LET THE FUNCTION FLAG BE 1
1043    13032  035710          STB  COUNT   STORE THE FUNCTION FLAG
1044    13033  070537          LDB  A,I     SAVE THE EXPONENT WORD
1045    13034  035706          STB  GFG       FOR FUTURE REFERENCES
1046    13035  062550          JSM  INIT+1  FETCH THE ARGUMENT AND
                                            INITIALIZE THE FLAGS
1047    13036  062653          JSM  SCRT+1  CALCULATE SQR (1+OR-XX)
1048    13037  074070          SIB  *+1     LOAD THE FIRST 4 DIGITS
1049    13040  074537          LDB  B,I       OF THE NUMBER SPECIFIED
                                            BY THE ADDRESS IN B
1050    13041  076210          RZB  *+4     SKIP IF THEY ARE NOT ZERO
1051    13042  061256          JSM  CLAR2   *CLEAR AR2
1052    13043  021716          LDA  SIGN    *LOAD A WITH THE ORIGINAL
                                            SIGN
1053    13044  067244          JMP  POOT+3  JUMP TO ATNS ROUTINE TO
                                            STORE +- PI/2
1054*
1055    13045  062674          JSM  SCRT1   JUMP TO FETCH THE DIVIDE
                                            ADDESSSES OF SCRT
1056    13046  062731          JSM  .FDV+1  DIVIDE THE RESULTS OF SCRT
1057    13047  021703          LDA  ADR3    SET THE ADDRESS OF THE RESULT
1058    13050  067206          JMP  ATNS    JUMP TO THE ARCTANGENT
                                            ROUTINE
1059*
1060*
1061**********************************
1062*
1063*   FIND THE ARCSINE OF AN ARGUMENT
1064*
1065    13051  063031  ASM     JSM  ASNS    CALCULATE THE ANSWER IN
                                            RADIANS
1066    13052  067256          JMP  EATN    CONVERT IT TO THE PROPER
                                            UNITS
```

```
PAGE 193          FUNCTIONS FOR 9830
1068*
1069*
1070**********************************
1071*
1072*   FIND THE TANGENT OF AN ARGUMENT
1073*
1074    13053  062714   TAN      JSM  STN      FETCH THE ARGUMENT IN
                                                  RADIANS AND INITIALIZE FLAGS
1075    13054  024012            LDB  P1       SET THE RECIPROCAL
1076    13055  035711            STB  RCPFG      FLAG TO 1
1077    13056  025754            LDB  AR2E     LOAD THE EXPONENT WORD
1078    13057  035716            STB  SIGN
1079    13060  074153            SBP  *+3      SKIP IF THE EXPONENT IS POSITIVE
1080    13061  045706   GET 3    ISZ  GFG    OTHERWISE SET GFG=1 AND
1081    13062  067116            JMP  GET        DO NOT SCALE
1082    13063  026536            LDB  TWOPI    SCALE THE ARGUMENT TO
1083    13064  062605            JSM  FRAC       WITHIN ONE CIRCLE
1084    13065  062635            JSM  ZERO     DETERMINE IF THE RESULT IS
                                                  ZERO
1085    13066  070635            SEC  FAL1,C   STORE ZERO IF IT IS
1086    13067  075512            SBM  GET3   SKIP IF THE EXPONENT IS NOW
1087*                                             NONZERO
1088    13070  020023            LDA  PI/2     LOAD PI/2
1089    13071  062754            JSM  XAR1     INTO AR1
1090    13072  170400            CMY           COMPLEMENT IT
1091    13073  074742            SBR  16       SUBTRACT AR 1 FROM AR2
1092    13074  170420            FDV             UNTIL AR2 GOES NEGATIVE
1093    13075  935711            STB  RCPFG    STORE THE NO. OF SHIFTS
                                                  BEFORE OVERFLOW
1094    13076  062635            JSM  ZERO     DETERMINE IF AR2 IS NOW ZERO
1095    13077  070434            SES  *+8,C    SKIP IF IT IS NOT ZERO
1096*
1097    13100  025711            LDB  RCPFG    SKIP IF THE NO. OF SUBTRACTS
1098    13101  074111            SLB  *+2        ABOVE WAS EVEN
1099    13102  065256   FAL1     JMP  CLAR2    STORE ZERO IF ODD — EXIT HERE
                                                  FOR SIN0, COS 90, TAN
1100        EXIT BELOW FOR SIN 90, COS0, AND TAN 90
1101    13103  025754            LDB  AR2E     LOAD THE EXPONENT WORD
1102    13104  055704            DSZ  TEMP     STORE MAX NO. IF THE SIN
1103    13105  065274            JMP  STMAX    ROUTINE WAS NOT CALLED
1104    13106  170402            RET           OTHERWISE RETURN WITH A=0
1105*
1106    13107  062576            JSM  NORM+1   NORMALIZE AR2
1107*
1108    13110  074312            SBM  GET      SKIP IF THE NEW EXPONENT IS
                                                  NEGATIVE
1109    13111  020157            LDA  N256     MAKE THE EXPONENT
1110    13112  041716            IOR  SIGN       MINUS ONE AND
1111    13113  031754            STA  AR2E       ORIGINAL MANTISSA SIGN BIT
1112    13114  031716            STA  SIGN     STORE THIS ALSO OVER THE
                                                  ORIGINAL EXPONENT
1113*
1114    13115  067121            JMP  GET+3    JUMP TO AVOID THE OFFSET
                                                  BELOW
1115    13116  035716   GET      STB  SIGN     STORE THE NEW EXPONENT WORD
1116    13117  024012            LDB  P1       SET B=1 AND
1117    13120  061305            JSM  ROUND    JUMP TO RIGHT SHIFT AR2
1118*
1119    13121  063523            JSM  ATD      INITIALIZE THE DIGIT STACK
                                                  POINTER
1120*
1121    13122  021754            LDA  AR2E     LOAD THE EXPONENT WORD
1122    13123  070240            AAR  6        MULTIPLY THE EXPONENT
                                                  WORD BY 4
1123    13124  070076            TCA           COMPLEMENT IT
```

PAGE 194 FUNCTIONS FOR 9830

```
1124  13125  002546          ADA  THETT   ADD IT TO THE TRIG TABLE LINK IN A

1125  13126  025754          LDB  AR2E    LOAD THE EXPONENT WORD
1126  13127  074340          ABR  8       ALLIGN THE EXPONENT WORD
1127  13130  004024          ADB  P7        AND ADD 7 TO IT
1128  13131  074453          SBP  .T.     SKIP IF THE RESULT IS POSITIVE
1129*
1130  13132  171450          NRM          NORMALIZE AR2
1131  13133  062571          JSM  ITR     TRANSFER AR2 INTO THE RESULT
                                                              LOCATION
1132  13134  025711          LDB  RCPFG   LOAD THE NO. OF SUBTRACTS FROM
                                                                 ABOVE
1133  13135  074111          SLB  *+2     SKIP IF IT IS EVEN
1134  13136  067200          JMP  OUT-2   IF ODD JUMP TO THE STORE ROUTINE
1135  13137  062646          JSM  RECIP   RECIPROCATE THE RESULT
1136  13140  025711          LDB  RCPFG   LOAD THE NO. OF SUBTRACTS
1137  13141  067200          JMP  OUT-2   JUMP TO THE STORE ROUTINE
1138  13142  075410  .T.     SZB  *+8     SKIP BACK IF THE EXPONENT WAS
                                                                   -7
1139*
1140  13143  063431          JSM  IN      EXECUTE PHASE I
1141*
1142  13144  021754          LDA  AR2E    LOAD THE EXPONENT WORD
1143  13145  000013          ADA  P256    INCREMENT THE EXPONENT BY 1
1144  13146  070340          AAR  8       SHIFT TO THE LOW 8 BITS IN A
1145  13147  074742          SBR  16      SET THE EXPONENT
1146  13150  035754          STB  AR2E      WORD OF AR2 TO0
1147  13151  070137          LDB  A       SET 8 EQUAL TO 6
1148  13152  070076          TCA            MINUS THE
1149  13153  004023          ADB  P6        6 REGISTER
1150  13154  063457          JSM  IN2     EXECUTE PHASE II
1151*
1152  13155  021711          LDA  RCPFG   LOAD THE RECIPROCAL FLAG
1153  13156  070211          SLA  *+4     SKIP IF IT IS EVEN
1154  13157  020213          LDA  AR1A    SET A TO THE ADD. OF CORDIC X
1155  13160  025713          LDB  RY1     SET B TO THE ADDRESS OF CORDIC
                                                                    Y
1156  13161  067164          JMP  *+3     JUMP TO NORMALIZE THESE
1157  13162  021713          LDA  RY1     SET A TO THE ADDRESS OR CORDIC
                                                                    Y
1158  13162  024213          LDB  AR1A    SET B TO THE ADD. OF CORDIC X
1159  13164  062563          JSM  DIV     JUMP TO NORMALIZE THESE
                                                              QUANTITIES
1160  13165  022542          LDA  RSLT    LOAD THE ADDRESS OF THE DIVISOR
1161  13166  026541          LDB  TREG    LOAD THE ADDRESS OF THE
                                                                 DIVIDEND
1162  13167  062730          JSM  .FDV      JUMP TO THE DIVIDE ROUTINE
1163*
1164  13170  025716          LDB  SIGN    LOAD THE EXPONENT ORIGINAL
                                                  EXPONENT WORD INTO A
1165  13171  005711          ADB  RCPFG   ADD THE RECIPROCAL FLAG TO THE
                                                    MANTISSA SIGN BIT
1166  13172  004013          ADB  P256    INCREMENT THE EXPONENT BY 1
1167  13173  021711          LDA  RCPFG   LOAD THE RECIPROCAL FLAG INTO B
1168  13174  070111          SLA  *+2     SKIP IF IT IS EVEN
1169  13175  067200          JMP  OUT-2   JUMP TO THE STORE ROUTINE
1170  13176  074076          TCB          COMPLEMENT B AND
1171  13177  004033          ADB  D0010     PROPOGATE BIT 7 INTO THE
                                                              EXPONENT
1172  13200  005706          ADB  GFG     ADD THE G FLAG TO THE MANTISSA
                                                              SIGN INB
```

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```
1173   13201  021754          LDA  AR2E    STORE THE EXPONENT WORD OF
                                                                    AR2
1174   13202  031744   OUT    STA  AR1E      IN AR1 FOR THE STORE ROUTINE
1175*
1176   13203  022542          LDA  RSLT    RESET THE RETURN
1177   13204  031703          STA  ADR3      LOCATION ADDRESS
1178*
1179   13205  065237   ZOR    JMP  STAR2     JUMP TO THE STORE ROUTINE
```

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```
1181*
1182*
1183**********************************
1184*
1185*  ARCTANGENT SUBROUTINE
1186*
1187   13206  024062  ATNS   LDB  D8000   LOAD THE ARCTANGENT FLAG —
                                          BCD 8000
1188   13207  062547         JSM  INIT    JUMP TO FETCH THE ARGUMENT
                                          AND INITIALIZE THE FLAGS
1189*
1190   13210  071655         SEC  ZOR     RETURN IF IT IS ZERO
1191   13211  074312         SBM  OK+1    SKIP IF THE EXPONENT IS NEGATIVE
1192   13212  006544         ADB  EN12    IF THE EXPONENT IS LESS THAN 12
1193   13213  074152         SBM  OK        JUMP TO CONTINUE
1194   13214  061256  FAP    JSM  CLAR2   OTHERWISE SET AR2=0 AND JUMP TO
1195   13215  067241         JMP  POOT    STORE AN ANSWER OF PI/2
1196*
1197   13216  062646  OK     JSM  RECIP   RECIPROCATE THE ARGUMENT
1198*
1199   13217  062704         JSM  CLER    CLEAR THE DIGIT STACK
1200   13220  021754         LDA  AR2E    SET THE A REGISTER EQUAL
1201   13221  070300         AAR  7         TO 22-2* THE EXPONENT
1202   13222  070076         TCA            TO BE USED AS A SHIFT
1203   13223  000035         ADA  P12     FACTOR IN PHASE II
1204   13224  024030         LDB  P12     SET R=12 TO BE USED AS A LOOP COUNT
1205*
1206   13225  063457         JSM  IN2     EXECUTE PHASE II
1207   13226  021754         LDA  AR2E    SAVE THE EXPONENT
1208   13227  031714         STA  SAVE      OF AR2 IN SAVE
1209   13230  070340         AAR  8       SET A EQUAL TO
1210   13231  070076         TCA            6 MINUS THE EXPONENT
1211   13232  000023         ADA  P6        TO BE USED AS A LOOP COUNT
1212*
1213   13233  000144         ADA  N13       IN PHASE III
1214   13234  070112         SAM  *+2     IF THIS QUANTITY IS GREATER
1215   13235  020132         LDA  N1        THAN 12 SET THE
1216   13236  000031         ADA  P13       A REGISTER TO 12
1217   13237  026535         LDB  PI      LET B=THE ADDRESS OF THE TRIG
                                          CORDIC TABLE
1218   13240  063654         JSM  IN3     EXECUTE PHASE III
1219*
1220   13241  021716  POOT   LDA  SIGN    LOAD THE ORIGINAL EXPONENT
                                          WORD
1221   13242  031754         STA  AR2E      AND STORE IT IN AR2
1222   13243  070452         SAM  GONO    SKIP IF THE EXPONENT IS NEGATIVE
1223*
1224   13244  050012         AND  P1      OTHERWISE CLEAR ALL BUT THE
                                          MANTISSA
1225   13245  031754         STA  AR2E      SIGN BIT IN THE EXPONENT WORD
1226   13246  025714         LDB  SAVE    LOAD THE EXPONENT FROM
                                          AFTER THE RECIPROCATION
1227   13247  062625         JSM  UNRM+1  UNNORMALIZE AR2
1228*
1229   13250  020023         LDA  PI/2    SET PI/2 IN THE
1230   13251  062754         JSM  XAR1    AR1 TEMPORARY
1231*
1232   13252  170400         CMY          CALCULATE
1233   13253  170560         FXA            AR2=AR1-AR2
1234*
1235   13254  066576  GONO   JMP  NORM+1  NORMALIZE THE RESULT
1236*
```

PAGE 196 FUNCTIONS FOR 9830

```
1237*
1238**********************************
1239*
1240*   FIND THE ARCTANGENT OF AN ARGUMENT
1241*
1242    13255  063206   ATN      JSM   ATNS     JUMP TO CALCULATE THE ANSWER IN
                                                        RADIANS
1243*
1244    13256  025434   EATN     LDB   UNITS    LOAD THE UNITS MODE WORD
1245    13257  076110            RZB   *+2      IF IT IS SET TO DEGREES
1246    13260  062743            JSM   RTOD       CONVERT THE ANSWER TO DEGREES
1247    13261  022533            LDA   GPERR    IF GRADS ARE SET
1248    13262  014017            CPB   GRA        CONVERT THE ANSWER
1249    13263  062744            JSM   RTOD+1     TO GRADS
1250*
1251    13264  074742   SOUT     SBR   16       CLEAR B AND RETURN
1252    13265  067201            JMP   OUT-1      THRU THE STORE ROUTINE
1253*
1254*
1255**********************************
```

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```
1257*  RAISE NAPERIAN E TO A POWER
1258*
1259   13266  021703          LDA  ADR2
1260   13267  062751          JSM  .FMP
1261   13270  021703          LDA  ADR3
1262   13271  024012  .EXP    LDB  P1      LET THE FUNCTION FLAG BE 1
1263   13272  062547          JSM  INIT    FETCH THE ARGUMENT AND
                                             INITIALIZE THE FLAGS
1264   13273  006543          ADB  EN3     IF THE EXPONENT IS 3 OR GREATER
1265   13274  074413          SBP  STM1-1    JUMP TO THE STORE MAX ROUTINE
1266*
1267   13275  026534          LDB  LN10    SUBTRACT AS MANY WHOLE LN10'S
1268   13276  062605          JSM  FRAC      FROM THE NO. AS POSSIBLE
1269   13277  062624          JSM  UNRM    UNNORMALIZE THE RESULT
1270*
1271   13300  021710          LDA  COUNT   LOAD THE NO. OF SUBTRACTS FROM
                                             ABOVE
1272   13301  070542          SAR  12      ISOLATE THE FIRST DIGIT
1273   13302  070210          SZA  STM1+1  IF IT IS NOT ZERO
1274   13303  025716          LDB  SIGN    LOAD THE EXPWORD OF THE ORIGINAL
                                             ARGUMENT
1275   13304  074044          SBL  15      POSITION THE SIGN BIT AND JUMP TO
1276   13305  065264  STM1    JMP  OF+3    THE OVERFLOW/UNDERFLOW
                                             ROUTINE
1277*
1278   13306  025710          LDB  COUNT   LOAD THE NO. OF LN10'S
1279   13307  074404          SBL  8       ISOLATE THE UNITS DIGIT
1280   13310  074142          SBR  4        OF IT IN B
1281   13311  021710          LDA  COUNT   ISOLATE THE TENS DIGIT
1282   13312  070342          SAR  8         OF IT IN A
1283   13313  070344          SAL  9       MULTIPLY THE A REGISTER
1284   13314  070037          ADB  A         BY 10 AND ADD IT
1285   13315  070704          SAL  2         TO B
1286   13316  070037          ADB  A       THIS QUANTITY WILL BE THE
                                             EXPONENT
1287   13317  035711          STB  RCPFG     OF THE UNNORMALIZED ANSWER
1288
1289   13320  062704          JSM  CLER    CLEAR THE DIGIT STACK
1290   13321  063523          JSM  ATD     INITIALIZE THE DIGIT
1291   13322  055717          DSZ  DIGIT     STACK POINTER
1292   13323  022545          LDA  THETL   PUT THE ADDRESS OF THE LOG
                                             CONSTANT STACK IN A
1293   13324  024023          LDR  P6      SET B=6 LOOPS
1294   13325  063431          JSM  IN      EXECUTE PHASE I
1295*
1296   13326  024136          LDB  N5      TRANSFER THE LAST
1297   13327  045717          ISZ  DIGIT     SIX DIGITS OF THE
1298   13330  171400          MLS            REDUCED ARGUMENT
1299   13331  131717          STA  DIGIT,I   INTO THE DIGIT STACK
1300   13332  077670          RIB  *-3       FROM AR2
1301*
1302   13333  062753          JSM  OTO     SET AR1=1
1303   13334  063603          JSM  PTJ     EXECUTE PHASE IV
1304*
1305   13335  021711  BACK    LDA  RCPFG   STORE THE EXPONENT CALCULATED
1306   13336  031754          STA  AR2F      ABOVE IN AR2
1307   13337  171450          NRM          NORMALIZE THE ANSWER
1308*
1309   13340  021716          LDA  SIGN    IF THE ORIGINAL ARGUMENT
1310   13341  070111          SLA  *+2       WAS NEGATIVE RECIPROCATE
1311   13342  062646          JSM  RECIP     THE ANSWER
1312   13343  067264          JMP  SOUT    JUMP TO THE STORE ROUTINE
```

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```
1314*
1315*
1316************************************
1317*
1318*  FIND THE NATURAL LOGARITHM OF AN ARGUMENT
1319*
1320   13344  024132  LNX     LDB  N1        SET THE FUNCTION FLAG TO -1
1321   13345  062547          JSM  INIT      FETCH THE ARGUMENT AND
                                              INITIALIZE THE FLAGS
1322*
1323   13346  070314          SES  *+6
1324   13347  160205          JSM  AERRA,I
1325   13350  177632          DEC  -102
1326   13351  024012          LDB  P1      SET THE FUNCTION FLAG TO 1
1327   13352  035712          STB  FNCFG     FNCFG IS FLAGED TO RETURN
                                              -9.9E99  WHEN  LOG10  CALL.
1328   13353  065274          JMP  STMAX
1329   13354  074111          SLB  *+2
1330   13355  160206  ER47    JSM  ERRA,I
1331*
1332   13356  062704          JSM  CLER      CLEAR THE DIGIT STACK
1333   13357  063603          JSM  PTJ       EXECUTE  PHASE  IV
1334   13360  055717          DSZ  DIGIT     DECREMENT THE DIGIT STACK
                                                              POINTER
1335*
1336   13361  020023          LDA  P6        LET 1=6 LOOPS
1337   13362  026534          LDB  LN10      LET B=THE ADDRESS OF THE LOG
                                                    CONSTANT STACK
1338*
1339   13363  063654          JSM  IN3       EXECUTE PHASE III
1340*
1341   13364  026540          LDB  ADR0      SAVE THE MANTISSA OF THE ANSWER
                                                                    IN
1342   13365  020214          LDA  AR2A      IN A TEMPORARY
1343   13366  170004          XFR
1344*
1345   13367  062757          JSM  OTT       SET AR2=1
1346*
1347   13370  021716          LDA  SIGN      LOAD THE ORIGINAL EXPONENT
1348   13371  000013          ADA  P256      INCREMENT IT
1349   13372  070153          SAP  *+3       IF IT IS NEGATIVE
1350   13373  070071          SLA  *+,C        CLEAR THE MANTISSA SIGN
1351   13374  070076          TCA              AND COMPLEMENT IT
1352   13375  070342          SAR  8         SHIFT IT TO THE LOW 8 BITS
1353*
1354   13376  000156          ADA  N100      SUBTRACT 100 FROM IT
1355   13377  024013          LDB  D0100     SET B=RCD 0100
1356   13400  070153          SAP  *+3       SKIP IF THE EXPONENT IS POSITIVE
1357   13401  000060          ADA  P100      OTHERWISE RESTORE IT AND
1358   13402  074742          SBR  16          CLEAR B
1359*
1360   13403  000141          ADA  N10       SUBTRACT 10 FROM IT
1361   13404  070152          SAM  *+3       SKIP IF IT IS NEGATIVE
1362   13405  004033          ADB  D00010    OTHERWISE ADD BCD 0010TO B
1363   13406  067403          JMP  *-3       JUMP BACK TO ADD AGAIN
1364   13407  000061          ADA  P10       RESTORE A
1365*
1366   13410  070037          ADB  A         ADD THE ONES LEFT TO B
1367   13411  035755          STB  AR2E+1    STORE THIS WORD AS THE FIRST 4
                                                              DIGITS OF AR2
1368*
1369   13412  020110          LDA  EP3       SET THE EXPONENT
```

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```
1370   13413  031754        STA  AR2E      OF AR2 TO +3
1371   13414  062576        JSM  NORM+1    NORMALIZE AR2
1372*
1373   13415  022534        LDA  LN10      MULTIPLY AR2 BY
1374   13416  062750        JSM  .FMP-1     LOG OF 10
1375*
1376   13417  021703        LDA  ADR3      NORMALIZE THIS AND THE
1377*
1378   13420  026540        LDB  ADR0        RESULT OF THE
1379   13421  062563        JSM  DIV         CORDIC ITERATION
1380*
1381   13422  146542        ISZ  RSLT,I    NEGATE THE MANTISSA QUANTITY
1382*
1383   13423  021716        LDA  SIGN      IF THE EXPONENT OF THE
1384   13424  070113        SAP  *+2         ORIGINAL WAS NEGATIVE
1385   13425  045630        ISZ  TREGE       NEGATE THE LN10 MULTIPLE
1386   13426  022541        LDA  TREG      ADD THESE TWO
1387   13427  026542        LDB  RSLT        QUANTITIES FOR THE
1388   13430  066734        JMP  .FAD      FINAL ANSWER
```

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```
1390*
1391*
1392************************************
1393*
1394*  CORDIC LOOP
1395*
1396*
1397************************************
1398*
1399*  PHASE I
1400*
1401   13431  031705  IN      STA  TABL0   STORE THE TABLE ADDRESS
1402   13432  035707         STB  SHIFT   STORE THE NO. OF LOOPS
1403*
1404   13433  062635  PTA     JSM  ZERO    DETERMINE IF THE ARGUMENT IS ZERO
1405   13434  070154         SES  *+3     IF IT IS INCREMENT THE
1406   13435  145717         ISZ  DIGIT,I   LAST DIGIT IN THE STACK
1407   13436  170402         RET            AND RETURN
1408*
1409   13437  170400         CMY          COMPLEMENT THE ARGUMENT
1410*
1411   13440  045717         ISZ  DIGIT   INCREMENT THE DIGIT STACK POINTER
1412*
1413   13441  020021         LDA  P4      FETCH THE NEXT CONSTANT
1414   13442  001705         ADA  TABL0   FETCH THE NEXT CONSTANT
1415   13443  031705         STA  TABL0   INTO AR1
1416   13444  024213         LDB  AR1A
1417   13445  170004         XFR
1418*
1419   13446  074004         SBL  16      ADD AR1 TO AR2
1420   13447  170420         FDV            UNTIL OVERFLOW
1421*
1422   13450  135717         STB  DIGIT,I STORE THE NO. OF SUBTRACTS BEFORE
                                                              OVERLOW
1423*
1424   13451  170400         CMY          RESTORE THE
1425   13452  170560         FXA            ARGUMENT TO ITS LAST NEGATIVE
                                                                  VALUE
1426*
1427   13453  171400         MLS          LEFT SHIFT THE ARGUMENT
1428*
1429   13454  055707         DSZ  SHIFT   DECREMENT THE LOOP COUNTER
1430   13455  067433         JMP  PTA     CONTINUE IF IT IS NONZERO
1431   13456  170402         RET          OTHERWISE RETURN
```

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```
1433*
1434*
1435**********************************
1436*
1437*  PHASE II
1438*
1439   13457  031714  IN2     STA  SAVE     STORE THE SHIFT FACTOR
1440   13460  035707          STB  SHIFT    STORE THE LOOP COUNT
1441   13461  062753          JSM  OTO      SET AR1=1
1442*
1443   13462  022540          LDA  ADRY     INITIALIZE RY1 AND RY2
1444   13463  031713          STA  RY1        TO THE ADDRESSES OF
1445   13464  020111          LDA  ADRX       TWO TEMPORARIES FOR
1446   13465  031715          STA  RY2        INTERMEDIATE STORAGE
1447*
1448   13466  025712          LDB  FNCFG    SKIP TO PTE IF THE ATN
1449   13467  076650          RZB  PTE        IS BEING CALCULATED
1450   13470  067525  PTL1    JMP  PTL      OTHERWISE GO TO PTL
1451*
1452   13471  076710  PTB     RZB  PTN
1453   13472  067534          JMP  PTC
1454*
1455   13473  055717  PTD     DSZ  DIGIT    DECREMENT THE DIGIT STACK POINTER
1456   13474  025712          LDB  FNCFG    SKIP TO PTL IF THE
1457   13475  075550          SZB  PTL1       TAN IS BEING CALCULATED
1458*
1459   13476  021755  PTO     LDA  AR2E+1   LOAD THE FIRST FOUR DIGITS OF AR2
1460   13477  070542          SAR  12       ISOLATE THE FIRST ONE
1461   13500  070150          SZA  *+3        AND SKIP IF IT IS ZERO
1462   13501  170410          DRS           OTHERWISE RIGHT SHIFT
1463   13502  067507          JMP  PTN        AR2 AND JUMP TO PTN
1464   13503  171400          MLS           LEFT SHIFT AR2 ONCE
1465   13504  020214  PTE     LDA  AR2A     STORE THE NEW VALUE
1466   13505  025713          LDB  RY1        OF Y IN
1467   13506  170004          XFR             RY1
1468*
1469   13507  174400  PTN     CMX           NEGATE AR1=X
1470   13510  170560          FXA           AR2=AR2-AR1 (Y-X)
1471   13511  070314          SES  *+6      SKIP ON OVERFLOW
1472   13512  021713          LDA  RY1      OTHERWISE RESTORE
1473   13513  024214          LDB  AR2A     AR2 WITH ITS
1474   13514  170004          XFR             LAST VALUE
1475   13515  174400          CMX           RECOMPLEMENT AR1=X
1476   13516  067600  PTF1    JMP  PTF      JUMP TO PTF
1477*
1478   13517  174400          CMX           RECOMPLEMENT AR1
1479*
1480   13520  062635          JSM  ZERO     DETERMINE IF AR2=0
1481   13521  070634          SES  PTM,C    SKIP IF IT IS NOT
1482   13522  155717          DSZ  DIGIT,I  IF IT IS ZERO DECREMENT THE
1483   13523  022537  ATD     LDA  AWRDN      LAST DIGIT AND FINALIZE THE
1484   13524  066712          JMP  CK-1       DIGIT STACK POINTER AND RETURN
1485   13525  024012  PTL     LDB  P1       RIGHT SHIFT AND ROUND UP
1486   13526  061305          JSM  ROUND    AR1 ONCE
1487*
1488   13527  020214          LDA  AR2A     STORE THIS
```

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```
1489  13530  025713        LDB  RY1      NEW Y IN
1490  13531  170004        XFR           RY1
1491*
1492  13532  121717        LDA  DIGIT,I  IF THE PRESENT DIGIT IS ZERO FOR
1493  13533  071150        SZA  PTF1       THE TAN JUMP TO PTF
1494*
1495  13534  170560  PTC   FXA           OTHERWISE CALCULTE AR2=AR2+ARY
                                                              (Y=Y+X)
1496*
1497  13535  021713  PTM   LDA  RY1      EXCHANGE THE NEW
1498  13536  025715        LDB  RY2        AND OLD VALUES
1499  13537  031715        STA  RY2        OF Y BY EXCHANGING
1500  13540  035713        STB  RY1        THEIR ADDRESSES
1501  13541  020214        LDA  AR2A     STORE THE NEW
1502  13542  170004        XFR             Y INTO AR2
1503*
1504  13543  021715        LDA  RY2      FETCH THE VALUE
1505  13544  024214        LDB  AR2A     OF Y USED IN THE LAST LOOP
1506  13545  170004        XFR
1507*
1508  13546  021712        LDA  FNCFG    LOAD THE FUNCTION FLAG
1509  13547  025707        LDB  SHIFT    LOAD THE LOOP COUNTER
1510  13550  004132        ADB  N1       SUBTRACT 1 FROM IT
1511  13551  074774        SBL  1        MULTIPLY IT BY 2
1512*
1513  13552  070150        SZA  *+3      SKIP IF TAN
1514  13553  074076        TCB           COMPLEMENT IT AND
1515  13554  067556        JMP  *+2        JUMP
1516  13555  005714        ADB  SAVE     ADD THE SHIFT FACTOR TO IT
1517  13556  005714        ADB  SAVE       TWICE IF TAN AND ONCE IF ATN
1518*
1519  13557  074117        LDA  B        IF THE RESULTING
1520  13560  000143        ADA  N12        VALUE IS 12 OR
1521  13561  070453        SAP  PTK        MORE SKIP TO PTK
1522*
1523  13562  061305        JSM  ROUND    RIGHT SHIFT AR2 B TIMES AND
                                                            ROUND UP
1524*
1525  13563  025712        LDB  FNCFG    LOAD THE FUNCTION FLAG
1526  13564  076110        RZB  *+2        AND COMPLEMENT AR2 IF
1527  13565  170400        CMY             THE TAN IS BEING CALCULATED
1528  13566  170560        FXA           ADD THE SHIFTED Y TO X FOR A NEW X
1529*
1530  13567  020214        LDA  AR2A     STORE THE NEW VALUE OF X
1531  13570  024213        LDB  AR1A     BACK IN AR1
1532  13571  170004        XFR
1533*
1534  13572  021713  PTK   LDA  RY1      FETCH THE LAST
1535  13573  024214        LDB  AR2A     CALCULATED VALUE OF Y INTO AR2
1536  13574  170004        XFR
1537*
1538  13575  025712        LDB  FNCFG    LOAD THE FUNCTION FLAG
1539  13576  155717        DSZ  DIGIT,I  DECREMENT THE PRESENT DIGIT
1540  13577  067471        JMP  PTB      JUMP TO PTB IF IT IS NOT ZERO
1541*
1542  13600  055707  PTF   DSZ  SHIFT    OTHERWISE DECREMENT THE LOOP
                                                            COUNTER
1543  13601  067473        JMP  PTD      JUMP TO PTD IF NOT FINISHED
1544  13602  170402        RET           OTHERWISE RETURN
```

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```
1546*
1547*
1548**********************************
1549*
1550*  PHASE III
1551*
1552   13603  022537  PTJ     LDA  AWRDN   INITIALIZE THE
1553   13604  031717          STA  DIGIT     DIGIT STACK POINTER
1554*
1555   13605  020030          LDA  P12     INITIALIZE THE
1556   13606  031707          STA  SHIFT     LOOP COUNT TO 12
1557   13607  025712          LDB  FNCFG   JUMP TO PTS IF THE
1558   13610  074312          SBM  PTS       LN IS BEING CALCULATED
1559   13611  062757          JSM  OTT     DUPLICATE AR1 IN AR2
1560*
1561   13612  025712  PTR     LDB  FNCFG   JUMP TO PTI IF THE
1562   13613  074353          SBP  PTI       EXP IS BEING CALCULATED
1563   13614  174400          CMX          SUBTRACT
1564   13615  170560          FXA            AR1 FROM AR2
1565   13616  020214  PTS     LDA  AR2A    DUPLICATE AR2, THE NEW X, IN AR1
1566   13617  024213          LDB  AR1A
1567   13620  170004          XFR
1568   13621  067624          JMP  PTH-2   JUMP
1569*
1570   13622  121717  PTI     LDA  DIGIT,I SKIP IF THE PRESENT
1571   13623  070750          SZA  GOON-1    DIGIT IN THE STACK IS ZERO
1572*
1573   13624  020061          LDA  P10     INITIALIZE THE INNER
1574   13625  031705          STA  TABL0     LOOP COUNT TO 10
1575   13626  025707  PTH     LDB  SHIFT   SUBTRACT THE OUTER
1576   13627  074076          TCB            LOOP COUNT FROM 12
1577   13630  004030          ADB  P12       FOR THE SHIFT FACTOR
1578   13631  070742          SAR  16      RIGHT SHIFT AR1
1579   13632  174430          MRX            THIS MANY TIMES
1580*
1581   13633  025712          LDB  FNCFG   IF THE EXP IS BEING CALCULATED
1582   13634  014012          CPB  P1        SET THE OVERFLOW BIT IF THE
1583   13635  000136          ADA  N5        LAST SHIFTED DIGIT IS >=5
1584*
1585   13636  170560          FXA          CALCULATE THE NEW X
1586*
1587   13637  070454          SES  PTG     SKIP ON OVERFLOW
1588   13640  055705          DSZ  TABL0   OTHERWISE DECREMENT THE INNER
                                                          LOOP COUNTER
1589   13641  067643          JMP  GOON      JUMP BACK IF THIS DIGIT COUNT
1590   13642  067650          JMP  PTG       IS LESS THAN 10
1591*
1592   13643  020214  GOON    LDA  AR2A    DUPLICATE THE NEW VALUE
1593   13644  024213          LDB  AR1A    OF X IN AR1
1594   13645  170004          XFR
1595*
1596   13646  155717          DSZ  DIGIT,I DECREMENT THE STACK DIGIT
1597   13647  067626          JMP  PTH       JUMP TO PTN IF IT IS NOT ZERO
1598   13650  045717  PTG     ISZ  DIGIT   OTHERWISE INCREMENT THE DIGIT
                                                          STACK POINTER
1599   13651  055707          DSZ  SHIFT   DECREMENT THE MAIN LOOP COUNTER
1600   13652  067612          JMP  PTR       JUMP TO PTR IF NOT FINISHED
1601   13653  170402          RET            OTHERWISE RETURN
```

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```
1603*
1604*
1605************************************
1606*
1607*  PHASE IV
1608*
1609   13654  035705  IN3     STB  TABL0    STORE THE CONSTANT TABLE ADDRESS
1610   13655  031704          STA  TEMP     STORE THE SHIFT FACTOR
1611   13656  031707          STA  SHIFT    STORE THE LOOP COUNT
1612*
1613   13657  020214          LDA  AR2A
1614   13660  170000          CLR           CLEAR AR2
1615*
1616   13661  121717  PTP     LDA  DIGIT,I  LOAD THE PRESENT DIGIT FROM THE
                                                                      STACK
1617   13662  070076          TCA           COMPLEMENT IT
1618   13663  024012          LDB  P1       SHIFT IT INTO
1619   13664  174470          MRY             AR2
1620   13665  025712          LDB  FNCFG    LOAD THE FUNCTION FLAG
1621   13666  074151          SLB  *+3      SKIP IF LN
1622   13667  055717          DSZ  DIGIT    ESTABLISH WHERE THE NEXT DIGIT
1623   13670  067672          JMP  *+2
1624   13671  045717          ISZ  DIGIT    IS.
1625   13672  055707          DSZ  SHIFT    DECREMENT THE LOOP COUNTER
1626   13673  067661          JMP  PTP      JUMP BACK IF IT IS NONZERO
1627*
1628   13674  070742          SAR  16       ESTABLISH THE NEW LOOP
1629   13675  025704          LDB  TEMP       COUNTER AS 12
1630   13676  074076          TCB           MINUS THE LAST
1631   13677  004030          ADB  P12        INITIAL ONE AND
1632   13700  035707          STB  SHFT       SHIFT AR2 RIGHT
1633   13701  174470          MRY             THIS MANY TIMES
1634*
1635   13702  020135  PTQ     LDA  N4       FETCH THE NEXT CONSTANT
1636   13703  001705          ADA  TABL0    INTO AR1
1637   13704  031705          STA  TABL0
1638   13705  024213          LDB  AR1A
1639   13706  170004          XFR
1640   13707  070742          SAR  16       CLEAR A
1641   13710  025707          LDB  SHIFT    SKIP IF THE LOOP COUNT
1642   13711  076110          RZB  *+2      IS NOT ZERO
1643   13712  170402          RET           OTHERWISE RETURN
1644   13713  004132          ADB  N1       SHIFT AR1 THE LOOP COUNT
1645   13714  174430          MRX             MINUS 1 TIMES
1646*
1647   13715  000136          ADA  N5       IF THE LAST SHIFTED
1648   13716  070175          SEC  *+3,C      OUT DIGIT IS=75
1649   13717  020213          LDA  AR1A     INCREMENT THE
1650   13720  170540          MDI             CONSTANT IN AR1
1651*
1652   13721  125717          LDB  DIGIT,I  LOAD THE PRESENT DIGIT
1653   13722  074076          TCB           COMPLEMENT IT
1654   13723  171460          FMP           ADD AR1 INTO AR2 THIS MANY TIMES
1655*
1656   13724  025712          LDB  FNCFG
1657   13725  074151          SLB  *+3
1658   13726  055717          DSZ  DIGIT
```

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```
1659   13727  067731          JMP  *+2
1660   13730  045717          ISZ  DIGIT
1661   13731  055707          DSZ  SHIFT     DECREMENT THE LOOP COUNTER
1662   13732  067702          JMP  PTQ       JUMP BACK IF IT IS NOT ZERO
1663   13733  170402          RET            OTHERWISE RETURN
1664*
1665**********************************
1666*
1667*  FIND THE LOG BASE TEN OF AN ARGUMENT
1668*
1669   13734  063344  LOG     JSM  LNX       TAKE THE NATURAL LOG OF THE
                                                                  ARGUMENT
1670   13735  026534          LDB  LN10
1671   13736  055712          DSZ  FNCFG       ZERO DIVIDE THE RESULT
1672   13737  066727          JMP  DTOR+1      BY LN10
1673   13740  170402          RET            OTHERWISE RETURN WITH THE MAX NO.
1674*
1675*   LAST WORD AVAILABLE 13740B
```

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```
1678*
1679*  MATH ROUTINES BEGIN HERE
1680*
1681*
1682   11465                    ORG  11465B
1683*
1684   11465  077764  MASK2     OCT  77764
1685*
1686**********************************
1687*
1688*  FLOATING POINT SUBTRACT
1689*
1690*
1691   11466  031703  FSB       STA  ADR2
1692   11467  074117            LDA  B
1693   11470  024057            LDB  ATEMP
1694   11471  035702            STB  ADR1
1695   11472  170004            XFR
1696   11473  120057            LDA  ATEMP,I
1697   11474  072111            SLA  *+2,S     * CHANGE THE SIGN
1698   11475  070071            SLA  *+1,C     * AND ADD
1699   11476  130057            STA  ATEMP,I
1700   11477  067502            JMP  FAD+2
1701*
1702*
1703**********************************
1704*
1705*  FLOATING POINT ADDITION
1706*
1707*
1708   11500  031703  FAD       STA  ADR2
1709   11501  035702            STB  ADR1
1710   11502  125702            LDB  ADR1,I   "SUBTRACT" ENTRY POINT
1711   11503  074340            ABR  8          SUBTRACT THE
1712   11504  074076            TCB             EXPONENT OF THE
1713   11505  121703            LDA  ADR2,I     SECOND ARGUMENT FROM
1714   11506  070340            AAR  8          THE FIRST ARGUMENT
1715   11507  070037            ADB  A          AND STORE THIS OFFSET
1716   11510  035701            STB  TEMPA      IN A TEMPORARY
1717*
1718   11511  021703            LDA  ADR2      LOAD THE ADDRESS OF THE FIRST
                                                                  ARGUMENT
1719   11512  074253            SBP  *+5       JUMP IF THE 1ST AR1. IS LARGER
1720   11513  024214            LDB  AR2A
1721   11514  170004            XFR            TRANSFER THE SMALLER NUMBER
                                                                  INTO AR2
1722   11515  024213            LDB  AR1A      LOAD THE ADDRESS OF
1723   11516  067522            JMP  *+4       AR1 AND JUMP
1724   11517  024213            LDB  AR1A      TRANSFER THE LARGER NUMBER
                                                                  INTO AR1
1725   11520  170004            XFR
1726   11521  024214            LDB  AR2A      TRANSFER THE OTHER
1727   11522  021702            LDA  ADR1        ARGUMENT INTO THE
1728   11523  170004            XFR              OTHER WORKING REGISTER
1729*
1730*
1731   11524  021755            LDA  AR2E+1    JUMP IF THE SMALLER
1732   11525  070510            SZA  BNZ         ARGUMENT IS ZERO TO STORE THE
                                                                  LARGER
1733*
```

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```
1734   11526  021745          LDA  AR1E+1  JUMP IF THE LARGER
1735   11527  072110          RZA  *+2       NUMBER IS NON-ZERO
1736   11530  065254          JMP  ZONK    STORE THE LARGER ARGUMENT
1737*
1738*
1739   11531  021701          LDA  TEMPA   LOAD THE OFFSET
1740   11532  070113          SAP  *+2       AND COMPLEMENT IT
1741   11533  070076          TCA            IF ITS NEGATIVE
1742   11534  070137          LDB  A       IF THE OFFSET IS GREATER
1743   11535  003465          ADA  MASK2     THAN ELEVEN THEN
1744   11536  070253          SAP  *+5     JUMP TO STORE THE
1745   11537  020213  BNZ     LDA  AR1A    LARGER NUMBER
1746   11540  024214          LDB  AR2A
1747   11541  170004          XFR
1748   11542  065254          JMP  ZONK
1749*
1750*
1751   11543  061305          JSM  ROUND   RIGHT JUSTIFY AND ROUND THE
                                                    SMALLER ARGUMENT
1752*
1753   11544  021744          LDA  AR1E    ADD THE SIGNS OF THE
1754   11545  001754          ADA  AR2E      TWO MANTISSAS AND
1755   11546  070511          SLA  INTLK   JUMP IF SAME
1756*
1757*
1758*
1759   11547  170400          CMY          THEY HAVE ULIKE SIGNS SO
                                                  COMPLEMENT THE LARGER
1760   11550  170560          FXA          ADD THE MANTISSAS
1761   11551  070154          SES  *+3     IF A CARRY DIGIT IS GENERATED
1762   11552  170400          CMY            COMPLEMENT THE ANSWER AND
1763   11553  045744          ISZ  AR1E      CHANGE THE SIGN OF THE LARGER
                                                          ARGUMENT
1764   11554  171450          NRM          NORMALIZE THE ANSWER:PUT THE
                                                      NO. OF SHIFTS IN B
1765   11555  074076          TCB          COMPLEMENT AND ALLIGN THE
1766   11556  074404          SBL  8         NO. OF SHIFTS
1767   11557  067572          JMP  .FAD.   JUMP TO STORE ROUTINE IF NOT ZERO
1768*
1769   11560  070074  INTLK   SES  *+1,C   CLEAR THE E REGISTER
1770   11561  170560          FXA          ADD THE MANTISSAS
1771   11562  070214          SES  *+4     IF NO CARRY IS GENERATED
1772   11563  021744          LDA  AR1E      LET THE EXPONENT WORD OF THE
1773   11564  031754          STA  AR2E    LARGER ARGUMENT
1774   11565  065254          JMP  ZONK    JUMP TO THE STORE ROUTINE
1775   11566  170002          MOV          ELSE SHIFT A ONE INTO
1776   11567  070137          LDB  A         THE MOST SIGNIFICANT
1777   11570  174470          MRY            LOCATION OF THE ANSWER
1778   11571  024013          LDB  P256    LOAD B WITH THE EXPONENT
                                                        CORRECTION
1779*
1780   11572  021755  .FAD.   LDA  AR2E+1
1781   11573  070110          SZA  *+2     IF THE MANTISSA WAS 0 CLEAR AR2
1782   11574  065237          JMP  STAR2
1783   11575  065256          JMP  CLAR2
```

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```
1785*
1786*
1787************************************
1788*
1789*  FLOATING POINT DIVISION
1790*
1791*
1792   11576  035702  FDV     STB  ADR1
1793   11577  031703         STA  ADR2
1794*
1795   11600  024214         LDB  AR2A      PUT THE DIVIDEND INTO AR2
1796   11601  170004         XFR
1797*
1798   11602  021702         LDA  ADR1      PLACE THE DIVISOR INTO AR1
1799   11603  024213         LDB  AR1A
1800   11604  170004         XFR
1801*
1802   11605  020057         LDA  ATEMP     INITIALIZE THE WORD
1803   11606  031475         STA  TEMP2       POINTER FOR THE QUOTIENT
1804   11607  170000         CLR            CLEAR THE QUOTIENT REGISTER
1805*
1806*
1807*
1808   11610  021745         LDA  AR1E+1
1809   11611  072310         RZA  GOOD
1810   11612  160205         JSM  AERRA,I
1811   11613  177631         DEC  -103
1812   11614  025754         LDB  AR2E      LOAD THE DIVIDED WORD
1813   11615  074073         SBP  *+1,C       AND COEAR THE SIGN BIT
1814   11616  065274         JMP  STMAX
1815*
1816   11617  021755  GOOD   LDA  AR2E+1
1817   11620  072110         RZA  *+2
1818   11621  065254         JMP  ZONK
1819*
1820   11622  170400         CMY            COMPLEMENT THE DIVISOR
1821   11623  020132         LDA  N1        INITIAL FIRST DIVIDED DIGIT TO -1
1822   11624  024144         LDB  M13       INITIALIZE THE DIGIT
1823   11625  035477         STB  TEMP4       COUNT TO 13
1824*
1825   11626  024135  NWWD   LDB  M4        SET THE WORD DIGIT
1826   11627  035701         STB  TEMPA       COUNT TO 4
1827*
1828   11630  074604  NXDG   SBL  4         CLEAR LOCATION FOR NEXT
                                                CALCULATED DIGIT AND ALLIGN
1829   11631  031476         STA  TEMP3     STORE FIRST DIVIDED DIGIT
1830*
1831   11632  170420  DINC   FDV           SUBTRACT DIVISOR FROM DIVIDEND
                                                              UNTIL OVERFLOW
1832   11633  074070         SIB  *+1       INCREMENT THIS COUNT
1833   11634  045476         ISZ  TEMP3     INCREMENT FIRST DIVIDED DIGIT
1834   11635  067632         JMP  DINC      JUMP BACK IF NOT ZERO
1835*
1836   11636  021755         LDA  AR2E+1    JUMP OUT OF
1837   11637  001756         ADA  AR2E+2      MAIN LOOP
1838   11640  001757         ADA  AR2E+3      IF DIVIDEND
1839   11641  072150         RZA  NO          IS ZERO (I.E. AN
1840   11642  070134         SES  NO,C        EXACT QUOTIENT
```

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```
1841  11643  067663          JMP  YES        WAS FOUND)
1842*
1843  11644  170400  NO      CMY             OTHERWISE RESTORE THE
1844  11645  170560          FXA               DIVIDEND TO ITS LAST POSITIVE
                                                 VALUE
1845  11646  004132          ADB  N1         SUBTRACT ONE FROM THE LAST
                                                 CALCULATED DIGIT
1846  11647  170400          CMY             COMPLEMENT THE DIVIDEND AGAIN
1847*
1848  11650  171400          MLS             SHIFT THE DIVIDEND LEFT ONE DIGIT
1849  11651  000141          ADA  N10        LET THE NEW FIRST DIGIT BE THE
                                                 ONE SHIFTED OUT-10
1850*
1851  11652  045477          ISZ  TEMP4      INCREMENT THE DIGIT COUNT
1852  11653  070112          SAM  *+2        JUMP OUT OF LOOP IF DONE OR
1853  11654  067665          JMP  DONE         IF DIVISOR HAS A NON BCD DIGIT
1854  11655  045701          ISZ  TEMPA      INCREMENT WORD DIGIT COUNT
1855  11656  067630          JMP  NXDG       JUMP BACK THRU LOOP IF NON ZERO
1856  11657  135475          STB  TEMP2,I    GLSE STORE LAST 4 DIGITS IN
                                                 QUOTIENT
1857  11660  045475          ISZ  TEMP2      INCREMENT THE QUOTIENT WORD
                                                 POINTER
1858  11661  067626          JMP  NWWD         AND JUMP BACK
1859*
1860  11662  074604          SDL  4          ALLIGN THE LAST DIGIT
1861  11663  045701  YES     ISZ  TEMPA      IF A PERFECT QUOTIENT
1862  11664  067662          JMP  *-2          WAS FOUND
1863*
1864  11665  135475  DONE    STB  TEMP2,I    STORE THE LAST 4 DIGITS
1865  11666  020057          LDA  ATEMP      TRANSFER
1866  11667  000132          ADA  N1           THE QUOTIENT
1867  11670  024214          LDB  AR2A       INTO A
1868  11671  170004          XFR             WORKING REGISTOR
1869*
1870  11672  171450          NRM             NORMALIZE THE ANSWER
1871  11673  074310          SZB  .GOON        SKIP IF IT WAS NORMALIZED (B=0)
1872*
1873  11674  021753          LDA  AR2E-1     LOAD LAST DIGIT
1874  11675  050032          AND  P15          AND STORE IT
1875  11676  001757          ADA  AR2E+3       IN THE
1876  11677  031757          STA  AR2E+3       QUOTIENT
1877  11700  024157          LDB  N256       LOAD AN EXP OF -1 INTO B
1878*
1879  11701  105703  .GOON    ADB  ADR2,I
1880  11702  021744          LDA  AR1E
1881  11703  070076          TCA               EXPONENT OF
1882  11704  000017          ADA  P2         THE DIVISOR AND PASS INTO
1883  11705  031744          STA  AR1E       THE STORE ROUTINE
1884  11706  065237          JMP  STAR2
1885*
```

PAGE 210 MATH ROUTINED FOR 9830, CALLED 'MATH'

```
1887*
1888************************************
1889*
1890    11707                   ORG  11707B
1891    11707  000000           BSS  11          RESERVED FOR OTHER POINTERS
1892    11722  001077           ABS  ACS-*
1893    11723  001126           ABS  ASN-*
1894************************************
1895*
1896*   LINKAGE
1897*
1898    11724  002010           ABS  LOG-*       LOG BASE 10
1899    11725  001330           ABS  ATN-*       ARC TANGENT
1900    11726  001125           ABS  TAN-*       TANGENT
1901    11727  001060           ABS  COS-*       COSINE
1902    11730  001031           ABS  SIN-*       SINE
1903    11731  005123           ABS  SGN-*       SIGN
1904    11732  004046           ABS  INT-*       INTEGER VALUE
1905    11733  004227           ABS  FSR-*       SQUARE ROOT
1906    11734  005155           ABS  ABS-*       ABSOLUTE VALUE
1907    11735  001407           ABS  LNX-*       NATURAL LOG
1908    11736  001333           ABS  .EXP-*      E TO THE POWER
1909*
1910*
```

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```
1912   17000                    ORG  17000B
1913*
1914   01256          CLRA2     EQU  CLAR2
1915   00051          LDVSR     EQU  .46          POINTER TO .1E4
1916   01471          DIVSR     EQU  L2T2
1917   17000  037400  B37.4     OCT  37400
1918*
1919*  CONVERT FULL-PRECISION FLOATING NUMBER TO INTEGER
1920*
1921*  FLOATING NUMBER IS IN AR2
1922*
1923*      JSM FLTFX
1924*      ---      ERROR EXIT (OVERFLOW)
1925*      ---      NORMAL RETURN WITH RESULT IN (B)
1926*
1927*  NEGATIVE INTEGER IN 2'S COMPLEMENT FORM
1928*
1929   17001  074742  FLTFX     SBR  16           CLEAR B
1930   17002  021754           LDA  AR2          LOOK AT EXPONENT
1931   17003  070652           SAM  PP2          DONE IF FRACTIONAL
1932   17004  000157  FLT1      ADA  M256           ELSE DECREMENT 10'S EXPONENT
1933   17005  031471           STA  L2T2         AND SAVE IT.
1934   17006  020061           LDA  .10            *10
1935   17007  061201           JSM  IMPY
1936*
1937*     ON RETURN THE A-REG IS SET NEGATIVE ON OVERFLOW, TESTING
1938*     IS NOT MADE UNTIL THE NEXT DIGIT IS ADDED IN.
1939*
1940   17010  070137           LDB  A
1941   17011  171400           MLS                 NEXT DIGIT
1942   17012  070037           ADB  A            ADD NEW DIGIT
1943   17013  074352  FLT2      SBM  RET1           OVERFLOW?
1944   17014  021471           LDA  L2T2         RECALL EXPONENT
1945   17015  071353           SAP  FLT1           LOOP IF POSITIVE
1946   17016  070111           SLA  *+2            TEST MANTISSA SIGN
1947   17017  074076           TCB
1948   17020  064357  PP2       JMP  RETN2
1949*
1950*     CONVERT FULL-PRECISION FLOATING NUMBER TO ROUNDED INTEGER
1951*
1952*       FLOATING NUMBER IN AR2
1953*         JSM FLTRF
1954*       --- ERROR EXIT
1955*           --- NORMAL RETURN WITH RESULT IN B
1956*
1957   17021  063001  FLTRF     JSM  FLTFX        GO GET INTEGER
1958   17022  064444  RET1      JMP  XFAR2        P+1 RETURN FOR OVERFLOW ERRORS
1959   17023  076210           RZB  *+4          IS (B) =0?
1960   17024  031471           STA  L2T2         YES, SAVE AR2 EXP AT L2T2
1961   17025  000013           ADA  B400         ADD EXP OF 1 TO CHECK IF<.1
1962   17026  071512           SAM  PP2          IF EXP IS STILL NEGATIVE RETURN
1963   17027  171400           MLS               GET MS FRACTIONAL DIGIT
1964   17030  000136           ADA  M5           ADD -5
1965   17031  071352           SAM  PP2          DONE IF .LT. 5
1966   17032  074113           SBP  *+2            IS B POSITIVE?
1967   17033  074076           TCB               NO — MAKE IT SO
```

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```
1968   17034  074070            SIB   *+1        ADD 1 FOR ROUNDING
1969   17035  067013            JMP   FLT2       USE FLTFX TO RESTORE SIGN,
1970*                           AND OVERFLOW TEST
1971*
1972*
1973*
1974*   OUTPUT AN INTEGER GIVEN IN (B) TO THE I/O BUFFER
1975*
1976   17036  063055  OUTIN     JSM   FXFLT
1977   17037  035470            STB   L2T1         (B)=EXPONENT WORD OF AR2
1978   17040  061314            JSM   ODGIT
1979   17041  025470            LDB   L2T1         LOOK AT EXPONENT
1980   17042  004157            ADB   M256         DECREMENT 10'S EXPONENT
1981   17043  075613            SBP   *-4          LOOP IF POSITIVE
1982   17044  170402  .R1       RET
1983*
1984*   TRANSFER A BCD DIGIT INTO D12 OF AR2
1985*
1986   17045  031470            STA   L2T1         ALTERNATE ENTRY POINT
1987   17046  171400  XFER      MLS
1988   17047  021757            LDA   AR2+3
1989   17050  041470            IOR   L2T1
1990   17051  031757            STA   AR2+3
1991   17052  170402            RET
1992*
1993**************************************************
1994*
1995   17053  000000            BSS   1          CHECKSUM WORD FOR THIS 256 WORD
                                                                        BLOCK
1996*
1997**************************************************
```

PAGE 213 NUMBER CONVERSION ROUTINES

```
1999*
2000*     SIGN ROUTINE
2001*
2002*     ON RETURN AR2 = 1 IF ARG WAS +, 0 IF 0, AND -1 IF NEGATIVE
2003*
2004   17054  061317  SGN      JSM  SGNS      SGN FLOWS INTO FXFLT
2005*
2006*  CONVERT INTEGER TO FULL-PRECISION FLOATING NUMBER
2007*  FLOATING NUMBER BUILT IN AR2
2008*
2009*       LDB N
2010*       JSM FXFLT
2011*
2012   17055  061256  FXFLT    JSM  CLRA2     CLEAR AR2
2013   17056  075310           SZB  .R1      RETURN IF A IS ZERO
2014   17057  074153           SBP  *+3      AND GET ABSOLUTE VALUE
2015   17060  074076           TCB           MAKE B POSITIVE
2016   17061  045754           ISZ  AR2      NOTE THE SIGN OF THE INTEGER
2017   17062  020051           LDA  LDVSR       INITIALIZE THE DIVISOR POINTER
2018   17063  031471           STA  DIVSR
2019   17064  121471  FXFL     LDA  DIVSR,I
2020   17065  070513           SAP  .IK
2021   17066  035470           STB  L2T1
2022   17067  063046           JSM  XFER     UNITS POSITION
2023   17070  171450           NRM
2024   17071  004142           ADB  M11      COMPUTE EXPONENT
2025   17072  074076           TCB              PLACEMENT
2026   17073  074404           SBL  8        SHIFT B LEFT 8
2027   17074  005754           ADB  AR2      MERGE IN THE SIGN BIT
2028   17075  035754           STB  AR2      STORE IT IN AR2
2029   17076  170402           RET
2030   17077  070076  .IK      TCA
2031   17100  031467           STA  LOCL2       STORE NEGATIVE DIVISOR
2032   17101  020132           LDA  M1
2033   17102  070070           SIA  *+1         INCREMENT INTEGER COUNTER
2034   17103  005467           ADB  LOCL2
2035   17104  075713           SBP  *-2
2036   17105  105471           ADB  DIVSR,I     RESTORE DIVIDEND
2037   17106  063045           JSM  XFER-1   MERGE A INTO D12 SLOT
2038   17107  045471           ISZ  DIVSR       ADVANCE TO NEXT DIVISOR
                                                              IN TABLE
2039   17110  067064           JMP  FXFL
2040*****************************
2041*  ABSOLUTE VALUE
2042*
2043   17111  060445  ABS      JSM  XFAR2+1
2044   17112  025754           LDB  AR2
2045   17113  074071           SLB  *+1,C
2046   17114  067075           JMP  .IK-2
2047*
2048*****************************
2049*
2050*  CONVERT FULL-PRECISION FLOATING NUMBER TO SPLIT
2051*
2052*  FLOATING NUMBER IS IN AR2
2053*       LDB ADDRESS FOR SPLIT
2054*       JSM FLTSP
```

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```
2055*
2056   17115  160205  SPLUF   JSM   AERRA,I     THE EXPONENT=10XXXXXX
2057   17116  177625          DEC   -107       THIS IS AN UNDERFLOW CONDITION
2058   17117  061256          JSM   CLRA2        CONDITION SO CLEAR AR2
2059   17120  067122          JMP   FLTSP+1     AR2 IS ZERO — PROCEED
2060*
2061   17121  035727  FLTSP   STB   MBIN2       SAVE STARTING ADD. OF SPLIT
2062   17122  021754          LDA   AR2         GET SIGN
2063   17123  050012          AND   .1            OF MANTISSA
2064   17124  031726          STA   MBIN1       AND SAVE
2065   17125  025754          LDB   AR2         LOAD EXPONENT FOR OVERFLOW
                                                        CHECK
2066   17126  074706          RBR   15          POSITION BIT 15 IN LSB
2067   17127  074111          SLB   *+2         IS BIT 15=1?
2068   17130  075273          SBP   SPLUF,C     YES — IF BIT 14=1; CONTINUE
2069   17131  074333          SBP   OK1,C       NO — IF BIT 14=0; JUMP OVER ERROR
2070*
2071   17132  160205          JSM   AERRA,I     OVERFLOW ERROR
2072   17133  177626          DEC   -106
2073   17134  061274          JSM   STMAX       SET AR2=THE MAX NUMBER
2074   17135  023000          LDA   B37.4       SET EXPONENT
2075   17136  031754          STA   AR2           =E63
2076*
2077   17137  024017  OK1     LDB   .2
2078   17140  070742          SAR   16
2079   17141  174470          MRY               SHIFT AR2 MANTISSA RIGHT
2080   17142  021754          LDA   AR2         PICK UP EXPONENT WORD
2081   17143  070300          AAR   7           SHIFT OFF 7 BITS
2082   17144  041726          IOR   MBIN1       ADD IN MANTISSA SIGN
2083   17145  070404          SAL   8
2084   17146  041755          IOR   AR2+1       ADD IN FIRST TWO DIGITS
2085   17147  131727          STA   MBIN2,I     STASH FIRST WORD
2086   17150  045727          ISZ   MBIN2
2087   17151  021756          LDA   AR2+2
2088   17152  131727          STA   MBIN2,I       STASH SECOND WORD
2089   17153  170402          RET
2090*
```

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```
2092*
2093*     BUILD A NUMBER IN AR2
2004*       FIRST CHARACTER IN A
2095*
2096   17154  070137  NUMCK   LDB  A
2097   17155  061256          JSM  CLRA2        CLEAR AR2
2098   17156  020132          LDA  M1
2099   17157  031745          STA  EXCNT    SET EXPONENT COUNT TO -1
2100   17160  031746          STA  DPFLG    SET DECIMAL POINT FLAG TO -1
2101   17161  020143          LDA  M12
2102   17162  031744          STA  SIGDG    SET SIGNIFICANT DIGIT COUNT TO
                                                                    -12
2103   17163  074117          LDA  B        RECALL CHARACTER
2104   17164  067175          JMP  NUMC1
2105*
2106*    PROCESS A DECIMAL POINT
2107*
2108   17165  021746  .ANUM   LDA  DPFLG     DECIMAL POINT YET?
2109   17166  072250          RZA  NUMC1-2   NO — SET NUMBER FOUND AND GET
                                                              NEXT CHAR.
2110   17167  055745          DSZ  EXCNT      YES — DECR. EXPONENT COUNT
2111   17170  067174          JMP  NUMC1-1
2112   17171  045746  NUMCP   ISZ  DPFLG    SET FLAG
2113   17172  160206          JSM  ERRA,I    FLAG ALREADY SET, 2 DECIMAL
                                                                  POINTS
2114   17173  045754          ISZ  AR2       SET EXPONENT NON-ZERO; NUMBER
                                                                  FOUND
2115   17174  061055          JSM  GNEXT     GET NEXT CHAR.
2116   17175  060750  NUMC1   JSM  DIGCK     DIGIT?
2117   17176  067215          JMP  NUMC2      NO — IT'S NOT A DIGIT
2118   17177  076210          RZB  NUMCD     ZERO?
2119   17200  021744          LDA  SIGDG     YES,
2120   17201  010143          CPA  M12       ANY SIGNIFICANT DIGITS YET?
2121   17202  067165          JMP  .ANUM      NO — NON-SIGNIFICANT ZERO
2122*    PROCESS A SIGNIFICANT DIGIT
2123   17203  021746  NUMCD   LDA  DPFLG     DECIMAL POINT FOUND YET?
2124   17204  070150          SZA  *+3
2125   17205  045745          ISZ  EXCNT     NO, INC COUNT
2126   17206  067207          JMP  *+1
2127   17207  021744          LDA  SIGDG     12 DIGITS
2128   17210  070230          SIA  NUML1      FOUND YET? IF YES SKIP
2129   17211  031744          STA  SIGDG     UPDATE COUNT
2130   17212  035470          STB  L2T1        MERGE LATEST DIGIT
2131   17213  063046          JSM  XFER         INTO D12 OF AR2
2132   17214  067173  NUML1   JMP  NUMC1-2
2133*
2134*    PROCESS NON-DIGIT MANTISSA CHAR
2135*
2136*
2137   17215  010051  NUMC2   CPA  .46       DECIMAL POINT?
2138   17216  067171          JMP  NUMCP     YES
2139   17217  025754          LDB  AR2
2140   17220  076110          RZB  *+2       ANY MANTISSA FOUND?
2141   17221  170402          RET            NO, RETURN TO P+1
2142   17222  010071          CPA  E         "E"?
2143   17223  067250          JMP  NUMCE     YES
2144   17224  074742          SBR  16        NO, SET 0 EXPONENT
2145   17225  072053          SAP  *+1,S     SET FIXED POINT FLAG
2146*    CHARACTER IS NOT PART OF NUMBER
2147   17226  045746  NUMC3   ISZ  DPFLG     COMPLEMENT EXPONENT
```

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```
2148  17227  067231          JMP   *+2
2149  17230  074076          TCB                 IF NEGATIVE
2150  17231  005745          ADB   EXCNT         ADD EXPONENT DUE TO DECIMAL
                                                         PLACEMENT
2151  17232  035745          STB   EXCNT         STORE EXPONENT
2152  17233  171450          NRM                 LEFT JUSTIFY MANTISSA
2153  17234  025745          LDB   EXCNT         RECALL EXPONENT
2154  17235  074404          SBL   8             LEFT JUSTIFY EXPONENT
2155  17236  045721          ISZ   .SIGN         .SIGN WAS SET IN "CONST" ROUTINE.
2156  17237  067241          JMP   *+2
2157  17240  074070          SIB   *+1           ADD IN SIGN OF MANTISSA
2158  17241  070115          SEC   *+2           IF MANTISSA IS 0
2159  17242  074742          SBR   16              THEN SET EXPONENT TO 0
2160  17243  035754          STB   AR2           STORE EXPONENT WORD
2161  17244  004021          ADB   .4            SET FLOATING FLAG (BIT 2)
2162  17245  070133          SAP   *2+2,C        LEAVE (B) AT .4 IF THERE WAS AN
                                                         EXPONENT
2163  17246  004133          ADB   M2            NO, SET FIXED FLAG (BIT1)
2164  17247  064357          JMP   RETN2         RETURN TO P+2
2165*     PROCESS EXPONENT
2166  17250  024132  NUMCE   LDB   M1
2167  17251  035724          STB   GFLAG         SET INTCK TO RETURN ON ERROR
2168  17252  061166          JSM   GSIGN         GET EXPONENT SIGN
2169  17253  035746          STB   DPFLG         SAVE IT
2170  17254  060750          JSM   DIGCK         DIGIT?
2171  17255  160206  NUMER   JSM   ERRA,I       NO, MISSING EXPONENT
2172  17256  025745          LDB   EXCNT         COMPUTE — (ABSOLUTE VALUE
2173  17257  004156          ADB   M100            OF MAX. ALLOWALE EXPONENT)
2174  17260  060676          JSM   INTCK         GET ABSOLUTE VALUE OF EXPONENT
2175  17261  067264          JMP   *+3
2176  17262  077550          RZB   NUMER           EXPONENT OVERFLOW
2177  17263  067226          JMP   NUMC3           EXPONENT OF ZERO GIVEN
2178  17264  055706          DSZ   SBPTR         RESET BUFFER POINTER
2179  17265  067226          JMP   NUMC3         EXPONENT OF ZERO GIVEN
2180  01744          SIGDG   EQU   AR1
2181  01745          EXCNT   EQU   AR1+1
2182  01746          DPFLG   EQU   AR1+2
```

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```
2184*
2185*   CONVERT A NUMBER IN AR2 INTO SYNTAX FORMAT AND STORE IT
2186*     (B)=EXPONENT WORD
2187*       (A)=NEXT CHARCTER, MUST BE SAVED.
2188*
2189   17266  031474  NUMOP  STA  TEMP1
2190   17267  074117        LDA  B
2191   17270  050105        AND  B377          GET MANTISSA SIGN AND FLOAT
                                                        FLAG
2192   17271  070006        RAR  1             POSITION FLAG AND MOVE SIGN
                                                        TO BIT 15
2193   17272  072113        SAP  *+2,S
2194   17273  040107        IOR  B1000         SET MANTISSA SIGN IN BIT 9
2195   17274  024030        LDB  .12
2196   17275  005744        ADB  SIGDG         GET SIGNIFICANT DIGIT COUNT
2197   17276  076110        RZB  *+2
2198   17277  074070        SIB  *+1           IF 0, SET TO 1
2199   17300  074544        SBL  5             MOVE TO OPERAND FIELD
2200   17301  074217        IOR  B             MERGE
2201   17302  055706        DSZ  SBPTR
2202   17303  141706        IOR  SBPTR,I       COMBINE WITH OPERAND
2203   17304  131706        STA  SBPTR,I         AND STORE
2204   17305  074202  NUMO1 SBR  5             COMPUTE NUMBER OF
2205   17306  004022        ADB  .5
2206   17307  074042        SBR  2               WORDS TO BE TRANSFERRED +1
2207   17310  035477        STB  TEMP4         SAVE COUNT
2208   17311  021754        LDA  AR2
2209   17312  050157        AND  M256          GET EXPONENT
2210   17313  025755        LDB  AR2+1
2211   17314  074342        SBR  8
2212   17315  074217        IOR  B             COMBINE WITH D1 AND D2
2213   17316  060456        JSM  SBPUD         UPDATE POINTER
2214   17317  171400        MLS
2215   17320  171400        MLS                SHIFT MANTISSA
2216   17321  024214        LDB  AR2A          GET MANTISSA ADDRESS
2217   17322  074070  NUMO2 SIB  *+1           UPDATE MANTISSA ADDRESS
2218   17323  074517        LDA  B,I       GET READY TO STORE WORD IN SYN.
                                                        BUFF.
2219   17324  060456        JSM  SBPUD         UPDATE SYNTAX ADDRESS
2220   17325  055477        DSZ  TEMP4         MORE WORDS TO BE
                                                        TRANSFERRED?
2221   17326  067322        JMP  NUMO2           YES
2222   17327  021474        LDA  TEMP1         NO, RECALL CHAR AND RETURN
2223   17330  170402        RET
```

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```
2225*       SNFLT    ROUTINE
2226*
2227*      THIS ROUTINE TRANSFERS A
2228*      NUMBER IN SYNTAX FORMAT TO
2229*      AR2 AND STORES IT IN STANDARD
2230*      FORMAT
2231*
2232*      ENTRY CONDITIONS:
2233*
2234*          TEMPS=WORD POINTER TO
2235*                START OF NUMBER
2236*
2237*      EXIT CONDITIONS:
2238*
2239*          TEMPS=WORD POINTER TO FIRST
2240*                WORD FOLLOWING NUMBER
2241*            AR2=NUMBER IN STANDARD FORM
2242*
2243*
2244   17331  021472  SNFLT    LDA  TEMPS
2245   17332  070070          SIA  *+1        TRANSFER THE NUMBER
2246   17333  024214          LDB  AR2A       INTO AR2
2247   17334  170004          XFR
2248*
2249   17335  121472          LDA  TEMPS,I
2250   17336  031470          STA  L2T1
2251   17337  070202          SAR  5
2252   17340  050032          AND  B17        GET THE # OF DIGITS
2253   17341  000022          ADA  .5
2254   17342  070042          SAR  2          COMPUTE HOW MANY WORDS THIS IS
2255   17343  070137          LDB  A
2256   17344  001472          ADA  TEMPS
2257   17345  031472          STA  TEMPS      MOVE TEMPS TO THE LAST WORD OF
                                               THE NUMBER
2258   17346  004214          ADB  AR2A
2259   17347  070742          SAR  16
2260   17350  014112          CPB  B1760
2261   17351  067355          JMP  *+4
2262   17352  074557          STA  B,I        CLEAR THE REMAINDER OF
2263   17353  074070          SIB  *+1        THE MANTISSA DIGITS
2264   17354  067350          JMP  *-4
2265*
2266   17355  024017          LDB  .2         RIGHT SHIFT AR2
2267   17356  174470          MRY             TWO PLACES
2268   17357  021754          LDA  AR2
2269   17360  070404          SAL  8
2270   17361  041755          IOR  AR2+1      MERGE INTO AR2+1 DIGITS ONE AND
                                               TWO
2271   17362  031755          STA  AR2+1
2272   17363  021754          LDA  AR2        LOAD THE EXPONENT
2273   17364  050157          AND  M256       AND MASK
2274   17365  025470          LDB  L2T1
2275   17366  074402          SBR  9          INCLUDE THE SIGN BIT
2276   17367  074111          SLB  *+2
2277   17370  070070          SIA  *+1
2278   17371  031754          STA  AR2
2279   17372  170402          RET
2280**********************************
```

PAGE 219 MORE 9830 FUNCTIONS

```
2282*****************************************
2283   16000                ORG  16000B
2284*
2285*
2286*  INTEGER ROUTINE
2287*
2288   16000  062015  INT    JSM  FDFRC   TRANSFER ARG. INTO AR1, AND TEST
                                                          FOR FRACTIONAL
2289   16001  066005         JMP  *+4     P+1, FRACTIONAL ARGUMENT
2290*
2291   16002  060444         JSM  XFAR2   P+2, NON FRACTIONAL ARG.
2292   16003  171450         NRM         TRANSFER TO AR2, AND NORMALIZE
2293   16004  065254         JMP  ZONK
2294*
2295   16005  062002         JSM  INT+2
2296   16006  025744         LDB  AR1     LOAD (B) WITH THE EXPONENT
2297   16007  074113         SBP  *+2     IF THE EXPONENT WAS NEGATIVE
2298   16010  061256         JSM  CLAR2   CLEAR AR2
2299   16011  075551         SLB  INT+4   RETURN IF THE ARG WAS +.
2300   16012  020214         LDA  AR2A    THE ARGUMENT WAS – AND IT HAD A
2301   16013  024020         LDB  ONE     FRACTIONAL PART
2302   16014  164217         JMP  .FSBA,I SO SUBTRACT ONE FROM IT
2303*
2304*****************************************
2305*
2306*
2307*      SUBROUTINE FOR INT AND UPARROW
2308*
2309   16015  024213  FDFRC  LDB  AR1A
2310   16016  170004         XFR
2311   16017  020012         LDA  .1      SET THE FLAG
2312   16020  031714         STA  SAVE
2313   16021  025744         LDB  AR1     LOAD THE EXPONENT
2314   16022  074512         SBM  UP1+7   EXIT IF EXP IS FRACTIONAL
2315   16023  074340         ABR  8
2316   16024  004142         ADB  M11
2317*
2318   16025  074313  UP1    SBP  *+6     MUST BE AN INTEGER IF (B) IS +
2319   16026  170410         DRS         RIGHT SHIFT AR1
2320   16027  074070         SIB  *+1
2321   16030  071650         SZA  UP1     SKIP BACK IS SHIFTED DIGIT WAS ZERO
2322   16031  045714         ISZ  SAVE    OTHERWISE INCR. THE FLAG FOR
                                                          FRACTIONAL PART
2323   16032  066025         JMP  UP1     SKIP BACK TO FINISH INTEGERATION
2324   16033  055714         DSZ  SAVE    SKIP IF THERE WAS NO FRACTIONAL
                                                                  PART
2325   16034  170402         RET         P+1 RETURN FOR FRACTIONAL PART
2326   16035  064357         JMP  RETN2   P+2 IF IT WAS AN INTEGER
```

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```
2328*
2329  16036  001734  ADRYY  OCT  1734      ADDRESS OF REGISTOR Y
2330  16037  013344  ILNX   DEF  LNX
2331  16040  012550  IINIT  DEF  INIT+1
2332  16041  013266  I.EXP  DEF  .EXP-3
2333*
2334*   RET4 IS USED WHEN THE NUMBER IS ZERO
2335*
2336  16042  021741  RET4   LDA  XC+1      LOAD DIGITS 1—4 OF THE POWER
2337  16043  070410         SZA  ER49      IF THE POWER IS ZERO ERROR 49
2338  16044  021740         LDA  XC        LOAD THE EXPONENT OF THE POWER
2339  16045  074742         SBR  16        CLEAR (B) FOR STMAX ROUTINE
2340  16046  070211         SLA  *+4       RETURN IF THE POWER IS POSITIVE:
                                                                  AR2 = 0
2341  16047  061274         JSM  STMAX     SET AR2 = +9.9999E99: NEGATIVE POWER
2342  16050  160205         JSM  AERRA,I
2343  16051  177630         DEC  -104
2344  16052  170402         RET
2345*
2346  16053  160206  ER49   JSM  ERRA,I    10 ERROR
2347*
2348**********************
2349*
2350*   RAISE A NUMBER TO A POWER
2351*
2352**********************
2353*
2354  16054  035702  UPARO  STB  ADR1      STORE THE ADDRES OF THE POWER,
                                                    (A) IS SAVED BY INIT
2355*
2356  16055  162040         JSM  IINIT,I
2357  16056  021702         LDA  ADR1      TRANSFER THE POWER INTO
2358  16057  024111         LDB  B1740     XC REGISTOR
2359  16060  170004         XFR
2360  16061  071055         SEC  RET4      STORE ZERO IF IT IS ZERO
2361*
2362  16062  021702         LDA  ADR1      LOAD THE ADDRESS OF THE POWER
2363  16063  362015         JSM  FDFRC     GO CHECK IF THERE IS A FRACTIONAL
                                                                    PART
2364  16064  066137         JMP  .UPA1     YES THERE WAS
2365*
2366  16065  025747  UP3    LDB  AR1+3     SAVE THE D12 DIGIT IN CASE THERE
2367  16066  035714         STB  SAVE      IS AN OVERFLOW IN FLTFA
2368  16067  021702         LDA  ADR1
2369  16070  060445         JSM  XFAR2+1
2370  16071  160226         JSM  FLTFA,I   CONVERT AR2 TO AN INTEGER
2371  16072  066153         JMP  UP4       IT'S AN INTEGER BUT TO LARGE
2372*
2373*       RAISE AN ARGUMENT TO AN INTEGER POWER
2374*
2375  16073  035714  IPWR   STB  SAVE
2376  16074  074113         SBP  *+2
2377  16075  074076         TCB
2378  16076  035710         STB  COUNT     SAVE THE ABS(POWER)
2379  16077  020020         LDA  ONE
2380  16100  026036         LDB  ADRYY     INITIALIZE THE RESULT TO ONE
2381  16101  170004         XFR
2382  16102  021703         LDA  ADR2
2383  16103  024057         LDB  ATEMP     PLACE THE BASE IN REGISTOR Y
```

```
2384   16104  170004          XFR
2385*
2386   16105  021710  IPW1    LDA   COUNT    LOAD THE POWER
2387   16106  070411          SLA   IPW2     IS THE POWER ODD?
2388*
2389   16107  020057          LDA   ATEMP    YES
2390   16110  026036          LDB   ADRYY
2391   16111  160220          JSM   .FMPA,I  MULTIPLY BY PARTIAL RESULT
2392   16112  026036          LDB   ADRYY
2393   16113  020214          LDA   AR2A     AND PLACE IT BACK
2394   16114  170004          XFR
2395   16115  021710          LDA   COUNT
2396*
2397   16116  070002  IPW2    SAR   1        EVEN POWER ENTRY POINT, DIVIDE
                                                                  POWER BY 2
2398   16117  031710          STA   COUNT    AND RESTORE
2399*
2400   16120  070410          SZA   DPW      IF THE POWER IS ZERO, JUMP TO EXIT
                                                                  PART
2401*
2402   16121  020057          LDA   ATEMP
2403   16122  024057          LDB   ATEMP
2404   16123  160220          JSM   .FMPA,I  THE POWER WAS EVEN SO MULTIPY
2405   16124  024057          LDB   ATEMP    IT BY ITSELF
2406   16125  020214          LDA   AR2A     AND PLACE IT BACK
2407   16126  170004          XFR
2408   16127  066105          JMP   IPW1
2409*
2410   16130  021714  DPW     LDA   SAVE     ALMOST DONE
2411   16131  070152          SAM   *+3      WAS THE SIGN OF THE EXPONENT NEG?
2412   16132  022036          LDA   ADRYY    NO, TRANSFER THE ANSWER INTO AR2
2413   16133  064445          JMP   XFAR2+1
2414   16134  020020          LDA   ONE      YES, TAKE THE RECIPICAL OF THE
                                                                  ANSWER
2415   16135  026036          LDB   ADRYY
2416   16136  164221          JMP   .FDVA,I
2417*
2418*
2419*
2420*
2421   16137  125703  .UPA1    LDB   ADR2,I   LOAD THE EXPONENT WORD OF THE
                                                                  BASE
2422   16140  074131          SLB   UP2,C    SKIP IF IT IS POSITIVE
2423*
2424*
2425   16141  160206  ER50    JSM   ERRA,I   (-BASE)↑(FRACTIONAL EXPOENT)
2426*
2427*
2428   16142  035714  UP2     STB   SAVE
2429   16143  021703          LDA   ADR2     LOAD THE ADDRESS OF THE BASE
2430   16144  162037          JSM   ILNX,I   TAKE NATURAL LOG OF THE BASE
2431   16145  024111          LDB   B1740    LOAD THE ADDRESS OF THE EXPONENT
                                                          (SAVED IN XC)
2432   16146  162041          JSM   LEXP,I   EXP ( POWER * LOG ( BASE))
2433*
2434   16147  021714          LDA   SAVE     LOAD THE LAST DIGIT OF THE ORIGNAL
                                                                  EXPOENET
2435   16150  070451          SLA   OVER
2436   16151  045754          ISZ   AR2      NEGATE THE ANSWER IF IT IS ODD
2437   16152  065254          JMP   ZONK     STORE ANSWER
2438*
2439*
```

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```
2440*      INTEGER POWER, BUT GREATER THAN 32676
2441*
2442   16153  125703  UP4     LDB  ADR2,I
2443   16154  074131          SLB  *+2,C
2444   16155  066157          JMP  *+2
2445   16156  035714          STB  SAVE      THE BASE WAS +, SO CLEAR BIT 0
2446   16157  135703          STB  ADR2,I    TAKE THE ABS(BASE)
2447   16160  066143          JMP  UP2+1
2448*
```

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```
2450*
2451   16161  170402  OVER    RET
2452*
2453*  FLOATING SQUARE ROOT
2454*
2455*
2456   16162  024213  FSR     LDB  AR1A
2457   16163  170004          XFR
2458   16164  020214          LDA  AR2A
2459   16165  170000          CLR
2460*
2461   16166  021745          LDA  AR1E+1     IF THE ARGUMENT
2462   16167  071510          SZA  OVER         IS ZERO RETURN
2463*
2464*
2465   16170  024022          LDB  P5         MULTIPLY THE ARGUMENT
2466   16171  171460          FMP               BY 5
2467   16172  025744          LDB  AR1E       RIGHT SHIFT THE ARGUMENT
2468   16173  074444          SBL  7            ONCE IF THE EXPONENT IS
2469   16174  074112          SBM  *+2          ODD AND TWICE IF ITS GVEN
2470   16175  074070          SIB  *+1      AND ONCE MOR IF A CARRY
2471   16176  074070          SIB  *+1      EXISTS FROM THE MULTIPLY
2472*
2473   16177  061306          JSM  ROUND+1    ROUND IF THE LAST SHIFTED DIGIT
                                                                    IS >=5
2474*
2475   16200  020213          LDA  AR1A       INITIALIZE THE ANSWER
2476   16201  070070          SIA  *+1        ANSWER WORD POINTER 1 AND 2
2477   16202  031701          STA  TEMPA        TO THE SECOND WORD OF THE
2478   16203  031476          STA  TEMP3        WORKING REGISTER
2479   16204  170000          CLR             CLEAR THE WORKING REGISTER
2480*
2481   16205  021744          LDA  AR1E       IF THE RADICAND IS
2482   16206  070131          SLA  *+2,C      NEGATIVE — RETURN.
2483   16207  160206  ER48    JSM  ERRA,I
2484*
2485   16210  070000          AAR  1          DIVIDE THE EXPONENT WORD BY 2,
2486   16211  050163          AND  ZAP          CLEAR BITS 1—7
2487   16212  031744          STA  AR1E         AND STORE
2488*
2489   16213  020117          LDA  AD5        INITIALIZE THE
2490   16214  031475          STA  TEMP2        'FIVE' WORD TO 0500
2491   16215  020004          LDA  D1000      INITIALIZE THE
2492   16216  031477          STA  TEMP4        'N' WORD TO 0100
2493*
2494   16217  021477  CONT    LDA  TEMP4      IF THE LOW DIGIT OF THE
2495   16220  070111          SLA  *+2          'N' WORD IS A 1 THEN
2496   16221  045476          ISZ  TEMP3        INCREMENT POINTER 2
2497   16222  070146          RAR  4          ROTATE THE 'N' WORD ONE
2498   16223  031477          STA  TEMP4        BCD AND REPLACE
2499*
2500   16224  021475          LDA  TEMP2      MASK OUT THE LAST
2501   16225  070056          CMA               FIVE FROM THE
2502   16226  151701          AND  TEMPA,I      WORKING
2503   16227  131701          STA  TEMPA,I      REGISTER
2504*
2505   16230  021475          LDA  TEMP2      IF THE LOW DIGIT OF THE
```

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```
2506  16231  070111          SLA  *+2       'FIVE' WORD IS A 5 THEN
2507  16232  045701          ISZ  TEMPA       INCREMENT POINTER 1
2508  16233  070146          RAR  4         ROTATE THE 'FIVE' WORD
2509  16234  031475          STA  TEMP2       ONE BCD AND REPLACE
2510  16235  101701          ADA  TEMPA,I   LOCATE THE NEXT FIVE INTO
2511  16236  131701          STA  TEMPA,I     THE WORKING REGISTER
2512*
2513  16237  125476          LDB  TEMP3,I   LOAD THE WORKING REGISTER WORD
                                                TO BE INCREMENTED INT
2514  16240  170400          CMY            COMPLEMENT THE ARGUMENT
2515*
2516  16241  020061          LDA  P10       SET THE INCREMENT
2517  16242  031466          STA  TEMP5       COUNTER=10
2518*
2519  16243  135476          STB  TEMP3,I   STORE B INTO THE WORKING REGISTER
2520  16244  170560          FXA            ADD THE WORKING REGISTER TO THE
                                                ARGUMENT
2521  16245  005477          ADB  TEMP4     INCREMENT THE PROPER DIGIT OF B
2522  16246  055466          DSZ  TEMP5     DECREMENT THE INCREMENT COUNTER
                                              AND EXIT LOOP IF ZER
2523  16247  071635          SEC  *-4,C     IF NO OVERFLOW OCCURRED JUMP
                                                BACK INTO LOOP
2524*
2525  16250  170400          CMY            COMPLEMENT THE ARGUMENT
2526*
2527  16251  021755          LDA  AR2E+1    JUMP OUT OF THE
2528  16252  001756          ADA  AR2E+2      MAIN LOOP IF
2529  16253  001757          ADA  AR2E+3      AN PERFECT SQUARE
2530  16254  070134          SES  *+2,C       HAS BEEN
2531  16255  070350          SZA  PFSQ        FOUND
2532*
2533  16256  170560          FXA            RESTORE THE ARGUMENT
2534  16257  171400          MLS            SHIFT THE ARGUMENT LEFT ONCE
2535*
2536  16260  021476          LDA  TEMP3     IF 12 DIGITS HAVE
2537  16261  010057          CPA  ATEMP       BEN CALCULATED
2538  16262  066302          JMP  LSTLP       EXIT FROM MAIN LOOP
2539  16263  066217          JMP  CONT        ELSE CONTINUE
2540*
2541  16264  025701  PFSQ    LDB  TEMPA     A PERFECT SQUARE HAS BEEN FOUND
2542  16265  014057          CPB  .1000
2543  16266  066272          JMP  *+4       DO NOT STORE THE LAST DIGIT
2544  16267  004025          ADB  P8          SO INCREMENT THE LEAST
                                                SIGNIFICANT
2545  16270  021475          LDA  TEMP2       DIGIT (A5) OF THE WORKING
                                                REGISTER
2546  16271  074557          STA  B,I         BY 5 AND
2547  16272  170560          FXA              THEN LEFT SHIFT
2548  16273  171400          MLS              IT ONCE
2549*
2550  16274  070250          SZA  *+5       IF A DIGIT WAS SHIFTED OU
2551  16275  070137          LDB  A
2552  16276  174470          MRY            SHIFT IT BACK IN AND INCREMENT
                                                THE EXPONENT
2553  16277  024013          LDB  P256
2554  16300  065237          JMP  STAR2
2555  16301  065240          JMP  STAR2+1   OTHERWISE STORE THE ANSWER AND
                                                RETURN
2556*
2557  16302  021750  LSTLP   LDA  AR1E+4    LOCATE THE LAST DIGIT
2558  16303  070542          SAR  12          ALLIGN IT
2559  16304  175400          DLS              AND SHIFT IT INTO THE ANSWER
2560  16305  020213          LDA  AR1A
2561  16306  024214          LDB  AR2A
```

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```
2562   16307  170004          XFR
2563   16310  065254          JMP  ZONK
2564*
2565*
2566**********************************
2567*
2568*  FLOATING POINT MULTIPLY
2569*
2570*
2571   16311  031702  FMP     STA  ADR1
2572   16312  074117          LDA  B
2573   16313  024213          LDB  AR1A     TRANSFER THE MULTIPLICAND INTO A
2574   16314  170004          XFR             TEMPORARY
2575*
2576   16315  021702          LDA  ADR1     TRANSFER THE MULTIPLIER
2577   16316  024057          LDB  ATEMP    INTO A TEMPORARY
2578   16317  170004          XFR
2579   16320  020214          LDA  AR2A
2580   16321  170000          CLR           INITIALIZE WORD POINTER FOR THE
2581   16322  031475          STA  TEMP2    MULTIPLIER AND CLEAR AR2
2582*
2583   16323  020134          LDA  M3       INITIALIZE THE
2584   16324  031476          STA  TEMP3      WORD COUNT TO 3
2585*
2586   16325  055475  NXWD    DSZ  TEMP2    DECREMENT THE WORD POINTER
2587   16326  125475          LDB  TEMP2,I  LOAD 4 DIGITS OF THE MULTIPLIER
2588*
2589   16327  171460          FMP           ACCUMULATE THE PRESENT DIGIT
                                                          MULTIPLICAND
2590   16330  004145          ADB  N14      SET BITS 0-3=0001 IN B
2591   16331  174470          MRY           ALLIGN THE TEMP ANSWER FOR NEXT
                                                                  DIGIT
2592   16332  074142          SBR  4        SHIFT IN THE NEXT MULTIPLIER DIGIT
2593*
2594   16333  171460          FMP
2595   16334  004145          ADB  N14
2596   16335  174470          MRY
2597   16336  074142          SBR  4
2598*
2599   16337  171460          FMP
2600   16340  004145          ADB  N14
2601   16341  174470          MRY
2602   16342  074142          SBR  4
2603*
2604   16343  171460          FMP
2605   16344  004145          ADB  N14
2606   16345  174470          MRY
2607*
2608   16346  045476          ISZ  TEMP3    INCREMENT THE WORD COUNT AND
2609   16347  066325          JMP  NXWD       JUMP IF NON ZERO
2610*
2611   16350  025755          LDB  AR2E+1   SKIP IF THE FIRST
2612   16351  074542          SBR  12         DIGIT OF THE ANSWER
2613   16352  076350          RZB  *+7        IS NOT ZERO
2614*
2615   16353  070137          LDB  A        IT IS ZERO SO
2616   16354  171400          MLS             NORMALIZE ANSWER
2617   16355  005757          ADB  AR2E+3   PICK UP THE 12TH DIGIT
```

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```
2618   16356  035757          STB  AR2E+3     WHICH WAS SHIFTED OUT ABOVE
2619*
2620   16357  124057          LDB  ATEMP,I    LOAD THE EXPONENT WORD OF THE
2621   16360  065237          JMP  STAR2        MULTIPLIER AND EXIT TO RETURN
                                                                    ANSWER
2622*
2623   16361  061307          JSM  ROUND+2    ROUND UP ANSWER IF 13TH DIGIT
                                                                    IS >=5
2624   16362  124057          LDB  ATEMP,I    LOAD EXPONENT OF THE MULTIPLIER
2625   16363  004013          ADB  P256       INCREMENT IT
2626   16364  065237          JMP  STAR2      EXIT TO RETURN ANSWER
2627*
2628*
2629*   CONVERT SPLIT TO FULL-PRECISION FLOATING POINT NUMBER
2630*
2631*   LDB ADDRESS OF SPLIT
2632*   JSM SPLFL
2633*
2634*   FULL FLOATING POINT NUMBER IN AR2 ON RETURN
2635*
2636   16365  061256  SPLFL  JSM  CLAR2      CLEAR AR2
2637   16366  074517         LDA  B,I        LOAD EXPONENT , SIGN, D1 AND D2
2638   16367  031754         STA  AR2        SAVE TEMPORARLY IN AR2
2639   16370  050105         AND  B377       MASK D1 AND D2
2640   16371  031755         STA  AR2+1      AND STORE
2641   16372  074070         SIB  *+1
2642   16373  074517         LDA  B,I
2643   16374  031756         STA  AR2+2      STORE D3 THUR D6
2644   16375  171450         NRM
2645   16376  074742         SBR  16         FIX
2646   16377  021754         LDA  AR2         UP
2647   16400  070340         AAR  8            THE
2648   16401  070131         SLA  *+2,C          FULL
2649   16402  074070         SIB  *+1              EXPONENT
2650   16403  070444         SAL  7
2651   16404  074217         IOR  B
2652   16405  031754         STA  AR2
2653   16406  170402         RET
2654*
2655   16407  000000         BSS  1          *** CHECKSUM WORD ***
2656*
2657                          END
*  NO ERRORS *
```

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CROSS-REFERENCE TABLE

.1	0020	0522	2063	2311	
.10	0071	0072	0574	1934	
.100	0070	0685			
.1000	0069	0534	2542		
.11	0035	0043			
.12	0036	0527	2195		
.13	0039				
.15	0048	0083	0529		
.16	0049	0084			
.1E4	0068				
.2	0027	0523	2077	2266	
.21	0050				
.22	0051	0087	0684		
.23	0052	0088			
.28	0053				
.3	0028	0045			
.31	0054	0090			
.32	0055				
.33	0056				
.34	0057	0091			
.37	0058				
.4	0029	0524	2161		
.40	0059				
.41	0060				
.43	0061				
.45	0062				
.46	0063	1915	2137		
.48	0064				
.5	0030	0525	2205	2253	
.58	0065	0094			
.6	0031	0044	0572		
.63	0066				
.7	0032	0573			
.8	0033	0526			
.9	0034				
.99	0074				
.ANUM	2108	2121			
.BUFA	0180				
.CS	0989	0982			
.EXP	1262	1908	2332		
.FAD	0930	1388			
.FAD.	1780	1767			
.FADA	0185	0582			
.FDV	0920	0836	0987	1056	1162
.FDVA	0188	0584	2416		
.FMP	0952	0794	0856	1260	1374
.FMPA	0187	0583	2391	2404	
.FSBA	0186	2302			
.FSR	0190	0866			
.GOON	1879	1871			
.IK	2030	2020	2046		
.LNUM	0314				
.NPWR	0504				
.R1	1982	2013			
.SIGN	0399	0400	2155		

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B133	0096								
B140	0097								
B1400	0103	0204	0697						
B17	0083	2252							
B170K	0121								
B1740	0104	0203	0692	2358	2431				
B1760	0105	0158	2260						
B177	0098								
B1774	0106								
B1775	0107								
B1777	0108								
B20	0084	0699							
B22	0085								
B23	0086								
B2400	0110	0710							
B26	0087								
B27	0088								
B3000	0111								
B36	0089								
B37	0090								
B37.4	1917	2074							
B377	0099	2191	2639						
B400	0100	0530	0698	1961					
B4000	0112	0162	0700						
B42	0091								
B44	0092								
B52	0093								
B6K	0113	0167							
B72	0094								
B777	0101								
BACK	1305								
BADDR	0291								
BADRP	0204								
BEND	0198	0199							
BHSTP	0454								
BLANK	0388								
BNZ	1745	1732							
C1	0598	0703							
C2	0628	0688	0704						
C3	0665	0689							
C4	0670	0690							
C5	0015								
C6	0011	0114							
C7	0022	0100							
C8	0675	0683							
CHRSA	0219								
CK	0891	1484							
CLAR2	0501	0854	1051	1099	1194	1783	1914	2298	2636
CLER	0884	1199	1289	1332					
CLERA	0160								
CLINE	0316								
CLPIA	0217								
CLRA2	1914	2012	2058	2097					
COMCE	0446								
COMCK	0445								
CONST	0494								

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CROSS-REFERENCE TABLE

ER47	1330	0285									
ER48	2483	0286									
ER49	2346	0287	2337								
ER50	2425	0288									
ERRA	0177	1330	2113	2171	2346	2425	2483				
EXCNT	2181	2099	2110	2125	2150	2151	2153	2172			
EXP	0401	0402									
EXPOP	0118										
F	0081										
FAD	1708	0185	1700								
FAD1	0929	0863	1013	1034							
FAL1	1099	1085									
FAP	1194										
FDAAA	0222										
FDFRC	2309	2288	2363								
FDV	1792	0188									
FDV1	0919	0776									
FETCH	0498										
FILLA	0201										
FIRST	0367										
FIX	0511										
FLGBT	0073	0578									
FLOAT	0386										
FLT1	1932	1945									
FLT2	1943	1969									
FLTFA	0193	2370									
FLTFX	1929	0193	1957								
FLTRA	0192										
FLTRF	1957	0192									
FLTSA	0195										
FLTSP	2061	0195	2059								
FMP	2571	0187									
FN	0148										
FNCFG	0558	0724	1327	1448	1456	1508	1525	1538	1557	1561	1581
	1620	1656	1671								
FND	0472										
FND1A	0224										
FNDAA	0223										
FNDPS	0486										
FOPBS	0206										
FORMA	0172										
FORME	0336										
FORMS	0335										
FORMT	0334										
FPAGE	0461										
FRAC	0776	1083	1268								
FROMA	0122										
FSB	1691	0186									
FSCA	0173										
FSCE2	0451										
FSCE4	0456										
FSR	2456	0190	1905								
FTMP1	0337										
FTMP2	0338										
FWAM	0157										
FWUP	0296										

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CROSS-REFERENCE TABLE

FXFL	2Ø19	2Ø39							
FXFLA	Ø194								
FXFLT	2Ø12	Ø194	1976						
GET	1115	1Ø81	11Ø8	1114					
GET3	1Ø8Ø	1Ø86							
GETAD	Ø471								
GETCH	Ø481								
GETSK	Ø485								
GFG	Ø554	Ø9Ø1	1Ø3Ø	1Ø45	1Ø8Ø	1172			
GFLAG	Ø4Ø4	2167							
GFRST	Ø484								
GNEXT	Ø483	2115							
GONO	1235	1222							
GOOD	1816	18Ø9							
GOON	1592	1571	1589						
GPARM	Ø434								
GPERR	Ø683	Ø91Ø	1247						
GRA	Ø7Ø6	1248							
GRAF	Ø7ØØ	Ø852							
GSIGN	Ø496	2168							
GTCON	Ø51Ø								
GTMP	Ø482								
GTOPP	Ø476								
GTOR	Ø91Ø								
GTSTA	Ø213								
HFLG1	Ø321								
HSTPT	Ø3Ø2								
I	ØØ67								
I.EXP	2332	2432							
ICNT	Ø432								
IINIT	2331	2356							
ILNX	233Ø	243Ø							
IMPY	Ø497	1935							
IN	14Ø1	114Ø	1294						
IN2	1439	115Ø	12Ø6						
IN3	16Ø9	1218	1339						
INF	ØØ77								
INIT	Ø724	Ø9Ø3	1Ø46	1188	1263	1321	2331		
INITS	Ø466								
INREA	Ø226								
INT	2288	19Ø4	2295	2299					
INTCK	Ø469	2174							
INTEA	Ø178								
INTEL	Ø34Ø								
INTFL	ØØ75								
INTGR	Ø4Ø2								
INTLK	1769	1755							
IOBUF	Ø359								
IOHEA	Ø229								
IOSTA	Ø225								
IPW1	2386	24Ø8							
IPW2	2397	2387							
IPWR	2375								
ITR	Ø752	Ø833	Ø868	1Ø32	1131				
KEYFG	Ø324								
L2T1	Ø347	1977	1979	1986	1989	2Ø21	213Ø	225Ø	2274

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CROSS-REFERENCE TABLE

L2T2	Ø348	1916	1933	1944	196Ø	
LASTN	Ø398					
LBOP	Ø119					
LDEF	Ø499					
LDVSR	1915	2Ø17				
LETCK	Ø474					
LIMIT	Ø475					
LISTA	Ø167					
LN1Ø	Ø688	1267	1337	1373	167Ø	
LNFD	Ø072					
LNINC	Ø315					
LNUM	Ø467					
LNX	132Ø	1669	19Ø7	233Ø		
LOCL1	Ø345	Ø542				
LOCL2	Ø346	2Ø31	2Ø34			
LOG	1669	1898				
LPCK	Ø447					
LPCKE	Ø448					
LPOP	Ø12Ø					
LROMA	Ø123					
LSTAK	Ø299					
LSTLP	2557	2538				
LSTPT	Ø3Ø1					
LTR	Ø489					
LWAM	Ø295					
M1	Ø124	Ø531	2Ø32	2Ø98	2166	
M1Ø	Ø131	Ø532				
M1ØØ	Ø144	Ø687	2173			
M1Ø24	Ø146					
M11	Ø132	1ØØ9	2Ø24	2316		
M12	Ø133	Ø577	21Ø1	212Ø		
M13	Ø134	Ø686	1822			
M14	Ø135	Ø711				
M15	Ø136					
M2	Ø125	Ø575	2163			
M23	Ø137					
M25	Ø138					
M256	Ø145	Ø533	1932	198Ø	22Ø9	2273
M3	Ø126	2583				
M32	Ø139					
M36	Ø14Ø					
M4	Ø127	Ø576	1825			
M48	Ø141					
M5	Ø128	Ø423	1964			
M6	Ø129					
M64	Ø142					
M8Ø	Ø143					
M9	Ø13Ø					
MASK1	Ø153					
MASK2	1684	1743				
MASK5	Ø154					
MAW	Ø294					
MAXIN	Ø4ØØ					
MAXSN	Ø147					
MBIN1	Ø4Ø6	2Ø64	2Ø82			
MBIN2	Ø4Ø7	2Ø61	2Ø85	2Ø86	2Ø88	

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CROSS-REFERENCE TABLE

MBOX1	Ø351									
MDIMA	Ø2Ø8									
MER8	Ø455									
MINIT	Ø465									
MLT	Ø583	Ø952								
MODE	Ø3Ø5									
MSFLG	Ø389									
MVTOH	Ø487									
N1	Ø531	Ø889	1Ø28	1215	132Ø	151Ø	1644	1821	1845	1866
N1Ø	Ø532	136Ø	1849							
N1ØØ	Ø687	1354								
N12	Ø577	Ø8Ø6	152Ø							
N13	Ø686	1213								
N14	Ø711	259Ø	2595	26ØØ	26Ø5					
N2	Ø575	Ø885	Ø992							
N256	Ø533	Ø783	11Ø9	1877						
N4	Ø576	1635								
N5	Ø423	1296	1583	1647						
NDISP	Ø382									
NDWRT	Ø5Ø6									
NEXT1	Ø46Ø									
NEXTA	Ø477									
NEXTL	Ø459									
NMOTA	Ø2ØØ									
NO	1843	1839	184Ø							
NOEOF	Ø492									
NORM	Ø762	Ø747	Ø751	Ø791	11Ø6	1235	1371			
NPRIN	Ø383									
NPWRT	Ø5Ø5									
NUM	Ø396	Ø397								
NUMC1	2116	21Ø4	21Ø9	2111	2132					
NUMC2	2137	2117								
NUMC3	2147	2177	2179							
NUMCA	Ø211									
NUMCD	2123	2118								
NUMCE	2166	2143								
NUMCK	2Ø96	Ø211								
NUMCP	2112	Ø246	2138							
NUMER	2171	Ø245	2176							
NUML1	2132	2128								
NUMO1	22Ø4									
NUMO2	2217	2221								
NUMOA	Ø212									
NUMOP	2189	Ø212								
NWWD	1825	1858								
NXDG	1828	1855								
NXTDT	Ø3Ø4									
NXTST	Ø4Ø5									
NXWD	2586	26Ø9								
OBLNK	Ø478									
ODGIT	Ø5Ø2	1978								
OF	Ø426	1276								
OK	1197	1191	1193							
OK1	2Ø77	2Ø69								
ONE	ØØ45	Ø834	Ø862	Ø960	Ø965	23Ø1	2379	2414		
ONEXT	Ø479									

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PAGE 236 CROSS-REFERENCE TABLE

PTH	1575	1568	1597								
PTI	157Ø	1562									
PTJ	1552	13Ø3	1333								
PTK	1534	1521									
PTL	1485	145Ø									
PTL1	145Ø	1457									
PTM	1497	1481									
PTN	1469	1452	1463								
PTO	1459										
PTP	1616	1626									
PTQ	1635	1662									
PTR	1561	16ØØ									
PTS	1565	1558									
QTCHA	Ø23Ø										
QTOP	Ø1Ø9	Ø161									
RAD	Ø7Ø5	Ø9Ø7									
RAX	Ø875	Ø871									
RBOP	Ø117										
RBUFF	Ø36Ø										
RCOUT	Ø333										
RCPFG	Ø557	Ø991	1Ø76	1Ø93	1Ø97	1132	1136	1152	1165	1167	1287
	13Ø5										
RDYDA	Ø166										
RECIP	Ø833	1135	1197	1311							
REED	Ø161										
REEDL	Ø339										
RES	Ø417										
RESB1	Ø463										
RESBP	Ø464										
RET1	1958	1943									
RET2	Ø431										
RET4	2336	236Ø									
RETN2	Ø43Ø	1948	2164	2326							
RETN3	Ø429										
ROUND	Ø425	Ø81Ø	1117	1486	1523	1751	2473	2623			
RPCK	Ø449										
RPCKE	Ø45Ø										
RPOP	Ø115										
RSAVE	Ø292										
RSLT	Ø696	Ø731	Ø735	Ø752	Ø86Ø	Ø873	Ø875	Ø929	116Ø	1176	1381
	1387										
RSLTE	Ø373	Ø696									
RSRTR	Ø418										
RSTAK	Ø416										
RSTKA	Ø158										
RSULT	Ø436										
RTOD	Ø944	1246	1249								
RTT	Ø735	Ø762	Ø966								
RUNA	Ø163										
RY1	Ø559	1155	1157	1444	1466	1472	1489	1497	15ØØ	1534	
RY2	Ø561	1446	1498	1499	15Ø4						
S	ØØ82										
SALTA	Ø2Ø7										
SANS	Ø933	Ø922	Ø953	Ø983							
SAVBP	Ø462										
SAVE	Ø56Ø	12Ø8	1226	1439	1516	1517	2312	2322	2324	2367	2375

PAGE 237 CROSS-REFERENCE TABLE

	2410	2428	2434	2445							
SAVEA	Ø325										
SAVEB	Ø326										
SBADR	Ø394										
SBPTR	Ø387	2178	22Ø1	22Ø2	22Ø3						
SBPUD	Ø441	2213	2219								
SBUFA	Ø199										
SCRT	Ø845	Ø985	1Ø47								
SCRT1	Ø87Ø	1Ø55									
SEC	Ø32Ø										
SFLAG	Ø393										
SGN	2ØØ4	19Ø3									
SGNS	Ø5Ø3	2ØØ4									
SHIFT	Ø555	14Ø2	1429	144Ø	15Ø9	1542	1556	1575	1599	1611	1625
	1632	1641	1661								
SIGDG	218Ø	21Ø2	2119	2127	2129	2196					
SIGN	Ø562	Ø728	Ø994	1Ø52	1Ø78	111Ø	1112	1115	1164	122Ø	1274
	13Ø9	1347	1383								
SIN	Ø976	1Ø14	19Ø2								
SLCOD	Ø328										
SLEND	Ø2Ø2										
SLWST	Ø457										
SNFLA	Ø197										
SNFLT	2244	Ø197									
SOUT	1251	1312									
SPLFA	Ø196										
SPLFL	2636	Ø196									
SPLUF	2Ø56	2Ø68									
SSBPT	Ø395										
SSYMA	Ø17Ø										
ST	Ø377										
STAR2	Ø424	1179	1782	1884	2554	2555	2621	2626			
START	Ø162	ØØØ7									
STEXP	Ø453										
STM1	1276	1265	1273								
STMAX	Ø427	11Ø3	1328	1814	2Ø73	2341					
STN	Ø9ØØ	Ø976	1ØØ6	1Ø74							
STOR1	Ø438										
STORE	Ø437										
STPFL	Ø323										
STROP	Ø44Ø										
STSRH	Ø452										
SUMPA	Ø227										
SYE12	Ø495										
SYE25	Ø47Ø										
SYMC1	Ø443										
SYMC2	Ø442										
SYMCK	Ø444										
SYMTP	Ø298										
SYTSA	Ø2Ø9										
TABLØ	Ø553	14Ø1	1414	1415	1574	1588	16Ø9	1636	1637		
TAN	1Ø74	Ø978	19ØØ								
TEMP	Ø552	Ø553	Ø554	Ø555	Ø556	Ø557	Ø558	Ø559	Ø56Ø	Ø561	Ø562
	Ø563	Ø564	Ø9Ø2	Ø977	11Ø2	161Ø	1629				
TEMP1	Ø352	2189	2222								
TEMP2	Ø353	18Ø3	1856	1857	1864	249Ø	25ØØ	25Ø5	25Ø9	2545	2581

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```
0001                    ASMB,A,B,L
0003*
0004*
0005*
0006*
0007*              ****   9830A TAPE CASSETTE SYSTEM    ****
0008*
0009*
0010*
0011   00000                        ORG  0
0012*
0013   00000  164121                JMP  START,I    START OF MONITOR
0014   00001  043060                OCT  43060      CONSTANT NEEDED BY PROCESSOR
0015   00002  000000                BSS  1          FOR INTERPT
0016*
0017   00003  000000  C6            OCT  0          ONE
0018   00004  010000                OCT  010000     0000
0019   00005  000000                OCT  0          0000
0020*
0021   00006  000000  C5            OCT  0000000    PI/2
0022   00007  012560                OCT  12560      1570
0023   00010  074543                OCT  074543     7963
0024   00011  023200                OCT  023200     2680
0025*
0026   00012  000001  .1            DEC  1
0027*
0028   00013  000400  C7            OCT  000400     180/PI
0029   00014  053451                OCT  053451     5729
0030   00015  053571                OCT  053571     5779
0031   00016  050450                OCT  050450     5128
0032*
0033   00017  000002  .2            DEC  2
0034   00020  000003  .3            DEC  3
0035   00021  000004  .4            DEC  4
0036   00022  000005  .5            DEC  5
0037   00023  000006  .6            DEC  6
0038   00024  000007  .7            DEC  7
0039   00025  000010  .8            DEC  8
0040   00026  000011  .9            DEC  9
0041   00027  000013  .11           DEC  11
0042   00030  000014  .12           DEC  12
0043   00031  000015  CRTN          OCT  15
0044   00031          EOL           EQU  CRTN
0045   00031          .13           EQU  CRTN
0046**********
0047*  POINTERS TO FUNCTIONS CONSTANTS
0048*
0049   00027          DPERR         EQU  .11        POINTER TO 180/PI
0050   00023          PI/2          EQU  .6         POINTER TO PI/2
0051   00020          ONE           EQU  .3         POINTER TO THE CONSTANT ONE
0052*
0053**********
0054   00032  000017  .15           DEC  15
0055   00033  000020  .16           DEC  16
0056   00034  000025  .21           DEC  21
0057   00035  000026  .22           DEC  22
```

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```
0058  00036  000027  .23     DEC  23
0059  00037  000034  .28     DEC  28
0060  00040  000037  .31     DEC  31
0061  00041  000040  .32     DEC  32
0062  00042  000041  .33     DEC  33
0063  00043  000042  .34     DEC  34
0064  00044  000045  .37     DEC  37
0065  00045  000050  .40     DEC  40
0066  00046  000051  .41     DEC  41
0067  00047  000053  .43     DEC  43
0068  00050  000055  .45     DEC  45
0069  00051  000056  .46     DEC  46
0070  00052  000060  .48     DEC  48
0071  00053  000072  .58     DEC  58
0072  00054  000077  .63     DEC  63
0073  00055  000111  I       OCT  111
0074  00056  023420  .1E4    DEC  10000
0075  00057  001750  .1000   DEC  1000
0076  00060  000144  .100    DEC  100
0077  00061  000012  .10     DEC  10
0078  00061          LNFD    EQU  .10
0079  00062  100000  FLGBT   OCT  100000
0080  00063  000143  .99     DEC  99
0081  00064  100004  INTFL   OCT  100004
0082  00065  076000  OPMSK   OCT  76000
0083  00066  077777  INF     OCT  77777
0084  00067  100037  TYPFL   OCT  100037
0085  00070  101777  OPDMK   OCT  101777
0086  00071  000105  E       OCT  105
0087  00072  000106  F       OCT  106
0088  00073  000123  S       OCT  123
0089  00032          B17     EQU  .15
0090  00033          B20     EQU  .16
0091  00074  000022  B22     OCT  22
0092  00075  000023  B23     OCT  23
0093  00035          B26     EQU  .22
0094  00036          B27     EQU  .23
0095  00076  000036  B36     OCT  36
0096  00040          B37     EQU  .31
0097  00043          B42     EQU  .34
0098  00077  000044  B44     OCT  44
0099  00100  000052  B52     OCT  52
0100  00053          B72     EQU  .58
0101  00101  000100  B100    OCT  100
0102  00102  000133  B133    OCT  133
0103  00103  000140  B140    OCT  140
0104  00104  000177  B177    OCT  177
0105  00105  000377  B377    OCT  377
0106  00013          B400    EQU  C7
0107  00106  000777  B777    OCT  777
0108  00107  001000  B1000   OCT  1000
0109  00110  001400  B1400   OCT  1400
0110  00111  001740  B1740   OCT  1740
0111  00112  001760  B1760   OCT  1760
0112  00113  001774  B1774   OCT  1774
0113  00114  001775  B1775   OCT  1775
```

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```
0114  00115  001777  B1777   OCT  1777
0115  00116  002000  QTOP    OCT  2000
0116  00117  002400  B2400   OCT  2400
0117  00120  003000  B3000   OCT  3000
0118  00121  004000  B4000   OCT  4000
0119  00122  006000  B6K     OCT  6000
0120  00004        B10K    EQU  C6+1
0121  00004        RPOP    EQU  B10K
0122  00123  012000  B12K    OCT  12000
0123  00123        RBOP    EQU  B12K
0124  00124  032000  EXPOP   OCT  32000
0125  00125  050000  LBOP    OCT  50000
0126  00126  052000  LPOP    OCT  52000
0127  00127  170000  B17OK   OCT  170000
0128  00130  013777  FROMA   OCT  13777
0129  00131  000000  LROMA   BSS  1
0130  00132  177777  M1      DEC  -1
0131  00133  177776  M2      DEC  -2
0132  00134  177775  M3      DEC  -3
0133  00135  177774  M4      DEC  -4
0134  00136  177773  M5      DEC  -5
0135  00137  177772  M6      DEC  -6
0136  00140  177767  M9      DEC  -9
0137  00141  177766  M10     DEC  -10
0138  00142  177765  M11     DEC  -11
0139  00143  177764  M12     DEC  -12
0140  00144  177763  M13     DEC  -13
0141  00145  177762  M14     DEC  -14
0142  00146  177761  M15     DEC  -15
0143  00147  177751  M23     DEC  -23
0144  00150  177747  M25     DEC  -25
0145  00151  177740  M32     DEC  -32
0146  00152  177734  M36     DEC  -36
0147  00153  177720  M48     DEC  -48
0148  00154  177700  M64     DEC  -64
0149  00155  177660  M80     DEC  -80
0150  00156  177634  M100    DEC  -100
0151  00157  177400  M256    DEC  -256
0152  00160  176000  M1024   DEC  -1024
0153  00161  154360  MAXSN   DEC  -10000    -(MAXIMUM ALLOWABLE LINE
                                             NUMBER)
0154  00162  043116  FN      ASC  1,FN
0155*
0156*   MATH CONSTANTS THAT ARE NEEDED ON BASE PAGE
0157*
0158  00163  177401  ZAP     OCT  177401
0159  00164  063440  MASK1   OCT  063440
0160  00165  061400  MASK5   OCT  061400
```

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```
0162*
0163  00166  000000  FWAM    BSS  1      FIRST WORD OF AVAILABLE MEM
0164  00112        RSTKA   EQU  B1760    START OF RETURN STACK
0165  00167  000000  WRITE   BSS  1      PRINTER AND DISPLAY DRIVER
0166  00170  000000  CLERA   BSS  1      CLEAR SCREEN
0167  00116        REED    EQU  QTOP     KEYBOARD DRIVER QTOP IS = 2000B
0168  00121        START   EQU  B4000
0169  00171  000000  RUNA    BSS  1
0170  00172  000000  XEC4A   BSS  1
0171  00173  000000  PEXMA   BSS  1
0172  00174  000000  RDYDA   BSS  1
0173  00122        LISTA   EQU  B6K
0174  00175  000000  TSRHA   BSS  1      TABLE SEARCH
0175  00176  000000  ELINA   BSS  1      OUTPUT I/O BUFFER
0176  00177  000000  SSYMA   BSS  1      SEARCH SYMBOL TABLE FOR
                                                          SYMBOL
0177  00200  000000  OPCHA   BSS  1
0178  00201  000000  FORMA   BSS  1
0179  00202  000000  FSCA    BSS  1
0180  00203  000000  ACTSA   BSS  1
0181  00204  000000  DELSA   BSS  1
0182  00205  000000  AERRA   BSS  1      ALTERNATE ENTRY FOR ERROR
0183  00206  000000  ERRA    BSS  1
0184  00207  014560  INTEA   DEF  ISERV
0185  00210  000000  OUTIA   BSS  1      OUTPUT AN INTEGER
0186  00211  000000  .BUFA   BSS  1      FIRST CHAR OF I/O BUFFER
0187  00212  000000  .SLBF   BSS  1       REFRESH BUFFER POINTER
0188  00213  001744  AR1A    DEF  AR1
0189  00214  001754  AR2A    DEF  AR2
0190  00215  000000  TMPOP   BSS  1
0191  00216  000000  .FADA   BSS  1      ADD
0192  00217  000000  .FSRA   BSS  1      SUBTRACT
0193  00220  000000  .FMPA   BSS  1      MULTPY
0194  00221  000000  .FDVA   BSS  1      DIVIDE
0195  00222  000000  ENTFA   BSS  1
0196  00223  000000  .FSR    BSS  1      SQUARE ROOT
0197  00224  000000  UPARA   BSS  1      UP ARROW
0198  00225  000000  FLTRA   BSS  1
0199  00226  000000  FLTFA   BSS  1
0200  00227  000000  FXFLA   BSS  1
0201  00230  000000  FLTSA   BSS  1
0202  00231  000000  SPLFA   BSS  1
0203  00232  000000  SNFLA   BSS  1
0204  00233  000000  BEND    BSS  1      I/O BUFFER END
0205  00233        SBUFA   EQU  BEND
0206  00234  000000  NMOTA   BSS  1      NUMBER OUTPUT ROUTINE LINK
0207  00235  000000  FILLA   BSS  1       SUPPLY NEEDED BLANKS ON
                                                          OUTPUT
0208  00236  000000  SLEND   BSS  1      REFRESH BUFFER END
0209  00111        TMPA    EQU  B1740
0210  00110        BADRP   EQU  B1400    POINTER POINTER TO I/O BUFFER
0211*
0212  00123        FOPBS   EQU  B12K
0213  00237  000000  SALTA   BSS  1
0214  00240  000000  MDIMA   BSS  1
0215  00241  000000  SYTSA   BSS  1
0216  00242  000000  DCOMA   BSS  1
0217  00243  000000  NUMCA   BSS  1
```

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```
0218   00244  000000  NUMOA   BSS   1
0219   00245  000000  GTSTA   BSS   1
0220   00246  000000  VAROA   BSS   1
0221   00247  000000  ECALA   BSS   1
0222   00250  000000  OVCHA   BSS   1
0223   00251  000000  CLP1A   BSS   1
0224   00252  000000  ENTEA   BSS   1
0225   00253  000000  CHRSA   BSS   1
0226   00254  000000  XSCRA   BSS   1
0227   00255  000000  XEC6A   BSS   1
0228   00256  000000  FDAAA   BSS   1
0229   00257  000000  FNDAA   BSS   1
0230   00260  000000  FND1A   BSS   1
0231   00261  000000  IOSTA   BSS   1
0232   00262  000000  INREA   BSS   1
0233   00263  000000  SUMPA   BSS   1
0234   00264  000000  CRCKA   BSS   1
0235   00265  000000  IOHEA   BSS   1
0236   00266  000000  QTCHA   BSS   1
0237**********************************
0238*
0239   00267  000000          BSS   1        CHECKSUM WORD**********
```

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0241	00270	000000	E1	BSS	1
0242	00271	000000		BSS	1
0243	00272	000000		BSS	1
0244	00273	000000		BSS	1
0245	00274	000000	E5	BSS	1
0246	00275	000000		BSS	1
0247	00276	000000		BSS	1
0248	00277	000000		BSS	1
0249	00300	000000		BSS	1
0250	00301	000000	E10	BSS	1
0251	00302	000000		BSS	1
0252	00303	000000		BSS	1
0253	00304	000000		BSS	1
0254	00305	000000		BSS	1
0255	00306	000000	E15	BSS	1
0256	00307	000000		BSS	1
0257	00310	000000		BSS	1
0258	00311	000000		BSS	1
0259	00312	000000		BSS	1
0260	00313	000000	E20	BSS	1
0261	00314	000000		BSS	1
0262	00315	000000		BSS	1
0263	00316	000000		BSS	1
0264	00317	000000		BSS	1
0265	00320	000000	E25	BSS	1
0266	00321	000000		BSS	1
0267	00322	000000		BSS	1
0268	00323	000000		BSS	1
0269	00324	000000		BSS	1
0270	00325	000000	E30	BSS	1
0271	00326	000000		BSS	1
0272	00327	000000		BSS	1
0273	00330	000000		BSS	1
0274	00331	000000		BSS	1
0275	00332	000000	E35	BSS	1
0276	00333	000000		BSS	1
0277	00334	000000		BSS	1
0278	00335	000000		BSS	1
0279	00336	000000		BSS	1
0280	00337	000000	E40	BSS	1
0281	00340	000000		BSS	1
0282	00341	000000		BSS	1
0283	00342	000000		BSS	1
0284	00343	000000		BSS	1
0285	00344	000000	E45	BSS	1
0286	00345	000000		BSS	1
0287	00346	000000		BSS	1
0288	00347	000000		BSS	1
0289	00350	000000		BSS	1
0290	00351	000000	E50	BSS	1
0291	00352	000000		BSS	1
0292	00353	000000		BSS	1
0293	00354	000000		BSS	1
0294	00355	000000		BSS	1

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```
0296  01400                    ORG  1400B
0297  01400  000000  BADDR     BSS  1      CURRENT CHAR POINTER
0298  01401  000000  RSAVE     BSS  1          SAVE (A) FOR RETN 2
0299  01402  000000  OTPTR     BSS  1      REFRESH POINTER
0300  01403  000000  MAW       BSS  1      LAST WORD OF R/W MEM
0301  01404  000000  LWAM      BSS  1      LAST WORD AVAILABLE FOR USER
0302  01405  000000  FWUP      BSS  1      FIRST WORD OF COMMON OR MAINLINE
0303  01406  000000  VALUE     BSS  1      FIRST WORD -1 OF VALUE TABLE
0304  01407  000000  STMTP     BSS  1      FIRST WORD -1 OF SYMBOL TABLE
0305  01410  000000  LSTAK     BSS  1      FIRST WORD OF OPERATOR STACK
0306  01411  000000  TSTPT     BSS  1      TEMPORARY STACK POINTER
0307  01412  000000  LSTPT     BSS  1      OPERATOR STACK POINTER
0308  01413  000000  HSTPT     BSS  1      OPERAND STACK POINTER
0309  01414  000000  DSTRT     BSS  1      DATA STATEMENT
0310  01415  000000  NXTDT     BSS  1        POINTERS
0311  01416  000000  MODE      BSS  1      PROGRAM=0; KEYBOARD=1
0312  01417  000000  PARMA     BSS  1      PARAMETER ADDRESS
0313  01420  000000  PARMN     BSS  1      PARAMETER NAME
0314  01421  000000  PRADD     BSS  1      LAST WORD+1 OF CURRENT STMT
0315  01422  000000  UKPTR     BSS  1      USER KEY POINTER
0316  01423  000000  PBPTR     BSS  1      LAST WORD OF CURRENT PROGRAM
0317  01424  000000  PBUFF     BSS  1      FIRST WORD OF CURRENT PROGRAM
0318  01425  000000  PBUFO     BSS  1      FIRST WORD OF MAINLINE
0319  01426  000000  PBPTO     BSS  1      LAST WORD+1 OF MAINLINE
0320  01427  000000  .LNUM     BSS  1      CURRENT LINE NUMBER
0321  01430  000000  LNINC     BSS  1      AUTO LINE INCREMENT
0322  01431  000000  CLINE     BSS  1      CURRENT LINE FOR LIST
0323  01432  000000  DRQST     BSS  1      INPUT STMT FLAG
0324  01433  000000  TFLAG     BSS  1      PTAPE FLAG
0325  01434  000000  UNITS     BSS  1      TRIG UNITS
0326  01435  000000  SEC       BSS  1      SECURE PROGRAM FLAG
0327  01436  000000  HFLG1     BSS  2      STOP ADDRESS
0328  01440  000000  TFLG1     BSS  2      TRACE LIMIT ADDRESSES
0329  01442  000000  STPFL     BSS  1      STOP FLAG
0330  01443  000000  KEYFG     BSS  1      KEYBOARD FLAG
0331  01444  000000  SAVEA     BSS  1      INTERRUPT
0332  01445  000000  SAVEB     BSS  1
0333  01446  000000  ADRSS     BSS  1        TEMPORARIES
0334  01447  000000  SLCOD     BSS  1      SELECT CODE
0335  01450  000000  PMODE     BSS  1      PRINT-ALL FLAG
0336  01451  000000  CTYPE     BSS  1      KEYBOARD
0337  01452  000000  CPLAC     BSS  1        FORMAT FLAGS
0338  01453  000000  PRFLG     BSS  1      PRINT/DISP FLAG
0339  01454  000000  RCOUT     BSS  1      FORMAT
0340  01455  000000  FORMT     BSS  1
0341  01456  000000  FORMS     BSS  1
0342  01457  000000  FORME     BSS  1        STATEMENT FLAGS
0343  01460  000000  FTMP1     BSS  1      CURRENT OPERATOR CODE
0344  01461  000000  FTMP2     BSS  1      CURRENT OPERATOR PRECEDENCE
0345  01462  000000  REEDL     BSS  1
0346  01463  000000  INTEL     BSS  1
0347  01464  000000            BSS  2        UNUSED
0348*
0349*   TEMPORARIES
0350*
0351  01466  000000  LOCL1     BSS  1
```

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```
0352   01467  000000  LOCL2   BSS  1
0353   01470  000000  L2T1    BSS  1
0354   01471  000000  L2T2    BSS  1
0355   01472  000000  TEMPS   BSS  1
0356   01473  000000  TEMP    BSS  1
0357   01473          MBOX1   EQU  TEMP
0358   01474  000000  TEMP1   BSS  1
0359   01475  000000  TEMP2   BSS  1
0360   01476  000000  TEMP3   BSS  1
0361   01477  000000  TEMP4   BSS  1
0362*
0363*  BUFFERS
0364*
0365   01500  000000  IOBUF   BSS  41      INPUT AND RECALL BUFFER
0366   01551  000000  RBUFF   BSS  41      SINGLE LINE RESEARCH BUFFER
0367*
0368*  PRINT ROUTINE FLAGS
0369*
0370   01622  000000  TERM    BSS  1       CRLF FLAG
0371   01623  000000  PEND    BSS  1       BUFFER OVERFLOW FLAG
0372   01624  000000  PPFF    BSS  1       BUFFER POINTER OR TAB FLAG
0373   01625  000000  FIRST   BSS  1
0374   01626  000000          BSS  2        UNUSED
0375*
0376*  MATH TEMPORARIES
0377*
0378   01630  000000  TREGE   BSS  4
0379   01634  000000  RSLTE   BSS  4
0380*
0381*  STATEMENT SYNTAX AND EXECUTION TEMPORARIES
0382*
0383   01640  000000  ST      BSS  32
0384*
0385*  SYSTEM SYNTAX AND EXECUTION TEMPORARIES
0386*
0387   01700  000000          BSS  1       SAVED FOR PROCESSOR
0388   01701  000000  NDISP   BSS  1
0389   01702  000000  NPRIN   BSS  1
0390   01703  000000  PLACE   BSS  1
0391   01704  000000  WIDTH   BSS  1
0392   01705  000000  FLOAT   BSS  1
0393   01706  000000  SBPTR   BSS  1
0394   01707  000000  BLANK   BSS  1
0395   01710  000000  MSFLG   BSS  1
0396   01711  000000  DFLAG   BSS  1
0397   01712  000000  PFLAG   BSS  1
0398   01713  000000  UFLAG   BSS  1
0399   01714  000000  SFLAG   BSS  1
0400   01715  000000  SBADR   BSS  1
0401   01716  000000  SSBPT   BSS  1
0402   01717  000000  NUM     BSS  1
0403   01717          OPTYP   EQU  NUM
0404   01720  000000  LASTN   BSS  1
0405   01721  000000  SIGN    BSS  1
0406   01721          MAXIN   EQU  SIGN
0407   01722  000000  EXP     BSS  1
```

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```
0408  01722          INTGR  EQU  EXP
0409  01723  000000  ARYAD  BSS  1
0410  01724  000000  GFLAG  BSS  1
0411  01725  000000  NXTST  BSS  1
0412  01726  000000  MBIN1  BSS  1
0413  01727  000000  MBIN2  BSS  1
0414*
0415*   ARITHMETIC REGISTERS AND RETURN STACK
0416*
0417  01740          ORG  1740B
0418  01740  000000  XC     BSS  4
0419  01744  000000  AR1    BSS  4
0420  01750  000000  YC     BSS  4
0421  01754  000000  AR2    BSS  4
0422  01760  000000  RSTAK  BSS  11          RETURN STACK
0423  01773  000000  RES    BSS  4           RESULT REGISTER
0424  01777  000000  RSPTR  BSS  1           RETURN STACK POINTER
0425  00356          RETN3  EQU  356B
0426  00357          RETN2  EQU  357B
0427  00365          RET2   EQU  365B
0428  00373          ICNT   EQU  373B
0429  00374          WBUFF  EQU  374B
0430  00400          GPARM  EQU  400B
0431  00405          XFAR1  EQU  405B
0432  00412          RSULT  EQU  412B
0433  00416          STORE  EQU  416B
0434  00425          STOR1  EQU  425B
0435  00444          XFAR2  EQU  444B
0436  00450          STROP  EQU  450B
0437  00456          SBPUD  EQU  456B
0438  00461          SYMC2  EQU  461B
0439  00463          SYMC1  EQU  463B
0440  00464          SYMCK  EQU  464B
0441  00504          COMCK  EQU  504B
0442  00510          COMCE  EQU  510B
0443  00513          LPCK   EQU  513B
0444  00521          LPCKE  EQU  521B
0445  00524          RPCK   EQU  524B
0446  00534          RPCKE  EQU  534B
0447  00535          FSCE2  EQU  535B
0448  00537          STSRH  EQU  537B
0449  00546          STEXP  EQU  546B
0450  00553          BHSTP  EQU  553B
0451  00561          MER8   EQU  561B
0452  00561          FSCE4  EQU  561B
0453  00563          SLWST  EQU  563B
0454  00567          UNSTK  EQU  567B
0455  00574          NEXTL  EQU  574B
0456  00606          NEXT1  EQU  606B
0457  00613          FPAGE  EQU  613B
0458  00626          SAVBP  EQU  626B
0459  00633          RESB1  EQU  633B
0460  00640          RESBP  EQU  640B
0461  00645          MINIT  EQU  645B
0462  00651          INITS  EQU  651B
0463  00664          LNUM   EQU  664B
```

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```
0464  00666          PGINT   EQU  666B
0465  00676          INTCK   EQU  676B
0466  00726          SYE25   EQU  726B
0467  00730          GETAD   EQU  730B
0468  00742          FND     EQU  742B
0469  00750          DIGCK   EQU  750B
0470  00752          LETCK   EQU  752B
0471  00753          LIMIT   EQU  753B
0472  00771          GTOPP   EQU  771B
0473  01007          NEXTA   EQU  1007B
0474  01015          OBLNK   EQU  1015B
0475  01016          ONEXT   EQU  1016B
0476  01017          OUTCR   EQU  1017B
0477  01041          GETCH   EQU  1041B
0478  01053          GTMP    EQU  1053B
0479  01055          GNEXT   EQU  1055B
0480  01062          GFRST   EQU  1062B
0481  01066          GETSK   EQU  1066B
0482  01075          FNDPS   EQU  1075B
0483  01121          MVTOH   EQU  1121B
0484  01131          PGIN0   EQU  1131B
0485  01140          LTR     EQU  1140B
0486  01147          ENDS    EQU  1147B
0487  01151          EOST    EQU  1151B
0488  01152          NOEOF   EQU  1152B
0489  01153          EOLCK   EQU  1153B
0490  01156          CONST   EQU  1156B
0491  01165          SYEI2   EQU  1165B
0492  01166          GSIGN   EQU  1166B
0493  01201          IMPY    EQU  1201B
0494  01217          FETCH   EQU  1217B
0495  01225          LDEF    EQU  1225B
0496  01254          ZONK    EQU  1254B
0497  01256          CLAR2   EQU  1256B
0498  01314          ODGIT   EQU  1314B
0499  01317          SGNS    EQU  1317B
0500  01330          .NPWR   EQU  1330B
0501  01335          NPWRT   EQU  1335B
0502  01337          NDWRT   EQU  1337B
0503  01342          CRLF    EQU  1342B
0504  01344          CRLF1   EQU  1344B
0505  01351          TTY     EQU  1351B
0506  01362          GTCON   EQU  1362B
0507  01371          FIX     EQU  1371B
```

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```
0510                                LST
0511*          CTAPE  3-20-72-9:30
0512   14000                        ORG  14000B
0513*
0514*   SYSTEM COMMAND TABLE
0515*
0516   14000  000003                ABS  ESEC-*
0517   14001  051505  CMNDT         ASC  1,SE        SECURE, OPCODE 1
0518   14002  041761                OCT  41761       C, OPCODE
0519   14003  060730  ESEC          JSM  GETAD       A=LNX1,B=LNX2
0520   14004  035647                STB  TAP1        TEMPOR, LNX2 ADDR
0521   14005  025477                LDB  TEMP4       LNX1 ADDR
0522   14006  015647  ESEC3         CPB  TAP1          DONE ?
0523   14007  066016                JMP  ESEC6
0524   14010  074517                LDA  B,I
0525   14011  070410                SZA  ESEC4       SKIP IF TYPING AID
0526   14012  072053                SAP  *+1,S       SET BIT 15
0527   14013  074557                STA  B,I         RESTORE LINE
0528   14014  061007                JSM  NEXTA       NO, GET NEXT LINE
0529   14015  066006                JMP  ESEC3
0530   14016  021435  ESEC6         LDA  SECFL
0531   14017  040062                IOR  FLGBT       SET BIT 15
0532   14020  031435                STA  SECFL       CUSTOMER SECURING PROG
0533   14021  164174  ESEC4         JMP  RDYDA,I       ET TO SYSTEM
0534*
0535*
0536   14022  000000                BSS  1           ********** C.S.**********
0537*
0538*
0539*      SUB-TABLE FOR STORE AND LOAD
0540*
0541*
0542   14023  041111  SUBT          ASC  1,BI        BIN OPCODE 24
0543   14024  047264                OCT  47264       N, OPCODE
0544   14025  045505                ASC  1,KE        KEY, OPCODE 20
0545   14026  054660                OCT  54660       Y, OPCODE
0546   14027  042101                ASC  2,DATA      DATA, OPCODE 21
       14030  052101
0547   14031  170400                OCT  170400      OPCODE, EOT
0548*
0549*
0550*      SYNTAX SERVICE SUBR
0551*
0552*
0553   14032  061055  SERV          JSM  GNEXT
0554   14033  060456                JSM  SBPUD
0555   14034  010031                CPA  EOL         EOL ?
0556   14035  170402                RET
0557   14036  055706                DSZ  SBPTR
0558   14037  055400                DSZ  BADDR
0559   14040  160202                JSM  FSCA,I      GEET NO. OR EXPRESSION
0560   14041  064357                JMP  RETN2
0561*
0562*
0563*
0564*
```

```
Ø565*                                  EXECUTION
Ø566*
Ø567*
Ø568*
Ø569*
Ø57Ø*     ALOAD — ALL LOAD EXECT ENTRY
Ø571*
Ø572*
Ø573   14Ø42  Ø6Ø771  ALOAD   JSM  GTOPP    GET OPERAND
Ø574   14Ø43  Ø7251Ø          RZA  LOADP    SKIP IF OPERAND GIVEN
Ø575   14Ø44  Ø45472          ISZ  TEMPS
Ø576   14Ø45  121472          LDA  TEMPS,I
Ø577   14Ø46  Ø13732          CPA  DATOP    DATA OPCODE?
Ø578   14Ø47  Ø67172          JMP  LDATA    YES
Ø579   14Ø5Ø  Ø13733          CPA  KEYOP    KEU OPCODE?
Ø58Ø   14Ø51  Ø67315          JMP  LKEY     YES
Ø581   14Ø52  Ø13734          CPA  BINOP    BINARY OPCODE?
Ø582   14Ø53  Ø67421          JMP  LBIN     YES
Ø583   14Ø54  Ø55472          DSZ  TEMPS
Ø584*
Ø585*
Ø586*     LOADP — LOAD PROGRAM
Ø587*
Ø588*
Ø589   14Ø55  Ø62Ø7Ø  LOADP   JSM  LOAD2
Ø59Ø   14Ø56  Ø62Ø1Ø          JSM  LOAD8
Ø591   14Ø57  Ø6Ø645          JSM  MINIT    SRATCH SYMBOL TABLE
Ø592   14Ø6Ø  Ø216Ø6          LDA  TAP7
Ø593   14Ø61  Ø62161          JSM  LOAD3
Ø594   14Ø62  Ø21416  LOAD9   LDA  MODE
Ø595   14Ø63  Ø7Ø15Ø          SZA  *+3
Ø596   14Ø64  Ø6Ø651          JSM  INITS    RESET STACKS
Ø597   14Ø65  164174          JMP  RDYDA,I  KEYB-RET TO SYSTEM-DO NOT
                                            EXECUTE
Ø598   14Ø66  Ø21661          LDA  TAP8     SEC LINE #
Ø599   14Ø67  164171          JMP  RUNA,I
Ø6ØØ*
Ø6Ø1*
Ø6Ø2*
Ø6Ø3   14Ø7Ø  Ø623ØØ  LOAD2   JSM  SFLOC
Ø6Ø4   14Ø71  Ø27745          LDB  TAPAD    TEMPOR, ADDR
Ø6Ø5   14Ø72  Ø21472  LO3     LDA  TEMPS    STATEMENT POINTER
Ø6Ø6   14Ø73  Ø11421          CPA  PRADD    EOL FOLLOWS?
Ø6Ø7   14Ø74  17Ø4Ø2          RET           YES, PROCESS
Ø6Ø8   14Ø75  Ø45472          ISZ  TEMPS    POINT TO LINE #
Ø6Ø9   14Ø76  121472          LDA  TEMPS,I  LINE #
Ø61Ø   14Ø77  Ø74557          STA  B,I      TAP–TAP8, LINE #S
Ø611   141ØØ  Ø45472          ISZ  TEMPS
Ø612   141Ø1  Ø77471Ø         RIB  LO3      LOOK FOR SECOND LINE #
Ø613*
Ø614*
Ø615*
Ø616   141Ø2  Ø21661  LOAD8   LDA  TAP8
Ø617   141Ø3  Ø7Ø11Ø          SZA  *+2
Ø618   141Ø4  Ø66126          JMP  LOAD7–2     LNX2 GIVEN
Ø619   141Ø5  Ø21416          LDA  MODE
Ø62Ø   141Ø6  Ø7Ø11Ø          SZA  *+2         SKIP ON PROGRAM
```

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```
0621  14107  066130          JMP  LOAD7     DO NOT EXECUTE
0622  14110  121421          LDA  PRADD,I   GET NEXT LINE #
0623  14111  070072          SAM  *+1,C      CLEAR SEC BIT
0624  14112  025421          LDB  PRADD
0625  14113  015423          CPB  PBPTR
0626  14114  020056          LDA  .1E4        10000
0627  14115  070076          TCA
0628  14116  001660          ADA  TAP7      LNX1 — LINE # FOR START LOAD
0629  14117  070213          SAP  *+4       NEXT LINE OK
0630  14120  021660          LDA  TAP7       START AT FIRST LINE OF LOADED
                                                                    PROG.
0631  14121  031661          STA  TAP8      FOR    START    OF    EXECUTION
0632  14122  066126          JMP  *+4
0633  14123  021427          LDA  .LNUM       PRESENT L.N.
0634  14124  070070          SIA  *+1
0635  14125  031661          STA  TAP8       START AT NEXT N←N←LINE
0636  14126  070742          SAR  16
0637  14127  031416          STA  MODE       EXECUTE
0638  14130  025421  LOAD7   LDB  PRADD
0639  14131  163756          JSM  DCM1A,I       DECOMPILE
0640  14132  021666          LDA  IDB0+2    FILE TYPE
0641  14133  010020          CPA  .3        SOURCE?
0642  14134  066142          JMP  *+6
0643  14135  010036          CPA  .23       SEC SOURCE ?
0644  14136  066140          JMP  *+2        YES
0645  14137  067325          JMP  ERR7       TYPE ERROR
0646  14140  024106          LDB  B777
0647  14141  035435          STB  SECFL      SET SECURE FLAG
0648  14142  021424          LDA  PBUFF
0649  14143  011423          CPA  PBPTR      NULL PROG?
0650  14144  066151          JMP  LO12        YES
0651  14145  121424          LDA  PBUFF,I    TYPING AID RESIDENT?
0652  14146  072150          RZA  LO12
0653  14147  160205  ERR8    JSM  AERRA,I    OVERLAY ERROR
0654  14150  177701          DEC  -63
0655  14151  025660  LO12    LDB  TAP7
0656  14152  074210          SZB  *+4       START LINE SPECIFIED ?
0657  14153  025670          LDB  IDB0+4     YES, COMPUTE DIFF
0658  14154  074076          TCB             BETWEEN SPECIFIED
0659  14155  005660          ADB  TAP7       AND ACTUAL LINE #
0660  14156  035663          STB  OFSET      TEMPOR
0661  14157  170402          RET
0662*
0663*
0664*
0665  14160  061075  LOAD3   JSM  FNDPS      FIND ADDR OF START LINE
0666  14161  066271          JMP  LO6       L.N. BEYOND END OF PROGR
0667  14162  066163          JMP  *+1        L.N. BETWEEN PROGRAM LINES
0668  14163  035650          STB  TAP2      L. N. EXACTLY FOUND — STORE START
                                                                    ADDR
0669  14164  035477          STB  TEMP4     SAVE FOR CLP1A
0670  14165  025423          LDB  PBPTR
0671  14166  160251          JSM  CLP1A,I       DEL FROM HERE TO END OF
                                                                    PROGR
0672*
0673*
0674*
0675  14167  021671  LOAD4   LDA  IDB0+5     END LINE #
0676  14170  001663          ADA  OFSET
```

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```
0677  14171  000012          ADA  .1
0678  14172  060742          JSM  FND       FIND ADDR OF END LINE
0679  14173  015650          CPB  TAP2      SAVE AS START ADDR
0680  14174  066176          JMP  *+2        YES
0681  14175  066147          JMP  ERR8       NO, OVERLAY
0682  14176  035660          STB  TAP7       TEMPOR
0683*
0684*     CHECK FOR LEGAL COMMON AND OVERFLOW
0685*           UPDATE POINTERS
0686*
0687  14177  021672  COMON   LDA  IDB0+6     LOADING COMMON?
0688  14200  072210          RZA  YCOMN
0689  14201  021665          LDA  IDB0+1     NO COMMON
0690  14202  160250          JSM  OVCHA,I        UPDATE PROGRAM POINTERS
0691  14203  066231          JMP  KCOMN
0692  14204  025660  YCOMN   LDB  TAP7       YES
0693  14205  015424          CPB  PBUFF      LOADING AT FIRST LINE?
0694  14206  066210          JMP  *+2        YES
0695  14207  164330          JMP  E30+3,I      NO, MISPLACED COM
0696  14210  025422          LDB  UKPTR
0697  14211  076350          RZB  COM1
0698  14212  025405          LDB  FWUP
0699  14213  035424          STB  PBUFF
0700  14214  035426          STB  PBPTO
0701  14215  035423          STB  PBPTR
0702  14216  035476          STB  TEMP3
0703  14217  066221          JMP  *+2
0704  14220  070742  COM1     SAR  16         DO NOT ALLOCATE SPACE FOR
                                                        COMMON
0705  14221  001665          ADA  IDB0+1     ADD PROGR SIZE TO COMMON SIZE
0706  14222  160250          JSM  OVCHA,I    CHECK OVERFLOW AND UPDATE
                                                        POINTERS
0707  14223  021422          LDA  UKPTR
0708  14224  072250          RZA  KCOMN      SKIP IF KEY
0709  14225  021424          LDA  PBUFF
0710  14226  001672          ADA  IDB0+6     UPDATE PBUFF
0711  14227  031424          STA  PBUFF
0712  14230  031660          STA  TAP7       UPDATE LOAD ADDR
0713  14231  061121  KCOMN    JSM  MVTOH      OPEN UP SPACE
0714*
0715*     LOAD THE FILE
0716*
0717  14232  063105          JSM  RRID        REV READ BOF; READ IMMDT FILE
                                                        ID
0718  14233  021660          LDA  TAP7        START ADDR
0719  14234  025665          LDB  IDB0+1     CURR FILE SIZE
0720  14235  070037          ADB  A          END ADDR
0721  14236  062717          JSM  TRD        READ FILE
0722  14237  063031          JSM  HALT
0723  14240  070115          SEC  *+2
0724  14241  067100          JMP  ERR4       CHECK SUM ERROR
0725*
0726*     ADD OFFSET TO ALL LINE NUMBER REFERENCES
0727*
0728  14242  021423          LDA  PBPTR
0729  14243  031647          STA  TAP1       SAVE END OF PROG POINTER
0730  14244  021654          LDA  TAP5
0731  14245  031423          STA  PBPTR      SET TO END OF LOADED AREA
0732  14246  021653          LDA  TAP4       POINTER TO START OF LOADED AREA
```

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```
0733  14247  160257          JSM  FNDAA,I  FIND FIRST LINE /# REF
0734  14250  066256          JMP  LO4
0735  14251  001663          ADA  OFSET    ADD OFFSET
0736  14252  131472          STA  TEMPS,I  RESTORE
0737  14253  160260          JSM  FNDIA,I  FIND NEXT REF
0738  14254  066256          JMP  LO4      END OF LOADED AREA
0739  14255  066251          JMP  *-4
0740*
0741*
0742*     ADD OFFSET TO ALL LINE NUMBERS LOADED
0743*
0744  14256  025653  LO4     LDB  TAP4     POINT TO START OF LOADED AREA
0745  14257  015423          CPB  PBPTR    END OF LOADED AREA?
0746  14260  066266          JMP  LO5      YES
0747  14261  074517          LDA  B,I      GET LOADED LINE NUMBER
0748  14262  001663          ADA  OFSET    ADD OFFSET
9749  14263  074557          STA  B,I      STORE NEW LINE #
0750  14264  061007          JSM  NEXTA    COMPUTE ADDR OF NEXT LINE
0751  14265  066257          JMP  LO4+1
0752  14266  025647  LO5     LDB  TAP1
0753  14267  035423          STB  PBPTR    RESTORE END OF PROGR POINTER
0754  14270  170402          RET
0755*
0756*     APPEND
0757*
0758  14271  035660  LO6     STB  TAP7     START ADDR
0759  14272  025671          LDB  IDBO+5     END LINE #
0760  14273  005663          ADB  OFSET
0761  14274  004161          ADB  MAXSN    FINAL LINE #
0762  14275  074112          SBM  *+2        EXCEED 9999?
0763  14276  164273          JMP  E5-1,I   YES
0764  14277  066177          JMP  COMON
0765*
0766*
0767*     SUBR FOR FILE LOCATING
0768*
0769*
0770  14300  062457  SFLOC   JSM  UNITC
0771  14301  021472          LDA  TEMPS
0772  14302  011421          CPA  PRADD    END OF STATEMENT?
0773  14303  066312          JMP  SF2      YES, PROCESS
0774  14304  062510          JSM  FILEC    NO
0775  14305  031644          STA  TFILE
0776  14306  074742          SBR  16
0777  14307  035660          STB  TAP7
0778  14310  035661          STB  TAP8
0779  14311  067123          JMP  LOCF2      LOC FILE AND RET
0780  14312  074742  SF2     SBR  16
0781  14313  035660          STB  TAP7
0782  14314  635661          STB  TAP8
0783  14315  035644          STB  TFILE      FILE 0
0784  14316  067123          JMP  LOCF2
0785*
0786*
0787*
0788*
```

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```
0789*
0790*    ALSTOR — ALL STORE EXECUTION ENTRY
0791*
0792*
0793   14317  060771  ASTOR   JSM  GTOPP     GET OPERAND
0794   14320  072510          RZA  STORP     SKIP IF OPERAND GIVEN
0795   14321  045472          ISZ  TEMPS
0796   14322  121472          LDA  TEMPS,I
0797   14323  013732          CPA  DATOP     DATA OPCODE?
0798   14324  067216          JMP  SDATA     YES
0799   14325  013733          CPA  KEYOP     KEY OPCODE?
0800   14326  067403          JMP  SKEY      YES
0801   14327  013734          CPA  BINOP     BINARY OPCODE?
0802   14330  167755          JMP  ERR0,I
0803   14331  055472          DSZ  TEMPS
0804*
0805*
0806*      STORP — STORE PROGRAM
0807*
0808*
0809   14332  062300  STORP   JSM  SFLOC
0810   14333  062071          JSM  LO3-1
0811   14334  063025          JSM  WPERM
0812   14335  025421          LDB  PRADD
0813   14336  163756          JSM  DCM1A,I      DECOMPILE
0814   14337  121424          LDA  PBUFF,I
0815   14340  070072          SAM  *+1,C        ASSUME FIRST LINE #
0816   14341  025660          LDB  TAP7         FIRST LINE #
0817   14342  074110          SZB  *+2
0818   14343  021660          LDA  TAP7
0819   14344  025661          LDB  TAP8         SECOND LINE #
0820   14345  076110          RZB  *+2          SKIP IF GIVEN
0821   14346  024056          LDB  .1E4         ASSUME LAST LINE IN PROGRAM
0822   14347  060730          JSM  GETAD        GET ADDR LIMITS
0823   14350  015477          CPB  TEMP4
0824   14351  067242          JMP  ERR5            NULL PROGRAM
0825   14352  121477          LDA  TEMP4,I
0826   14353  070072          SAM  *+1,C
0827   14354  031670          STA  IDB0+4          IN FILE ID
0828   14355  021477          LDA  TEMP4        START OF STORE AREA
0829   14356  031472          STA  TEMPS        LOW LIMIT
0830   14357  031650          STA  TAP2         LOW LIMIT
0831   14360  035660          STB  TAP7         HIGH LIMIT
0832   14361  060602          JSM  NEXT1-4
0833   14362  001466          ADA  LOCL1
0834   14363  013746          CPA  TCOM         IS IT COMMON?
0835   14364  066366          JMP  *+2          YES
0836   14365  066373          JMP  *+6          NO
0837   14366  025405          LDB  FWUP         START OF USER AREA
0838   14367  074076          TCB
0839   14370  005424          ADB  PBUFF        FIND SIZE OF COMMON
0840   14371  035672          STB  IDB0+6       IN FILE ID BUFF
0841   14372  066375          JMP  *+3
0842   14373  074742          SBR  16
0843   14374  035672          STB  IDB0+6       ZERO COMMON
0844   14375  025720          LDB  LASTN        LAST LINE #
```

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```
0845  14376  035671          STB  IDB0+5     IN FILE ID BUFF
0846  14377  025660          LDB  TAP7       TEMPR, END ADDR
0847  14400  021650          LDA  TAP2       TEMPR, START ADDR
0848  14401  063237          JSM  SDAT2
0849  14402  063463          JSM  SECCK
0850  14403  024020          LDB  .3         UNSEC SOURCE
0851  14404  070113          SAP  *+2
0852  14405  024036          LDB  .23        SEC SOURCE
0853  14406  035666          STB  IDB0+2
0854  14407  067231          JMP  SDAT3+2
0855*
0856*
0857*   MERGE EXECUTION
0858*
0859*
0860  14410  025472  MERGE   LDB  TEMPS
0861  14411  004133          ADB  M2         ADDR OF MERGE LINE
0862  14412  074517          LDA  B,I        MERGE LINE NO.
0863  14413  070072          SAM  *+1,C       CLEAR SEC BIT
0864  14414  031630          STA  TREGE       TEMPOR
0865  14415  062070          JSM  LOAD2
0866  14416  021661          LDA  TAP8
0867  14417  072310          RZA  LO7-2      LNX2 GIVEN
0868  14420  021416          LDA  MODE
0869  14421  072310          RZA  LO7        DO NOT EXECUTE
0870  14422  021630          LDA  TREGE
0871  14423  000012          ADA  .1         POINT TO NEXT LINE
0872  14424  031661          STA  TAP8       LINE FOR START EXECUTION
0873  14425  070742          SAR  16
0874  14426  031416          STA  MODE       EXECUTE
0875  14427  062130  LO7     JSM  LOAD7
0876  14430  060645          JSM  MINIT
0877  14431  021670          LDA  IDB0+4     START L.N.
0878  14432  001663          ADA  OFSET
0879  14433  061075          JSM  FNDPS      FIND START ADDR
0880  14434  066442          JMP  MERG1
0881  14435  066437          JMP  *+2
0882  14436  066147          JMP  ERR8       OVERLAY ERROR
0883  14437  035650          STB  TAP2       SAVE ADDR
0884  14440  062167          JSM  LOAD4
0885  14441  066062          JMP  LOAD9
0886  14442  062271  MERG1   JSM  LO6
0887  14443  066062          JMP  LOAD9
0888*
0889*
0890*       LINK EXECUTION
0891*
0892*
0893  14444  062070  LINK    JSM  LOAD2
0894  14445  062102          JSM  LOAD8
0895  14446  021660          LDA  TAP7
0896  14447  062160          JSM  LOAD3
0897  14450  021416          LDA  MODE
0898  14451  070150          SZA  *+3
0899  14452  060651          JSM  INITS      RESET STACKS
0900  14453  164174          JMP  RDYDA,I    KEYB-RET TO SYSTEM- DONOT
                                                          EXECUTE
```

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```
0901   14454  021661          LDA  TAPR      SEC LINE #
0902   14455  031725          STA  NXTST
0903   14456  164005          JMP  XECA,I
0904*
0905*
0906*  UNIT NO CONFIGURATION
0907*
0908*
0909   14457  060771  UNITC   JSM  GTOPP     GET OPERAND
0910   14460  072510          RZA  F5        NO # PRESENT
0911   14461  045472          ISZ  TEMPS
0912   14462  021472          LDA  TEMPS
0913   14463  011421          CPA  PRADD
0914   14464  066472          JMP  F5
0915   14465  121472          LDA  TEMPS,I
0916   14466  050065          AND  OPMSK
0917   14467  013742          CPA  NUMS      IS IT #?
0918   14470  066475          JMP  GUNT      GET UNIT
0919   14471  055472          DSZ  TEMPS
0920   14472  023735  F5      LDA  B120K     ASSUME INTERNAL
0921   14473  031645          STA  TUNIT     UNIT TEMPOR
0922   14474  170402          RET
0923   14475  061217  GUNT    JSM  FETCH     EVALUATE FORMULA
0924   14476  160225          JSM  FLTRA,I   CONVERT TO INTEGER
0925   14477  164342  UOVF    JMP  E40+3,I
0926   14500  075752          SBM  *-1
0927   14501  074117          LDA  B         SAVE UNIT IN A REG
0928   14502  004142          ADB  M11       UNIT<11 ?
0929   14503  075613          SBP  UOVF
0930   14504  070204          SAL  12        POSITION UNIT NO.
0931   14505  072110          RZA  *+2
0932   14506  066477          JMP  UOVF
0933   14507  066473          JMP  F5+1
0934*
0935*
0936*  FILE NO. CONFIGURATION
0937*
0938*
0939   14510  061217  FILEC   JSM  FETCH     EVALUATE FORMULA
0940   14511  160225          JSM  FLTRA,I   CONVERT TO INTEGER
0941   14512  066514          JMP  *+2
0942   14513  074153          SBP  *+3       RET ON POSITIVE
0943   14514  160205  ERR1    JSM  AERRA,I   WRONG FILE NO.
0944   14515  177710          DEC  -56
0945   14516  074117          LDA  B
0946   14517  170402          RET            WITH FILE NO IN A REG
0947*
0948*
0949*  FINDE — FIND EXECUTION
0950*
0951*
0952   14520  062457  FINDE   JSM  UNITC     GET UNIT NO.
0953   14521  070542          SAR  12        POSITUON UNIT
0954   14522  062554          JSM  FITAS
0955   14523  000012          ADA  .1        FIG. TABLE ADDR OF SERV SUBR
0956   14524  027744          LDB  CASIN     CASST INTRPT SUBRT ADDR
```

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```
0957  14525  070577          STB  A,I
0958  14526  062510          JSM  FILEC     GET FILE
0959  14527  031644          STA  TFILE
0960  14530  063106  FIND3   JSM  RIFS
0961*
0962*
0963*
0964  14531  025664  DIREC   LDB  FILEN     FILE NO.; FROM ID BUFF
0965  14532  074076          TCB            MAKE FILE NO READ NEG.
0966  14533  005644          ADB  TFILE     FILE WANTED
0967  14534  004132          ADB  M1        SUBTR, ONE TO STOP FRONT OF
                                                          CERRECT
0968  14535  062552          JSM  FITA3
0969  14536  070577          STB  A,I       STORE FILE DIFF IN STATUS
0970  14537  076210          RZB  DI3
0971  14540  063031          JSM  HALT      FILE LOCATED
0972  14541  173741  DI2     CLF  1         TURN ON INTERPT
0973  14542  164172          JMP  XEC4A,I       BACK TO SYSTEM
0974  14543  074212  DI3     SBM  *+4
0975  14544  023747          LDA  RCFF      READ CONTRL FORW FASR←T
0976  14545  063033          JSM  COUTP+1
0977  14546  066541          JMP  DI2
0978  14547  023750          LDA  RCRF      READ CONTRL REV FAST
0979  14550  063033          JSM  COUTP+1
0980  14551  066541          JMP  DI2
0981*
0982*    FITAS — FIG. INTRPT TABLE ADDR FOR STATUS
0983*
0984  14552  021645  FITA3   LDA  TUNIT
0985  14553  070542          SAR  12
0986  14554  000132  FITAS   ADA  M1
0987  14555  070744          SAL  1
0988  14556  003743          ADA  ITBAS     INTRPT TABLE BASE
0989  14557  170402          RET
0990*
0991*
0992*    ISERV — INTERRUPT SERVICE SUBR
0993*
0994*
0995  14560  031444  ISERV   STA  SAVEA
0996  14561  035445          STB  SAVEB
0997  14562  172700          SFC  0
0998  14563  066611          JMP  IS2       MUST BE STOP
0999  14564  172241          LIA  1         INPUT INTERPT ADDRESSES
1000  14565  070504          SAL  6
1001  14566  070242          SAR  6         CLEAR 6 MSB
1002  14567  072410          RZA  ISE4
1003  14570  023736          LDA  KEYBD
1004  14571  172160          OTA  16
1005  14572  172741          STF  1
1006  14573  172240          LIA  0
1007  14574  070342          SAR  8
1008  14575  031443          STA  KEYFG
1009  14576  066651          JMP  RESTR
1010  14577  074742  ISE4    SBR  16
1011  14600  035446          STB  IADDR     TEMPR INTRPT ADDR
1012  14601  070006          RAR  1         POSITION NEXT H.P. BIT
```

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```
1013  14602  045446          ISZ  IADDR     INCRM COUNT
1014  14603  071713          SAP  *-2       CONTINUE
1015  14604  021446          LDA  IADDR
1016  14605  062554          JSM  FITAS
1017  14606  000012          ADA  .1        FIG. TABLE ADDR OF SERV SUBR
1018  14607  070537          LDB  A,I
1019  14610  074737          JMP  B,I       GO TO SERVICE SUBR
1020  14611  020040  IS2     LDA  .31
1021  14612  031442          STA  STPFL
1022  14613  020104          LDA  B177
1023  14614  031443          STA  KEYFG
1024  14615  021444  IS3     LDA  SAVEA
1025  14616  025445          LDB  SAVEB
1026  14617  170402          RET
1027*
1028*
1029*   IST0 — STATUS OF FIND COMMAND
1030*
1031*
1032*      POSITIVE FILE DIFF FOR FORW AND NEG FOR REV DIRECTION
1033*
1034*
1035  14620  021446  IST0    LDA  IADDR
1036  14621  070204          SAL  12          FIGURE SELECT CODE
1037  14622  063003          JSM  STAT+2      GET STATUS
1038  14623  063007          JSM  STACK       STATUS CHECK
1039  14624  021446          LDA  IADDR
1040  14625  062554          JSM  FITAS
1041  14626  070537          LDB  A,I         LOAD FILE STATUS
1042  14627  074152          SBM  *+3
1043  14630  004132          ADB  M1        ADD -1 FOR FORW DIRECTIN
1044  14631  066633          JMP  IST1
1045  14632  004012          ADB  .1        ADD +1 FOR REV DIRECTION
1046  14633  070577  IST1    STB  A,I         RESTORE UPDATED STATUS
1047  14634  076110          RZB  *+2
1048  14635  067020          JMP  INSTP         FILE LOCATED
1049  14636  021446          LDA  IADDR
1050  14637  070204          SAL  12          FIG. SELECT, CODE
1051  14640  074252          SBM  *+5
1052  14641  043747          IOR  RCFF        READ-CONTROL-FORW-FAST
1053  14642  063034          JSM  COUTP+2
1054  14643  172741          STF  1
1055  14644  066650          JMP  COINT       COMMAND OUTPUT , INTRPT TURN
                                                                      ON
1056  14645  043750          IOR  RCRF        READ-CONTROL-REV-FAST
1057  14646  063034          JSM  COUTP+2
1058  14647  172741          STF  1           CLEAR CONTROL
1059*
1060*
1061*
1062*
1063*
1064  14650  063034  COINT   JSM  COUTP+2
1065*
1066*
1067*          RESTORE REGISTERS
1068*
```

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```
1069*
1070   14651  062615  RESTR   JSM  IS3
1071   14652  173741          CLF  1
1072   14653  170402          RET
1073*
1074*
1075*   BASIC DATA WRITER
1076*
1077*
1078   14654  031653  TWR     STA  TAP4   STORE LOW ADDRESS LIMIT
1079   14655  035654          STB  TAP5   STORE THE HIGH LIMIT
1080   14656  021645  TWR1    LDA  TUNIT  UNIT NO.
1081   14657  040116          IOR  WDFS   WRITE DATA FORW SLOW
1082   14660  070075          SEC  *+1,C  CLEAR E
1083   14661  074742  TWR4    SBR  16
1084   14662  035655          STB  TAP6   CLEAR CHECK:SUM REG
1085   14663  025653          LDB  TAP4   LOAD INITIAL POINTER VALUE
1086   14664  172501          SFS  1
1087   14665  066664          JMP  *-1
1088   14666  172141          OTA  1
1089   14667  121653          LDA  TAP4,I
1090   14670  066674          JMP  NWL2
1091   14671  074517  NWL     LDA  B,I    LOAD A TRANSFER WORD
1092   14672  172501  NWL1    SFS  1      SKIP IF READY
1093   14673  066672          JMP  *-1
1094   14674  172140  NWL2    OTA  0      WRITE 8 BITS
1095   14675  073655          SEC  NWL1,S WRITE 8 MORE BITS IF E=0
1096   14676  001655          ADA  TAP6   UPDATE CHECK-SUM
1097   14677  031655          STA  TAP6
1098   14700  070075          SEC  *+1,C  CLEAR E
1099   14701  015654          CPB  TAP5   AREA TRANSFERRED?
1100   14702  066705          JMP  COUT   YES, OUTPUT CHECK-SUM
1101   14703  077330          RIB  NWL    WRITE MORE
1102   14704  066671          JMP  NWL    JUMP IF B=0
1103   14705  021655  COUT    LDA  TAP6   LOAD CHECK-SUM
1104   14706  172501          SFS  1
1105   14707  066706          JMP  *-1
1106   14710  172140          OTA  0      OUTPUT 8 BITS
1107   14711  073655          SEC  *-3,S
1108   14712  025442          LDB  STOP
1109   14713  074150          SZB  *+3
1110   14714  063031          JSM  HALT
1111   14715  067016          JMP  ERR3   IMPROPER  STOP
1112   14716  170402          RET
1113*
1114*
1115*   BASIC DATA READER
1116*
1117*
1118   14717  031653  TRD     STA  TAP4   STORE START OF BUFFER AREA
1119   14720  035654          STB  TAP5   STORE THE HIGH LIMIT
1120   14721  021645  TRD1    LDA  TUNIT  UNIT NO.
1121   14722  172141          OTA  1        READ DATA FORW SLOW
1122   14723  172601          STC  1      ENABLE CASST
1123   14724  070742          SAR  16
1124   14725  031655          STA  TAP6   CLEAR CHECK SUM REG
```

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```
1125  14726  021653          LDA  TAP4    LOAD INITIAL POINTER VALUE
1126  14727  070075  TRL     SEC  *+1,C   CLEAR ERROR FLAG
1127  14730  172501          SFS  1       SKIP IF DONE
1128  14731  066730          JMP  *-1
1129  14732  176240          LIB  0       INPUT 8 BITS
1130  14733  073655          SEC  *-3,S   GET NEXT 8 BBITS
1131  14734  011654          CPA  TAP5    AREA TRANSFERED?
1132  14735  066742          JMP  CHCK    YES, RETURN AFTER CHECKING
                                                              RESULT
1133  14736  070577          STB  A,I     STORE THE READ WORD
1134  14737  005655          ADB  TAP6    UPDATE CHECK SUM WORD
1135  14740  035655          STB  TAP6
1136  14741  073330          RIA  TRL     READ MORE
1137  14742  015655  CHCK    CPB  TAP6    CHECK-SUM OK?
1138  14743  070075          SEC  *+1,C   CLEAR ERROR FLAG
1139  14744  172741          STF  1       TURN OFF CEO
1140  14745  170402          RET
1141*
1142*
1143*   WRFIL—WRITE A FILE
1144*   THE FILE HAS BEEN LOCATED
1145*   BACK UP AND WRITE NEW ID AND FILE
1146*
1147  14746  063610  WRFIL   JSM  RRBOF
1148  14747  062776          JSM  CSTOP
1149  14750  020121  WRF3    LDA  RCFS    READ CONTROL FORW SLOW
1150  14751  063037          JSM  BOFCK
1151  14752  017740          CPB  MARK
1152  14753  066755          JMP  *+2
1153  14754  066750          JMP  WRF3    KEEP LOOKING
1154  14755  062656          JSM  TWR1     WRITE ID
1155  14756  021650          LDA  TAP2    START ADDR
1156  14757  025660          LDB  TAP7    END ADDR
1157  14760  004132          ADB  M1     ADJUST COUNTER FOR WRITE ROUTINE
1158  14761  062654          JSM  TWR     WRITE FILE BODY
1159  14762  172501          SFS  1
1160  14763  066762          JMP  *-1     WAIT
1161  14764  067031          JMP  HALT
1162*
1163*
1164*   STATE—GET STATUS
1165*
1166*
1167  14765  063001  STATE   JSM  STAT
1168  14766  074406          RBR  9       POSITION POWER ON BIT
1169  14767  074153          SBP  STAT5     CAST NOT ON OR NOT PRESENT
1170  14770  074046          RBR  2         POSITION CLR+OPEN DOOR BITS
1171  14771  074111          SLB  *+2
1172  14772  067014  STAT5   JMP  STAC3
1173  14773  074112          SBM  *+2
1174  14774  066776          JMP  *+2
1175  14775  064357          JMP  RETN2   CLEAR LEADER
1176  14776  025442  CSTOP   LDB  STOP    CHECK STOP
1177  14777  074350          SZB  STAT4
1178  15000  067606          JMP  GBACK   STOP CASST+GO BACK TO SYSTM
1179*
1180*
```

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```
1181*
1182   15001  021645  STAT    LDA  TUNIT
1183   15002  172741          STF  1          TURN OFF INTERPT
1184   15003  172141          OTA  1          LOAD I/O REG WITH SELECT CODE
1185   15004  172741          STF  1          LOAD I/O REG WITH STATUS
1186   15005  176241          LIB  1          INPUT STATUS INFO
1187   15006  170402  STAT4   RET
1188*
1189*
1190*   STACK — STATUS CHECK
1191*
1192*
1193   15007  074506  STACK   RBR  11         POSITION CLEAR LEADER + OPEN
                                                        DOOR BITS
1194   15010  074112          SBM  *+2        CHECK CLEAR LEADER
1195   15011  075651          SLB  STAT4          CHECK OPEN DOOR
1196   15012  063020          JSM  INSTP
1197   15013  067016          JMP  ERR3
1198   15014  063031  STAC3   JSM  HALT           STOP CASST
1199   15015  173741          CLF  1          TURN ON INTERPT
1200   15016  160205  ERR3    JSM  AERRA,I
1201   15017  177706          DEC  -58
1202*
1203*
1204*       INSTP — STOP FROM INTRPT ROUTINE
1205*
1206*
1207   15020  021446  INSTP    LDA  IADDR
1208   15021  070204          SAL  12         FIG. SEL CODE
1209   15022  040117          IOR  STOPC
1210   15023  063034          JSM  COUTP+2
1211   15024  066651          JMP  RESTR
1212*
1213*
1214*   WPERM — IS WRITE PERMITTED?
1215*
1216*
1217   15025  063001  WPERM   JSM  STAT
1218   15026  074504          SBL  6          POSITION WRITE PERMIT
1219   15027  074353          SBP  COUT1
1220   15030  067014          JMP  STAC3          NOT PERMITTED
1221*
1222*
1223*           HALT SUBR
1224*
1225*
1226   15031  020117  HALT    LDA  STOPC          CONSTANT
1227*
1228*
1229*   COMMAND OUTPUT
1230*
1231*   ENTRY: COMMAND CONSTANT IN A REG.
1232*
1233*
1234   15032  172741  COUTP   STF  1          TURN OFF INTERPT
1235   15033  041645          IOR  TUNIT
1236   15034  172141          OTA  1          OUTPUT COMMAND
```

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```
1237  15035  172601          STC  1          ENABLE CAST
1238  15036  170402  COUT1   RET
1239*
1240*
1241*    BOFCK — CHECK FOR BOF
1242*
1243*
1244  15037  063032  BOFCK   JSM  COUTP
1245  15040  172501          SFS  1
1246  15041  067046          JMP  BSTP
1247  15042  176241          LIB  1          INPUT CONTRL CHAR
1248  15043  074404          SBL  8
1249  15044  074342          SBR  8          CLEAR 8 MSB
1250  15045  170402          RET
1251  15046  025442  BSTP    LDB  STOP
1252  15047  075450          SZB  BOFCK+1        WAIT FOR BOF
1253  15050  067606          JMP  GBACK          STOP CASST + GO BACK TO
                                                                  SYSTEM
1254*
1255*
1256*    RIFID — READ IMMDT FILE ID
1257*
1258*
1259  15051  063031  RIFID   JSM  HALT
1260  15052  062765          JSM  STATE
1261  15053  067055          JMP  *+2
1262  15054  063656          JSM  OFFCL          GET OFF CLR LDR
1263  15055  020133  RIFI5   LDA  M2
1264  15056  031643          STA  TAP0
1265  15057  023751          LDA  IDBA          ID BUFF ADDR
1266  15060  031653          STA  TAP4
1267  15061  023753          LDA  EOBID          END OF BUFF FOR ID
1268  15062  031654          STA  TAP5
1269  15063  062776  RIF4    JSM  CSTOP
1270  15064  020121          LDA  RCFS          READ CONTRL FORW SLOW
1271  15065  063037          JSM  BOFCK
1272  15066  017740          CPB  MARK          BOF?
1273  15067  067073          JMP  RD1           READ ID
1274  15070  062765          JSM  STATE
1275  15071  067063          JMP  RIF4
1276  15072  170402          RET               CLEAR LEADER
1277  15073  062721  RD1     JSM  TRD1              READ FILE ID
1278  15074  070114          SES  *+2           ERROR?
1279  15075  064357          JMP  RETN2          NO
1280  15076  045643          ISZ  TAP0
1281  15077  067103          JMP  RIF6
1282  15100  063031  ERR4    JSM  HALT
1283  15101  160205          JSM  AERRA,I        CHECK SUM ERROR
1284  15102  177705          DEC  -59
1285  15103  063610  RIF6    JSM  RRBOF
1286  15104  067057          JMP  RIFI5+2        TRY AGAIN
1287*
1288*
1289*
1290  15105  063610  RRRID   JSM  RRBOF         REV READ BOF
1291  15106  063051  RIFS    JSM  RIFID          READ IMMDT FILE ID
1292  15107  067016          JMP  ERR3          CLR LDR
```

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```
1293   15110  170402            RET
1294*
1295*
1296*
1297*   LOCF — LOCATE A FILE
1298*
1299   15111  045472  LOCF      ISZ  TEMPS
1300   15112  121472            LDA  TEMPS,I
1301   15113  050065            AND  OPMSK
1302   15114  013742            CPA  NUMS       IS IT ≠ ?
1303   15115  067120            JMP  *+3
1304   15116  062472            JSM  F5         ASSUME INTERNAL
1305   15117  067121            JMP  *+2
1306   15120  062475            JSM  GUNT       GET UNIT NO.
1307   15121  062510            JSM  FILEC      GET FILE
1308   15122  031644            STA  TFILE
1309   15123  063106  LOCF2     JSM  RIFS
1310   15124  020133            LDA  M2
1311   15125  031647            STA  TAP1       FLAG FOR FILE LOCATION
1312   15126  025664  LOCF1     LDB  FILEN      FILE NO. FROM ID BUFF
1313   15127  015644            CPB  TFILE
1314   15130  067031  LOCF3     JMP  HALT        FILE LOCATED, RET
1315   15131  074076            TCB             MAKE FIL NO. READ NEG.
1316   15132  005644            ADB  TFILE        FILE WANTED
1317   15133  004132            ADB  M1
1318   15134  035653            STB  TAP4        SAVE DIFF
1319   15135  076110            RZB  *+2
1320   15136  067162            JMP  FVERF       FILE LOCATED
1321   15137  074153            SBP  *+3
1322   15140  023750            LDA  RCRF        READ CONTRL REV FAST
1323   15141  067145            JMP  GDIR-1
1324   15142  074076            TCB              MAKE DIFF NEG.
1325   15143  035653            STB  TAP4
1326   15144  023747            LDA  RCFF        READ CONTRL FORW FAST
1327   15145  031654            STA  TAP5
1328   15146  021654  GDIR      LDA  TAP5
1329   15147  062776            JSM  CSTOP
1330   15150  063037            JSM  BOFCK
1331   15151  017740            CPB  MARK
1332   15152  067156            JMP  GDIR2
1333   15153  062765            JSM  STATE
1334   15154  067146            JMP  GDIR       LOK←OK FOR BOF
1335   15155  067016            JMP  ERR3       CLR LDR
1336   15156  045653  GDIR2     ISZ  TAP4
1337   15157  067146            JMP  GDIR        CONTINUE LOOKING
1338   15160  020160            LDA  DEL2           15.6 MS DELAY
1339   15161  072030            RIA  *
1340*
1341*
1342*
1343   15162  063106  FVERF     JSM  RIFS        READ IMMDT FILE ID
1344   15163  021644            LDA  TFILE
1345   15164  011664            CPA  IDB0
1346   15165  067031            JMP  HALT        FILE LOCATED, T←RETURN
1347   15166  045647            ISZ  TAP1
1348   15167  067126            JMP  LOCF1       TRY AGAIN
```

```
1349   15170  063031          JSM  HALT
1350   15171  066514          JMP  ERR1        FILE NOT FOUND
1351*
1352*
1353*   LDATA— LOAD DATA EXECUTION
1354*
1355*
1356   15172  063111  LDATA   JSM  LOCF
1357   15173  063256          JSM  ARYLS
1358   15174  025652          LDB  TAP3        TEMPR, PRECISION
1359   15175  015670          CPB  IDB0+4
1360   15176  067201          JMP  *+3         PRECISION OK
1361   15177  160205  ERR6    JSM  AERRA,I      WORNG PRECISION
1362   15200  177703          DEC  -61
1363   15201  070056          CMA
1364   15202  001665          ADA  IDB0+1       CHECK SIZE
1365   15203  070112          SAM  *+2
1366   15204  067242          JMP  ERR5
1367   15205  063105          JSM  RRRID       REV READ BOF; READ IMMDT FILE
                                                                        ID
1368   15206  021650          LDA  TAP2        POINT TOSTART OF LOAD AREA
1369   15207  025665          LDB  IDB0+1      FILE SIZE
1370   15210  070037          ADB  A            POINT TO END OF LOAD AREA
1371   15211  062717          JSM  TRD         READ THE FILE
1372   15212  063031          JSM  HALT
1373   15213  070115          SEC  *+2
1374   15214  067100          JMP  ERR4        CHECK SUM ERROR
1375   15215  067654          JMP  SYSRE        SYSTEM RET
1376*
1377*
1378*          SDATA — STORE DATA
1379*
1380*
1381   15216  063252  SDATA   JSM  ISTOR
1382   15217  063256          JSM  ARYLS
1383   15220  025650          LDB  TAP2        TEMPOR, ARRAY START ADDR
1384   15221  070037          ADB  A           COMPUTE END ADDR
1385   15222  021652          LDA  TAP3         TEMPOR, PRECISION
1386   15223  031670          STA  IDB0+4       STORE IN ID TABLE
1387   15224  035660          STB  TAP7        TEMPOR, END ADDR
1388   15225  021650          LDA  TAP2
1389   15226  063237          JSM  SDAT2
1390*
1391*
1392*
1393   15227  020017  SDAT3   LDA  .2          TYPE = DATA
1394   15230  031666          STA  IDB0+2        IN FILE ID BUFF
1395   15231  023751          LDA  IDBA         POINT TO BEG. OF ID
1396   15232  031653          STA  TAP4
1397   15233  023754          LDA  EBIDW         POINT TO END OF ID
1398   15234  031654          STA  TAP5
1399   15235  062746          JSM  WRFIL       ERITE THE FILE
1400   15236  067654          JMP  SYSRE        SYSTEM RET
1401*
1402*        ENTER: AREG=START ADDR, BREG=END ADDR
1403*
1404   15237  070076  SDAT2   TCA
```

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```
1405  15240  070037          ADB  A        FIND FILE FIZE NEEDED
1406  15241  076150          RZB  *+3      SKIP IF NON-ZERO
1407  15242  160205  ERR5    JSM  AERRA,I  WRONG FILE SIZE
1408  15243  177704          DEC  -60
1409  15244  075712          SBM  *-2      ERROR IF NEG
1410  15245  035665          STB  IDB0+1
1411  15246  074076          TCB
1412  15247  005667          ADB  IDB0+3     ABS FILE SIZE ON TAPE
1413  15250  075512          SBM  ERR5     SIZE ERROR
1414  15251  170402          RET
1415*
1416*
1417*     ISTOR — INITLZ FOR STORE
1418*
1419*
1420  15252  063111  ISTOR    JSM  LOCF
1421  15253  063025          JSM  WPERM
1422  15254  023752          LDA  IDB4A
1423  15255  067647          JMP  RE3-1    CLEAR 4 CENTER WORDS + RET
1424*
1425*
1426*ARYLS — DATA ARRAY CALCULATIONS
1427*
1428*
1429  15256  021472  ARYLS    LDA  TEMPS
1430  15257  011421          CPA  PRADD    END OF STMT?
1431  15260  067302          JMP  ARCOM    YES, MUST BE COMMON
1432  15261  060771          JSM  GTOPP    NO, GET ARRAY NAME
1433  15262  160177          JSM  SSYMA,I  SEARCH SYMBOL TABLE
1434  15263  164340          JMP  E40+1,I    NOT FOUND
1435  15264  074517          LDA  B,I      READ NAME AND TYPE
1436  15265  031661          STA  TAP8     TEMPR
1437  15266  050040          AND  B37
1438  15267  070042          SAR  2
1439  15270  031652          STA  TAP3     TEMPR, PRECISION
1440  15271  004132          ADB  M1
1441  15272  074517          LDA  B,I      GET ARRAY ADDR
1442  15273  031650          STA  TAP2
1443  15274  000132          ADA  M1
1444  15275  070537          LDB  A,I      READ CURR DIMENSION
1445  15276  021661          LDA  TAP8
1446  15277  160240          JSM  MDIMA,I  COMPUTE THE SIZE
1447  15300  000133          ADA  M2
1448  15301  170402          RET
1449  15302  020020  ARCOM    LDA  .3
1450  15303  031652          STA  TAP3     SET COMMON TYPE
1451  15304  021405          LDA  FWUP
1452  15305  031650          STA  TAP2     SET START ADDR
1453  15306  070076          TCA
1454  15307  025422          LDB  UKPTR
1455  15310  074150          SZB  *+3      KEY?
1456  15311  001425          ADA  PBUFO    YES
1457  15312  170402          RET
1458  15313  001424          ADA  PBUFF    COMPUTE SIZE OF COMMON
1459  15314  170402          RET
1460*
```

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```
1461*
1462*   LKEY — LOAD KEYS
1463*
1464*
1465   15315  063111  LKEY    JSM  LOCF
1466   15316  025421         LDB  PRADD
1467   15317  163756         JSM  DCM1A,I      DECOMPILE
1468   15320  021666         LDA  IDB0+2       FILE TYPE
1469   15321  010021         CPA  .4           KEY?
1470   15322  067331         JMP  *+7
1471   15323  013741         CPA  .24            SEC KEY ?
1472   15324  067327         JMP  *+3
1473   15325  160205  ERR7   JSM  AERRA,I      TYPE ERROR
1474   15326  177702         DEC  -62
1475   15327  024106         LDB  B777
1476   15330  035435         STB  SECFL        SET SEC FLAG
1477   15331  021416         LDA  MODE
1478   15332  072350         RZA  LKEY4        CALC MODE?
1479   15333  021427         LDA  .LNUM        NO
1480   15334  070070         SIA  *+1
1481   15335  031661         STA  TAP8          SAVE CURRENT LINE #+1
1482   15336  021422         LDA  UKPTR
1483   15337  070110         SZA  *+2          KEY MODE
1484   15340  066147         JMP  ERR8         YES, OVEPLAY ERROR
1485   15341  061225  LKEY4  JSM  LDEF         INSURE NOT IN KEY MODE
1486   15342  021405         LDA  FWUP
1487   15343  070076         TCA
1488   15344  000166         ADA  FWAM         COMPUTE — CURR KEY SIZE
1489   15345  001665         ADA  IDB0+1       COMPUTE DIFFERENCE (NEW—OLD)
1490   15346  072110         RZA  *+2
1491   15347  067371         JMP  LKEY9
1492   15350  070412         SAM  LKEY5        NEW KEYS LARGER?
1493   15351  160250         JSM  OVCHA,I        YES CHECK FOR OVERFLOW
1494   15352  021405         LDA  FWUP
1495   15353  031476         STA  TEMP3        SET PROGRAM RELOCATION POINTER
1496   15354  035470         STB  L2T1
1497   15355  061121         JSM  MVTOH        MOVE MAINLINE AND COMMON
1498   15356  025470         LDB  L2T1
1499   15357  067364         JMP  LKEY6
1500   15360  001405  LKEY5  ADA  FWUP
1501   15361  031477         STA  TEMP4        COMPUTE NEW END OF KEYS
1502   15362  025405         LDB  FWUP
1503   15363  160251         JSM  CLP1A,I      CLOSE UP PROGRAM
1504   15364  021424  LKEY6  LDA  PBUFF
1505   15365  074017         ADA  B
1506   15366  031424         STA  PBUFF        UPDATE START OF MAINLINE
1507   15367  005405         ADB  FWUP
1508   15370  035405         STB  FWUP           UPDATE END OF KEY AREA
1509   15371  063105  LKEY9  JSM  RRRID        REV READ BOF; READ IMMDT FIELD
1510   15372  020166         LDA  FWAM         START OF KEY AREA
1511   15373  025665         LDB  IDB0+1       FILE SIZE
1512   15374  070037         ADB  A            END OF KEY AREA
1513   15375  062717         JSM  TRD          READ THE FILE
1514   15376  063031         JSM  HALT
1515   15377  070115         SEC  *+2
1516   15400  067100         JMP  ERR4         CHECK SUM ERROR
```

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```
1517  15401  060651          JSM  INITS      RESET STACKS
1518  15402  066062          JMP  LOAD9
1519*
1520*
1521*   SKEY — STORE KEYS
1522*
1523*
1524  15403  063252  SKEY    JSM  ISTOR
1525  15404  025421          LDB  PRADD
1526  15405  163756          JSM  DCM1A,I
1527  15406  063463          JSM  SECCK
1528  15407  024021          LDB  .4         UNSEC KEY
1529  15410  070113          SAP  *+2
1530  15411  027741          LDB  .24         SEC KEY
1531  15412  035666          STB  IDB0+2     INFILE ID BUFF
1532  15413  020166          LDA  FWAM       START OF KEY AREA
1533  15414  031650          STA  TAP2       TEMPOR
1534  15415  025405          LDB  FWUP       END OF KEY AREA+1
1535  15416  035660          STB  TAP7       END OF KEY AREA
1536  15417  063237          JSM  SDAT2
1537  15420  067231          JMP  SDAT3+2
1538*
1539*
1540*     LBIN — LOAD BINARY
1541*
1542*
1543  15421  063111  LBIN    JSM  LOCF
1544  15422  021403          LDA  MAW        POINTER
1545  15423  025665          LDB  IDB0+1     FILE SIZE
1546  15424  074076          TCB
1547  15425  074017          ADA  B          FIG. MEMORY START ADDR
1548  15426  070137          LDB  A        SAVE A
1549  15427  070076          TCA
1550  15430  001426          ADA  PBPTO      POINTER
1551  15431  070112          SAM  *+2
1552  15432  064561          JMP  MER8       OVERFLOW
1553  15433  021666          LDA  IDB0+2     FILE TYPE
1554  15434  010012          CPA  .1         BINARY?
1555  15435  067443          JMP  LB12        YES , UNSEC
1556  15436  012034          CPA  .21         SEC BIN ?
1557  15437  067441          JMP  *+2
1558  15440  067325          JMP  ERR7
1559  15441  020106          LDA  B777
1560  15442  031435          STA  SECFL      SET SEC FLAG
1561  15443  021427  LBI2    LDA  .LNUM       PRESENT L.N.
1562  15444  070070          SIA  *+1
1563  15445  031661          STA  TAP8
1564  15446  076070          RIB  *+1
1565  15447  035404          STB  LWAM         POINTER
1566  15450  063105          JSM  RRRID      REV READ BOF; READ IMMDT FILE
                                                                      ID
1567  15451  021404          LDA  LWAM
1568  15452  025665          LDB  IDB0+1     FILE SIZE
1569  15453  070037          ADB  A          END OF BIN
1570  15454  062717          JSM  TRD        READ THE FILE
1571  15455  063031          JSM  HALT
1572  15456  070115          SEC  *+2
```

```
1573   15457  067100          JMP  ERR4      CHECK SUM ERROR
1574   15460  055404          DSZ  LWAM
1575   15461  060645          JSM  MINIT     SCRATCH SYMBOL TABLE
1576   15462  066062          JMP  LOAD9
1577*
1578*
1579*       SECCK — SECURE CHECK
1580*
1581*
1582   15463  021435  SECCK   LDA  SECFL
1583   15464  050106          AND  B777
1584   15465  070150          SZA  *+3
1585   15466  160205          JSM  AERRA,I       SEC NOT ALLOWED
1586   15467  177707          DEC  -57
1587   15470  021435          LDA  SECFL     RET WITH SEC FLG IN A
1588   15471  170402          RET
1589*
1590*
1591*       WRZE — WRITE ZEROS
1592*
1593*
1594   15472  024013  WRZE    LDB  B400
1595   15473  074744          SBL  1         CONVERT WORD COUNT TO CH. COUNT
1596   15474  074076          TCB            NEG. COUNT
1597   15475  021645          LDA  TUNIT
1598   15476  040116          IOR  WDFS       WRITE DATA FORW SLOW
1599   15477  172501          SFS  1
1600   15500  067477          JMP  *-1
1601   15501  172141          OTA  1
1602   15502  070742  WRZE1   SAR  16
1603   15503  172501          SFS  1
1604   15504  067503          JMP  *-1
1605   15505  172140          OTA  0
1606   15506  077630          PIB  WRZE1
1607   15507  170402          RET
1608*
1609*
1610*    MARKE — MARK TAPE EXECUTION
1611*
1612*
1613   15510  062457  MARKE   JSM  UNITC      GET UNIT NO.
1614   15511  063025          JSM  WPERM
1615   15512  062765          JSM  STATE     GET STATUS
1616   15513  067631          JMP  MAR3       NO CLEAR LEADER
1617   15514  063524          JSM  MAR4
1618   15515  063656  MAR2    JSM  OFFCL     GET OFF CLEAR LEADER
1619   15516  020116          LDA  WDFS      WRITE — DATA — FORW — SLOW
1620   15517  063032          JSM  COUTP     COMMAND OUTPUT
1621   15520  063472          JSM  WRZE       WRITE 256 WORDS OF 0
1622   15521  172501          SFS  1
1623   15522  067521          JMP  *-1       STILL WRITING
1624   15523  067547          JMP  MCONT
1625*
1626*
1627*
1628   15524  062510  MAR4    JSM  FILEC     GET NO. OF FILES TO BE MARKED
```

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```
1629  15525  000012          ADA  .1          WRITE N+1 FILES
1630  15526  070076          TCA               MAKE FILE COUNT NEG.
1631  15527  031644          STA  TFILE
1632  15530  062510          JSM  FILEC        GET LENGTH OF FILE
1633  15531  031653          STA  TAP4         ABS SIZE
1634  15532  070137          LDB  A
1635  15533  074002          SBR  1            FIND    LENGTH/2
1636  15534  000135          ADA  M4
1637  15535  070113          SAP  *+2
1638  15536  066514          JMP  ERR1         FILE TOO SMALL
1639  15537  021653          LDA  TAP4
1640  15540  074017          ADA  B
1641  15541  000045          ADA  .40            40 WORDS ADDITIONAL BUFF
1642  15542  031657          STA  TLENG        LENGTH TEMPOR
1643  15543  063644          JSM  IDCLR
1644  15544  021653          LDA  TAP4          ABS SIZE
1645  15545  031667          STA  IDB0+3
1646  15546  170402          RET
1647*
1648*
1649*
1650  15547  023730  MCONT   LDA  WCFS         WRITE—CONTROL—FORW—SLOW
1651  15550  041645          IOR  TUNIT
1652  15551  172141          OTA  1
1653  15552  172601          STC  1            ENABLE CASRT
1654  15553  023751  MCON2   LDA  IDBA          POINTER TO BEGIN OF ID
1655  15554  027754          LDB  EBIDW         POINT TO END OF ID
1656  15555  062654          JSM  TWR          WRITE THE FILE ID
1657  15556  025657          LDB  TLENG        LOAD ACTUAL FILE LENGTH
1658  15557  063473          JSM  WRZE+1         WRITE THE FILE
1659  15560  172501          SFS  1
1660  15561  067560          JMP  *-1           WAIT , IF STILL WRITING
1661  15562  172741          STF  1
1662  15563  172241          LIA  1             INPUT STATUS
1663  15564  050122          AND  B6K           ISOLATE OPEN DOOR+CLR LLR
1664  15565  070610          SZA  MC2           SKIP IF OK
1665  15566  070506          RAR  11            POSITION STATUS BITS
1666  15567  070151          SLA  *+3
1667  15570  063031  ER3     JSM  HALT
1668  15571  067016          JMP  ERR3
1669  15572  020107  MC3     LDA  RDRS         READ DAR←TA REV SLOW
1670  15573  063657          JSM  OFFCL+1        GET OFF CLEAR LEADER-EOT
1671  15574  063610          JSM  RRBOF
1672  15575  063472          JSM  WRZE          ERASE LAST BOF
1673  15576  172501          SFS  1
1674  15577  067576          JMP  *-1           WAIT IF STILL WRITING
1675  15600  063652          JSM  REWND+1      GIVE COMMAND AND RETURN TO
                                                                    SYSTEM
1676  15601  045664  MC2     ISZ  IDB0         INCRM FILE NO.
1677  15602  045644          ISZ  TFILE        INCRM FILE COUNTER
1678  15603  067547          JMP  MCONT        CONTINUE
1679  15604  024151          LDB  M32
1680  15605  063611          JSM  RRBOF+1        BYPASS 32 CH. + REV. READ BOF
1681  15606  063031  GBACK   JSM  HALT
1682  15607  067654          JMP  SYSRE          SYSTEM RET
1683*
1684*
```

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```
1685*   RRBOF — REVERS READ BOF
1686*
1687*
1688   15610  024146  RRBOF  LDB  M15
1689   15611  020107        LDA  RDRS      READ—DATA—REV—SLOW
1690   15612  063032        JSM  COUTP
1691   15613  172501        SFS  1
1692   15614  067613        JMP  *-1
1693   15615  172240        LIA  0
1694   15616  077670        RIB  *-3
1695   15617  023731        LDA  RCRS      READ—CONTRL—REV—SLOW
1696   15620  063037        JSM  BOFCK
1697   15621  017740        CPB  MARK      BOF?
1698   15622  067626        JMP  DEL65
1699   15623  062765        JSM  STATE     GET STATUS
1700   15624  067610        JMP  RRBOF     KEEP LOOKING
1701   15625  067016        JMP  ERR3      BOT — CLR LDR
1702   15626  023737  DEL65 LDA  DEL1          75 MS DELAY
1703   15627  072030        RIA  *
1704   15630  170402        RET
1705*
1706*
1707*
1708   15631  063106  MAR3  JSM  RIFS        READ IMMDT FILE ID
1709   15632  063610        JSM  RRBOF     REV. READ BOF
1710   15633  025664        LDB  IDB0      SAVE LAST FILE NO.
1711   15634  035643        STB  TAP0      TEMPOR
1712   15635  063524        JSM  MAR4
1713   15636  025643        LDB  TAP0
1714   15637  035664        STB  IDB0
1715   15640  020121        LDA  RCFS      READ CONTROL FORW SLOWW
1716   15641  063037        JSM  BOFCK
1717   15642  017740        CPB  MARK      BOF?
1718   15643  067553        JMP  MCON2       WRITE MORE FILES
1719*
1720*
1721*   IDCLR — CLEAR ID BUFF
1722*
1723*
1724   15644  023751  IDCLR LDA  IDBA
1725   15645  170000        CLR            CLEAR FILE NO. — ABS SIZE
1726   15646  000021        ADA  .4
1727   15647  170000        CLR          CLEAR STARTING LN + 3 WORDS
1728   15650  170402  RE3   RET
1729*
1730*
1731*   REWND — GIVE COMMAND AND RETURN TO SYSTEM
1732*
1733*
1734   15651  062457  REWND JSM  UNITC       GET UNIT NO.
1735   15652  020110        LDA  RDRF      READ—DATA—REV—FAST
1736   15653  063032        JSM  COUTP
1737   15654  173741  SYSRE CLF  1         TURN ON INTRPT
1738   15655  164172        JMP  XEC4A,I     RETURN TO SYSTEM
1739*
1740*
```

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```
1741*   OFFCL — GET OFF CLEAR LEADER
1742*
1743*
1744   15656  020003  OFFCL   LDA  RDFS     READ DATA FORW SLOW
1745   15657  024124          LDB  DLCNT    DELAY COUNT
1746   15660  035652          STB  TAP3      TEMPR
1747   15661  063032          JSM  COUTP     COMMAND OUTPUT
1748   15662  063001  OF1     JSM  STAT     GET STATUS
1749   15663  074544          SBL  5         POSITION CLEAR LEADER BIT
1750   15664  075213          SBP  RE3
1751   15665  045652          ISZ  TAP3      INCRM DELAY
1752   15666  067662          JMP  OF1       WAIT
1753   15667  067016          JMP  ERR3      MUST BE EOT
1754*
1755*
1756*   LISTE — TAPE LIST EXECUTION
1757*
1758*
1759   15670  062457  LISTE   JSM  UNITC
1760   15671  063106          JSM  RIFS
1761   15672  061344          JSM  CRLF1
1762   15673  063031  LI2     JSM  HALT
1763   15674  025664          LDB  IDB0
1764   15675  063720          JSM  PRIN      PRINT FILE NO.
1765   15676  025666          LDB  IDB0+2
1766   15677  063720          JSM  PRIN      FILE TYPE
1767   15700  025667          LDB  IDB0+3
1768   15701  063720          JSM  PRIN      RPINT ABS FILE SIZE
1769   15702  025665          LDB  IDB0+1
1770   15703  063720          JSM  PRIN      CUR SIZE
1771   15704  025670          LDB  IDB0+4
1772   15705  063720          JSM  PRIN      START LINE NO.
1773   15706  025671          LDB  IDB0+5
1774   15707  063720          JSM  PRIN      END LINE NO.
1775   15710  025672          LDB  IDB0+6
1776   15711  063720          JSM  PRIN      NO. OF WORDS IN COMON
1777   15712  061344          JSM  CRLF1
1778   15713  160170          JSM  CLERA,I
1779   15714  031453          STA  PRFLG       CL. FLAG FO CRLF
1780   15715  063055          JSM  RIFI5
1781   15716  067652          JMP  REWND+1     RET TO SYSTEM + REWIND
1782   15717  067673          JMP  LI2       CONTINUE LIST
1783   15720  035647  PRIN    STB  TAP1
1784   15721  160170          JSM  CLERA,I   CLEAR SINGLE LINE BUFF
1785   15722  025647          LDB  TAP1
1786   15723  045400          ISZ  BADDR
1787   15724  160210          JSM  OUTIA,I   MAKE ASCII AND STORE
1788   15725  020022          LDA  CCNT      CHARACTER COUNT
1789   15726  024212          LDB  .SLBF     POINT TO FIRST CHAR.
1790   15727  065337          JMP  NDWRT     PRINT
1791*
1792*
1793*
1794*
1795*
1796*
```

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```
1797*
1798*   DEFINITIONS
1799*
1800*
1801  00003          RDFS   EQU  C6        ZERO
1802  15730  006074  WCFS   OCT  6074
1803  15731  005000  RCRS   OCT  5000
1804  00110          RDRF   EQU  B1400
1805  00107          RDRS   EQU  B1000
1806  01657          TLENG  EQU  1657B
1807  00124          DLCNT  EQU  EXPOP     32000B
1808  15732  077040  DATOP  OCT  77040
1809  15733  077000  KEYOP  OCT  77000
1810  15734  077200  BINOP  OCT  77200
1811  15735  120000  B120K  OCT  120000
1812  15736  140000  KEYBD  OCT  140000
1813  00004          XECA   EQU  B10K
1814  00160          B176K  EQU  M1024
1815  15737  166272  DEL1   DEC  -4934
1816  00160          DEL2   EQU  M1024
1817  15740  000074  MARK   OCT  74
1818  15741  000030  .24    DEC  24
1819  00022          CCNT   EQU  .5
1820  15742  040000  NUMS   OCT  40000
1821  01645          TUNIT  EQU  1645B
1822  01644          TFILE  EQU  1644B
1823  01446          IADDR  EQU  ADRSS
1824  15743  040400  ITBAS  DEF  40400B
1825  01643          TAP0   EQU  1643B
1826  01647          TAP1   EQU  1647B
1827  01650          TAP2   EQU  1650B
1828  15744  014620  CASIN  DEF  IST0
1829  01664          FILEN  EQU  1664B
1830  01652          TAP3   EQU  1652B
1831  01653          TAP4   EQU  1653B
1832  01654          TAP5   EQU  1654B
1833  01655          TAP6   EQU  1655B
1834  01660          TAP7   EQU  1660B
1835  01661          TAP8   EQU  1661B
1836  15745  001660  TAPAD  DEF  1660B
1837  15746  011775  TCOM   OCT  11775
1838  01435          SECFL  EQU  SEC
1839  01663          OFSET  EQU  1663B
1840  15747  004400  RCFF   OCT  4400
1841  00121          RCFS   EQU  B4000
1842  15750  005400  RCRF   OCT  5400
1843  15751  001664  IDBA   DEF  1664B
1844  01664          IDB0   EQU  1664B
1845  15752  001670  IDB3A  DEF  1670B
1846  15753  001700  EOBID  DEF  1700B
1847  15754  001677  EBIDW  DEF  1677B     END OF ID BUFF FOR WRITE
1848  00116          WDFS   EQU  QTOP
1849  00013          RDFF   EQU  B400
1850  00245          GETSA  EQU  GTSTA
1851  01442          STOP   EQU  STPFL
1852  00117          STOPC  EQU  B2400
```

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```
1853   15755  016747  ERRØ     DEF  ERROR
1854   15756  005717  DCM1A    DEF  5717B
1855*
1856*   TABLE LINKS
1857*
1858   15762                   ORG  15762B
1859   15762  176462           ABS  LINK-*
1860   15763  176334           ABS  ASTOR-*
1861   15764  176534           ABS  FINDE-*
1862   15765  177703           ABS  LISTE-*
1863   15766  177663           ABS  REWND-*
1864   15767  177521           ABS  MARKE-*
1865   15770  176052           ABS  ALOAD-*
1866   15771  176417           ABS  MERGE-*
1867   15772  000000           BSS  1                  ******* CHECK SUM **********
1868   15773  176030           ABS  SUBT-*
1869   15774  162111           ABS  B377-*
1870   15775  176004           ABS  CMNDT-*
1871   15776  000630           ABS  SNMT-*
1872   15777  014000           OCT  14000
1873*
1874*
1875*       SYNTAX
1876*
1877   16615                   ORG  16615B
1878*   SYNTAX JUMP TABLE
1879   16615  000041           ABS  MLOST-*
1880   16616  000064           ABS  ELOST-*
1881   16617  000051           ABS  FIMAR-*
1882   16620  000124           ABS  REWLI-*
1883   16621  000123           ABS  REWLI-*
1884   16622  000046           ABS  FIMAR-*
1885   16623  000057           ABS  ELOST-*
1886   16624  000032           ABS  MLOST-*
1887   16625  000031  B31      OCT  31
1888*   SYNTAX TABLE
1889   16626  043111  SNMT     ASC  2,FIND    FIND, OPCOF←DE 7
       16627  047104
1890   16630  123522           OCT  123522    OPCODE, R
1891   16631  042527           ASC  2,EWIN    REWIND, OPCODE 5
       16632  044516
1892   16633  042245           OCT  42245     D,OPCODE
1893   16634  046505           ASC  2,MERG    MERGE, OPCODE 2
       16635  051107
1894   16636  042642           OCT  42642     E,OPCODE
1895   16637  051524           ASC  2,STOR        STORE, OPCODE 10
       16640  047522
1896   16641  042650           OCT  42650         E,OPCODE
1897   16642  046117           ASC  2,LOAD    LOAD OPCODE 3
       16643  040504
1898   16644  121515           OCT  121515    OPCODE, M
1899   16645  040522           ASC  1,AR      MARK, OPCODE 4
1900   16646  045644           OCT  45644     K, OPCODE
1901   16647  052114           ASC  2,TLIS    TLIST, OPCODE 6
       16650  044523
1902   16651  052246           OCT  52246         T, OPCODE
```

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```
1903   16652  046111            ASC  2,LINK      LINK, OPCODE 11
       16653  047113
1904   16654  164000            OCT  164000      OPCODE, ET
1905*
1906*
1907*   MERGE, LOAD, STORE SYNTAX CHECK
1908*
1909*
1910   16655  062764  ML        JSM  UNIT1       DECRM POINTERS
1911   16656  062751  MLOST     JSM  UNIT
1912   16657  066661            JMP  MA          NO UNIT GIVEN
1913   16660  062770            JSM  COMEL       COMA? NO, EOL
1914   16661  162773  MA        JSM  SERVA,I
1915   16662  065153            JMP  EOLCK       0←EOL? ACCEPT
1916   16663  062770            JSM  COMEL       FILE NO. GIVEN
1917   16664  060664            JSM  LNUM        GET LINE #1
1918   16665  062770            JSM  COMEL
1919   16666  060664            JSM  LNUM        GET LINE #2
1920   16667  065151            JMP  EOST
1921*
1922*
1923*   FIND AND MARK SYNTAX CHECK
1924*
1925*
1926   16670  062751  FIMAR     JSM  UNIT
1927   16671  066673            JMP  AA          NO UNIT GIVEN
1928   16672  060510            JSM  COMCE       COMA? NO, ERROR
1929   16673  160202  AA        JSM  FSCA,I      GET FILE
1930   16674  025473            LDB  TEMP
1931   16675  014024            CPB  .7          FIND
1932   16676  065151            JMP  EOST        ACCEPT STATEMENT
1933   16677  060510            JSM  COMCE
1934   16700  160202            JSM  FSCA,I
1935   16701  065151            JMP  EOST
1936*
1937*
1938*   ENTRY FOR ALL LOAD AND STORE
1939*
1940*
1941   16702  021466  ELOST     LDA  LOCL1
1942   16703  050040            AND  B37
1943   16704  031473            STA  TEMP        TEMPOR, OPCODE
1944   16705  060456            JSM  SBPUD       INCRM POINTER SBPTR
1945   16706  061055            JSM  GNEXT       GET NEXT CHARACTER
1946   16707  026774            LDB  SUBTA       ADDR OF SUB-TABLE
1947   16710  060546            JSM  STEXP
1948   16711  066655            JMP  ML          LOAD, STORE
1949   16712  070202            SAR  5           POSITION KEY OR DATA OPCODE
1950   16713  050040            AND  B37
1951   16714  001473            ADA  TEMP        FIGURE EXACT OPCODE
1952   16715  001473            STA  TEMP
1953*
1954*
1955*       LOADK,STOREK,LOADD,STORED,LOADB,STOREB,SYNTAX CHECK
1956*
1957*
```

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```
1958   16716  062754          JSM  UNIT2
1959   16717  066741          JMP  LA        NO UNIT GIVEN
1960   16720  060510          JSM  COMCE     COMA? NO, ERROR
1961   16721  162773  LA1     JSM  SERVA,I
1962   16722  066747          JMP  ERROR     EOL AFTER COMA
1963   16723  025473          LDB  TEMP
1964   16724  016625          CPB  B31         STORE DATA?
1965   16725  066731          JMP  *+4       YES
1966   16726  016775          CPB  BB24       LOAD DATA?
1967   16727  066731          JMP  *+2       YES
1968   16730  065151          JMP  EOST      DEMAND EOL
1969   16731  062770          JSM  COMEL     COMA? NO, EOL
1970   16732  061140          JSM  LTR       CHECK FOR ARRAY
1971   16733  066747          JMP  ERROR
1972   16734  021474          LDA  TEMP1     LETTER; LOAD VARIABLE NAME
1973   16735  024020          LDB  .3        ASSUME ARRAY
1974   16736  060451          JSM  STROP+1   PUT IN MEMORY
1975   16737  021475          LDA  TEMP2     LOAD FOLLOWING CHARACTER
1976   16740  065151          JMP  EOST
1977   16741  070742  LA      SAR  16
1978   16742  060456          JSM  SBPUD
1979   16743  066721          JMP  LA1
1980*
1981*
1982*   REWIND AND TLIST SYNTAX CHECK
1983*
1984*
1985   16744  062751  REWLI   JSM  UNIT
1986   16745  065147          JMP  ENDS
1987   16746  065151          JMP  EOST      ACCEPT STATEMENT
1988   16747  160205  ERROR   JSM  AERRA,I
1989   16750  177711          DEC  -55
1990*
1991*
1992*    UNIT SYNTAX CHECK
1993*
1994*
1995   16751  021466  UNIT    LDA  LOCL1
1996   16752  050040          AND  B37       RECALL OPCODE
1997   16753  031473          STA  TEMP      OPCODE TEMPORARY
1998   16754  060456  UNIT2   JSM  SBPUD     GET NEW SYNTAX WORD
1999   16755  061055          JSM  GNEXT     GET NEW CHARACTER
2000   16756  060463          JSM  SYMC1     CHECK FOR #
2001   16757  012017          OCT  12017
2002   16760  066764          JMP  UNIT1     NO
2003   16761  066762          JMP  FS        YES
2004   16762  160202  FS      JSM  FSCA,I    GET UNIT
2005   16763  064357          JMP  RETN2
2006   16764  055706  UNIT1   DSZ  SBPTR
2007   16765  055400          DSZ  BADDR
2008   16766  170402          RET
2009*
2010*
2011*   COMA-EOL CHECK
2012*
2013*
```

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```
2Ø14    16767  Ø61Ø55  COMA     JSM  GNEXT
2Ø15    16770  Ø6Ø5Ø4  COMEL    JSM  COMCK  COMA?
2Ø16    16771  Ø65151           JMP  EOST   NO
2Ø17    16772  17Ø4Ø2           RET
2Ø18*
2Ø19*       DIFINITIONS
2Ø2Ø*
2Ø21    16773  Ø14Ø32  SERVA    DEF  SERV
2Ø22    16774  Ø3ØØ46  SUBTA    DEF  SUBT+SUBT
2Ø23    16775  ØØØØ24  BB24     OCT  24
2Ø24                            END
*  NO ERRORS*
```

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CROSS-REFERENCE TABLE

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CROSS-REFERENCE TABLE

AR2	Ø421	Ø189									
AR2A	Ø189										
ARCOM	1449	1431									
ARYAD	Ø4Ø9										
ARYLS	1429	1357	1382								
ASTOR	Ø793	186Ø									
B	ØØØØ	Ø524	Ø527	Ø61Ø	Ø747	Ø749	Ø862	Ø927	Ø945	1Ø19	1Ø91
	1435	1441	15Ø5	1547	164Ø						
B1ØØ	Ø1Ø1										
B1ØØØ	Ø1Ø8	18Ø5									
B1ØK	Ø12Ø	Ø121	1813								
B12ØK	1811	Ø92Ø									
B12K	Ø122	Ø123	Ø212								
B133	Ø1Ø2										
B14Ø	Ø1Ø3										
B14ØØ	Ø1Ø9	Ø21Ø	18Ø4								
B17	ØØ89										
B17ØK	Ø127										
B174Ø	Ø11Ø	Ø2Ø9									
B176Ø	Ø111	Ø164									
B176K	1814										
B177	Ø1Ø4	1Ø22									
B1774	Ø122										
B1775	Ø113										
B1777	Ø114										
B2Ø	ØØ9Ø										
B22	ØØ91										
B23	ØØ92										
B24ØØ	Ø116	1852									
B26	ØØ93										
B27	ØØ94										
B3ØØØ	Ø117										
B31	1887	1964									
B36	ØØ95										
B37	ØØ96	1437	1942	195Ø	1996						
B377	Ø1Ø5	1869									
B4ØØ	Ø1Ø6	1594	1849								
B4ØØØ	Ø118	Ø168	1841								
B42	ØØ97										
B44	ØØ98										
B52	ØØ99										
B6K	Ø119	Ø173	1663								
B72	Ø1ØØ										
B777	Ø1Ø7	Ø646	1475	1559	1583						
BADDR	Ø297	Ø558	1786	2ØØ7							
BADRP	Ø21Ø										
BB24	2Ø23	1966									
BEND	Ø2Ø4	Ø2Ø5									
BHSTP	Ø45Ø										
BINOP	181Ø	Ø581	Ø8Ø1								
BLANK	Ø394										
BOFCK	1244	115Ø	1252	1271	133Ø	1696	1716				
BSTP	1251	1246									
C5	ØØ21										
C6	ØØ17	Ø12Ø	18Ø1								
C7	ØØ28	Ø1Ø6									

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CROSS-REFERENCE TABLE

CASIN	1828	Ø956									
CCNT	1819	1788									
CHCK	1137	1132									
CHRSA	Ø225										
CLAR2	Ø497										
CLERA	Ø166	1778	1784								
CLINE	Ø322										
CLP1A	Ø223	Ø671	15Ø3								
CMNDT	Ø517	187Ø									
COINT	1Ø64	1Ø55									
COM1	Ø7Ø4	Ø697									
COMA	2Ø14										
COMCE	Ø442	1928	1933	196Ø							
COMCK	Ø441	2Ø15									
COMEL	2Ø15	1913	1916	1918	1969						
COMON	Ø687	Ø764									
CONST	Ø49Ø										
COUT	11Ø3	11ØØ									
COUT1	1238	1219									
COUTP	1234	Ø976	Ø979	1Ø53	1Ø57	1Ø64	121Ø	1244	162Ø	169Ø	1736
	1747										
CPLAC	Ø337										
CRCKA	Ø234										
CRLF	Ø5Ø3										
CRLF1	Ø5Ø4	1761	1777								
CRTN	ØØ43	ØØ44	Ø¢45								
CSTOP	1176	1148	1269	1329							
CTYPE	Ø336										
DATOP	18Ø8	Ø577	Ø797								
DCM1A	1854	Ø639	Ø813	1467	1526						
DCOMA	Ø216										
DEL1	1815	17Ø2									
DEL2	1816	1338									
DEL65	17Ø2	1698									
DELSA	Ø181										
DFLAG	Ø396										
DI2	Ø972	Ø977	Ø98Ø								
DI3	Ø974	Ø97Ø									
DIGCK	Ø469										
DIREC	Ø964										
DLCNT	18Ø7	1745									
DPERR	ØØ49										
DRQST	Ø323										
DSTRT	Ø3Ø9										
E	ØØ86										
E1	Ø241										
E1Ø	Ø25Ø										
E15	Ø255										
E2Ø	Ø26Ø										
E25	Ø265										
E3Ø	Ø27Ø	Ø695									
E35	Ø275										
E4Ø	Ø28Ø	Ø925	1434								
E45	Ø285										
E5	Ø245	Ø763									
E5Ø	Ø29Ø										

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EBIDW	1847	1397	1655					
ECALA	Ø221							
ELINA	Ø175							
ELOST	1941	188Ø	1885					
ENDS	Ø486	1986						
ENTEA	Ø224							
ENTFA	Ø195							
EOBID	1846	1267						
EOL	ØØ44	Ø555						
EOLCK	Ø489	1915						
EOST	Ø487	192Ø	1932	1935	1968	1976	1987	2Ø16
ER3	1667							
ERRØ	1853	ØØ2						
ERR1	Ø943	135Ø	1638					
ERR3	12ØØ	1111	1197	1292	1335	1668	17Ø1	1753
ERR4	1282	Ø724	1374	1516	1573			
ERR5	14Ø7	Ø824	1366	1413				
ERR6	1361							
ERR7	1473	Ø645	1558					
ERR8	Ø653	Ø681	ØØ82	1484				
ERRA	Ø183							
ERROR	1988	1853	1962	1971				
ESEC	Ø519	Ø516						
ESEC3	Ø522	Ø529						
ESEC4	Ø533	Ø525						
ESEC6	Ø53Ø	Ø523						
EXP	Ø4Ø7	Ø4Ø8						
EXPOP	Ø124	18Ø7						
F	ØØ87							
F5	Ø92Ø	Ø91Ø	Ø914	Ø933	13Ø4			
FDAAA	Ø228							
FETCH	Ø494	Ø923	Ø939					
FILEC	Ø939	Ø774	Ø958	13Ø7	1628	1632		
FILEN	1829	Ø964	1312					
FILLA	Ø2Ø7							
FIMAR	1926	1881	1884					
FIND3	Ø96Ø							
FINDE	Ø952	1861						
FIRST	Ø373							
FITA3	Ø984	Ø968						
FITAS	Ø986	Ø954	1Ø16	1Ø4Ø				
FIX	Ø5Ø7							
FLGBT	ØØ79	Ø531						
FLOAT	Ø392							
FLTFA	Ø199							
FLTRA	Ø198	Ø924	Ø94Ø					
FLTSA	Ø2Ø1							
FN	Ø154							
FND	Ø468	Ø678						
FND1A	Ø23Ø	Ø737						
FNDAA	Ø229	Ø733						
FNDPS	Ø482	Ø665	Ø879					
FOPBS	Ø212							
FORMA	Ø178							
FORME	Ø342							
FORMS	Ø341							

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IOSTA	Ø231				
IS2	1Ø2Ø	Ø998			
IS3	1Ø24	1Ø7Ø			
ISE4	1Ø1Ø	1ØØ2			
ISERV	Ø995	Ø184			
IST0	1Ø35	1828			
IST1	1Ø46	1Ø44			
ISTOR	142Ø	1381	1524		
ITBAS	1824	Ø988			
KCOMN	Ø713	Ø691	Ø7Ø8		
KEYBD	1812	1ØØ3			
KEYFG	Ø33Ø	1ØØ8	1Ø23		
KEYOP	18Ø9	Ø579	Ø799		
L2T1	Ø353	1496	1498		
L2T2	Ø354				
LA	1977	1959			
LA1	1961	1979			
LASTN	Ø4Ø4	Ø844			
LBI2	1561	1555			
LBIN	1543	Ø582			
LBOP	Ø125				
LDATA	1356	Ø578			
LDEF	Ø495	1485			
LETCK	Ø47Ø				
LT2	1762	1782			
LIMIT	Ø471				
LINK	Ø893	1859			
LISTA	Ø173				
LISTE	1759	1862			
LKEY	1465	Ø58Ø			
LKEY4	1485	1478			
LKEY5	15ØØ	1492			
LKEY6	15Ø4	1499			
LKEY9	15Ø9	1491			
LNFD	ØØ78				
LNINC	Ø321				
LNUM	Ø463	1917	1919		
LO12	Ø655	Ø65Ø	Ø652		
LO3	Ø6Ø5	Ø612	Ø81Ø		
LO4	Ø744	Ø734	Ø738	Ø751	
LO5	Ø752	Ø746			
LO6	Ø758	Ø666	Ø886		
LO7	Ø875	Ø867	Ø869		
LOAD2	Ø6Ø3	Ø589	Ø865	Ø893	
LOAD3	Ø665	Ø593	Ø896		
LOAD4	Ø675	Ø884			
LOAD7	Ø638	Ø618	Ø621	Ø875	
LOAD8	Ø616	Ø59Ø	Ø894		
LOAD9	Ø594	Ø885	Ø887	1518	1576
LOADP	Ø589	Ø574			
LOCF	1299	1356	142Ø	1465	1543
LOCF1	1312	1348			
LOCF2	13Ø9	Ø779	Ø784		
LOCF3	1314				
LOCL1	Ø351	Ø833	1941	1995	
LOCL2	Ø352				

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LPCK	0443							
LPCKE	0444							
LPOP	0126							
LROMA	0129							
LSTAK	0305							
LSTPT	0307							
LTR	0485	1970						
LWAM	0301	1565	1567	1574				
M1	0130	0967	0986	1043	1157	1317	1440	1443
M10	0137							
M100	0150							
M1024	0152	1814	1816					
M11	0138	0928						
M12	0139							
M13	0140							
M14	0141							
M15	0142	1688						
M2	0131	0861	1263	1310	1447			
M23	0143							
M25	0144							
M256	0151							
M3	0132							
M32	0145	1679						
M36	0146							
M4	0133	1636						
M48	0147							
M5	0134							
M6	0135							
M64	0148							
M80	0149							
M9	0136							
MA	1914	1912						
MAR2	1618							
MAR3	1708	1616						
MAR4	1628	1617	1712					
MARK	1817	1151	1272	1331	1697	1717		
MARKE	1613	1864						
MASK1	0159							
MASK5	0160							
MAW	0300	1544						
MAXIN	0406							
MAXSN	0153	0761						
MBIN1	0412							
MBIN2	0413							
MBOX1	0357							
MC2	1676	1664						
MC3	1669							
MCON2	1654	1718						
MCONT	1650	1624	1678					
MDIMA	0214	1446						
MERB	0451	1552						
MERG1	0886	0880						
MERGE	0860	1866						
MINIT	0461	0591	0876	1575				
ML	1910	1948						
MLOST	1911	1879	1886					

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MODE	Ø311	Ø594	Ø619	Ø637	Ø868	Ø874	Ø897	1477			
MSFLG	Ø395										
MVTOH	Ø483	Ø713	1497								
NDISP	Ø388										
NDWRT	Ø502	179Ø									
NEXT1	Ø456	Ø832									
NEXTA	Ø473	Ø528	Ø75Ø								
NEXTL	Ø455										
NMOTA	Ø2Ø6										
NOEOF	Ø488										
NPRIN	Ø389										
NPWRT	Ø5Ø1										
NUM	Ø4Ø2	Ø4Ø3									
NUMCA	Ø217										
NUMOA	Ø128										
NUMS	182Ø	Ø917	13Ø2								
NWL	1Ø91	11Ø1	11Ø2								
NWL1	1Ø92	1Ø95									
NWL2	1Ø94	1Ø9Ø									
NXTDT	Ø310										
NXTST	Ø411	Ø9Ø2									
OBLNK	Ø474										
ODGIT	Ø498										
OF1	1748	1752									
OFFCL	1744	1262	1618	167Ø							
OFSET	1839	Ø66Ø	Ø676	Ø735	Ø748	Ø76Ø	Ø878				
ONE	ØØ51										
ONEXT	Ø475										
OPCHA	Ø177										
OPDMK	ØØ85										
OPMSK	ØØ82	Ø916	13Ø1								
OPTYP	Ø4Ø3										
OTPTR	Ø299										
OUTCR	Ø476										
OUTIA	Ø185	1787									
OVCHA	Ø222	Ø69Ø	Ø7Ø6	1493							
PARMA	Ø312										
PARMN	Ø313										
PBPTO	Ø319	Ø7ØØ	155Ø								
PBPTR	Ø316	Ø625	Ø649	Ø67Ø	Ø7Ø1	Ø728	Ø731	Ø745	Ø753		
PBUFF	Ø317	Ø648	Ø651	Ø693	Ø699	Ø7Ø9	Ø711	Ø814	Ø839	1458	15Ø4
	15Ø6										
PBUFO	Ø318	1456									
PEND	Ø371										
PEXMA	Ø171										
PFLAG	Ø397										
PGINØ	Ø484										
PGINT	Ø464										
PI/2	ØØ5Ø										
PLACE	Ø39Ø										
PMODE	Ø335										
PPFF	Ø372										
PRADD	Ø314	Ø6Ø6	Ø622	Ø624	Ø638	Ø772	Ø812	Ø913	143Ø	1466	1525
PRFLG	Ø338	1779									
PRIN	1783	1764	1766	1768	177Ø	1772	1774	1776			
QTCHA	Ø236										

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SECCK	1582	Ø849	1527								
SECFL	1838	Ø53Ø	Ø532	Ø647	1476	156Ø	1582	1587			
SERV	Ø553	2Ø21									
SERVA	2Ø21	1914	1961								
SF2	Ø78Ø	Ø773									
SFLAG	Ø399										
SFLOC	Ø77Ø	Ø6Ø3	Ø8Ø9								
SGNS	Ø499										
SIGN	Ø4Ø5	Ø4Ø6									
SKEY	1524	Ø8ØØ									
SLCOD	Ø334										
SLEND	Ø2Ø8										
SLWST	Ø453										
SNFLA	Ø2Ø3										
SNMT	1889	1871									
SPFLA	Ø2Ø2										
SSBPT	Ø4Ø1										
SSYMA	Ø176	1433									
ST	Ø383										
STAC3	1198	1172	122Ø								
STACK	1193	1Ø38									
START	Ø168	ØØ13									
STAT	1182	1Ø37	1167	1217	1748						
STAT4	1187	1177	1195								
STAT5	1172	1169									
STATE	1167	126Ø	1274	1333	1615	1699					
STEXP	Ø449	1947									
STOP	1851	11Ø8	1176	1251							
STOPC	1852	12Ø9	1226								
STOR1	Ø434										
STORE	Ø433										
STORP	Ø8Ø9	Ø794									
STPFL	Ø329	1Ø21	1851								
STROP	Ø436	1974									
STSRH	Ø448										
SUBT	Ø542	1868	2Ø22	2Ø22							
SUBTA	2Ø22	1946									
SUMPA	Ø233										
SYE12	Ø491										
SYE25	Ø466										
SYMC1	Ø439	2ØØØ									
SYMC2	Ø438										
SYMCK	Ø44Ø										
SYMTP	Ø3Ø4										
SYSRE	1737	1375	14ØØ	1682							
SYTSA	Ø215										
TAPØ	1825	1264	128Ø	1711	1713						
TAP1	1826	Ø52Ø	Ø522	Ø729	Ø752	1311	1347	1783	1785		
TAP2	1827	Ø668	Ø679	Ø83Ø	Ø847	Ø883	1155	1368	1383	1388	1442
	1452	1533									
TAP3	183Ø	1358	1385	1439	145Ø	1746	1751				
TAP4	1831	Ø732	Ø744	1Ø78	1Ø85	1Ø89	1118	1125	1266	1318	1325
	1336	1396	1633	1639	1644						
TAP5	1832	Ø73Ø	1Ø79	1Ø99	1119	1131	1268	1327	1328	1398	
TAP6	1833	1Ø84	1Ø96	1Ø97	11Ø3	1124	1134	1135	1137		
TAP7	1834	Ø592	Ø628	Ø63Ø	Ø655	Ø659	Ø682	Ø692	Ø712	Ø718	Ø758

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	Ø777	Ø781	Ø816	Ø818	Ø831	Ø846	Ø895	1156	1387	1535	
TAP8	1835	Ø598	Ø616	Ø631	Ø635	Ø778	Ø782	Ø819	Ø866	Ø872	Ø9Ø1
	1436	1445	1481	1563							
TAPAD	1836	Ø6Ø4									
TCOM	1837	Ø834									
TEMP	Ø356	Ø357	193Ø	1943	1951	1952	1963	1997			
TEMP1	Ø358	1972									
TEMP2	Ø359	1975									
TEMP3	Ø36Ø	Ø7Ø2	1495								
TEMP4	Ø361	Ø521	Ø669	Ø823	Ø825	Ø828	15Ø1				
TEMPS	Ø355	Ø575	Ø576	Ø583	Ø6Ø5	Ø6Ø8	Ø6Ø9	Ø611	Ø736	Ø771	Ø795
	Ø796	Ø8Ø3	Ø829	Ø86Ø	Ø911	Ø912	Ø915	Ø919	1299	13ØØ	1429
TERM	Ø37Ø										
TFILE	1822	Ø775	Ø783	Ø959	Ø966	13Ø8	1313	1316	1344	1631	1677
TFLAG	Ø324										
TFLG1	Ø328										
TLENG	18Ø6	1642	1657								
TMPA	Ø2Ø9										
TMPOP	Ø19Ø										
TRD	1118	Ø721	1371	1513	157Ø						
TRD1	112Ø	1277									
TREGE	Ø378	Ø864	Ø87Ø								
TRL	1126	1136									
TSRHA	Ø174										
TSTPT	Ø3Ø6										
TTY	Ø5Ø5										
TUNIT	1821	Ø921	Ø984	1Ø8Ø	112Ø	1182	1235	1597	1651		
TWR	1Ø78	1158	1656								
TWR1	1Ø8Ø	1154									
TWR4	1Ø83										
TYPFL	ØØ84										
UFLAG	Ø398										
UKPTR	Ø315	Ø696	Ø7Ø7	1454	1482						
UNIT	1995	1911	1926	1985							
UNIT1	2ØØ6	191Ø	2ØØ2								
UNIT2	1998	1958									
UNITC	Ø9Ø9	0770	Ø952	1613	1734	1759					
UNITS	Ø325										
UNSTK	Ø454										
UOVF	Ø925	Ø929	Ø932								
UPARA	Ø197										
VALUE	Ø3Ø3										
VAROA	Ø22Ø										
WBUFF	Ø429										
WCFS	18Ø2	165Ø									
WDFS	1848	1Ø81	1598	1619							
WIDTH	Ø391										
WPERM	1217	Ø811	1421	1614							
WRF3	1149	1153									
WRFIL	1147	1399									
WRITE	Ø165										
WRZE	1594	1621	1658	1672							
WRZE1	16Ø2	16Ø6									
XC	Ø418										
XEC4A	Ø17Ø	Ø973	1738								
XEC6A	Ø227										

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XECA	1813	Ø9Ø3
XFAR1	Ø431	
XFAR2	Ø435	
XSCRA	Ø226	
YC	Ø42Ø	
YCOMN	Ø692	Ø688
ZAP	Ø158	
ZONK	Ø496	

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```
0501                                LST
0502   20000                        ORG  20000B
0503*
0504*  MATRIX BLOCK
0505*
0506*  12001          QUOTE  EQU  12001B     TABLE OF EQUATES FOR SYNTAX
0507   12002          COMMA  EQU  QUOTE+1
0508   12007          ASSOP  EQU  QUOTE+6
0509   12011          PLUS   EQU  QUOTE+8
0510   12013          TIMES  EQU  QUOTE+10
0511*
0512*
0513   20000  000256  ID     ABS  DETT-*    DETERMINANT JUMP TABLE
0514*
0515   20001  000100         ABS  REDS-*    SYNTAX JUMP TABLE
0516   20002  000041         ABS  MATS-*
0517   20003  000000         NOP             ** CHECKSUM WORD **
0518*
0519   20004  046501  SYSNT  OCT  046501     MA      STATEMENT-NAME TABLE
0520   20005  052242         OCT  052242     T(2)
0521   20006  051105         OCT  051105     RE
0522   20007  042111         OCT  042111     DI
0523   20010  046603         OCT  046603     M(3)
0524*
0525   20011  046501         OCT  046501     MA
0526   20012  052040         OCT  052040     T
0527   20013  050122         OCT  050122     PR
0528   20014  044516         OCT  044516     IN
0529   20015  052204         OCT  052204     T(4)
0530   20016  046501         OCT  046501     MA
0531   20017  052040         OCT  052040     T
0532   20020  051105         OCT  051105     RE
0533   20021  040504         OCT  040504     AD
0534   20022  142400         OCT  142400       (5)   END
0535*
0536   20023  052122  NFOPT  OCT  052122     TR      NON-FORMULA OPERATOR
                                                            TABLE
0537   20024  047201         OCT  047201     N(1)
0538   20025  044516         OCT  044516     IN
0539   20026  053202         OCT  053202     V(2)
0540   20027  055105         OCT  055105     ZE
0541   20030  051203         OCT  051203     R(3)
0542   20031  041517         OCT  041517     CO
0543   20032  047204         OCT  047204     N(4)
0544   20033  044504         OCT  044504     ID
0545   20034  047305         OCT  047305     N (5)   END
0546*
0547   20035  042105  FUNCT  OCT  042105     DE      FUNCTION-NAME TABLE
0548   20036  052335         OCT  052335     T (29)  END
0549*
0550   20037  000777  BN777  OCT  777        NULL TABLE
0551*
0552   20040  177771  M7     DEC  -7
0553   20041  026000  B26K   OCT  26000
0554   20042  000046  NFOPA  DEF  NFOPT+NFOPT-ID-ID
```

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```
0556*
0557*  MAT STATEMENT SYNTAX
0558*
0559   20043  021717  MATS    LDA  NUM      GET PAGE INFO
0560   20044  070442          SAR  10
0561   20045  070244          SAL  11
0562   20046  031660          STA  T8
0563*
0564   20047  055706          DSZ  SBPTR    MOVE S-BUFFER POINTER
0565   20050  061055          JSM  GNEXT    GET FIRST CHARACTER
0566   20051  026220          LDB  SUBTA    GET SUBSIDIARY TABLE ADDRESS
0567   20052  005660          ADB  T8
0568   20053  060537          JSM  STSRH    DO SEARCH FOR "PRINT" OR "READ"
0569   20054  066107          JMP  MATS2    NOT FOUND
0570   20055  045706          ISZ  SBPTR
0571   20056  010004          CPA  B10K     PRINT?
0572   20057  066066          JMP  MATS0    YES
0573*
0574*  MAT READ SYNTAX
0575*
0576   20060  062227  MATS1   JSM  ARRID    RECORD ARRAY
0577   20061  062240          JSM  MATSB    IF SUBSCRIPT, RECORD IT
0578   20062  066064          JMP  *+2      NOP
0579   20063  061153          JSM  EOLCK    END-OF-STATEMENT?
0580   20064  060510          JSM  COMCE    NO. DEMAND COMMA
0581   20065  066060          JMP  MATS1
0582*
0583*  MAT PRINT SYNTAX
0584*
0585   20066  062227  MATS0   JSM  ARRID    RECORD ARRAY
0586   20067  061153          JSM  EOLCK    END-OF-STATEMENT?
0587   20070  060461          JSM  SYMC2    NO. LOOK FOR COMMA OR
                                                          SEMICOLON
0588   20071  012001          DEF  COMMA-1
0589   20072  164277          JMP  E10-2,I  NOT FOUND, ERROR 8
0590   20073  061066          JSM  GETSK    END-OF-STATEMENT?
0591   20074  066077          JMP  *+3      YES
0592   20075  055400          DSZ  BADDR    NO
0593   20076  066066          JMP  MATS0
0594   20077  045706          ISZ  SBPTR
0595   20100  164203          JMP  ACTSA,I
0596*
0597*  REDIM SYNTAX
0598*
0599   20101  062227  REDS    JSM  ARRID    RECORD ARRAY
0600   20102  062240          JSM  MATSB    RECORD SUBSCRIPT
0601   20103  066105          JMP  *+2      NOP
0602   20104  164306          JMP  E15,I    NONE FOUND, ERROR 15
0603   20105  060510          JSM  COMCE    DEMAND COMMA
0604   20106  066101          JMP  REDS
```

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```
0606*
0607*  OTHER SYNTAX
0608*
0609  20107  045706  MATS2   ISZ  SBPTR
0610  20110  061141          JSM  LTR+1     LETTER?
0611  20111  164321          JMP  E25+1,I   NO, ERROR 26
0612  20112  021706          LDA  SBPTR     SAVE CHARACTER ADDRESS
0613  20113  031723          STA  ARYAD
0614  20114  062231          JSM  ARRI      RECORD ARRAY
0615  20115  060463          JSM  SYMC1     LOOK FOR "="
0616  20116  012006          DEF  ASSOP-1
0617  20117  164325          JMP  E30,I     NOT FOUND, ERROR
0618  20120  061055          JSM  GNEXT
0619  20121  045706          ISZ  SBPTR
0620  20122  026042          LDB  NFOPA     SEARCH NON-FORMULA
                                            OPERATOR TABLE
0621  20123  005660          ADB  T8
0622  20124  060546          JSM  STEXP
0623  20125  066147          JMP  MATS8     NOT FOUND, MUST BE ARITHMETIC
0624  20126  045706          ISZ  SBPTR
0625  20127  070202          SAR  5
0626  20130  050040          AND  B37       RETRIEVE OPCODE
0627  20131  031661          STA  T9
0628  20132  000134          ADA  M3        INV OR TRN?
0629  20133  070252          SAM  MATS3     YES
0630  20134  061066          JSM  GETSK     NO, END-OF-STATEMENT?
0631  20135  164203          JMP  ACTSA,I   YES
0632  20136  062240          JSM  MATSB     NO, GO RECORD SUBSCRIPT
0633  20137  065152          JMP  NOEOF
0634*
0635*  INV & TRN SYNTAX
0636*
0637  20140  061055  MATS3   JSM  GNEXT
0638  20141  060521          JSM  LPCKE     DEMAND LEFT PARENTHESIS
0639  20142  062227          JSM  ARRID     RECORD ARRAY
0640  20143  060534          JSM  RPCKE     DEMAND RIGHT PARENTHESIS
0641  20144  055661          DSZ  T9        TRN?
0642  20145  065151          JMP  EOST      NO
0643  20146  066205          JMP  LHSC      GO CHECK PREVIOUS ARRAY
                                            IDENTIFIER
0644*
0645  20147  061141  MATS8   JSM  LTR+1     LETTER?
0646  20150  066154          JMP  MATS4     NO, IT MUST BE SCALAR MULTIPLY
0647  20151  060752          JSM  LETCK     LETTER?
0648  20152  066164          JMP  MATS5     NO, IT MUST BE MAT ARITHMETIC
0649  20153  164326          JMP  E30+,I    YES, ERROR 31
```

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```
0651*
0652*  SCALAR MULTIPLY SYNTAX
0653*
0654   20154  060521  MATS4   JSM  LPCKE     DEMAND LEFT PARENTHESIS
0655   20155  160202          JSM  FSCA,I     FETCH FORMULA
0656   20156  060534          JSM  RPCKE     DEMAND RIGHT PARENTHESIS
0657   20157  060463          JSM  SYMC1     LOOK FOR "*"
0658   20160  012012          DEF  TIMES-1
0659   20161  164326          JMP  E30+1,I   NOT FOUND, ERROR 31
0660   20162  062227          JSM  ARRID     RECORD ARRAY
0661   20163  065151          JMP  EOST
0662*
0663*  MAT ARITHMETIC SYNTAX
0664*
0665   20164  055706  MATS5   DSZ  SBPTR
0666   20165  062231          JSM  ARRI      RECORD ARRAY
0667   20166  061153          JSM  EOLCK     END-OF-STATEMENT?
0668   20167  024020          LDB  .3        NO, SEARCH FOR "+" "-" OR "*"
0669   20170  060464          JSM  SYMCK
0670   20171  012010          DEF  PLUS-1
0671   20172  164326          JMP  E30+1,I   NOT FOUND, ERROR 31
0672   20173  074742          SBR  16        SET B FOR PFLAG
0673   20174  012041          CPA  B26K      "*"?
0674   20175  066212          JMP  MATS7     YES
0675*
0676   20176  035712  MATS6   STB  PFLAG     SET PFLAG
0677   20177  062227          JSM  ARRID     RECORD SECOND ARRAY
0678   20200  010031          CPA  EOL       END-OF-STATEMENT?
0679   20201  066203          JMP  *+2       YES
0680   20202  065152          JMP  NOEOF     NO, ERROR
0681   20203  045712          ISZ  PFLAG     WAS OPERATOR A "*"?
0682   20204  164203          JMP  ACTSA,I   NO
0683   20205  125723  LHSC    LDB  ARYAD,I   YES, RETRIEVE PREVIOUS ARRAY
0684   20206  074504          SBL  6
0685   20207  015473          CPB  TEMP      SAME AS LEFT HAND SIDE?
0686   20210  164326          JMP  E30+1,I   YES, ERROR (IMPROPER ASSIGNMENT)
0687   20211  065151          JMP  EOST      NO
0688*
0689   20212  121723  MATS7   LDA  ARYAD,I   RETRIEVE ARRAY IDENTIFIER
0690   20213  070504          SAL  6
0691   20214  024132          LDB  M1        SET B FOR PFLAG
0692   20215  011473          CPA  TEMP      SAME AS LEFT HAND SIDE?
0693   20216  164326          JMP  E30+1,I   YES, ERROR (IMPROPER ASSIGNMENT)
0694   20217  066176          JMP  MATS6     NO
```

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```
0696   20220  000442  SUBTA   DEF  SUBTB+SUBTB-ID-ID
0697   20221  050122  SUBTB   OCT  050122      PR
0698   20222  044516          OCT  044516      IN
0699   20223  052204          OCT  052204      T (4)
0700   20224  051105          OCT  051105      RE
0701   20225  040504          OCT  040504      AD
0702   20226  142400          OCT  142400        (5)   END
0703*
0704*  SUBROUTINE TO FETCH ARRAY IDENTIFIER AND RECORD IT
0705*
0706   20227  061140  ARRID   JSM  LTR         LETTER?
0707   20230  164321          JMP  E25+1,I     NO, ERROR 26
0708   20231  021474  ARRI    LDA  TEMP1       RECORD ARRAY IDENTIFIER
0709   20232  024020          LDB  .3          OF UNKNOWN DIMENSIONS
0710   20233  060451          JSM  STROP+1
0711   20234  070504          SAL  6
0712   20235  031473          STA  TEMP
0713   20236  021475          LDA  TEMP2       RETRIEVE FOLLOWING CHARACTER
0714   20237  170402          RET
0715*
0716*  SUBROUTINE TO FETCH MAT SUBSCRIPT AND RECORD IT
0717*
0718   20240  060513  MATSB   JSM  LPCK        LOOK FOR LEFT PARENTHESIS
0719   20241  064357          JMP  RETN2       NOT FOUND, RETURN TO P+2
0720   20242  020125          LDA  LBOP        CHANGE ( TO [
0721   20243  131706          STA  SBPTR,I
0722   20244  160202          JSM  FSCA,I      FETCH SUBSCRIPT
0723   20245  060504          JSM  COMCK       LOOK FOR COMMA
0724   20246  066250          JMP  *+2         NOT FOUND
0725   20247  160202          JSM  FSCA,I      FOUND; FETCH SECOND SUBSCRIPT
0726   20250  060534          JSM  RPCKE       DEMAND RIGHT PARENTHESIS
0727   20251  055706          DSZ  SBPTR
0728   20252  024123          LDB  RBOP        CHANGE ) TO ]
0729   20253  135706          STB  SBPTR,I
0730   20254  045706          ISZ  SBPTR
0731   20255  065153          JMP  EOLCK       CHECK FOR END-OF-STATEMENT
```

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```
0733*
0734*  DETERMINANT
0735*
0736   20256  021416  DETT    LDA  MODE
0737   20257  070453          SAP  DETX      SYNTAX OR EXECUTION?
0738*
0739   20260  023777          LDA  OPCOD     GET MAT OPCODE
0740   20261  131706          STA  SBPTR,I
0741   20262  045706          ISZ  SBPTR
0742   20263  061055          JSM  GNEXT
0743   20264  060521          JSM  LPCKE     DEMAND LEFT PARENTHESIS
0744   20265  062227          JSM  ARRID     RECORD ARRAY
0745   20266  060534          JSM  RPCKE     DEMAND RIGHT PARENTHESIS
0746   20267  064356          JMP  RETN3
0747*
0748*
0749   20270  023726  DETX    LDA  B1A       SAVE FIRST SEVEN TEMPORARIES
0750   20271  024024          LDB  .7
0751   20272  162335          JSM  MOVST,I
0752   20273  021412          LDA  LSTPT     SET UP FOR DETERMINANT EXECUTION
0753   20274  031656          STA  T6
0754   20275  121472          LDA  TEMPS,I
0755   20276  045472          ISZ  TEMPS
0756   20277  045472          ISZ  TEMPS
0757   20300  063541          JSM  INFO1     ESTABLISH INFORMATION VECTOR
0758   20301  021642          LDA  B1+2
0759   20302  031645          STA  B3+2
0760   20303  063564          JSM  COMP1     EXTRACT DIMENSIONS
0761   20304  011653          CPA  T3
0762   20305  066307          JMP  *+2
0763   20306  067120          JMP  MERR5     MATRIX NOT SQUARE
0764*
0765   20307  061201          JSM  IMPY      N*N
0766   20310  025640          LDB  B1
0767   20311  035643          STB  B3
0768   20312  076110          RZB  *+2       GET # OF TEMPORARY WORDS NEEDED
0769   20313  070704          SAL  2
0770   20314  014012          CPB  .1
0771   20315  070744          SAL  1
0772   20316  025412          LDB  LSTPT
0773   20317  074070          SIB  *+1
0774   20320  035644          STB  B3+1
0775   20321  074017          ADA  B
0776   20322  063130          JSM  XIN2+1    GO CALCULATE DETERMINANT
0777   20323  066324          JMP  *+1       DET=0 RETURN
0778   20324  021656          LDA  T6
0779   20325  002040          ADA  M7
0780   20326  031412          STA  LSTPT
0781   20327  070070          SIA  *+1
0782   20330  027726          LDB  B1A       RESTORE FIRST SEVEN TEMPORARIES
0783   20331  170004          XFR
0784   20332  170004          XFR
0785   20333  023731          LDA  DELA
0786   20334  064445          JMP  XFAR2+1
0787*
0788   20335  011122  MOVST   DEF  11122B
```

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```
0790*
0791*  EXECUTE MAT PRINT
0792*
0793   20336  021416  EMATP   LDA  MODE     SAVE MODE FLAG
0794   20337  031656          STA  T6
0795   20340  121472  MTP3    LDA  TEMPS,I
0796   20341  045472          ISZ  TEMPS
0797   20342  063541          JSM  INFO1     ESTABLISH INFORMATION VECTOR
0798   20343  121472          LDA  TEMPS,I
0799   20344  070442          SAR  10        GET FORMAT INDICATOR
0800   20345  074742          SBR  16
0801   20346  035453          STB  PRFLG     INDICATE "PRINT"
0802   20347  010020          CPA  .3
0803   20350  024020          LDB  .3        3 IS ;   0 IS ,
0804   20351  021472          LDA  TEMPS
0805   20352  011421          CPA  PRADD     FALSE ALARM?
0806   20353  074742          SBR  16        YES, IT WAS PART OF NEXT STATEMENT
0807   20354  035655          STB  T5
0808   20355  021642          LDA  B1+2      SET UP BOUNDS INFO
0809   20356  025642          LDB  B1+2
0810   20357  063565          JSM  COMPR
0811*
0812   20360  020132          LDA  M1
0813   20361  031703          STA  PLACE
0814   20362  022442          LDA  LN72
0815   20363  031623          STA  PEND
0816*
0817   20364  020012          LDA  .1        START THE PRINT OPERATION
0818   20365  031646          STA  T1
0819   20366  020012  MTP1    LDA  .1
0820   20367  031652          STA  T2
0821   20370  160170          JSM  CLERA,I   CLEAR BUFFER
0822   20371  063600  MTP2    JSM  GETI1     GET AN ARRAY ELEMENT
0823   20372  070742          SAR  16
0824   20373  031705          STA  FLOAT     INDICATE FIXED-POINT FORMAT
0825   20374  031416          STA  MODE
0826   20375  160234          JSM  NMOTA,I
0827   20376  025400          LDB  BADDR
0828   20377  015623          CP8  PEND      CHECK FOR OVERFLOW
0829   20400  066435          JMP  OVFW
0830   20401  070742          SAR  16        SIGNAL NUMERIC (NOT QUOTE) TO FILL
                                              ROUTINE
0831   20402  031742          STA  XC+2
0832   20403  021655          LDA  T5        CHECK THE FORMAT INDICATOR
0833   20404  160235          JSM  FILLA,I   SUPPLY NEEDED BLANKS
0834   20405  160176          JSM  ELINA,I   OUTPUT ONE FIELD
0835   20406  021442          LDA  STPFL     CHECK STOP FLAG
0836   20407  010040          CPA  .31
0837   20410  066437          JMP  MTPX
0838   20411  021652          LDA  T2
0839   20412  011654          CPA  T4
0840   20413  066416          JMP  *+3
0841   20414  045652          ISZ  T2
0842   20415  066371          JMP  MTP2
0843   20416  061344          JSM  CRLF1     DOUBLE-SPACE BETWEEN ROWS
0844   20417  061344          JSM  CRLF1
```

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```
0846  20420  021646          LDA  T1
0847  20421  011653          CPA  T3
0848  20422  066425          JMP  *+3
0849  20423  045646          ISZ  T1
0850  20424  066366          JMP  MTP1
0851  20425  061344          JSM  CRLF1     EXTRA SPACE AFTER MATRICES
0852  20426  025472          LDB  TEMPS     CHECK FOR MORE ARRAYS TO BE
                                                                  PRINTED
0853  20427  015421          CPB  PRADD
0854  20430  066437          JMP  MTPX
0855  20431  121472          LDA  TEMPS,I
0856  20432  050115          AND  B1777     CHECK FOR TRAILING FORMAT
                                                                  INDICATOR
0857  20433  070210          SZA  MTPX
0858  20434  066340          JMP  MTP3
0859*
0860  20435  061344  OVFW    JSM  CRLF1
0861  20436  066370          JMP  MTP2-1
0862*
0863  20437  021656  MTPX    LDA  T6        RESTORE MODE
0864  20440  031416          STA  MODE
0865  20441  164172          JMP  XEC4A,I
0866*
0867  20442  003433  LN72    DEF  RBUFF+RBUFF+73
```

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```
0869*
0870*  EXECUTE MAT READ
0871*
0872   20443  121472  EMATR   LDA  TEMPS,I
0873   20444  045472          ISZ  TEMPS
0874   20445  027730          LDB  B3A
0875   20446  063542          JSM  INFOV     ESTABLISH INFORMATION VECTOR
0876   20447  121472          LDA  TEMPS,I
0877   20450  050065          AND  OPMSK
0878   20451  010125          CPA  LBOP      IS IT [ ?
0879   20452  063625          JSM  REDIR     YES, GO REDIMENSION
0880   20453  063563          JSM  COMP2
0881   20454  022462          LDA  EMRX      GO EXECUTE DATA TRANSFERS
0882   20455  062617          JSM  COMM
0883   20456  025472          LDB  TEMPS
0884   20457  015421          CPB  PRADD
0885   20460  164172          JMP  XEC4A,I   DONE
0886   20461  066443          JMP  EMATR
0887*
0888   20462  062463  EMRX    JSM  *+1
0889   20463  160256          JSM  FDAAA,I
0890*
0891*  SUBROUTINE TO STASH AN ARRAY ELEMENT
0892*
0893*  ELEMENT IS AN AR2
0894*
0895*  ROW & COLUMN VALUES ARE IN T1 AND T2
0896*
0897   20464  027730  STASH   LDB  B3A       FIND TARGET ADDRESS
0898   20465  063705          JSM  WHERE
0899   20466  021643          LDA  B3        FIND TYPE OF ARRAY
0900   20467  064421          JMP  STORE+3
0901*
0902*
0903*  EXECUTE REDIM
0904*
0905   20470  121472  EREDM   LDA  TEMPS,I
0906   20471  045472          ISZ  TEMPS
0907   20472  027730          LDB  B3A
0908   20473  063542          JSM  INFOV     ESTABLISH INFORMATION VECTOR
0909   20474  063625          JSM  REDIR     GO REDIMENSION
0910   20475  025472          LDB  TEMPS
0911   20476  015421          CPB  PRADD
0912   20477  164172          JMP  XEC4A,I   DONE
0913   20500  066470          JMP  EREDM
```

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```
0915  20501  121472  EMATX  LDA  TEMPS,I  GET DESTINATION ARRAY
0916  20502  045472         ISZ  TEMPS
0917  20503  027730         LDB  B3A
0918  20504  063542         JSM  INFOV    ESTABLISH INFORMATION VECTOR
0919  20505  121472         LDA  TEMPS,I
0920  20506  045472         ISZ  TEMPS
0921  20507  050115         AND  B1777
0922  20510  072310         RZA  MATX1    REGULAR MAT ASSIGNMENT?
0923  20511  121472         LDA  TEMPS,I  NO
0924  20512  070442         SAR  10
0925  20513  010040         CPA  .31      SCALAR MULTIPLY?
0926  20514  066531         JMP  MATX0    NO
0927  20515  066644         JMP  ESMY     YES
0928*
0929  20516  063541  MATX1  JSM  INFO1    ESTABLISH INFORMATION VECTOR
0930  20517  025472         LDB  TEMPS
0931  20520  015421         CPB  PRADD    STATEMENT EXHAUSTED?
0932  20521  066605         JMP  EMRP     YES, GO DO MAT REPLACEMENT
0933  20522  121472         LDA  TEMPS,I  NO, GET SECOND OPERAND
0934  20523  027727         LDB  B2A
0935  20524  063542         JSM  INFOV    ESTABLISH INFORMATION VECTOR
0936  20525  121472         LDA  TEMPS,I  THEN GET MAT OPERATOR
0937  20526  070442         SAR  10
0938  20527  000134         ADA  M3
0939  20530  066535         JMP  MATJ
0940*
0941  20531  121472  MATX0  LDA  TEMPS,I  IDENTIFY SPECIAL NON-FORMULA
                                          OPERATOR
0942  20532  045472         ISZ  TEMPS
0943  20533  070202         SAR  5
0944  20534  050040         AND  .31
0945  20535  002537  MATJ   ADA  XTBL1
0946  20536  070016         EXA           BRANCH TO PROPER ROUTINE
0947  20537  066537  XTBL1  JMP  *
0948  20540  066722         JMP  ETRN     TRN
0949  20541  067110         JMP  EINV     INV
0950  20542  066553         JMP  EZER     ZER
0951  20543  066550         JMP  ECON     CON
0952  20544  066562         JMP  EIDN     IDN
0953*
0954  20545  066671         JMP  EADD     +
0955  20546  066673         JMP  ESUB     -
0956  20547  066760         JMP  EMUL     *
```

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```
0958*  EXECUTE ZER AND CON
0959*
0960   20550  063622  ECON    JSM   REDIM    REDIMENSION IF NECESSARY
0961   20551  024004          LDB   B10K
0962   20552  066555          JMP   *+3
0963   20553  063622  EZER    JSM   REDIM    REDIMENSION IF NECESSARY
0964   20554  074742          SBR   16
0965   20555  061256          JSM   CLAR2    SET UP AR2
0966   20556  035755          STB   AR2+1
0967   20557  063563          JSM   COMP2    SET UP BOUNDS INFO
0968   20560  062611          JSM   CMR1     DO THE TRANSFERS
0969   20561  164172          JMP   XEC4A,I  DONE
0970*
0971*  EXECUTE IDN
0972*
0973   20562  063622  EIDN    JSM   REDIM    REDIMENSION IF NECESSARY
0974   20563  061256          JSM   CLAR2    SET UP AR2
0975   20564  063563          JSM   COMP2    SET UP BOUNDS INFO
0976   20565  011653          CPA   T3       CHECK FOR SQUARE MATRIX
0977   20566  066570          JMP   *+2
0978   20567  067120          JMP   MERR5
0979   20570  062611          JSM   CMR1     TRANSFER THE ZEROS
0980   20571  024004          LDB   B10K
0981   20572  035755          STB   AR2+1
0982   20573  020012          LDA   .1       TRANSFER THE ONES
0983   20574  031646          STA   T1
0984   20575  031652          STA   T2
0985   20576  062464  EID3    JSM   STASH
0986   20577  021646          LDA   T1
0987   20600  011653          CPA   T3
0988   20601  164172          JMP   XEC4A,I  DONE
0989   20602  045646          ISZ   T1
0990   20603  045652          ISZ   T2
0991   20604  066576          JMP   EID3
0992*
0993*  EXECUTE REPLACEMENT
0994*
0995   20605  021642  EMRP    LDA   B1+2     CHECK FOR COMPATIBLE
                                              DIMENSIONS
0996   20606  063564          JSM   COMP1
0997   20607  062613          JSM   CMR4     DO THE TRANSFERS
0998   20610  164172          JMP   XEC4A,I
```

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```
1000*
1001*  COMMON ROUTINE TO TRANSFER B3 ← AR2
1002*
1003   20611  022641  CMR1    LDA  ERPX
1004   20612  066617          JMP  COMM
1005*
1006*  COMMON ROUTINE TO TRANSFER B3 ← B1
1007*
1008   20613  021641  CMR4    LDA  B1+1       CHECK FOR REDUNDANT TRANSFER
1009   20614  011644          CPA  B3+1
1010   20615  170402          RET
1011   20616  022640          LDA  ETRX
1012*
1013*  COMMON ROUTINE MAT EXECUTION (EXCEPT MULTIPLY, INVERSE, & PRINT)
1014*
1015*      LDA PAGE ADDRESS OF SOME ROUTINE
1016*      JSM COMM
1017*
1018   20617  031655  COMM    STA  T5
1019   20620  020012          LDA  .1         INITIALIZE OUTER LOOP
1020   20621  031646          STA  T1
1021   20622  020012  COM1    LDA  .1         INITIALIZE INNER LOOP
1022   20623  031652          STA  T2
1023   20624  021655  COM2    LDA  T5
1024   20625  070016          EXA             JSM TO DESIGNATED ROUTINE
1025   20626  021652          LDA  T2
1026   20627  011654          CPA  T4
1027   20630  066633          JMP  *+3
1028   20631  045652          ISZ  T2
1029   20632  066624          JMP  COM2
1030   20633  021646          LDA  T1
1031   20634  011653          CPA  T3
1032   20635  170402          RET
1033   20636  045646          ISZ  T1
1034   20637  066622          JMP  COM1
1035*
1036*
1037*  20640  062642  ETRX    JSM  *+2
1038   20641  062643  ERPX    JSM  *+2
1039   20642  063600          JSM  GETI1
1040   20643  066464          JMP  STASH
```

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```
1042*
1043     EXECUTE SCALAR MULTIPLY
1044*
1045   20644  061217  ESMY    JSM  FETCH   EVALUATE EXPRESSION
1046   20645  045472          ISZ  TEMPS
1047   20646  121472          LDA  TEMPS,I
1048   20647  063541          JSM  INFO1    ESTABLISH INFORMATION VECTOR
1049   20650  020214          LDA  AR2A
1050   20651  027734          LDB  TF1A
1051   20652  170004          XFR
1052   20653  021642          LDA  B1+2     CHECK FOR COMPATIBLE DIMENSIONS
1053   20654  063564          JSM  COMP1
1054   20655  022660          LDA  ESMX     DO THE SCALAR MULTIPLY
1055   20656  062617          JSM  COMM
1056   20657  164172          JMP  XEC4A,I
1057*
1058   20660  062661  ESMX    JSM  *+1
1059   20661  063600          JSM  GETII
1060   20662  020214          LDA  AR2A
1061   20663  027735          LDB  TF2A
1062   20664  170004          XFR
1063   20665  023734          LDA  TF1A
1064   20666  027735          LDB  TF2A
1065   20667  160220          JSM  .FMPA,I
1066   20670  066464          JMP  STASH
1067*
1068*    EXECUTE ADD AND SUBTRACT
1069*
1070   20671  020216  EADD    LDA  .FADA
1071   20672  066674          JMP  *+2
1072   20673  020217  ESUB    LDA  .FSBA
1073   20674  031656          STA  T6
1074   20675  021642          LDA  B1+2     CHECK FOR COMPATIBLE DIMENSIONS
1075   20676  011651          CPA  B2+2
1076   20677  066701          JMP  *+2
1077   20700  067567          JMP  MERR8
1078   20701  063564          JSM  COMP1
1079   20702  022705          LDA  EASX     DO THE ADD OR SUBTRACT
1080   20703  062617          JSM  COMM
1081   20704  164172          JMP  XEC4A,I
1082*
1083   20705  062706  EASX    JSM  *+1
1084   20706  063600          JSM  GETI1
1085   20707  020214          LDA  AR2A
1086   20710  027734          LDB  TF1A
1087   20711  170004          XFR
1088   20712  063602          JSM  GETI2
1089   20713  020214          LDA  AR2A
1090   20714  027735          LDB  TF2A
1091   20715  170004          XFR
1092   20716  023734          LDA  TF1A
1093   20717  027735          LDB  TF2A
1094   20720  161656          JSM  T6,I
1095   20721  066464          JMP  STASH
```

PAGE 302 EXECUTE TRANSPOSE

```
1097*
1098*    EXECUTE TRANSPOSE
1099*
1100*        DOES A(I,J)←A(J,I)
1101*
1102   20722  121472  ETRN    LDA  TEMP,I
1103   20723  063541          JSM  INFO1    ESTABLISH INFORMATION VECTOR
1104   20724  063563          JSM  COMP2    CHECK FOR COMPATIBLE DIMENSIONS
1105   20725  031656          STA  T6
1106   20726  035655          STB  T5
1107   20727  021642          LDA  B1+2
1108   20730  025642          LDB  B1+2
1109   20731  063565          JSM  COMPR
1110   20732  011655          CPA  T5
1111   20733  066735          JMP  *+2
1112   20734  067567          JMP  MERR8
1113   20735  015656          CPB  T6
1114   20736  066740          JMP  *+2
1115   20737  067567          JMP  MERR8
1116   20740  022743          LDA  ETNX     DO THE TRANSPOSE
1117   20741  062617          JSM  COMM
1118   20742  164172          JMP  XEC4A,I
1119*
1120   20743  062744  ETNX    JSM  *+1
1121   20744  063600          JSM  GETI1
1122   20745  062747          JSM  REVRS
1123   20746  062464          JSM  STASH
1124*
1125   20747  021646  REVRS   LDA  T1       SWAP INDEX POINTERS
1126   20750  025652          LDB  T2
1127   20751  031652          STA  T2
1128   20752  035646          STB  T1
1129   20753  021653          LDA  T3
1130   20754  025654          LDB  T4
1131   20755  031654          STA  T4
1132   20756  035653          STB  T3
1133   20757  170402          RET
```

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```
1135*
1136*   EXECUTE MULTIPLY
1137*
1138*   B3(I,K)=SUM B1(I,P)*B2(P,K) FOR P=1 TO N
1139*
1140  20760  021642  EMUL   LDA  B1+2     CHECK FOR COMPATIBLE DIMENSIONS
1141  20761  025642         LDB  B1+2
1142  20762  063565         JSM  COMPR    B1 IS (M,N)
1143  20763  031656         STA  T6       T6=N
1144  20764  035661         STB  T9       T9=M
1145  20765  021651         LDA  B2+2
1146  20766  025651         LDB  B2+2
1147  20767  063565         JSM  COMPR    B2 IS (N,L)
1148  20770  015656         CPB  T6
1149  20771  066773         JMP  *+2
1150  20772  067567         JMP  MERR8    N'S NOT SAME
1151  20773  031656         STA  T6       T6=L
1152  20774  035660         STB  T8       SAVE N
1153  20775  063563         JSM  COMP2    B3 IS (M,L)
1154  20776  015661         CPB  T9
1155  20777  067001         JMP  *+2
1156  21000  067567         JMP  MERR8
1157  21001  011656         CPA  T6
1158  21002  067004         JMP  *+2
1159  21003  067567         JMP  MERR8
1160  21004  061256         JSM  CLAR2    ZERO B3
1161  21005  062611         JSM  CMR1
1162  21006  021660         LDA  T8
1163  21007  031653         STA  T3       T3=N
1164  21010  020012         LDA  .1       DO THE MULTIPLY
1165  21011  031656         STA  T6       T6=1
1166  21012  020012  EML3   LDA  .1
1167  21013  031652         STA  T2       T2=K
1168  21014  020012  EML4   LDA  .1
1169  21015  031646         STA  T1       T1=P
1170  21016  063602  EML5   JSM  GETI2    B2(P,K)
1171  21017  020214         LDA  AR2A
1172  21020  027735         LDB  TF2A
1173  21021  170004         XFR
1174  21022  021653         LDA  T3       SWAP N,L
1175  21023  025654         LDB  T4
1176  21024  031654         STA  T4       T4=N
1177  21025  035653         STB  T3       T3=L
1178  21026  021656         LDA  T6       PERMUTE P,K,I
1179  21027  025646         LDB  T1
1180  21030  031646         STA  T1       T1=I
1181  21031  021652         LDA  T2
1182  21032  035652         STB  T2       T2=P
1183  21033  031656         STA  T6       T6=K
1184  21034  063600         JSM  GETI1    B1(I,P)
1185  21035  020214         LDA  AR2A
1186  21036  027734         LDB  TF1A
1187  21037  170004         XFR
1188  21040  023734         LDA  TF1A
1189  21041  027735         LDB  TF2A
1190  21042  160220         JSM  .FMPA,I  CALL TO MULTIPLY
```

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```
1191  21043  020214          LDA  AR2A
1192  21044  027735          LDB  TF2A
1193  21045  170004          XFR
1194  21046  021653          LDA  T3        SWAP L,N
1195  21047  025654          LDB  T4
1196  21050  031654          STA  T4        T4=L
1197  21051  035653          STB  T3        T3=N
1198  21052  021652          LDA  T2        SWAP P,K
1199  21053  025656          LDB  T6
1200  21054  031656          STA  T6        T6=P
1201  21055  035652          STB  T2        T2=K
1202  21056  063604          JSM  GETI3     B3(I,K)
1203  21057  020214          LDA  AR2A
1204  21060  027734          LDB  TF1A
1205  21061  170004          XFR
1206  21062  023734          LDA  TF1A
1207  21063  027735          LDB  TF2A
1208  21064  160216          JSM  .FADA,I   CALL TO ADD
1209  21065  062464          JSM  STASH
1210  21066  021646          LDA  T1        SWAP I,P
1211  21067  025656          LDB  T6
1212  21070  031656          STA  T6        T6=I
1213  21071  035646          STB  T1        T1=P
1214  21072  015653          SPB  T3        CHECK P
1215  21073  067076          JMP  *+3
1216  21074  045646          ISZ  T1
1217  21075  067016          JMP  EML5
1218  21076  021652          LDA  T2
1219  21077  011654          CPA  T4        CHECK K
1220  21100  067103          JMP  *+3
1221  21101  045652          ISZ  T2
1222  21102  067014          JMP  EML4
1223  21103  021656          LDA  T6
1224  21104  011661          CPA  T9        CHECK I
1225  21105  164172          JMP  XEC4A,I   DONE
1226  21106  045656          ISZ  T6
1227  21107  067012          JMP  EML3
```

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```
1229*
1230*  EXECUTE INVERSE
1231*
1232*       USES GAUSS-JORDAN WITH ROW INTERCHANGE
1233*
1234  21110  021412  EINV    LDA  LSTPT     SET UP FOR INVERSE EXECUTION
1235  21111  031656          STA  T6
1236  21112  121472          LDA  TEMPS,I
1237  21113  063541          JSM  INFO1     ESTABLISH INFORMATION VECTOR
1238  21114  021642          LDA  B1+2      CHECK FOR COMPATIBLE DIMENSIONS
1239  21115  063564          JSM  COMP1
1240  21116  011653          CPA  T3
1241  21117  067122          JMP  *+3
1242  21120  160205  MERR5   JSM  AERRA,I   MATRIX NOT SQUARE
1243  21121  177676          DEC  -66
1244*
1245  21122  063127          JSM  XIN2      CALL DET/INV EXECUTION
1246  21123  067736          JMP  MER10     SINGULAR MATRIX
1247  21124  021656          LDA  T6
1248  21125  031412          STA  LSTPT     RESTORE LSTPT
1249  21126  164172          JMP  XEC4A,I
1250*
1251*
1252  21127  021412  XIN2    LDA  LSTPT     RESERVE INTERCHANGE VECTOR
1253  21130  031676          STA  ADL
1254  21131  001654          ADA  T4
1255  21132  031412          STA  LSTPT     SAVE NEW LSTPT
1256  21133  060554          JSM  BHSTP+1   CHECK FOR OVERLAP
1257  21134  062613          JSM  CMR4      COPY B1 INTO B3
1258  21135  020020          LDA  ONE       SET DEL = 1.0
1259  21136  027731          LDB  DELA
1260  21137  170004          XFR
1261  21140  020012          LDA  .1        DO THE INVERSE
1262  21141  031653  EN1     STA  T3        T3=K
1263  21142  070137          LDB  A
1264  21143  005676          ADB  ADL
1265  21144  074557          STA  B,I       L(K)=K
1266  21145  031646          STA  T1
1267  21146  031652          STA  T2
1268  21147  063604          JSM  GETI3
1269  21150  020214          LDA  AR2A
1270  21151  027732          LDB  BIGA      BIG=A(K,K)
1271  21152  170004          XFR
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```
1273  21153  Ø23732  EIN3    LDA  BIGA      SEARCH FOR LARGEST ELEMENT
1274  21154  Ø27734           LDB  TF1A
1275  21155  17ØØØ4           XFR
1276  21156  Ø2163Ø           LDA  TF1
1277  21157  Ø7Ø131           SLA  *+2,C     FORM ABS(BIG)
1278  2116Ø  Ø3163Ø           STA  TF1
1279  21161  Ø6361Ø4          JSM  GETI3
128Ø  21162  Ø2Ø214           LDA  AR2A
1281  21163  Ø27735           LDB  TF2A
1282  21164  17ØØØ4           XFR
1283  21165  Ø2Ø214           LDA  AR2A
1284  21166  Ø27733           LDB  HLDA
1285  21167  17ØØØ4           XFR
1286  2117Ø  Ø21634           LDA  TF2
1287  21171  Ø7Ø131           SLA  *+2,C     FORM ABS(A(I,K))
1288  21172  Ø31634           STA  TF2
1289  21173  Ø23734           LDA  TF1A
129Ø  21174  Ø27735           LDB  TF2A
1291  21175  16Ø217           JSM  .FSBA,I   ABS(BIG)—ABS(A(I,K))
1292  21176  Ø21754           LDA  AR2
1293  21177  Ø7Ø411           SLA  *+8
1294  212ØØ  Ø23733           LDA  HLDA
1295  212Ø1  Ø27732           LDB  BIGA
1296  212Ø2  17ØØØ4           XFR            BIG=A(I,K)
1297  212Ø3  Ø21646           LDA  T1
1298  212Ø4  Ø25653           LDB  T3
1299  212Ø5  ØØ5676           ADB  ADL
13ØØ  212Ø6  Ø74557           STA  B,I       L(K)=I
13Ø1  212Ø7  Ø21646           LDA  T1        CHECK I
13Ø2  212Ø8  Ø11654           CPA  T4
13Ø3  21211  Ø67214           JMP  EEIR
13Ø4  21212  Ø45646           ISZ  T1
13Ø5  21213  Ø67153           JMP  EIN3
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```
1307  21214  025653  EEIR   LDB  T3      INTERCHANGE ROWS
1308  21215  005676         ADB  ADL
1309  21216  074517         LDA  B,I
1310  21217  011653         CPA  T3
1311  21220  067261         JMP  DCPV
1312  21221  031655         STA  T5      T5=J
1313  21222  020012         LDA  .1
1314  21223  031652         STA  T2      T2=I
1315  21224  021653  EIN4   LDA  T3
1316  21225  031646         STA  T1
1317  21226  063604         JSM  GETI3
1318  21227  021755         LDA  AR2+1   FORM U-
1319  21230  070250         SZA  *+5
1320  21231  021754         LDA  AR2
1321  21232  072111         SLA  *+2,S
1322  21233  070071         SLA  *+1,C
1323  21234  031754         STA  AR2
1324  21235  020214         LDA  AR2A
1325  21236  027733         LDB  HLDA    HLD=-A(K,I)
1326  21237  170004         XFR
1327  21240  021655         LDA  T5
1328  21241  031646         STA  T1
1329  21242  063604         JSM  GETI3
1330  21243  021653         LDA  T3
1331  21244  031646         STA  T1
1332  21245  062464         JSM  STASH   A(K,I)=A(J,I)
1333  21246  023733         LDA  HLDA
1334  21247  024214         LDB  AR2A
1335  21250  170004         XFR
1336  21251  021655         LDA  T5
1337  21252  031646         STA  T1
1338  21253  062464         JSM  STASH   A(J,I)=HLD
1339  21254  021652         LDA  T2      CHECK I
1340  21255  011654         CPA  T4
1341  21256  067261         JMP  DCPV
1342  21257  045652         ISZ  T2
1343  21260  067224         JMP  EIN4
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```
1345  21261  Ø23732  DCPV   LDA  BIGA    DIVIDE COLUMN BY MINUS PIVOT
                                          VALUE
1346  21262  Ø27734         LDB  TF1A
1347  21263  17ØØØ4         XFR
1348  21264  Ø2163Ø         LDA  TF1
1349  21265  Ø7Ø131         SLA  *+2,C    FORM ABS(BIG)
135Ø  21266  Ø3163Ø         STA  TF1
1351  21267  Ø23735         LDA  TF2A
1352  21270  17ØØØØ         CLR
1353  21271  Ø2774Ø         LDB  EPSE
1354  21272  Ø35634         STB  TF2
1355  21273  Ø24ØØ4         LDB  B1ØK
1356  21274  Ø35635         STB  TF2+1    TOLERANCE = 1E–48
1357  21275  Ø23734         LDA  TF1A
1358  21276  Ø27735         LDB  TF2A
1359  21277  16Ø217         JSM  .FSBA,I
136Ø  213ØØ  Ø21754         LDA  AR2
1361  213Ø1  Ø7Ø211         SLA  *+4
1362  213Ø2  Ø23731         LDA  DELA
1363  213Ø3  17ØØØØ         CLR
1364  213Ø4  17Ø4Ø2         RET           SINGULAR MATRIX DETECTED
1365  213Ø5  Ø21653         LDA  T3
1366  213Ø6  Ø31652         STA  T2       T2=K
1367  213Ø7  Ø2ØØ12         LDA  .1
1368  2131Ø  Ø31646         STA  T1       T1=I
1369  21311  Ø21653  EIN6   LDA  T3
137Ø  21312  Ø11646         CPA  T1
1371  21313  Ø67332         JMP  EIN7
1372  21314  Ø636Ø4         JSM  GETI3
1373  21315  Ø2Ø214         LDA  AR2A
1374  21316  Ø27734         LDB  TF1A
1375  21317  17ØØØ4         XFR
1376  2132Ø  Ø23734         LDA  TF1A
1377  21321  Ø27732         LDB  BIGA
1378  21322  16Ø221         JSM  .FDVA,I
1379  21323  Ø21755         LDA  AR2+1    FORM U–
138Ø  21324  Ø7Ø25Ø         SZA  *+5
1381  21325  Ø21754         LDA  AR2
1382  21326  Ø72111         SLA  *+2,S
1383  21327  Ø7ØØ71         SLA  *+1,C
1384  2133Ø  Ø31754         STA  AR2
1385  21331  Ø62464         JSM  STASH    A(I,K)=–A(I,K)/RIG
1386  21332  Ø21646  EIN7   LDA  T1       CHECK I
1387  21333  Ø11654         CPA  T4
1388  21334  Ø67337         JMP  REDU
1389  21335  Ø45646         ISZ  T1
139Ø  21336  Ø67311         JMP  EIN6
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```
1392  21337  020012  REDU   LDA  .1          REDUCE MATRIX
1393  21340  031646         STA  T1          T1=I
1394  21341  031655         STA  T5          T5=I
1395  21342  021653  EIN8   LDA  T3
1396  21343  011646         CPA  T1
1397  21344  067411         JMP  EIN11
1398  21345  031652         STA  T2          T2=K
1399  21346  063604         JSM  GETI3
1400  21347  020214         LDA  AR2A
1401  21350  027733         LDB  HLDA        HLD=A(I,K)
1402  21351  170004         XFR
1403  21352  020012         LDA  .1
1404  21353  031652         STA  T2          T2=J
1405  21354  021653  EIN9   LDA  T3
1406  21355  011652         CPA  T2
1407  21356  067404         JMP  EIN10
1408  21357  031646         STA  T1          T1=K
1409  21360  063604         JSM  GETI3
1410  21361  020214         LDA  AR2A
1411  21362  027734         LDB  TF1A
1412  21363  170004         XFR
1413  21364  023733         LDA  HLDA
1414  21365  027734         LDB  TF1A
1415  21366  160220         JSM  .FMPA,I
1416  21367  020214         LDA  AR2A
1417  21370  027734         LDB  TF1A        HLD*A(K,J)
1418  21371  170004         XFR
1419  21372  021655         LDA  T5
1420  21373  031646         STA  T1          T1=I
1421  21374  063604         JSM  GETI3
1422  21375  020214         LDA  AR2A
1423  21376  027735         LDB  TF2A
1424  21377  170004         XFR
1425  21400  023734         LDA  TF1A
1426  21401  027735         LDB  TF2A
1427  21402  160216         JSM  .FADA,I
1428  21403  062464         JSM  STASH       A(I,J)=HLD*A(K,J)+A(I,J)
1429  21404  021652  EIN10  LDA  T2          CHECK J
1430  21405  011654         CPA  T4
1431  21406  067411         JMP  *+3
1432  21407  045652         ISZ  T2
1433  21410  067354         JMP  EIN9
1434  21411  021646  EIN11  LDA  T1          CHECK I
1435  21412  011654         CPA  T4
1436  21413  067417         JMP  *+4
1437  21414  045646         ISZ  T1
1438  21415  045655         ISZ  T5
1439  21416  067342         JMP  EIN8
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```
1441  21417  021653          LDA  T3        DIVIDE ROW BY PIVOT
1442  21420  031646          STA  T1        T1=K
1443  21421  020012          LDA  .1
1444  21422  031652          STA  T2        T2=J
1445  21423  021653  EIN12    LDA  T3
1446  21424  011652          CPA  T2
1447  21425  067436          JMP  EIN13
1448  21426  063604          JSM  GETI3
1449  21427  020214          LDA  AR2A
1450  21430  027734          LDB  TF1A
1451  21431  170004          XFR
1452  21432  023734          LDA  TF1A
1453  21433  027732          LDB  BIGA
1454  21434  160221          JSM  .FDVA,I
1455  21435  062464          JSM  STASH     A(K,J)=A(K,J)/BIG
1456  21436  021652  EIN13    LDA  T2        CHECK J
1457  21437  011654          CPA  T4
1458  21440  067443          JMP  *+3
1459  21441  045652          ISZ  T2
1460  21442  067423          JMP  EIN12
1461  21443  023731          LDA  DELA      PRODUCT OF PIVOTS
1462  21444  027732          LDB  BIGA
1463  21445  160220          JSM  .FMPA,I
1464  21446  020214          LDA  AR2A
1465  21447  027731          LDB  DELA
1466  21450  170004          XFR
1467  21451  023734          LDA  TF1A
1468  21452  170000          CLR
1469  21453  024014          LDB  B10K
1470  21454  035631          STB  TF1+1
1471  21455  023734          LDA  TF1A
1472  21456  027732          LDB  BIGA
1473  21457  160221          JSM  .FDVA,I
1474  21460  021653          LDA  T3
1475  21461  031646          STA  T1
1476  21462  031652          STA  T2
1477  21463  062464          JSM  STASH     A(K,K)=1./BIG
1478  21464  021653          LDA  T3        CHECK K
1479  21465  011654          CPA  T4
1480  21466  067471          JMP  *+3
1481  21467  070070  SIA      *+1
1482  21470  067141          JMP  EIN1
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1484	21471	Ø55653	EIN14	DSZ	T3	FINAL ROW INTERCHANGE
1485	21472	Ø67474		JMP	*+2	
1486	21473	Ø64357		JMP	RETN2	DONE
1487	21474	Ø25653		LDB	T3	
1488	21475	ØØ5676		ADB	ADL	
1489	21476	Ø74517		LDA	B,I	
149Ø	21477	Ø11653		CPA	T3	
1491	21500	Ø67471		JMP	EIN14	
1492	21501	Ø31655		STA	T5	T5=L(K)
1493	21502	Ø20012		LDA	.1	
1494	21503	Ø31646		STA	T1	T1=J
1495	21504	Ø21653	EIN15	LDA	T3	
1496	21505	Ø31652		STA	T2	T2=K
1497	21506	Ø63604		JSM	GETI3	
1498	21507	Ø20214		LDA	AR2A	
1499	21510	Ø27733		LDB	HLDA	HLD=A(J,K)
15ØØ	21511	17ØØØ4		XFR		
1501	21512	Ø21655		LDA	T5	
1502	21513	Ø31652		STA	T2	T2=I
1503	21514	Ø63604		JSM	GETI3	
1504	21515	Ø21755		LDA	AR2+1	FORM U–
1505	21516	Ø70250		SZA	*+5	
1506	21517	Ø21754		LDA	AR2	
1507	21520	Ø72111		SLA	*+2,S	
1508	21521	Ø70071		SLA	*+1,C	
1509	21522	Ø31754		STA	AR2	
1510	21523	Ø21653		LDA	T3	
1511	21524	Ø31652		STA	T2	T2=K
1512	21525	Ø62464		JSM	STASH	A(J,K)=–A(J,I)
1513	21526	Ø21655		LDA	T5	
1514	21527	Ø31652		STA	T2	T2=I
1515	21530	Ø23733		LDA	HLDA	
1516	21531	Ø24214		LDB	AR2A	
1517	21532	17ØØØ4		XFR		
1518	21533	Ø62464		JSM	STASH	A(J,I)=HLD
1519	21534	Ø21646		LDA	T1	CHECK J
1520	21535	Ø11654		CPA	T4	
1521	21536	Ø67471		JMP	EIN14	
1522	21537	Ø45646		ISZ	T1	
1523	21540	Ø67504		JMP	EIN15	

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1525*
1526*  SUBROUTINE TO EXTRACT ARRAY INFORMATION
1527*
1528*       LDA NAME INFORMATION
1529*       LDB INFORMATION VECTOR ADDRESS
1530*       JSM INFOV
1531*
1532   21541  027726  INFO1   LDB  B1A        ALTERNATE ENTRY FOR B1
1533   21542  035657  INFOV   STB  T7         TEMPORARY SAVE
1534   21543  050115          AND  B1777
1535   21544  160177          JSM  SSYMA,I    SEARCH SYMBOL TABLE
1536   21545  164340          JMP  E401,I     ERROR, NOT FOUND (UNDEFINED
                                                                  OPERAND)
1537   21546  074517          LDA  B,I        GET TYPE INFORMATION
1538   21547  050040          AND  .31        ISOLATE TYPE-FIELD
1539   21550  070042          SAR  2          LOOK AT SIZE
1540   21551  131657          STA  T7,I        AND SAVE IT
1541   21552  045657          ISZ  T7
1542   21553  004132          ADB  M1
1543   21554  074517          LDA  B,I        GET VALUE TABLE ADDRESS
1544   21555  131657          STA  T7,I        AND SAVE AS BASE ADDRESS
1545   21556  045657          ISZ  T7
1546   21557  000132          ADA  M1
1547   21560  070517          LDA  A,I        GET ACTUAL DIMENSIONS
1548   21561  131657          STA  T7,I        AND SAVE THEM
1549   21562  170402          RET
1550*
1551*  SUBROUTINE TO EXTRACT AND COMPARE DIMENSIONS OF TWO MATRICES
1552*
1553*       LDA DIMENSION INFORMATION #1
1554*       LDB DIMENSION INFORMATION #2
555*        JSM COMPR
1556*
1557   21563  021654  COMP2   LDA  B3+2
1558   21564  025645  COMP1   LDB  B3+2
1559   21565  074057  COMPR   CPA  B          EQUAL?
1560   21566  067571          JMP  *+3        YES
1561   21567  160205  MERR8   JSM  AERRA,I    INCOMPATIBLE DIMENSIONS
1562   21570  177673          DEC  -69
1563   21571  074342          SBR  8
1564   21572  074070          SIB  *+1
1565   21573  035653          STB  T3         SAVE # OF ROWS
1566   21574  050105          AND  B377
1567   21575  070070          SIA  *+1
1568   21576  031654          STA  T4         SAVE # OF COLUMNS
1569   21577  170402          RET
```

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```
1571*
1572*  SUBROUTINE TO OBTAIN AN ARRAY ELEMENT
1573*
1574*  ELEMENT PLACED IN AR2
1575*
1576*  ROW & COLUMN VALUES ARE IN T1 AND T2
1577*
1578*       JSM GETI(N)
1579*
1580   21600  027726  GET11   LDB  B1A
1581   21601  067605          JMP* *+4
1582   21602  027727  GET12   LDB  B2A
1583   21603  067605          JMP  *+2
1584   21604  027730  GET13   LDB  B3A
1585   21605  063705          JSM  WHERE
1586   21606  074517          LDA  B,I       CHECK IF UNDEFINED
1587   21607  010062          CPA  FLGBT
1588   21610  164337          JMP  E40,I     ERROR, NOT DEFINED (NO VALUE
                                               ASSIGNED)
1589   21611  121657          LDA  T7,I      FIND TYPE OF ARRAY
1590   21612  072110          RZA  *+2
1591   21613  067620          JMP  GTRL      REAL
1592   21614  010012          CPA  .1
1593   21615  164231          JMP  SPLFA,I   SPLIT
1594   21616  074537          LDB  B,I
1595   21617  164227          JMP  FXFLA,I   INTEGER
1596   21620  074117  GTRL    LDA  B
1597   21621  064445          JMP  XFAR2+1
```

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```
1599*
1600*  SUBROUTINE TO REDIMENSION AN ARRAY
1601*
1602   21622  021472  REDIM   LDA  TEMPS
1603   21623  011421          CPA  PRADD
1604   21624  170402          RET
1605   21625  063673  REDIR   JSM  MCKS      GET ROW DIMENSION
1606   21626  035646          STB  T1        SAVE IT
1607   21627  024012          LDB  .1        LOAD DEFAULT COLUMN COUNT
1608   21630  121472          LDA  TEMPS,I   HOW MANY DIMENSIONS?
1609   21631  050065          AND  OPMSK
1610   21632  010121          CPA  B4000
1611   21633  063673          JSM  MCKS
1612   21634  045472          ISZ  TEMPS
1613   21635  035652          STB  T2        SAVE COLUMN DIMENSION
1614   21636  021646          LDA  T1        RECALL ROW DIMENSION
1615   21637  061201          JSM  IMPY
1616   21640  031657          STA  T7        SAVE NEW PRODUCT
1617   21641  025644          LDB  B3+1      RECALL FORMAL DIMENSIONS
1618   21642  004133          ADB  M2
1619   21643  074517          LDA  B,I
1620   21644  070137          LDB  A
1621   21645  050105          AND  B377
1622   21646  074342          SBR  8
1623   21647  070070          SIA  *+1
1624   21650  074070          SIB  *+1
1625   21651  061201          JSM  IMPY      RETURNS WITH FORMAL PRODUCT
1626   21652  070056          CMA
1627   21653  001657          ADA  T7        COMPARE WITH NEW PRODUCT
1628   21654  070112          SAM  *+2       NEW>OLD?
1629   21655  067703          JMP  MERR7     YES, ERROR
1630   21656  021646          LDA  T1        NO, ESTABLISH NEW ACTUAL
                                              DIMENSIONS
1631   21657  025652          LDB  T2
1632   21660  031653          STA  T3        FIRST INTO T3 & T4
1633   21661  035654          STB  T4
1634   21662  000132          ADA  M1
1635   21663  004132          ADB  M1
1636   21664  070404          SAL  8         THEN PACK THE DIMENSIONS
1637   21665  074217          IOR  B
1638   21666  025644          LDB  B3+1      GET VALUE TABLE ADDRESS
1639   21667  004132          ADB  M1
1640   21670  074557          STA  B,I       STASH PACKED DIMENSIONS
1641   21671  031645          STA  B3+2
1642   21672  170402          RET
1643*
1644*
1645   21673  061217  MCKS    JSM  FETCH     EVALUATE SUBSCRIPT EXPRESSION
1646   21674  160225          JSM  FLTRA,I   CONVERT TO ROUNDED INTEGER
1647   21675  067703          JMP  MERR7     INTEGER OVERFLOW
1648   21676  074117          LDA  B
1649   21677  000132          ADA  M1        <1?
1650   21700  070152          SAM  *+3       YES
1651   21701  000157          ADA  M256      >256?
1652   21702  071412          SAM  MCKS-1
1653   21703  160205  MERR7   JSM  AERRA,I   NEW DIMENSIONS IMPOSSIBLE
1654   21704  177675          DEC  -67
```

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```
1656*
1657*   SUBROUTINE TO COMPUTE ADDRESS OF A MATRIX ELEMENT
1658*
1659*   ROW & COLUMN VALUES ARE IN T1 AND T2 RESPECTIVELY
1660*
1661*       LDB INFORMATION VECTOR ADDRESS
1622*       JSM WHERE
1663*
1664*   RETURNS WITH ADDRESS IN (A) & (B)
1665*
1666*   ADDRESS=BASE+SIZE*(T4*(T1—1)+(T2—1))
1667*
1668   21705  035657  WHERE   STB  T7      TEMPORARY SAVE
1669   21706  021646          LDA  T1
1670   21707  000132          ADA  M1
1671   21710  025654          LDB  T4
1672   21711  061201          JSM  IMPY    RETURNS WITH T4*(T1—1)
1673   21712  001652          ADA  T2
1674   21713  000132          ADA  M1
1675   21714  125657          LDB  T7,I
1676   21715  076110          RZB  *+2
1677   21716  070704          SAL  2
1678   21717  014012          CPB  .1
1679   21720  070744          SAL  1
1680   21721  025657          LDB  T7
1681   21722  074070          SIB  *+1
1682   21723  074417          ADA  B,I
1683   21724  070137          LDB  A
1684   21725  170402          RET
```

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```
1686*
1687*   MATRIX CONSTANTS
1688*
1689    21726  001640  B1A     DEF  B1
1690    21727  001647  B2A     DEF  B2
1691    21730  001643  B3A     DEF  B3
1692    21731  001662  DELA    DEF  DEL
1693    21732  001666  BIGA    DEF  BIG
1694    21733  001672  HLDA    DEF  HLD
1695    21734  001630  TF1A    DEF  TF1
1696    21735  001634  TF2A    DEF  TF2
1697*
1698    21736  160205  MER10   JSM  AERRA,I SINGULAR MATRIX
1699    21737  177674          DEC  -68
1700*
1701    21740  150000  EPSE    OCT  150000   EXPONENT FOR SINGULARITY
                                                TOLERANCE
1702    00025          LEFT    EQU  21766B-*
1703*
1704*
1705    01640                  ORG  1640B
1706*
1707    01640  000000  B1      BSS  3        B1 & B3 MUST COME FIRST
1708    01643  000000  B3      BSS  3
1709    01646  000000  T1      NOP
1701    01647  000000  B2      BSS  3
1711    01652  000000  T2      NOP
1712    01653  000000  T3      NOP
1713    01654  000000  T4      NOP
1714    01655  000000  T5      NOP
1715    01656  000000  T6      NOP
1716    01657  000000  T7      NOP
1717    01660  000000  T8      NOP
1718    01661  000000  T9      NOP
1719    01662  000000  DEL     BSS  4
1720    01666  000000  BIG     BSS  4
1721    01672  000000  HLD     BSS  4
1722    01676  000000  ADL     NOP
1723*
1724    01630                  ORG  1630B
1725*
1726    01630  000000  TF1     BSS  4
1727    01634  000000  TF2     BSS  4
1728*
1729    01640  070053          SAP  *+1      CONVENIENT "NOP" FOR REFERENCE
```

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```
1731   21766                      ORG  21766B
1732*
1733   21766  176455              ABS  EMATR-*  MAT READ EXECUTION
1734   21767  176347              ABS  EMATP-*  MAT PRINT EXECUTION
1735   21770  176500              ABS  EREDM-*  REDIM EXECUTION
1736   21771  176510              ABS  EMATX-*  MAT ARITHMETIC EXECUTION
1737   21772  000000              NOP           ** CHECKSUM WORD **
1738*
1739   21773  176030              ABS  NFOPT-*  NON-FORMULA OPERATOR TABLE
1740   21774  176041              ABS  FUNCT-*  FUNCTION-NAME TABLE
1741   21774  176042              ABS  BN777-*  COMMAND-NAME TABLE (NULL
                                                                    TABLE)
1742   21776  176006              ABS  SYSNT-*  STATEMENT-NAME TABLE
1743   21777  006000  OPCOD       OCT  6000    MAT OPCODE=3
1744                              END
*  NO ERRORS
```

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BIGA	1693	1270	1273	1295	1345	1377	1453	1462	1472
BLANK	0386								
BN777	0550	1741							
C5	0015								
C6	0011	0114							
C7	0022	0100							
CHRSA	0219								
CLAR2	0489	0965	0974	1160					
CLERA	0160	0821							
CLINE	0316								
CLP1A	0217								
CMR1	1003	0968	0979	1161					
CMR4	1008	0997	1257						
COM1	1021	1034							
COM2	1023	1029							
COMCE	0434	0580	0603						
COMCK	0433	0723							
COMM	1018	0882	1004	1055	1080	1117			
COMMA	0507	0588							
COMP1	1558	0760	0996	1053	1078	1239			
COMP2	1557	0880	0967	0975	1104	1153			
COMPR	1559	0810	1109	1142	1147				
CONST	0482								
CPLAC	0331								
CRCKA	0228								
CRLF	0495								
CRLF1	0496	0843	0844	0851	0860				
CRTN	0037	0038	0039						
CTYPE	0330								
DCOMA	0210								
DCPV	1345	1311	1341						
DEL	1719	1692							
DELA	1692	0785	1259	1362	1461	1465			
DELSA	0175								
DETT	0736	0513							
DETX	0749	0737							
DFLAG	0388								
DIGCK	0461								
DPERR	0043								
DRQST	0317								
DSTRT	0303								
E	0080								
E1	0235								
E10	0244	0589							
E15	0249	0602							
E20	0254								
E25	0259	0611	0707						
E30	0264	0617	0649	0659	0671	0686	0693		
E35	0269								
E40	0274	1536	1588						
E45	0279								
E5	0239								
E50	0284								
EADD	1070	0954							
EASX	1083	1079							
ECALA	0215								

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MATS	Ø559	Ø516					
MATSØ	Ø585	Ø572	Ø593				
MATS1	Ø576	Ø581					
MATS2	Ø6Ø9	Ø569					
MATS3	Ø637	Ø629					
MATS4	Ø654	Ø646					
MATS5	Ø665	Ø648					
MATS6	Ø676	Ø694					
MATS7	Ø689	Ø674					
MATS8	Ø645	Ø623					
MATSB	Ø718	Ø577	Ø6ØØ	Ø632			
MATXØ	Ø941	Ø926					
MATX1	Ø929	Ø922					
MAW	Ø294						
MAXIN	Ø398						
MAXSN	Ø147						
MBIN1	Ø4Ø4						
MBIN2	Ø4Ø5						
MBOX1	Ø349						
MCKS	1645	16Ø5	1611	1652			
MDIMA	Ø2Ø8						
MER1Ø	1698	1246					
MERB	Ø443						
MERR5	1242	Ø763	Ø978				
MERR7	1653	1629	1647				
MERR8	1561	1Ø77	1112	1115	115Ø	1156	1159
MINIT	Ø453						
MODE	Ø3Ø5	Ø736	Ø793	Ø825	Ø864		
MOVST	Ø788	Ø751					
MSFLG	Ø387						
MTP1	Ø819	Ø85Ø					
MTP2	Ø822	Ø842	Ø861				
MTP3	Ø795	Ø858					
MTPX	Ø863	Ø837	Ø854	Ø857			
MVTOH	Ø475						
NDISP	Ø38Ø						
NDWRT	Ø494						
NEXT1	Ø448						
NEXTA	Ø465						
NEXTL	Ø447						
NFOPA	Ø554	Ø62Ø					
NFOPT	Ø536	Ø554	Ø554	1739			
NMOTA	Ø2ØØ	Ø826					
NOEOF	Ø48Ø	Ø633	Ø68Ø				
NPRIN	Ø381						
NPWRT	Ø493						
NUM	Ø394	Ø395	Ø559				
NUMCA	Ø211						
NUMOA	Ø212						
NXTDT	Ø3Ø4						
NXTST	Ø4Ø3						
OBLNK	Ø466						
ODGIT	Ø49Ø						
ONE	ØØ45	1258					
ONEXT	Ø467						
OPCHA	Ø171						

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OPCOD	1743	Ø739					
OPDMK	ØØ79						
OPMSK	ØØ76	Ø877	16Ø9				
OPTYP	Ø395						
OTPTR	Ø293						
OUTCR	Ø468						
OUT1A	Ø179						
OVCHA	Ø216						
OVFW	Ø86Ø	Ø829					
PARMA	Ø3Ø6						
PARMN	Ø3Ø7						
PBPTO	Ø313						
PBPTR	Ø31Ø						
PBUFF	Ø311						
PBUFO	Ø312						
PEND	Ø363	Ø815	Ø828				
PEXMA	Ø165						
PFLAG	Ø389	Ø676	Ø681				
PGINØ	Ø476						
PGINT	Ø456						
PI/2	ØØ44						
PLACE	Ø382	Ø813					
PLUS	Ø5Ø9	Ø67Ø					
PMODE	Ø329						
PPFF	Ø364						
PRADD	Ø3Ø8	Ø8Ø5	Ø853	Ø884	Ø911	Ø931	16Ø3
PRFLG	Ø332	Ø8Ø1					
QTCHA	Ø23Ø						
QTOP	Ø1Ø9	Ø161					
QUOTE	Ø5Ø6	Ø5Ø7	Ø5Ø8	Ø5Ø9	Ø51Ø		
RBOP	Ø117	Ø728					
RBUFF	Ø358	Ø867	Ø867				
RCOUT	Ø333						
ROYDA	Ø166						
REDIN	16Ø2	Ø96Ø	Ø963	Ø973			
REDIR	16Ø5	Ø879	Ø9Ø9				
REDS	Ø599	Ø515	Ø6Ø4				
REDU	1392	1388					
REED	Ø161						
RES	Ø415						
RESB1	Ø451						
RESBP	Ø452						
RET2	Ø419						
RETN2	Ø418	Ø719	1486				
RETN3	Ø417	Ø746					
REVRS	1125	1122					
RPCK	Ø437						
RPCKE	Ø438	Ø64Ø	Ø656	Ø726	Ø745		
RPOP	Ø115						
RSAVE	Ø292						
RSLTE	Ø371						
RSPTR	Ø416						
RSTAK	Ø414						
RSTKA	Ø158						
RSULT	Ø424						
RUNA	Ø163						

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	13Ø2	134Ø	1387	143Ø	1435	1457	1479	152Ø	1568	1633	1671
T5	1714	Ø8Ø7	Ø832	1Ø18	1Ø23	11Ø6	111Ø	1312	1327	1336	1394
	1419	1438	1492	15Ø1	1513						
T6	1715	Ø753	Ø778	Ø794	Ø863	1Ø73	1Ø94	11Ø5	1113	1143	1148
	1151	1157	1165	1178	1183	1199	12ØØ	1211	1212	1223	1226
	1235	1247									
T7	1716	1533	154Ø	1541	1544	1545	1548	1589	1616	1627	1668
	1675	168Ø									
T8	1717	Ø562	Ø567	Ø621	1152	1162					
T9	1718	Ø627	Ø641	1144	1154	1224					
TEMP	Ø348	Ø349	Ø685	Ø692	Ø712						
TEMP1	Ø35Ø	Ø7Ø8									
TEMP2	Ø351	Ø713									
TEMP3	Ø352										
TEMP4	Ø353										
TEMPS	Ø347	Ø754	Ø755	Ø756	Ø795	Ø796	Ø798	Ø8Ø4	Ø852	Ø855	Ø872
	Ø873	Ø876	Ø883	Ø9Ø5	Ø9Ø6	Ø91Ø	Ø915	Ø916	Ø919	Ø92Ø	Ø923
	Ø93Ø	Ø933	Ø936	Ø941	Ø942	1Ø46	1Ø47	11Ø2	1236	16Ø2	16Ø8
	1612										
TERM	Ø362										
TF1	1726	1276	1278	1348	135Ø	147Ø	1695				
TF1A	1695	1Ø5Ø	1Ø63	1Ø86	1Ø92	1186	1188	12Ø4	12Ø6	1274	1289
	1346	1357	1374	1376	1411	1414	1417	1425	145Ø	1452	1467
	1471										
TF2	1727	1286	1288	1354	1356	1696					
TF2A	1696	1Ø61	1Ø64	1Ø9Ø	1Ø93	1172	1189	1192	12Ø7	1281	129Ø
	1351	1358	1423	1426							
TFLAG	Ø318										
TFLG1	Ø322										
TIMES	Ø51Ø	Ø658									
TMPA	Ø2Ø3										
TMPOP	Ø184										
TREGE	Ø37Ø										
TSRHA	Ø168										
TSTPT	Ø3ØØ										
TTY	Ø497										
TYPFL	ØØ78										
UFLAG	Ø39Ø										
UKPTR	Ø3Ø9										
UNITS	Ø319										
UNSTK	Ø446										
UPARA	Ø191										
VALUE	Ø297										
VAROA	Ø214										
WBUFF	Ø421										
WHERE	1668	Ø898	1585								
WIDTH	Ø383										
WRITE	Ø159										
XC	Ø41Ø	Ø831									
XEC4A	Ø164	Ø865	Ø885	Ø912	Ø969	Ø988	Ø998	1Ø56	1Ø81	1118	1225
	1249										
XEC6A	Ø221										
XFAR1	Ø423										
XFAR2	Ø427	Ø786	1597								
XIN2	1252	Ø776	1245								
XSCRA	Ø22Ø										

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XTBL1	Ø947	Ø945
YC	Ø412	
ZAP	Ø152	
ZONK	Ø488	

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```
0501                                LST
0502*
0503   22000          ORG     22000B
0504*
0505*       LINKS FOR THE MAIN SYSTEM AND
0506*       OTHER OPTION BLOCKS
0507*
0508*
0509   22000  066006  ID1     JMP  MSL     MAIN SYSTEM LINK
0510   22001  066034         JMP  SVARO
0511   22002  067357         JMP  GADD
0512   22003  067421         JMP  PSTR
0513   22004  066610         JMP  TRSTR
0514   22005  067334         JMP  .FDA1
0515*
0516*
0517*
0518*       EVALUATE A STRING VARIABLE
0519*       FOR THE PRINT ROUTINE
0520*
0521*       UPON EXIT:
0522*
0523*         B=STRING STARTING ADDRESS
0524*         A=STRING LENGTH
0525*         RETURN TO P+2
0526*
0527   22006  063357  MSL     JSM  GADD    GET STRING ADDRESS
0528   22007  024133         LDB  M2      EVALUATE SOURCE
0529   22010  063421         JSM  PSTR      STRING
0530   22011  035471         STB  L2T2
0531   22012  074117         LDA  B       PUT COUNT IN A
0532   22013  025742         LDB  TMP2    CHAR POINTER IN B
0533   22014  064357         JMP  RETN2   RETURN TO P+2
0534*
0535*
0536*       LET STATEMENT SYNTAX
0537*       LOOK FOR SOURCE STRING=
0538*
0539   22015  062340  LETS    JSM  SAVEP
0540   22016  062034         JSM  SVARO   VARIABLE?
0541   22017  066064         JMP  ABORT   NO
0542   22020  066064         JMP  ABORT   NUMERIC
0543   22021  060463         JSM  SYMC1   STRING
0544   22022  012020         OCT  12020   =?
0545   22023  164325         JMP  E30,I   No
0546*
0547*
0548*
0549*       LOOK FOR A DESTINATION STRING
0550*
0551*
0552   22024  062034  LTSYM   JSM  SVARO   VARIABLE?
0553   22025  066030         JMP  QUOCK   NO, LOOK FOR QUOTE FEILD
0554   22026  164312         JMP  E20-1,I NUMERIC
0555   22027  065151         JMP  EOST    YES, DEMAND END
0556   22030  045706  QUOCK   ISZ  SBPTR
```

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```
0557   22031  160245          JSM  GTSTA,I  GET A STRING CONSTANT
0558   22032  065151          JMP  EOST
0559*
0560*
```

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```
0562*
0563*
0564*       SVARO SUBROUTINE
0565*
0566*        EXIT CONDITIONS:
0567*
0568*          RETURN TO:
0569*            P+1  NO VARIABLE FOUND
0570*            P+2  NUMERIC VARIABLE
0571*            P+3  STRING VARIABLE
0572*
0573   22033  062340          JSM  SAVEP    SAVE PAGE
0574   22034  061140  SVARO   JSM  LTR      LETTER?
0575   22035  170402          RET           NO
0576   22036  010077          CPA  B44      $?
0577   22037  066041          JMP  *+2      YES
0578   22040  064357          JMP  RETN2    NO
0579   22041  045644          ISZ  ST+4     SET STRING OCCURED FLAG
0580   22042  163610          JSM  STRI2,I  STORE OPERAND
0581   22043  060513          JSM  LPCK     (?
0582   22044  064356          JMP  RETN3    NO
0583   22045  020125          LDA  LBOP
0584   22046  131706          STA  SBPTR,I  RECORD RIGHT BRACKET
0585   22047  020026          LDA  .9
0586   22050  031710          STA  MSFLG    ENABLE LOGICL=
0587   22051  160202          JSM  FSCA,I   GET FIRST INDEX
0588   22052  060463          JSM  SYMC1    LOOK FOR A COMMA
0589   22053  012001          OCT  12001
0590   22054  066056          JMP  *+2      NOT FOUND
0591   22055  160202          JSM  FSCA,I   FOUND
0592   22056  060534          JSM  RPCKE    DEMAND RIGHT PAREN
0593   22057  024123          LDB  RBOP
0594   22060  055706          DSZ  SBPTR
0595   22061  135706          STB  SBPTR,I  RECORD A RIGHT BRACKET
0596   22062  045706          ISZ  SBPTR
0597   22063  064356          JMP  RETN3    YES
```

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```
0599*
0600*       THIS ROUTINE RETURNS SYNTAX CONTROL TO OTHER
0601*       OPTION BLOCKS AND THE MAIN SYSTEM
0602*
0603*
0604*  22064  061064  ABORT  JSM  GFRST+2
0605   22065  061055  AB3    JSM  GNEXT     GET NEXT SYNTAX CHAR
0606   22066  025416         LDB  MODE
0607   22067  074151         SLB  *+3       CALC MODE?
0608   22070  024233         LDB  SBUFA
0609   22071  066077         JMP  AB1       YES
0610   22072  060750         JSM  DIGCK     CHAR IS DIGIT?
0611   22073  066075         JMP  *+2       NO
0612   22074  066065         JMP  ABORT+1   YES, LOOK FOR MORE
0613   22075  024233         LDB  SBUFA
0614   22076  074070         SIB  *+1
0615   22077  035706  AB1    STB  SBPTR     RESET SYNTAX BUFFER POINTER
0616   22100  024132         LDB  M1
0617   22101  035473         STB  TEMP      SEARCH FOR STATEMENTS
0618   22102  025640         LDB  ST
0619   22103  035717         STB  NUM       RESTORE PAGE
0620   22104  074742         SBR  16
0621   22105  035714         STB  SFLAG
0622   22106  035711         STB  DFLAG
0623   22107  015643         CPB  ST+3      IMPLIED LET?
0624   22110  070742         SAR  16
0625   22111  163602         JSM  SALT,I    SEARCH ALL PAGES
0626   22112  066112         JMP  *         CHECKSUM WORD
0627   22113  167601         JMP  STMTA,I
0628*
0629*
0630*
0631        IF STATEMENT SYNTAX
0632*
0633   22114  062033  IFSYN   JSM  SVARO-1  VARIABLE?
0634   22115  066064         JMP  ABORT     NO
0635   22116  066064         JMP  ABORT     NUMERIC
0636   22117  026146         LDB  GTEA
0637   22120  005640         ADB  ST
0638   22121  005640         ADB  ST
0639   22122  060546         JSM  STEXP     RELOP?
0640   22123  066143         JMP  IFERR     NO
0641   22124  045706         ISZ  SBPTR     YES
0642   22125  070742         SAR  16
0643   22126  131706         STA  SBPTR,I
0644   22127  062034  IF1    JSM  SVARO     VARIABLE?
0645   22130  066133         JMP  IF3       NO
0646   22131  066143         JMP  IFERR     NUMERIC
0647   22132  066134         JMP  IF2       YES
0648   22133  160245  IF3    JSM  GTSTA,I   STRING CONSTANT?
0649   22134  026145  IF2    LDB  THENA     YES, DEMAND THEM
0650   22135  005640         ADB  ST
0651   22136  005640         ADB  ST
0652   22137  060546         JSM  STEXP       AND STORE AS EXPANDED
                                                          OPERATOR
0653   22140  164317         JMP  E20+4,I   NOT FOUND
0654   22141  060664         JSM  LNUM      DEMAND A SEQUENCE NUMBER
```

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```
0655   22142  065151          JMP  EOST
0656   22143  160205  IFERR   JSM  AERRA,I  STRING IF ERROR
0657   22144  177672          DEC  -70
0658   22145  174722  THENA   ABS  THEN+THEN-ID-ID
0659   22146  174727  GTEA    ABS  GTE+GTE+1-ID-ID
0660*
0661*
0662*
0663*      IMPLIED DISP, LET SYNTAX
0664*
0665   22147  062340  IMPLT   JSN  SAVEP
0666   22150  031643          STA  ST+3       SET IMPLIED LET FLAG
0667   22151  055400          DSZ  BADDR
0668   22152  061055          JSM  GNEXT
0669   22153  055400          DSZ  BADDR
0670   22154  060752          JSM  LETCK      LETTER?
0671   22155  066167          JMP  ILET1+1    NO, TRY IMPLIED DISP
0672   22156  060626          JSM  SAVBP      SAVE POINTERS
0673   22157  062034          JSM  SVARO      VARIABLE?
0674   22160  066166          JMP  ILET1      NO
0675   22161  066166          JMP  ILET1      NUMERIC
0676   22162  060463          JSM  SYMC1      STRING
0677   22163  012020          OCT  12020      =?
0678   22164  066166          JMP  ILET1      NO
0679   22165  066024          JMP  LTSYM      YES
0680   22166  060640  ILET1   JSM  RESBP      RESTORE POINTERS
0681   22167  024123          LDB  PRTOP      STORE
0682   22170  055706          DSZ  SPBTR        CODE FOR
0683   22171  135706          STB  SPBTR,I        IMPLIED LET
0684   22172  045706          ISZ  SPBTR
0685   22173  025416          LDB  MODE
0686   22174  074111          SLB  NSTMT      SKIP IF PROG MODE
0687   22175  062227          JSM  PRNTS      PRINT STATEMENT?
0688   22176  066200  NSTMT   JMP  ILET2      NO
0689   22177  066213          JMP  PRIN1      YES
0690   22200  025644  ILET2   LDB  ST+4       STRING
0691   22201  074110          SZB  *+2          OCCURRED?
0692   22202  164274          JMP  E5,I       YES
0693   22203  066064          JMP  ABORT
0694   00123          PRTOP   EQU  B12K
0695*
0696*
```

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```
0698*
0699*
0700*
0701*       WRITE STATEMENT SYNTAX
0702*
0703   22204  160265  WRTS    JSM   IOCHEA,I  GET DEVICE AND FORMAT
0704   22205  060534          JSM   RPCKE     GET RIGHT PAREN
0705   22206  055400          DSZ   BADDR
0706   22207  055706          DSZ   SBPTR
0707*
0708*
0709   22210  062340  PRINS   JSM   SAVEP
0710   22211  062227          JSM   PRNTS     PRINT SYNTAX?
0711   22212  066216          JMP   PRIN2
0712   22213  025644  PRIN1   LDB   ST+4      YES, STRING OCCURRED?
0713   22214  074250          SZB   ABADD     NO
0714   22215  065151          JMP   EOST      YES
0715   22216  025644  PRIN2   LOB   ST+4
0716   22217  074110          SZB   *+2       STRING OCCURRED?
0717   22220  164277          JMP   E5+3,I     YES
0718   22221  066064  ABADD   JMP   ABORT     NO
0719*
0720*
0721*
0722*       PRINT STATEMENT SYNTAX
0723*
0724*
0725*
0726*
0727   22222  010043  PRSYN   CPA   B42       QUOTE FIELD?
0728   22223  066237          JMP   PR2+4     YES
0729   22224  060461          JSM   SYMC2     NO
0730   22225  012001          OCT   12001     COMMA OR SEMICOLON?
0731   22226  066233          JMP   PR2       NO
0732   22227  024132  PRNTS   LDB   M1
0733   22230  035712          STB   PFLAG     ENABLE FORMULA AND TAB
0734   22231  061066          JSM   GETSK
0735   22232  066300          JMP   PR1       END OF LINE
0736   22233  010043  PR2     CPA   B42       QUOTE?
0737   22234  066236          JMP   *+2        YES
0738   22235  066247          JMP   PR3       NO
0739   22236  045706          ISZ   SBPTR
0740   22237  160245          JSM   GTSTA,I    RECORD STRING CONSTANT
0741   22240  010031          CPA   EOL       EOL?
0742   22241  064357          JMP   RETN2     YES
0743   22242  074742          SBR   16
0744   22243  135706          STB   SBPTR,I   CLEAR OUT NEXT WORD
0745   22244  024132          LDB   M1
0746   22245  035712          STB   PFLAG
0747   22246  066222          JMP   PRSYN
0748   22247  045712  PR3     ISZ   PFLAG     TAB OR FORMULA PERMITTED?
0749   22250  170402          RET
0750   22251  027603          LDB   TABA
0751   22252  160175          JSM   TSRHA,I    TAB?
0752   22253  066263          JMP   PR4       NO
0753   22254  070544          SAL   5         YES
```

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```
Ø754   22255  Ø4ØØ67          IOR   TYPFL     SET PRE-DEFINED FUNCTION FLAGS
Ø755   22256  Ø6Ø454          JSM   SBPUD-2   STORE
Ø756   22257  Ø24123          LDB   RBOP
Ø757   2226Ø  135706          STB   SBPTR,I
Ø758   22261  16Ø2Ø2          JSM   FSCA,I    GET TAB FORMULA
Ø759   22262  Ø66275          JMP   PR5
Ø76Ø   22263  Ø554ØØ   PR4    DSZ   BADDR     BACK UP POINTER
Ø761   22264  Ø214ØØ         LDA   BADDR
Ø762   22265  Ø31645          STA   ST+5      SAVE BADDRR
Ø763   22266  Ø62Ø34          JSM   SVARO     VARIABLE?
Ø764   22267  Ø66272          JMP   PR6       NO
Ø765   2227Ø  Ø66272          JMP   *+2       NUMERIC
Ø766   22271  Ø66275          JMP   PR5       STRING
Ø767   22272  Ø21645   PR6    LDA   ST+5
Ø768   22273  Ø314ØØ         STA   BADDR     RESTORE BADDR
Ø769   22274  16Ø2Ø2          JSM   FSCA,I    FETCH FORMULA
Ø77Ø   22275  Ø1ØØ31   PR5    CPA   EOL       EOL?
Ø771   22276  Ø64357          JMP   RETN2
Ø772   22277  Ø66222          JMP   PRSYN     NO
Ø773   223ØØ  Ø457Ø6   PR1    ISZ   SBPTR
Ø774   2231   Ø64357          JMP   RETN2
Ø775*
Ø776*
Ø777*     READ AND INPUT STATEMENT SYNTAX
Ø778*
Ø779   2232   Ø62342   READS  JSM   SAVEP
Ø78Ø   2233   Ø62Ø34          JSM   SVARO     VARIABLE?
Ø781   2234   Ø66315          JMP   READ3
Ø782   2235   Ø66311          JMP   READ1     NUMERIC
Ø783   2236   Ø6Ø5Ø4   READ2  JSM   COMCK     COMMA?
Ø784   2237   Ø66213          JMP   PRIN1     NO
Ø785   2231Ø  Ø6633Ø          JMP   READS+1   YES
Ø786   22311  163ØØØ   READ1  JSM   VAR1,I
Ø787   22312  Ø66312          JMP   *         CONSTANT STORAGE
Ø788   22313  Ø6633Ø          JMP   READ2
Ø789   22314  Ø6633Ø          JMP   READ2
Ø79Ø   22315  Ø25644   READ3  LDB   ST+4
Ø791   22316  Ø74112          SZB   *+2       STRING OCCURRED?
Ø792   22317  164321          JMP   E25+1,I   YES
Ø793   2232Ø  Ø66Ø64          JMP   ABORT     NO
Ø794*
Ø795*
Ø796*     DATA STATEMENT SYNTAX
Ø797*
Ø798   22321  Ø62342   DATAS  JSM   SAVEP
Ø799   22322  Ø457Ø6          ISZ   SBPTR
Ø8ØØ   22323  Ø61156          JSM   CONST     LOOK FOR A NUMBER
Ø8Ø1   22324  Ø66331          JMP   DATA1     NOT FOUND
Ø8Ø2   22325  16Ø244          JSM   NUMOA,I   FOUND, STORE
Ø8Ø3   22326  Ø6Ø5Ø4   DATA2  JSM   COMCK     COMMA?
Ø8Ø4   22327  Ø66213          JMP   PRIN1     NO
Ø8Ø5   2233Ø  Ø66322          JMP   DATAS+1
Ø8Ø6   22331  Ø4564Ø   DATA1  ISZ   ST+4
Ø8Ø7   22332  Ø1ØØ43          CPA   B42       QUOTE?
Ø8Ø8   22333  Ø66335          JMP   *+2       YES
Ø8Ø9   22334  164316          JMP   E2Ø+3,I   NO
```

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```
0810   22335  160245          JSM  GTSTA,I  STRING CONSTANT?
0811   22336  066326          JMP  DATA2    YES
0812   22337  066064          JMP  ABORT    NO, ERROR
0813*
0814*
0815   22340  021717  SAVEP   LDA  NUM
0816   22341  031640          STA  ST
0817   22342  031643  PTR2    STA  ST+3     RESET IMPLIED LET FLAG
0818   22343  070742          SAR  16
0819   22344  031644          STA  ST+4     RESET STRING OCCURRED FLAG
0820   22345  170402          RET
0821*
0822*     NON-FORMULA OPERATORS
0823*
0824   22346  046105  LEN     ASC  1,LE
0825   22347  047215          OCT  47215    N, OPCODE 15
0826   22350  052100  THEN    ASC  2,THEN
       22351  042516
0827   22352  150074  GTE     OCT  150074   20,<
0828   22353  036602          OCT  36602    =,2
0829   22354  037075          ASC  1,>=
0830   22355  101443          OCT  101443   3,#
0831   22356  102074          OCT  102074   4,<
0832   22357  037204          OCT  37204    >,4
0833   22360  036605          OCT  36605    =,5
0834   22361  036206          OCT  36206    <,6
0835   22362  037307          OCT  37307    >,7
0836*
0837*
0838*     EXECUTE LEN STATEMENT
0839*
0840*
0841   22363  062450  ELEN    JSM  CKMOD
0842   22364  160227  ELEN1   JSM  FXFLA,I    PUT NUMBER IN AR2
0843   22365  045472  ELEN2   ISZ  TEMPS
0844   22366  170402          RET
0845*
0846*     CHECK LEN FUNCTION SYNTAX
0847*
0848*
0849   22367  062536  LENS    JSM  GVAR     GET FIRST PARAMETER
0850   22370  066446          JMP  LENER
0851   22371  066446          JMP  LENER    NO
0852   22372  025646  LENS1   LDB  PTR2
0853   22373  135472          STB  TEMPS,I    FLAG FOR FSC
0845   22374  060534          JSM  RPCKE    )?
0855   22375  025651          LDB  TEMP6     RESTORED STRING
0856   22376  035644          SIB  ST+4      OCCURRED FLG
0857   22377  064356          JMP  RETN3    YES
0858   22400  045706  LENS2   ISZ  SBPTR
0859   22401  160245          JSM  GTSTA,I  SEEK STRING CONSTANT
0860   22402  066372          JMP  LENS1
0861*
0862*
0863   22403  021416  EINDX   LDA  MODE
0864   22404  070113          SAP  *+2      SYNTAX MODE?
```

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```
0865  22405  066462          JMP  INDXS   YES
0866  22406  062550          JSM  GPTRS
0867  22407  035640          STB  CP0
0868  22410  031646          STA  PTR2
0869  22411  024133          LDB  M2
0870  22412  063421          JSM  PSTR
0871  22413  076110          RZB  *+2     NULL STRING?
0872  22414  066434          JMP  EIND3   YES
0873  22415  035647          STB  TMPRE
0874  22416  031644          STA  INTMP
0875  22417  025640          LDB  CP0
0876  22420  035654          STB  TNULL
0877  22421  027645  EIND2   LDB  PTR1A
0878  22422  061041          JSM  GETCH
0879  22423  031641          STA  CP1
0880  22424  027731          LDB  TMP2A
0881  22425  061041          JSM  GETCH
0882  22426  011641          CPA  CP1
0883  22427  066436          JMP  EIND1
0884  22430  021646          LDA  PTR2
0885  22431  031645          STA  PTR1
0886  22432  055647          DSZ  TMPRE
0887  22433  066417          JMP  EIND2-2
0888  22434  074742  EIND3   SBR  16
0889  22435  066364          JMP  ELEN1
0890  22436  055654  EIND1   DSZ  TNULL
0891  22437  066421          JMP  EIND2
0892  22440  025644          LDB  INTMP
0893  22441  005640          ADB  CP0
0894  22442  074076          TCB
0895  22443  005742          ADB  TMP2
0896  22444  004012          ADB  .1
0897  22445  066364          JMP  ELEN1
0898*
0899*
0900  22446  160205  LENER   JSM  AERRA,I
0901  22447  177671          DEC  -71
0902*
0903*
0904  22450  021416  CKMOD   LDA  MODE
0905  22451  070153          SAP  *+3     SYNTAX MODE?
0906  22452  055777          DSZ  RSPTR   YES
0907  22453  066367          JMP  LENS
0908  22454  045472  CKM1    ISZ  TEMPS
0909  22455  125472          LDB  TEMPS,I
0910  22456  074442          SBR  10
0911  22457  014012          CPB  .1      QUOTE?
0912  22460  066572          JMP  GP1     YES
0913  22461  066563          JMP  GP2     NO
0914*
0915  22462  062536  INDXS   JSM  GVAR    VARIABLE?
0916  22463  066446          JMP  LENER
0917  22464  066446          JMP  LENER   NUMERIC
0918  22465  060504  INDS2   JSM  COMCK   STRING, COMMA?
0919  22466  164305          JMP  E15-1,I NO
0920  22467  062034          JSM  SVARO   YES, VARIABLE?
```

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```
0921   22470  066400          JMP  LENS2     NO, LOOK FOR QUOTE FFILD
0922   22471  164312          JMP  E20-1,I    NUMERIC
0923   22472  066372          JMP  LENS1     STRING
0924*
0925   22473  066465          JMP  INDS2
0926*
0927*
0928   22474  062450  EVAL    JSM  CKMOD
0929   22475  025400          LDB  BADDR
0930   22476  060563          JSM  SLWST     SAVE BADDR
0931   22477  031645          STA  PTR1
0932   22500  045654          ISZ  TNULL     NULL STRING?
0933   22501  066503          JMP  *+2       NO
0934   22502  066534          JMP  VALER     YES
0935   22503  021412          LDA  LSTPT     SET BUFFER
0936   22504  070070          SIA  *+1         START TO
0937   22505  070744          SAL  1             LOW STACK
0938   22506  031400          STA  BADDR           POINTER PLUS 1
0939   22507  031646          STA  PTR2      SAVE BUFFER START
0940   22510  021413          LDA  HSTPT     SET BUFFER
0941   22511  070744          SAL  1           END TO HIGH
0942   22512  031623          STA  PEND          STACK POINTER PLUS 1
0943   22513  027645  EVAL1   LDB  PTR1A
0944   22514  061041          JSM  GETCH     GET A SOURCE CHAR
0945   22515  061016          JSM  ONEXT     PUT IN BUFFER
0946   22516  021400          LDA  BADDR
0947   22517  011623          CPA  PEND      OVERFLOW?
0948   22520  064561          JMP  MER8      YES, ERROR
0949   22521  045654          ISZ  TNULL     NO,DONE?
0950   22522  066513          JMP  EVAL1     NO
0951   22523  020055          LDA  I         TERMINATE THE BUFFER
0952   22524  061016          JSM  ONEXT       WITH A NON-DIGIT CHARACTER
0953   22525  021646          LDA  PTR2
0954   22526  031400          STA  BADDR     INITIALIZE BADDR
0955   22527  061156          JSM  CONST
0956   22530  066534          JMP  VALER
0957   22531  060567          JSM  UNSTK
0958   22532  031400          STA  BADDR     RESTORE BADDR
0959   22533  066365          JMP  ELEN2
0960   22534  160205  VALER   JSM  AERRA,I
0961   22535  177664          DEC  -76
0962*
0963*
0964*
0965*
0966   22536  121472  GVAR    LDA  TEMPS,I   GET LEFT PAREN COUNT
0967   22537  031646          STA  PTR2        AND SAVE
0968   22540  021644          LDA  ST+4      SAVE STRING
0969   22541  031651          STA  TEMP6       OCCURRED FLAG
0970   22542  061055          JSM  GNEXT     GET NEXT CHAR
0971   22543  055400          DSZ  BADDR
0972   22544  045706          ISZ  SBPTR
0973   22545  060521          JSM  LPCKE     DEMAND LEFT PAREN
0974   22546  045400          ISZ  BADDR
0975   22547  066034          JMP  SVARO
0976*
```

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```
0979*      STATEMENT EXECUTION
0980*
0981*
0982*      LET EXECUTION
0983*
0984*
0985*
0986   22550  063357  GPTRS   JSM  GADD
0987   22551  121472         LDA  TEMPS,I
0988   22552  045472         ISZ  TEMPS
0989   22553  031644         STA  INTMP     SAVE RELATIONAL OPERATOR
0990   22554  125472         LDB  TEMPS,I
0991   22555  074442         SBR  10
0992   22556  014012         CPB  .1        QUOTE?
0993   22557  066572         JMP  GP1       YES
0994   22560  050065         AND  OPMSK     NO
0995   22561  010065         CPA  OPMSK     NON-FORMULA OPERATOR?
0996   22562  045472         ISZ  TEMPS     YES
0997   22563  055472  GP2    DSZ  TEMPS
0998   22564  063357         JSM  GADD      GET SOURCE STRING ADDRESS
0999   22565  024133         LDB  M2
1000   22566  063421         JSM  PSTR      EVALUATE SOURCE STRING
1001   22567  035647  XFER   STB  TMPRE     SAVE LENGTH
1002   22570  031645         STA  PTR1
1003   22571  170402         RET
1004   22572  063551  GP1    JSM  GQUOT     GET QUOTE FIELD
1005   22573  066567         JMP  XFER
1006*
1007   22574  062550  LTEX   JSM  GPTRS     GET DEST STRING POINTERS
1008   22575  024132  LT4    LDB  M1        NO
1009   22576  063421         JSM  PSTR      EVALUATE DESTINATION STRING
1010   22577  074410         SZB  LT2+1     NULL STRING?
1011   22600  021416         LDA  MODE
1012   22601  070250         SZA  LT2       CALC MODE?
1013   22602  160170         JSM  CLERA,I   YES
1014   22603  021647         LDA  TMPRE
1015   22604  025645         LDB  PTR1
1016   22605  061330         JSM  .NPWR     DISPLAY THE STRING
1017   22606  062610  LT2    JSM  TRSTR
1018   22607  164172         JMP  XEC4A,I
1019*
1020*
1021*      STRING TRANSFER SUBROUTINE
1022*
1023*
1024   22610  021645  TRSTR   LDA  PTR1
1025   22611  070076         TCA
1026   22612  001742         ADA  TMP2
1027   22613  070413         SAP  TR1       FORWARD TRANSFER?
1028   22614  045654  TR2    ISZ  TNULL     YES
1029   22615  066617         JMP  *+2       YES
1030   22616  170402         RET
1031   22617  063255         JSM  FSCH      GET NEXT SOURCE CHAR
1032   22620  027731  LT5    LDB  TMP2A
1033   22621  061017         JSM  OUTCR     STORE IT
1034   22622  066614         JMP  TR2       LOOK FOR MORE
```

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```
1035   22623  021654  TR1     LDA  TNULL
1036   22624  070070          SIA  *+1
1037   22625  070056          CMA
1038   22626  070137          LDB  A
1039   22627  005645          ADB  PTR1
1040   22630  035645          STB  PTR1      POINT TO END OF SOURCE
1041   22631  001742          ADA  TMP2
1042   22632  031742          STA  TMP2      POINT TO END OF DEST
1043   22633  021654          LDA  TNULL
1044   22634  070056          CMA
1045   22635  025647          LDB  TMPRE
1046   22636  074076          TCB
1047   22637  070037          ADB  A
1048   22640  074113          SBP  *+2       TOO MUCH SOURCE?
1049   22641  074742          SBR  16        YES, NO BLANKS NEEDED
1050   22642  035647          STB  TMPRE     STORE BLANK COUNT
1051   22643  045654  TR4     ISZ  TNULL
1052   22644  066646          JMP  *+2
1053   22645  170402          RET
1054   22646  025647          LDB  TMPRE
1055   22647  074250          SZB  TR3       MORE BLANKS?
1056   22650  020041          LDA  .32       YES
1057   22651  055647          DSZ  TMPRE
1058   22652  066653          JMP  *+1
1059   22653  066657          JMP  TR5
1060   22654  027645  TR3     LDB  PTR1A
1061   22655  061041          JSM  GETCH
1062   22656  055645          DSZ  PTR1
1063   22657  027731  TR5     LDB  TMP2A
1064   22660  061017          JSM  OUTCR
1065   22661  055742          DSZ  TMP2
1066   22662  055742          DSZ  TMP2
1067   22663  055645          DSZ  PTR1
1068   22664  066643          JMP  TR4       NO
1069*
1070   22665  045654  FINCH   ISZ  TNULL     MORE TRANSFER STRING
1071   22666  066670          JMP  *+2       YES
1072   22667  170402          RET            NO
1073   22670  061040          JSM  GETCH-1
1074   22671  010031          CPA  EOL       END OF LINE?
1075   22672  170402          RET            YES
1076   22673  010043          CPA  B42       YES, QUOTE?
1077   22674  170402          RET            YES
1078   22675  027731          LDB  TMP2A     NO,
1079   22676  061017          JSM  OUTCR        STORE IT
1080   22677  066665          JMP  FINCH
1081*
```

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```
1083*
1084*
1085*      INPUT STATEMENT EXECUTION
1086*
1087*
1088  22700  063013  EINPT   JSM  ESAVE     SAVE CURRENT PAGE ADDRESS
1089  22701  020112          LDA  RSTKA
1090  22702  031777          STA  RSPTR     RESET STACK
1091  22703  021622          LDA  TERM
1092  22704  072110          RZA  *+2
1093  22705  160170          JSM  CLERA,I
1094  22706  021472          LDA  TEMPS
1095  22707  000133          ADA  M2
1096  22710  031641          STA  SPRDD     SAVE START OF INPUT STATEMENT
1097  22711  021641  EIN2    LDA  SPRDD
1098  22712  031421          STA  PRADD       INPUT STATEMENT
1099  22713  021472          LDA  TEMPS
1100  22714  031640          STA  TEPPP
1101  22715  121472          LDA  TEMPS,I
1102  22716  050040          AND  B37
1103  22717  010076          CPA  B36       STRING VARIABLE?
1104  22720  067017          JMP  INSTR     YES
1105  22721  023010          LDA  INLNK
1106  22722  001643          ADA  SAVE
1107  22723  031432          STA  DRQST     SET UP RETURN LINK
1108  22724  164173  INRET   JMP  PEXMA,I  CALL FOR INPUT
1109  22725  055400          DSZ  BADDR
1110  22726  025641          LDB  SPRDD
1111  22727  061007          JSM  NEXTA     SET PRADD BACK TO END
1112  22730  035421          STB  PRADD       OF INPUT STATEMENT
1113  22731  021472          LDA  TEMPS
1114  22732  031640          STA  TEPPP     SAVE START OF VARIABLE
1115  22733  160201  .EIN1    JSM  FORMA,I   GET THE ADDRESS OF THE VARIABLE
                                                                  IN HS
1116  22734  024017          LDB  .2
1117  22735  035706          STB  SBPTR     AIM SBPTR AT ROM
1118  22736  027007          LDB  INLN1
1119  22737  005643          ADB  SAVE
1120  22740  035432          STB  DRQST
1121  22741  061156          JSM  CONST     BUILD A NUMBER IN AR2
1122  22742  066765          JMP  INCH5     P+1 — NO NUMBER FOUND, SO INC
                                                                  HSTPTP
1123  22743  070742          SAR  16
1124  22744  031432          STA  DRQST     CLEAR FLAG
1125  22745  060412          JSM  RSULT     SAVE ARE AT HSTPT,I
1126  22746  025472          LDB  TEMPS
1127  22747  015421          CPB  PRADD     END OF STATEMENT
1128  22750  067011          JMP  CXEC4     YES
1129  22751  035640  EIN3    STB  TEPPP     RESET THE TEMPORARY POINTER
1130  22752  055400          DSZ  BADDR     NO — DINC BADDR TO LOOK AT THE
                                                                  LAST CH
1131  22753  061066          JSM  GETSK     GET LAST CHAR.
1132  22754  067005          JMP  INCH1
1133  22755  013642          CPA  B54       COMMA?
1134  22756  066760          JMP  *+2       YES
1135  22757  066777          JMP  INCH2     NO
1136  22760  121472          LDA  TEMPS,I
1137  22761  050040          AND  B37
1138  22762  010076          CPA  B36       STRING VARIABLE?
```

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```
1139   22763  Ø67Ø24          JMP  EIN4      YES
114Ø   22764  Ø66733          JMP  .EIN1     NO
1141*
1142   22765  16Ø17Ø  INCH5    JSM  CLERA,I
1143   22766  Ø23643          LDA  .17
1144   22767  Ø27712          LDB  ER3A
1145   2277Ø  Ø63137          JSM  ER4+2
1146   22771  Ø63135          JSM  ER4
1147   22772  Ø2164Ø  INCHT    LDA  TEPPP
1148   22773  Ø31472          STA  TEMPS     RESTORE VARIABLE POINTER
1149   22774  Ø45413          ISZ  HSTPT
115Ø   22775  Ø45413          ISZ  HSTPT
1151   22776  Ø66711          JMP  EIN2
1152*
1153   22777  16Ø17Ø  INCH2    JSM  CLERA,I
1154   23ØØØ  Ø2ØØ34          LDA  .21
1155   23Ø01  Ø27725          LDB  ER1A
1156   23Ø02  Ø63137          JSM  ER4+2
1157   23Ø03  Ø63135          JSM  ER4
1158   23Ø04  Ø66711          JMP  EIN2
1159*
116Ø   23Ø05  16Ø17Ø  INCH1    JSM  CLERA,I
1161   23Ø06  Ø66711          JMP  EIN2
1162   23Ø07  ØØØ772  INLN1    ABS  INCHT-ID1
1163   23Ø1Ø  ØØØ724  INLNK    ABS  INRET-ID1
1164*
1165   23Ø11  16Ø17Ø  CXEC4    JSM  CLERA,I
1166   23Ø12  164172          JMP  XEC4A,I
1167*
1168*      SAVE PAGE ADDRESS DURING EXECUTION
1169*
117Ø   23Ø13  Ø74117  ESAVE    LDA  B
1171   23Ø14  Ø5Ø16Ø          AND  B174K
1172   23Ø15  Ø31643          STA  SAVE
1173   23Ø16  17Ø4Ø2          RET
1174*
1175*
1176   23Ø17  Ø7Ø742  INSTR    SAR  16
1177   23Ø2Ø  Ø317Ø1          STA  NDISP
1178   23Ø21  Ø317Ø2          STA  NPRIN
1179   23Ø22  Ø317Ø7          STA  BLANK     DON'T IGNORE BLANKS
118Ø   23Ø23  Ø63142          JSM  INCAL
1181   23Ø24  Ø63357  EIN4     JSM  GADD      GET STRING ADDRESS
1182   23Ø25  Ø25412          LDB  LSTPT     EXTRACT
1183   23Ø26  ØØ4133          ADB  M2          PHYSICAL
1184   23Ø27  Ø74517          LDA  B,I           LENGTH OF
1185   23Ø3Ø  Ø7ØØØ2          SAR  1
1186   23Ø31  ØØØ132          ADA  M1                DESTINATION
1187   23Ø32  Ø7Ø517          LDA  A,I                 STRING
1188   23Ø33  Ø7Ø342          SAR  8
1189   23Ø34  Ø7ØØ76          TCA
119Ø   23Ø35  ØØ4Ø12          ADB  .1        SUBTRACT FIRST
1191   23Ø36  Ø74417          ADA  B,I         SUBSCRIPT
1192   23Ø37  ØØØ132          ADA  M1
1193   23Ø4Ø  Ø7ØØ76          TCA            STORE IT AS END OF
1194   23Ø41  Ø31647          STA  TMPRE       UNSPECIFIED DEST STRING
```

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```
1195  23042  024132          LDB  M1      PREPARE
1196  23043  063421          JSM  PSTR      DESTINATION STRING
1197  23044  021742          LDA  TMP2
1198  23045  031645          STA  PTR1
1199  23046  025654          LDB  TNULL   SAVE LENGTH
1200  23047  035644          STB  INTMP     ALLOWANCE
1201  23050  061055          JSM  GNEXT
1202  23051  067055          JMP  EINS
1203  23052  063142  EIN14    JSM  INCAL   GET INPUT RECORD
1204  23053  061062          JSM  GFRST
1205  23054  067054          JMP  *       CHECKSUM WORD
1206  23055  025645  EIN5     LDB  PTR1
1207  23056  035742          STB  TMP2    RESTORE STRING POINTER
1208  23057  010043          CPA  B42     QUOTE?
1209  23060  067062          JMP  *+2     YES
1210  23061  055400          DSZ  BADDR   NO
1211  23062  062665          JSM  FINCH   TRANSFER THE STRING
1212  23063  074742          SBR  16      ALL REQUESTED
1213  23064  015654          CPB  TNULL      CHARACTERS TRANSFERRED?
1214  23065  067112          JMP  EIN21   YES
1215  23066  015656          CPB  PS1     NO, TRANSFER LENGTH SPECIFIED
1216  23067  067106          JMP  EIN20   NO
1217  23070  031644          STA  INTMP   SAVE EOR CHAR
1218  23071  070742          SAR  16
1219  23072  031647          STA  TMPRE
1220  23073  001654          ADA  TNULL     TRANSFER
1221  23074  000132          ADA  M1
1222  23075  031654          STA  TNULL
1223  23076  062614          JSM  TR2
1224  23077  010031  EIN18    CPA  EOL     TRANSFER ENDED BY EOL?
1225  23100  067102          JMP  EINP6   YES
1226  23101  061055  EIN19    JSM  GNEXT   NO, WAS A"
1227  23102  025641  EINP6    LDB  SPRDD
1228  23103  061007          JSM  NEXTA   SET PRADD BACK TO
1229  23104  035421          STB  PRADD     END OF INPUT STATEMENT
1230  23105  066746          JMP  EIN3-3  LOOK FOR END
1231  23106  125651  EIN20    LDB  TEMP6,I SET LOGICAL
1232  23107  005654          ADB  TNULL     TO ACTUAL
1233  23110  135651          STB  TEMPS,I     STRING LENGTH
1234  23111  067077          JMP  EIN18
1235  23112  015656  EIN21    CPB  PS1     LENGTH OF TRANSFER SPECIFIED?
1236  23113  067121          JMP  EIN15   NO
1237  23114  061066  EIN16    JSM  GETSK   YES, END OF LINE?
1238  23115  067102          JMP  EINP6   YES
1239  23116  010043          CPA  B42
1240  23117  067101          JMP  EIN19   YES
1241  23120  067114          JMP  EIN16   NO, LOOK FOR "OR EOL
1242  23121  061066  EIN15    JSM  GETSK   EOL?
1243  23122  067102          JMP  EINP6   YES
1244  23123  010043          CPA  B42     NO, CLOSING QUOTE?
1245  23124  067101          JMP  EIN19   YES
1246  23125  021644          LDA  INTMP   NO, DESTINATION STRING EXCEEDED
1247  23126  031654          STA  TNULL   RESTORE DESTINATION
1248  23127  160170          JSM  CLERA,I
1249  23130  020033          LDA  .16
1250  23131  027726          LDB  ER2A
```

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```
1251   23132  Ø63137          JSM  ER4+2
1252   23133  Ø63135          JSM  ER4
1253   23134  Ø67Ø52          JMP  EIN14
1254*
1255*
1256*
1257   23135  Ø2ØØ25  ER4     LDA  .8
1258   23136  Ø27724          LDB  ER4A
1259   23137  ØØ5643          ADB  SAVE
1260   2314Ø  ØØ5643          ADB  SAVE
1261   23141  Ø653ØØ          JMP  .NPWR
1262*
1263   23142  Ø2ØØ12  INCAL   LDA  .1
1264   23143  Ø31432          STA  DRQST
1265   23144  Ø27727          LDB  QMRKA
1266   23145  Ø6133Ø          JSM  .NPWR    OUTPUT A?
1267   23146  161462          JSM  REEDL,I  GET INPUT RECORD
1268   23147  Ø67164          JMP  INC1     NULL RECORD
1269   2315Ø  Ø61Ø62          JSM  GFRST
1270   23151  Ø67164          JMP  INC1     YES
1271   23152  Ø21432          LDA  DRQST
1272   23153  Ø7221Ø          RZA  *+4      EXECUTION EXIT OCCURRED?
1273   23154  Ø2ØØ41          LDA  .32      YES
1274   23155  Ø317Ø7          STA  BLANK
1275   23156  167613          JMP  REEDY,I
1276   23157  Ø74742          SBR  16
1277   2316Ø  Ø35432          STB  DRQST
1278   23161  Ø35416          STB  MODE
1279   23162  Ø554ØØ          DSZ  BADDR
128Ø   23163  17Ø4Ø2          RET
1281   23164  Ø21432  INC1    LDA  DRQST
1282   23165  Ø7Ø15Ø          SZA  INC2     EXECUTION EXIT OCCURRED?
1283   23166  16Ø17Ø          JSM  CLERA,I  NO
1284   23167  Ø67142          JMP  INCAL
1285   2317Ø  167612  INC2    JMP  REEDX,I
1286*
1287*
1288*
1289*
1290*    IF STATEMENT EXECUTION
1291*
1292*
1293   23171  Ø6255Ø  IFEX    JSM  GPTRS    GET STRING PARAMETERS
1294   23172  Ø74Ø56          CMB
1295   23173  Ø3564Ø          STB  CPØ
1296   23174  Ø2Ø133          LDA  M2         LENGTH
1297   23175  Ø6342Ø          JSM  PSTR     PREPARE TEST STRING
1298   23176  Ø3564Ø          STB  CP1      SAVE ACTUAL LENGTH
1299   23177  Ø4564Ø  COMP2   ISZ  CPØ      MORE SPECIFIED STRING?
13ØØ   232ØØ  Ø672Ø3          JMP  COMP3    YES
1301   232Ø1  Ø74742          SBR  16       NO, LOAD A
1302   232Ø2  Ø672Ø6          JMP  COMP4      NULL CHARACTER
1303   232Ø3  Ø27645  COMP3   LDB  PTRIA
1304   232Ø4  Ø61Ø41          JSM  GETCH
1305   232Ø5  Ø71Ø37          LDB  A
1306   232Ø6  Ø45654  COMP4   ISZ  TNULL    MORE SPECIFIED TEST STRING?
```

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```
1307   23207  067216          JMP  COMP6   YES
1308   23210  070742          SAR  16      NO
1309   23211  074076  COMP5   TCB          COMPARE
1310   23212  074017          ADA  B           CHARACTERS
1311   23213  072110          RZA  *+2      EXIT ON NOT EQUAL
1312   23214  077150          RZB  COMP2    OR BOTH NULL CHARACTERS
1313   23215  067231          JMP  BRANC    EXIT TO BRANCH
1314   23216  021641  COMP6   LDA  CP1      MORE ACTUAL
1315   23217  072150          RZA  COMP7      TEST STRING?
1316   23220  020041          LDA  .32     NO
1317   23221  067211          JMP  COMP5
1318   23222  000132  COMP7   ADA  M1
1319   23223  031641          STA  CP1
1320   23224  035650          STB  ST+8
1321   23225  027731          LDB  TMP2A   EXTRACT NEXT
1322   23226  061041          JSM  GETCH     TEST
1323   23227  025650          LDB  ST+8
1324   23230  067211          JMP  COMP5       CHARACTER
1325*
1326   23231  070137  BRANC   LDB  A
1327   23232  021664          LDA  INTMP
1328   23233  050070          AND  OPDMK
1329   23234  070202          SAR  5
1330   23235  074153          SBP  BR1     LESS THAN?
1331   23236  070211          SLA  GOTOE   YES, EVEN OP CODE?
1332   23237  164172          JMP  XEC4A,I NO
1333   23240  076310  BR1     RZB  BR2     EQUAL?
1334   23241  010022          CPA  .5      YES, – OP?
1335   23242  167577  GOTOE   JMP  EGOS1,I YES
1336   23243  000135          ADA  M4
1337   23244  071712          SAM  *–2
1338   23245  164172          JMP  XEC4A,I
1339   23246  010023  BR2     CPA  .6      <?
1340   23247  164172          JMP  XEC4A,I
1341   23250  010022          CPA  .5      =?
1342   23251  164172          JMP  XEC4A,I
1343   23252  010017          CPA  .2
1344   23253  164172          JMP  XEC4A,I
1345   23254  167577          JMP  EGOS1,I
1346*
1347*
1348   23255  025647  FSCH    LDB  TMPRE
1349   23256  076150          RZB  *+3     OUT OF STRING?
1350   23257  020041          LDA  .32     YES, GET A
1351   23260  170402          RET            BLANK
1352   23261  004132          ADB  M1
1353   23262  035647          STB  TMPRE
1354   23263  027645          LDB  PTR1A
1355   23264  065041          JMP  GETCH
1356                          LST
1357*
1358   23265  121472  EREAD   LDA  TEMPS,I
1359   23266  050040          AND  B37
1360   23267  010076          CPA  B36     STRING VARIABLE?
1361   23270  067310          JMP  RDSTR   YES
1362   23271  160201          JSM  FORMA,I NO, GET VARIABLE ADDRESS
```

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```
1367   23272  163611  ER1     JSM  SWITH,I  EXCHANGE TEMPS AND NXTDT
1364   23273  Ø15414          CPB  DSTRT     NEED NEW DATA STATEMENT?
1365   23274  Ø63334          JSM  .FDA1     YES
1366   23275  163661          JSM  SWITH,I   NO
1367   23276  125415          LDB  NXTDT,I
1368   23277  Ø74152          SBM  *+3       NUMERIC DATA IS NEXT?
1369   233ØØ  16Ø2Ø5          JSM  AERRA,I   NO
137Ø   2331Ø  177665          DEC  -75
1371   2332Ø  16Ø256          JSM  FDAAA,I   YES
1372   2333Ø  Ø6Ø412          JSM  RSULT
1373   2334Ø  Ø21421  ER2     LDA  PRADD
1374   2335Ø  Ø11472          CPA  TEMPS     MORE VARIABLES?
1375   2336Ø  164172          JMP  XEC4A,I
1376   2337Ø  Ø67265          JMP  EREAD
1377   2338Ø  Ø63357  RDSTR   JSM  GADD      GET STRING VARIABLE PARAMETERS
1378   2339Ø  163611          JSM  SWITH,I
1379   2341Ø  Ø25472  ER3     LDB  TEMPS
138Ø   2342Ø  Ø15414          CPB  DSTRT     NEED NEW DATA STMT?
1381   2343Ø  Ø63334          JSM  .FDA1     YES
1382   2344Ø  Ø45472          ISZ  TEMPS
1383   2345Ø  125472          LDB  TEMPS,I
1384   2346Ø  Ø74442          SBR  1Ø
1385   2347Ø  Ø14Ø12          CPB  .1        QUOTE?
1386   2348Ø  Ø67234          JMP  *+3       YES
1387   2349Ø  16Ø2Ø5          JSM  AERRA,I   YES
1388   2350Ø  177665          DEC  -75
1389   2351Ø  Ø63351          JSM  GQUOT     NO
139Ø   2352Ø  Ø35647          STB  TMPRE
1391   2353Ø  Ø31645          STA  PTR1
1392   2354Ø  Ø24132          LDB  M1        PREPARE
1393   2355Ø  Ø63421          JSM  PSTR        DESTINATION STRING
1394   2356Ø  Ø6261Ø          JSM  TRSTR     TRANSFER THE STRING
1395   2357Ø  163611          JSM  SWITH,I
1396   2358Ø  Ø673Ø4          JMP  ER2
1397*
1398*
1399   23601  Ø21421  .FDA1    LDA  PRADD
14ØØ   23602  Ø31644          STA  INTMP
1401   23603  Ø35421          STB  PRADD
1402   23604  Ø25421  FD2     LDB  PRADD
1403   23605  Ø15423          CPB  PBPTR     END OF PROGRAM?
1404   23606  164358          JMP  E5O-1,I   OUT OF DATA
1405   23607  Ø35472          STB  TEMPS
1406   23610  Ø6Ø577          JSM  NEXTL+3
1407   23611  ØØ1466          ADA  LOCL1     ENCODE PAGE AND OP CODE
1408   23612  Ø13732          CPA  MSDAT     MAIN SYSTEM DATA STMT?
1409   23613  Ø67352          JMP  FD3       YES
1410   23614  Ø13733          CPA  STDAT     NO, STRING DATA STMT?
1411   23615  Ø67352          JMP  FD3       YES
1412   23616  Ø67337          JMP  FD2       NO, KEEP LOOKING
1413   23617  Ø25421  FD3     LDB  PRADD
1414   23620  Ø35414          STB  DSTRT
1415   23621  Ø25644          LDB  INTMP
1416   23622  Ø35421          STB  PRADD
1417   23623  17Ø4Ø2          RET
1418*
```

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```
1422*
1423*     GADD SUBROUTINE
1424*
1425*     FETCH STRING ADDRESS FROM SYMBOL TABLE
1426*
1427*     ENTRY CONDITIONS:
1428*
1429*        A=OPERAND
1430*        TEMPS POINTS TO STRING NAME
1431*
1432*     EXIT CONDITIONS:
1433*
1434*        STRING ADDRESS AND SUBSCRIPTS ARE
1435*        ON LOW STACK
1436*
1437  23357  060771  GADD   JSM  GTOPP    GET OPERAND
1438  23360  063567        JSM  GSYMB    GET SYMBOL ADDRESS
1439  23361  004132        ADB  M1
1440  23362  074537        LDB  B,I
1441  23363  074744        SBL  1
1442  23364  060563        JSM  SLWST    PUT ON STACK
1443  23365  045472        ISZ  TEMPS
1444  23366  021472        LDA  TEMPS
1445  23367  011421        CPA  PRADD    OUT OF CODE?
1446  23370  067375        JMP  GA2
1447  23371  121472        LDA  TEMPS,I
1448  23372  050065        AND  OPMSK    GET OP CODE
1449  23373  010125        CPA  LBOP     SUBSCRIPTED?
1450  23374  067401        JMP  GA1      YES
1451  23375  074742  GA2   SBR  16       NO
1452  23376  060563        JSM  SLWST
1453  23377  024132        LDB  M1
1454  23400  064563        JMP  SLWST
1455  23401  063412  GA1   JSM  SUBEV    EVALUATE SUBSCRIPTS
1456  23402  055472        DSZ  TEMPS
1457  23403  121472        LDA  TEMPS,I
1458  23404  070442        SAR  10
1459  23405  050040        AND  B37
1460  23406  010017        CPA  .2       COMMA?
1461  23407  067412        JMP  SUBEV    YES
1462  23410  045472        ISZ  TEMPS
1463  23411  067377        JMP  GA1-2    NO
1464*
1465*     SUBEV SUBROUTINE
1466*
1467*     EVALUATE AN EXPRESSION, CONVERT TO
1468*     AN INTEGER, STORE ON LOW STACK
1469*
1470  23412  061217  SUBEV  JSM  FETCH    EVALUATE EXPRESSION
1471  23413  160225        JSM  FLTRA,I  CONVERT TO INTEGER
1472  23414  164341        JMP  E40+2,I
1473  23415  004132        ADB  M1
1474  23416  075712        SBM  *-2      0 OR NEGATIVE?
1475  23417  045472        ISZ  TEMPS
1476  23420  064563        JMP  SLWST    NO
1477*
```

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```
1479*
1480*      PSTR SUBROUTINE
1481*
1482*      EVALUATE A STRING OPERAND
1483*
1484*      ENTRY CONDITIONS:
1485*
1486*        B=-2 FOR SOURCE STRINGS
1487*         B=-1 FOR DESTINATION STRING
1488*         LOW STACK HAS SECOND SUBSCRIPT.
1489*         FIRST SUBSCRIPT, STRING ADDRESS.
1490*         RESPECTIVELY.
1491*         TMPRE=SOURCE LENGTH
1492*
1493*      EXIT CONDITIONS:
1494*
1495*         TMP2=STRING POINTER
1496*         B=LENGTH
1497*         TEMP6=STRING LENGTH WORD POINTER
1498*         A=TMP2 IF SOURCE STRING
1499*        TNULL=1,S COMPLEMENT OF REQUESTED LENGTH
1500*
1501*
1502  23421  035655  PSTR    STB  PS0      SAVE MODE FLAG
1503  23422  025412         LDB  LSTPT
1504  23423  004134         ADB  M3
1505  23424  035412         STB  LSTPT    BUMP LOW STACK POINTER
1506  23425  004012         ADB  .1
1507  23426  035656         STB  PS1      SET FLAG POSITIVE
1508  23427  074517         LDA  B,I      GET STRING ADDRESS
1509  23430  031742         STA  TMP2     SAVE IT
1510  23431  070002         SAR  1
1511  23432  000132         ADA  M1       GET LENGTH WORD POINTER
1512  23433  031651         STA  TEMP6    SAVE IT
1513  23434  004012         ADB  .1
1514  23435  074517         LDA  B,I      GET FIRST SUBSCRIPT
1515  23436  031652         STA  MPT      SAVE IT
1516  23437  001742         ADA  TMP2     RECORD STRING
1517  23440  031742         STA  TMP2       START POINTER
1518  23441  004012  PS2    ADB  .1
1519  23442  074517         LDA  B,I      GET SECOND SUBSCRIPT
1520  23443  070513         SAP  PSTR2    SPECIFIED?
1521  23444  011655         CPA  PS0      NO, SOURCE MODE?
1522  23445  067451         JMP  PSTR1    NO.
1523  23446  121651         LDA  TEMP6,I  YES
1524  23447  050105         AND  B377     GET ACTUAL STRING LENGTH
1525  23450  067454         JMP  PSTR2-1
1526  23451  031656  PSTR1  STA  PS1      SET FLAG TO -1
1527  23452  021647         LDA  TMPRE    COMPUTE END OF
1528  23453  001652         ADA  MPT      STRING DESIGNATOR
1529  23454  000132         ADA  M1
1530  23455  031653  PSTR2  STA  NQT      SAVE IT
1531  23456  070056         CMA
1532  23457  001652         ADA  MPT
1533  23460  000132         ADA  M1
1534  23461  070152         SAM  PSTR8    NEGATIVE LENGTH?
```

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```
1535   23462  160205          JSM  AERRA,I   YES
1536   23463  177670          DEC  -72
1537   23464  031654  PSTR8   STA  TNULL     SAVE 1,S COMPLEMENT OF LENGTH
1538   23465  121651          LDA  TEMP6,I   DOES
1539   23466  050105          AND  B377        START OF
1540   23467  070056          CMA            CHARACTER
1541   23470  045655          ISZ  PS0             RELATE TO
1542   23471  070070          SIA  *+1               PREVIOUS STRING
1543   23472  001652          ADA  MPT                 VALUE
1544   23473  070112          SAM  *+2
1545   23474  067515          JMP  PSTR3
1546   23475  121651          LDA  TEMP6,I   YES
1547   23476  045655          ISZ  PS0       DESTINATION MODE?
1548   23477  070346          RAR  8         YES, USE PHYSICAL LENGTH
1549   23500  050105          AND  B377      NO USE ACTUAL LENGTH
1550   23501  000012          ADA  .1
1551   23502  070076          TCA
1552   23503  001653          ADA  NQT
1553   23504  024012          LDB  .1
1554   23505  015655          CPB  PS0       SOURCE MODE?
1555   23506  067525          JMP  PSTR5     NO
1556   23507  025654          LDB  TNULL     SPECIFIED SOURCE
1557   23510  000012          ADA  .1          STRING CONTAINED
1558   23511  070452          SAM  PSTR4           WITHIN DEFINED SOURCE
                                                        STRING?
1559   23512  004012          ADB  .1         NO,
1560   23513  070037          ADB  A           CORRECT LENGTH
1561   23514  067522          JMP  PSTR4
1562   23515  021655  PSTR3   LDA  PS0       SOURCE MODE?
1563   23516  072150          RZA  PSTR4-1   YES
1564   23517  160205          JSM  AERRA,I   NO
1565   23520  177667          DEC  -73
1566   23521  024132          LDB  M1
1567   23522  021742  PSTR4   LDA  TMP2      NO, GET STRING POINTER
1568   23523  074056          CMB
1569   23524  170402          RET
1570   23525  070152  PSTR5   SAM  *+3       OVERFLOW?
1571   23526  160205          JSM  AERRA,I   YES
1572   23527  177666          DEC  -74
1573   23530  045656          ISZ  PS1       NO, STRING END SPECIFIED?
1574   23531  067543          JMP  PSTR7     YES
1575   23532  045653          ISZ  NQT
1576   23533  067534          JMP  *+1
1577   23534  121651  PSTR6   LDA  TEMP6,I   NO
1578   23535  050157          AND  M256        RESET
1579   23536  041653          IOR  NQT           STRING
1580   23537  131651          STA  TEMP6,I         ACTUAL LENGTH
1581   23540  050105          AND  B377
1582   23541  070137          LDB  A
1583   23542  170402          RET
1584   23543  121651  PSTR7   LDA  TEMP6,I   IS NEW
1585   23544  050105          AND  B377        DESTINATION
1586   23545  070076          TCA                STRINT
1587   23546  001653          ADA  NQT             LONGER
1588   23547  071153          SAP  PSTR6-2           THAN OLD?
1589   23550  170402          RET            NO
1590*
```

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```
1591*
1592   23551  121472  GQUOT   LDA  TEMPS,I
1593   23552  050105          AND  B377      GET STRING LENGTH
1594   23553  070137          LDB  A
1595   23554  021472          LDA  TEMPS
1596   23555  000012          ADA  .1
1597   23556  031651          STA  TEMP6
1598   23557  074117          LDA  B
1599   23560  070070          SIA  *+1
1600   23561  070002          SAR  1
1601   23562  001651          ADA  TEMP6
1602   23563  031472          STA  TEMPS     UPDATE TEMPS
1603   23564  021651          LDA  TEMP6
1604   23565  070744          SAL  1
1605   23566  170402          RET
1606*
1607*
1608*
1609*      FIND VARIABLE ADDRESS
1610*
1611   23567  160177  GSYMB   JSM  SSYMA,I   SYMBOL IN TABLE?
1612   23570  160340          JSM  E40+1,I    NO
1613   23571  170402          RET
1614*
1615*
1616*
1617   23572  164172  EDATA   JMP  XEC4A,I
1618   23573  066574  EILET   JMP  LTEX
1619   23574  167604  WREX    JMP  RITE,I
1620*
1621   23575  167605  PREX    JMP  PRINT,I
1622*
1623   23576  167606  DSPEX   JMP  DISP,I
1624*
1625*
1626*
1627*
1628*
1629*    LINKS THAT MOVE WITH MONIT
1630*
1631   23577  010202  EGOS1   OCT  10202
1632   23600  012233  VAR1    OCT  12233
1633   23601  004171  STMTA   OCT  4171
1634   23602  016524  SALT    OCT  16524
1635   23603  023773  TABA    OCT  23773
1636   23604  007072  RITE    OCT  7072
1637   23605  006745  PRINT   OCT  6745
1638   23606  006746  DISP    OCT  6746
1639   23607  012436  STRID   OCT  12436
1640   23610  012455  STRI2   OCT  12455
1641   23611  010437  SWITH   OCT  10437
1642   23612  004117  REEDX   OCT  4117
1643   23613  004120  REEDY   OCT  4120
1644*
1645*
1646*
```

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```
1647   23614  176660           ABS  EVAL–*
1648   23615  176566           ABS  EINDX–*
1649   23616  176545           ABS  ELEN–*
1650   23617  046511  ERIL     ASC  11,MISSING COMMA, RETYPE
       23620  051523
       23621  044516
       23622  043440
       23623  041517
       23624  046515
       23625  040454
       23626  020122
       23627  042524
       23630  054520
       23631  042440
1651   23632  041101  ER2L     ASC  8,BAD    STRING INPUT
       23633  042040
       23634  051524
       23635  051111
       23636  047107
       23637  020111
       23640  047120
       23641  052524
1652   23642  000054  B54      OCT  54
1653   23643  000021  .17      DEC  17
1654   23644  000377  NTAB     OCT  377
1655   23645  001645  PTR1A    DEF  PTR1
1656   23646  046105  FTAB     ASC  1,LE
1657   23647  047230           OCT  47230    N, OPCODE 30
1658   23650  050117           ASC  1,PO
1659   23651  051631           OCT  51631    S, OPCODE 31
1660   23652  053101           ASC  1,VA
1661   23653  046332           OCT  46332    L, OPCODE 32
1662*
1663*
1664*
1665*
1666*      SYNTAX JUMP TABLE
1667*
1668*
1669   23654  176141           ABS  LETS–*
1670   23655  176425           ABS  READS–*
1671   23656  176424           ABS  READS–* INPUT
1672   23657  176442           ABS  DATAS–*
1673   23660  176330           ABS  PRINS–*  DISP
1674   23661  176233           ABS  IFSYN–*
1675   23662  176322           ABS  WRTS–
1676   23663  176325           ABS  PRINS–*
1677   23664  176263           ABS  IMPLT–*
1678*
1679*      SYNTAX TABLE
1680*
1681   23665  051105  SYN      ASC  2,READ
       23666  040504
1682   23667  104111           OCT  104111   OPCODE 8,I
1683   23670  047120           ASC  2,NPUT
       23671  052524
```

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```
1684   23672  103504          OCT  103504   OPCODE 7,D
1685   23673  040524          ASC  I,AT
1686   23674  040606          OCT  40606    A, OPCODE 6
1687   23675  000241          OCT  241      IMPLIED LET
1688   23676  042111          ASC  2,DISP
       23677  051520
1689   23700  122511          OCT  122511    OPCODE 5,I
1690   23701  043204          OCT  43204    F, OPCODE 4
1691   23702  053522          ASC  2,WRIT
       23703  044524
1692   23704  042643          OCT  42643    E, OPCODE 3
1693   23705  050122          ASC  2,PRIN
       23706  044516
1694   23707  052242          OCT  52242    PRINT, OPCODE 2
1695   23710  046105          ASC  1,LE     LE
1696   23711  052351          OCT  52351    T, OPCODE 11
1697*
1698*
1699*
1700   23712  003626  ER3A     ABS  *+*+2-ID1-ID1
1701   23713  041101          ASC  9,BAD NUMERIC INPUT,
       23714  042040
       23715  047125
       23716  046505
       23717  051111
       23720  041440
       23721  044516
       23722  050125
       23723  052054
1702   23724  003453  ER4A     ABS  ER1L+ER1L+13-ID1-ID1
1703   23725  003436  ER1A     ABS  ER1L+ER1L-ID1-ID1
1704   23726  003464  ER2A     ABS  ER2L+ER2L-ID1-ID1
1705   01640          CP0      EQU  ST
1706   01641          CP1      EQU  ST+1
1707   00160          B174K    EQU  M1024
1708   23727  000131  QMRKA    DEF  .63+.63+1
1709   01644          INTMP    EQU  ST+4
1710   23730  174716  LENA     ABS  LEN+LEN-ID-ID
1711   01645          PTR1     EQU  ST+5
1712   01646          PTR2     EQU  ST+6
1713   01647          TMPRE    EQU  ST+7
1714   01742          TMP2     EQU  XC+2
1715   01640          TEPPP    EQU  ST
1716   01641          SPRDD    EQU  ST+1
1717   01643          SAVE     EQU  ST+3
1718   01651          TEMP6    EQU  ST+9
1719   01652          MPT      EQU  ST+10
1720   01653          NQT      EQU  ST+11
1721   01654          TNULL    EQU  ST+12
1722   01655          PS0      EQU  ST+13
1723   01656          PS1      EQU  ST+14
1724   23731  001742  TMP2A    DEF  TMP2
1725   23732  011761  MSDAT    OCT  11761
1726   23733  003772  STDAT    OCT  3772
1727   01462          REEDL    EQU  1462B
1728*
```

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```
1729*
1730    23762                       ORG  23762B
1731*
1732*
1733*       STATEMENT EXECUTION TABLE
1734*
1735    23762   176612              ABS  LTEX-*
1736    23763   177302              ABS  EREAD-*
1737    23764   176714              ABS  EINPT-*
1738    23765   177605              ABS  EDATA-*
1739    23766   177610              ABS  DSPEX-*
1740    23767   177202              ABS  IFEX-*
1741    23770   177604              ABS  WREX-*
1742    23771   177604              ABS  PREX-*
1743    23772   177601              ABS  EILET-*
1744*
1745*
1746    23773   176353              ABS  LEN-*
1747    23774   177652              ABS  FTAB-*
1748    23775   177647              ABS  NTAB-*
1749    23776   177667              ABS  SYN-*
1750    23777   004000    ID        OCT  4000
1751                                END
*  NO ERRORS*
```

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CKM1	Ø9Ø8								
CKMOD	Ø9Ø4	Ø841	Ø928						
CLAR2	Ø489								
CLERA	Ø16Ø	1Ø13	1Ø93	1142	1153	116Ø	1165	1248	1283
CLINE	Ø316								
CLP1A	Ø217								
COMCE	Ø434								
COMCK	Ø433	Ø783	Ø8Ø3	Ø918					
COMP2	1299	1312							
COMP3	13Ø3	13ØØ							
COMP4	13Ø6	13Ø2							
COMP5	13Ø9	1317	1324						
COMP6	1314	13Ø7							
COMP7	1318	1315							
CONST	Ø482	Ø8ØØ	Ø955	1121					
CPØ	17Ø5	Ø867	Ø875	Ø893	1295	1299			
CP1	17Ø6	Ø879	Ø882	1298	1314	1319			
CPLAC	Ø331								
CRCKA	Ø228								
CRLF	Ø495								
CRLF1	Ø496								
CRTN	ØØ37	ØØ38	ØØ39						
CTYPE	Ø33Ø								
CXEC4	1165	1128							
DATA1	Ø8Ø6	Ø8Ø1							
DATA2	Ø8Ø3	Ø811							
DATAS	Ø798	Ø8Ø5	1672						
DCOMA	Ø21Ø								
DELSA	Ø175								
DFLAG	Ø388	Ø622							
DIGCK	Ø461	Ø61Ø							
DISP	1638	1623							
DPERR	ØØ43								
DRQST	Ø317	11Ø7	112Ø	1124	1264	1271	1277	1281	
DSPEX	1623	1739							
DSTRT	Ø3Ø3	1364	138Ø	1414					
E	ØØ8Ø								
E1	Ø235								
E1Ø	Ø244								
E15	Ø249	Ø919							
E2Ø	Ø254	Ø554	Ø653	Ø8Ø9	Ø922				
E25	Ø259	Ø792							
E3Ø	Ø264	Ø545							
E35	Ø269								
E4Ø	Ø274	1472	1612						
E45	Ø279								
E5	Ø239	Ø692	Ø717						
E5Ø	Ø284	14Ø4							
ECALA	Ø215								
EDATA	1617	1738							
EGOS1	1631	1335	1345						
EILET	1618	1743							
EIN14	12Ø3	1253							
EIN15	1242	1236							
EIN16	1237	1241							
EIN18	1224	1234							

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EIN19	1226	1240	1245				
EIN2	1097	1151	1158	1161			
EIN20	1231	1216					
EIN21	1235	1214					
EIN3	1129	1230					
EIN4	1181	1139					
EIN5	1206	1202					
EIND1	0890	0883					
EIND2	0877	0887	0891				
EIND3	0888	0872					
EINDX	0863	1648					
EINP6	1227	1225	1238	1243			
EINPT	1088	1737					
ELEN	0841	1649					
ELEN1	0842	0889	0897				
ELEN2	0843	0959					
ELINA	0169						
ENDS	0478						
ENTEA	0218						
ENTFA	0189						
EOL	0038	0741	0770	1074	1224		
EOLCK	0481						
EOST	0479	0555	0558	0655	0714		
ER1	1363						
ER1A	1703	1155					
ER1L	1650	1702	1702	1703	1703		
ER2	1373	1396					
ER2A	1704	1250					
ER2L	1651	1704	1704				
ER3	1379						
ER3A	1700	1144					
ER4	1257	1145	1146	1156	1157	1251	1252
ER4A	1702	1258					
EREAD	1358	1376	1736				
ERRA	0177						
ESAVE	1170	1088					
EVAL	0928	1647					
EVAL1	0943	0950					
EXP	0399	0400					
EXPOP	0118						
F	0081						
FD2	1402	1412					
FD3	1413	1409	1411				
FDAAA	0222	1371					
FETCH	0486	1470					
FILLA	0201						
FINCH	1070	1080	1211				
FIRST	0365						
FIX	0499						
FLGBT	0073						
FLOAT	0384						
FLTFA	0193						
FLTRA	0192	1471					
FLTSA	0195						
FN	0148						
FND	0460						

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FND1A	Ø224										
FNDAA	Ø223										
FNDPS	Ø474										
FOPBS	Ø2Ø6										
FORMA	Ø172	1115	1362								
FORME	Ø336										
FORMS	Ø335										
FORMT	Ø334										
FPAGE	Ø449										
FROMA	Ø122										
FSCA	Ø173	Ø587	Ø591	Ø758	Ø769						
FSCE2	Ø439										
FSCE4	Ø444										
FSCH	1348	1Ø31									
FTAB	1656	1747									
FTMP1	Ø337										
FTMP2	Ø338										
FWAM	Ø157										
FWUP	Ø296										
FXFLA	Ø194	Ø842									
GA1	1455	145Ø	1463								
GA2	1451	1446									
GADD	1437	Ø511	Ø527	Ø986	Ø998	1181	1377				
GETAD	Ø459										
GETCH	Ø469	Ø878	Ø881	Ø944	1Ø61	1Ø73	13Ø4	1322	1355		
GETSK	Ø473	Ø734	1131	1237	1242						
GFLAG	Ø4Ø2										
GFRST	Ø472	Ø6Ø4	12Ø4	1269							
GNEXT	Ø471	Ø6Ø5	Ø668	Ø97Ø	12Ø1	1226					
GOTOE	1335	1331									
GP1	1ØØ4	Ø912	Ø993								
GP2	Ø997	Ø913									
GPARM	Ø422										
GPTRS	Ø986	Ø866	1ØØ7	1293							
GQUOT	1592	1ØØ4	1389								
GSIGN	Ø484										
GSYMB	1611	1438									
GTCON	Ø498										
GTE	Ø827	Ø659	Ø659								
GTEA	Ø659	Ø636									
GTMP	Ø47Ø										
GTOPP	Ø464	1437									
GTSTA	Ø213	Ø557	Ø648	Ø74Ø	Ø81Ø	Ø859					
GVAR	Ø966	Ø849	Ø915								
HFLG1	Ø321										
HSTPT	Ø3Ø2	Ø94Ø	1149	115Ø							
I	ØØ67	Ø951									
ICNT	Ø42Ø										
ID	175Ø	Ø658	Ø658	Ø659	Ø659	171Ø	171Ø				
ID1	Ø5Ø9	1162	1163	17ØØ	17ØØ	17Ø2	17Ø2	17Ø3	17Ø3	17Ø4	17Ø4
IF1	Ø644										
IF2	Ø649	Ø647									
IF3	Ø648	Ø645									
IFERR	Ø656	Ø64Ø	Ø646								
IFEX	1293	174Ø									
IFSYN	Ø633	1674									

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ILET1	0680	0671	0674	0675	0678					
ILET2	0690	0688								
IMPLT	0665	1677								
IMPY	0485									
INC1	1281	1268	1270							
INC2	1285	1282								
INCAL	1263	1180	1203	1284						
INCH1	1160	1132								
INCH2	1153	1135								
INCH5	1142	1122								
INCHT	1147	1162								
INDS2	0918	0925								
INDXS	0915	0865								
INF	0077									
INITS	0454									
INLN1	1162	1118								
INLNK	1163	1105								
INREA	0226									
INRET	1108	1163								
INSTR	1176	1104								
INTCK	0457									
INTEA	0178									
INTFL	0075									
INTGR	0400									
INTMP	1709	0874	0892	0989	1200	1217	1246	1327	1400	1415
IOBUF	0357									
IOHEA	0229	0703								
IOSTA	0225									
KEYFG	0324									
L2T1	0345									
L2T2	0346	0530								
LASTN	0396									
LBOP	0119	0583	1449							
LDEF	0487									
LEN	0824	1710	1710	1746						
LENA	1710									
LENER	0900	0850	0851	0916	0917					
LENS	0849	0907								
LENS1	0852	0860	0923							
LENS2	0858	0921								
LETCK	0462	0670								
LETS	0539	1669								
LIMIT	0463									
LISTA	0167									
LNFD	0072									
LNINC	0315									
LNUM	0455	0654								
LOCL1	0343	1407								
LOCL2	0344									
LPCK	0435	0581								
LPCKE	0436	0973								
LPOP	0120									
LROMA	0123									
LSTAK	0299									
LSTPT	0301	0935	1182	1503	1505					
LT2	1017	1010	1012							

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PAGE 365 9830——BASE PAGE READ-WRITE MEMORY

```
0507                                    LST
0508*
0509*   R/W TEMPORARIES
0510*
0511    01640                           ORG  1640B
0512*
0513    01640  000000  YH       BSS  1
0514    01641  000000  XH       BSS  1
0515    01642  000000  XW       BSS  1
0516    01643  000000  YW       BSS  1
0517    01644  000000  CP3      BSS  1
0518    01645  000000  CP4      BSS  1
0519    01646  000000  T3       BSS  1
0520    01647  000000  T1       BSS  1
0521*
0522    01650  000000  XN       BSS  4
0523    01654  000000  XX       BSS  4
0524    01660  000000  YN       BSS  4
0525    01664  000000  YX       BSS  4
0526*
0527    01670  000000  Z1       BSS  4
0528    01674  000000  Z2       BSS  4
0529*
0530*   THESE FOUR WORDS ARE NOT SAFE DURING FUNCTIONS
0531*
0532    01734                           ORG  1734B
0533    01734  000000  DX       BSS  1
0534    01735  000000  DY       BSS  1
0535    01736  000000  CPX      BSS  1
0536    01737  000000  CPY      BSS  1
0537*
0538    01473          CCNT     EQU  TEMPS+1
0539    01477          TEMP5    EQU  TEMPS+5
0540    01734          CP2      EQU  DX
0541    01735          CPT      EQU  DY
0542    01735          T4       EQU  CPX
0543    01737          T2       EQU  CPY
```

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```
0545   22000                ORG  22000B
0546*
0547*
0548*     THE PLOT BLOCK HAS ABSOLUTE ADDRESSES TO THE
0549*     FOLLOWING BASIC SYSTEM SUBROUTINES
0550*
0551*     COS
0552*     SIN
0553*     RITE   WRITE STATEMENT SYNTAX
0554*     PRINN  PRINT STATEMENT EXCUTION
0555*     SCERI  FORMAT EXCUTION
0556*     MOVCK  MOVE THE SYMBOL TO LOWER MEMORY
0557*     TYPEC
0558*     QTCHK
0559*     FSPR
0560*     CKEOL
0561*     PFORM
0562*     KEYIN
0563*     VALUP
0564*     TBSRI
0565*
0566*   SPECIAL SYMBOL CODE'S USED IN THIS BLOCK ARE AS FOLLOWS:
0567*
0568*   B1740 SCALING IMFORMATION
0569*   B1760 CHARACTER DEFINITION
0570*    1660 CARRIAGE RETURN IMFORMATION
0571*
0572*     CODE STARTED 10—26—71
0573*
0574*     RELATIVE ADDRESSES TO SCALEING IMFORMATION IS AS FOLLOWS
0575*
0576*     0 = X SCALE FACTOR
0577*     4 = Y SCALE FACTOR
0578*     8 = X ADJUST
0579*    12 = Y ADJUST
0580*    16 = X PRESENT POSITION
0581*    20 = Y PRESENT POSITION
0582*    24 = X OFFSET
0583*    28 = Y OFFSET
0584*
0585*          CONSTANTS AND EQUATES
0586*
0587*
0588   22000  001400  N9/6    OCT  1400      1666.66  ** DON'T MOVE — IT'S RELATIVE
                                                        ADDRESS = 0
0589   22001  013146          OCT  13146
0590   22002  063146          OCT  63146
0591   22003  063146          OCT  63146
0592*
0593   22004  001400          OCT  1400      9999     ** DON'T MOVE, IT'S RELATIVE
                                                        ADDRESS =4
0594   22005  114631          OCT  114631
0595   22006  000000          OCT  0
0596   22007  000000          OCT  0
0597*
```

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```
0599*
0600*          GET THE PEN CONTROL PARAMETER
0601*
0602  22010  025654  PNPAR  LDB  XX        RECALL THE PEN CONTROL
0603  22011  074113         SBP  *+2       IF PSITIVE DO CONTROL NOW
0604  22012  170402         RET            IT'S NEGTIVE SOPEN CONTROL AFTER
0605  22013  075750  .P1    SZB  *-1       IF ZERO, NO PEN CONTROL
0606  22014  074251         SLB  PENDN
0607*
0608  22015  062032  PENUP  JSM  STATU
0609  22016  075613         SBP  .P1-1
0610  22017  020017         LDA  .2
0611  22020  066024         JMP  PENDN+3
0612  22021  062032  PENDN  JSM  STATU
0613  22022  075412         SBM  .P1-1
0614  22023  020020         LDA  .3
0615  22024  070246         RAR  6
0616*
0617  22025  062032  BUSY   JSM  STATU
0618  22026  074644         SBL  3
0619  22027  075713         SBP  BUSY
0620  22030  043737         IOR  SC16
0621  22031  065356         JMP  TTY+3
0622  22032  027737  STATU  LDB  SC16
0623  22033  172741         STF  1
0624  22034  176141         OTB  1
0625  22035  172741         STF  1
0626  22036  177241         LIB  1,C
0627  22037  074546         RBR  12
0628  22040  170402         RET
0629*
0630  22041  070742  AMOVE  SAR  16
0631  22042  031477         STA  TEMPS     ALTERNATE ENTRY FOR
                                           ABINCRMENTAL MOVE
0632*
0633  22043  023500  MOVE   LDA  XMIN
0634  22044  062070         JSM  .M
0635  22045  040107         IOR  B1000
0636  22046  062025         JSM  BUSY
0637  22047  021754         LDA  AR2
0638  22050  050105         AND  B377
0639  22051  040013         IOR  B400
0640  22052  062025         JSM  BUSY
0641  22053  023502         LDA  YMIN
0642  22054  062070         JSM  .M
0643  22055  040013         IOR  B400
0644  22056  062025         JSM  BUSY
0645  22057  021754         LDA  AR2
0646  22060  050105         AND  B377
0647  22061  040013         IOR  B400
0648  22062  041477         IOR  TEMP5
0649  22063  062025         JSM  BUSY
0650*
0651  22064  025442         LDB  STPFL
0652  22065  014040         CPB  .31       STOP KEY HIT
0653  22066  066554         JMP  EPEN      YES
0654  22067  170402         RET            NO
```

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```
0655*
0656   22070  060445  .M      JSM  XFAR2+1
0657   22071  160225          JSM  FLTRA,I
0658   22072  001654  XMAX    DEF  XX
0659   22073  074117          LDA  B
0660   22074  074212          SBM  *+4
0661   22075  004161          ADB  MAXSN
0662   22076  074112          SBM  *+2
0663   22077  023514          LDA  .9999
0664   22100  031754  STOR2   STA  AR2
0665   22101  070342          SAR  8
0666   22102  170402          RET
0667*
0668*        FIND THE ADDRESS OF THE R/W WORDS.
0669*        ON RETURN THE ADDRESS OF THE 1ST WORD IS IN B AND T1.
0670*
0671   22103  062015          JSM  PENUP
0672   22104  020111  GETRW   LDA  STEAL    LOAD THE CODE WORD
0673   22105  160177          JSM  SSYMA,I  LOOK FOR IT IN SYMBOL TABLE
0674   22106  066113          JMP  *+5      NOT FOUND
0675   22107  004132  GE1     ADB  M1
0676   22110  074537          LDB  B,I
0677   22111  035647          STB  T1
0678   22112  170402          RET
0679*
0680   22113  160205          JSM  AERRA,I
0681   22114  177660          DEC  -80      NO SCALE COMMAND EXECUTED
                                            BEFORE PLOT, ECT
0682*
0683*
0684*        TRANSFER ROUTINES
0685   22115  021646  WHERE   LDA  T3
0686   22116  070352          SAM  TXM
0687*
0688   22117  027502  TYM     LDB  YMIN
0689   22120  064406          JMP  XFAR1+1
0690*
0691   22121  027504  TYX     LDB  YMAX
0692   22122  064406          JMP  XFAR1+1
0693*
0694   22123  021646  OWHER   LDA  T3
0695   22124  071552          SAM  TYM      SKIP TO TYM IF IN XAXIS MODE
0696   22125  027500  TXM     LDB  XMIN
0697   22126  064406          JMP  XFAR1+1
0698*
0699   22127  026072  TXX     LDB  XMAX
0700   22130  064406          JMP  XFAR1+1
0701*
0702   22131  027772  TEMXX   LDB  TEMX
0703   22132  064406          JMP  XFAR1+1
0704*
0705   22133  021737          LDA  T2
0706   22134  160216          JSM  .FADA,I
0707   22135  025737  TRANS   LDB  T2
0708   22136  064406          JMP  XFAR1+1
0709*
```

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```
0711*
0712   22137  000051          ABS  SPEN-*     LETTER EYNTAX
0713   22140  000105          ABS  OFFS-*     CPLOT SYNTAX
0714   22141  000102          ABS  SCALE-*    SCALE SYNTAX
0715   22142  000047          ABS  SAXIS-*
0716   22143  000046          ABS  SAXIS-*    XAXIS SYNTAX
0717   22144  000103          ABS  PLOT-*     PLOT SYNTAX
0718   22145  000100          ABS  OFFS-*
0719   22146  000042          ABS  SPEN-*
0720   22147  000051          ABS  LABEL-*
0721   22150  000077          ABS  PLOT-*
0722   22151  000000          BSS  1          *** CHECKSUM WORD ***
0723*
0724   22152  044520  SNAME   ASC  1,IP       IPLOT
0725   22153  046117          ASC  1,LO
0726   22154  052242          OCT  52242      T
0727   22155  046101          ASC  1,LA       LABEL
0728   22156  041105          ASC  1,BE
0729   22157  046243          OCT  46243      L
0730   22160  050105          ASC  1,PE       PEN
0731   22161  047244          OCT  47244      N
0732   22162  047506          ASC  3,OFFSET
       22163  043123
       22164  042524
0733   22165  122520          OCT  122520     P
0734   22166  046117          ASC  1,LO       PLOT
0735   22167  052246          OCT  52246      T; OP CODE 6
0736   22170  054101          ASC  1,XA       XAXIS
0737   22171  054111          ASC  1,XI
0738   22172  051647          OCT  51647      S
0739   22173  054501          ASC  1,YA       YAXIS
0740   22174  054111          ASC  1,XI
0741   22175  051650          OCT  51650      S
0742   22176  051503          ASC  2,SCAL     SCALE ; OP CODE 9
       22177  045514
0743   22200  042651          OCT  42651      E; OP CODE 9
0744   22201  041520          ASC  2,CPLO
       22202  046117
0745   22203  052252          OCT  52252      T; OP CODE 10
0746   22204  046105          ASC  3,LETTER   FREE MODE
       22205  052124
       22206  042522
0747   22207  165400          OCT  165400     OP CODE 11
0748*
0749*        END OF SNYTAX NAME TABLE
0750*
```

PAGE 370 SYNTAX CODE FOR 9830 PLOTTER

```
0752*       PEN STATEMENT SYNTAX
0753*
0754   22210  065147  SPEN     JMP  ENDS
0755*
0756*       AXIS SYNTAX
0757*
0758   22211  160202  SAXIS    JSM  FSCA,I     DEMAND AN OPPSITIE ORGIN
0759   22212  060504           JSM  COMCK      ,?
0760   22213  065151           JMP  EOST       NO DEMAND EOL
0761   22214  160202           JSM  FSCA,I     YES, DEMAND A TIC PARAMETER
0762   22215  060504           JSM  COMCK
0763   22216  065151           JMP  EOST
0764   22217  066245           JMP  OFFS
0765*
0766*       LABEL STATEMENT SYNTAX
0767*
0768   22220  060456  LABEL    JSM  SBPUD      UPDATE POINTER
0769   22221  060520           JSM  LPCKE-1    DEMAND LEFT PAREN.
0770   22222  061055           JSM  GNEXT
0771   22223  060456           JSM  SBPUD
0772   22224  060463           JSM  SYMC1      CHECK FOR "*"
0773   22225  012012           DEF  12012B
0774   22226  066240           JMP  LAB2       NOT FOUND , MUST BE NUMBER
0775   22227  060456           JSM  SBPUD
0776   22230  061055           JSM  GNEXT
0777   22231  060504  LAB3     JSM  COMCK      FOUND, NOW CHECK FOR OPTIONAL
                                                PARAMETERS
0778   22232  066237           JMP  LAB1       P+1 , NO OPTIONS, GO DEMAND A
                                                RIGHT PAREN.
0779   22233  062254           JSM  FORM3      P+2, OPTIONS ARE THERE
0780   22234  060504           JSM  COMCK      CHECK IF PAPER DEMENSIONS ARE
                                                PRESENT
0781   22235  066237           JMP  LAB1       NO
0782   22236  160202           JSM  FSCA,I     YES, GET A FORMULA
0783   22237  167562  LAB1     JMP  RITE,I
0784   22240  055706  LAB2     DSZ  SBPTR
0785   22241  060663           JSM  LNUM-1
0786   22242  066231           JMP  LAB3
0787*
0788*       SCALE STATEMENT SYNTAX
0789*
0790   22243  062256  SCALE    JSM  FORM2
0791   22244  060510           JSM  COMCE
0792   22245  062256  OFFS     JSM  FORM2
0793   22246  065151           JMP  EOST
0794*
0795*       PLOT AND IPLOT STATEMENT SYNTAX
0796*
0797   22247  062256  PLOT     JSM  FORM2      DEMAND X AND Y COOR.
0798   22250  060504           JSM  COMCK      CHECK FOR COMMA
0799   22251  065151           JMP  EOST       "," NOT FOUND, DEMAND E.O.S.
0800   22252  160202           JSM  FSCA,I     PROCESS OPTIONAL PEN COMMAND
0801   22253  065151           JMP  EOST       DEMAND E.O.S.
0802*
0803   22254  160202  FORM3    JSM  FSCA,I
0804   22255  060510           JSM  COMCE      DEMAND ,
0805   22256  160202  FORM2    JSM  FSCA,I
0806   22257  060510           JSM  COMCE      DEMAND ,
0807   22260  164202           JMP  FSCA,I
```

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```
0809*
0810   22261  160201  FORM    JSM  FORMA,I
0811   22262  160201          JSM  FORMA,I
0812   22263  160201          JSM  FORMA,I
0813   22264  164201          JMP  FORMA,I
0814*
0815*        SCALE EXECUTION
0816*
0817   00111          STEAL   EQU  B1740
0818*
0819   22265  062652  ESCAL   JSM  CURPG    GET CURRENT PAGE
0820   22266  062261          JSM  FORM     STACK 4 FORMULA
0821*
0822   22267  020111          LDA  STEAL    LOAD SYMBOL FOR R/W WORDS
0823   22270  160177          JSM  SSYMA,I  CHECH IF PLOTTER WORDS ARE
                                             SAVED ALREADY
0824   22271  066273          JMP  *+2      NO, ENTER SAME
0825   22272  066306          JMP  ES1      YES, SKIP ENTRY
0826   22273  025406          LDB  VALUE    ENTER PLOTTER R/W WORDS INTO
                                             STACKS
0827   22274  023520          LDA  M34      MOVE DOWN 34 PLACES, 32 FOR
                                             VALUES
0828*
0829*   MOVE H-STACK DOWN AND CHEKC FOR OVERFLOW
0830*
0831*     MOVE DOWN -(A) WORDS
0832*     (B)=ADDRESS+1 OF THE LAST WORD TO BE MOVED
0833*
0834   22275  163666          JSM  MOVCK,I
0835*
0836   22276  003520          ADA  M34
0837   22277  070137          LDB  A        POINTER TO VALUE TABLE
0838   22300  000017          ADA  .2       POINTER TO 1ST WORD OF R/W
0839   22301  074557          STA  B,I      STORE ADDRESS POINTER TO
                                             PLOTTER R/W
0840   22302  074070          SIB  *+1
0841   22303  020111          LDA  STEAL    LOAD PLOTTER L/W CODE
0842   22304  074557          STA  B,I
0843   22305  035406          STB  VALUE
0844*
0845   22306  062107  ES1     JSM  GE1      LOAD THE ADDRESS POINTER TO 1ST
                                             WORD OF PLOTTER R/W
0846   22307  035737          STB  T2       SAVE B TEMPORARLY FOR ZERING
0847   22310  070742          SAR  16       CLEAR A
0848   22311  027554          LDB  M31
0849   22312  131737          STA  T2,I     ZERO 33 WORDS OF R/W
0850   22313  045737          ISZ  T2
0851   22314  077730          RIB  *-2      LOOP BACK IF NOT ZERO
0852*
0853*
0854*   COMPUTE THE SCALE FACTOR - 9999/(YMAX-YMIN)
0855*   AND YADJUST = -(S.F.*YMIN)
0856*
0857   22315  020021          LDA  .4       * SET-UP Y SCALE FACTOR
0858   22316  062322          JSM  SCAL     *
0859   22317  070004          SAL  16       *
0860   22320  062322          JSM  SCAL     *
0861   22321  164172          JMP  XEC4A,I  RETURN TO MONITOR
0862*
0863*   SCAL ROUTINE IS USED FOR X AND Y SCALE FACTORS
0864*     AND ADJUST VALUES
```

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```
0865*
0866   22322  031735  SCAL    STA  CPT
0867   22323  061220          JSM  FETCH+1   RECALL THE MAX
0868   22324  062127          JSM  TXX
0869   22325  061220          JSM  FETCH+1   RECALL THE MIN
0870   22326  062117          JSM  TYM
0871   22327  024033          LDB  .16
0872   22330  062344          JSM  TR/W-1
0873   22331  022072          LDA  XMAX
0874   22332  160217          JSM  .FSBA,I   (MAX-MIN)
0875   22333  062125          JSM  TXM
0876   22334  020021          LDA  .4        RELATIVE ADDRESS TO 9999
0877   22335  041645          IOR  CP4       INCLUDE CURRENT PAGE
0878   22336  160221          JSM  .FDVA,I   9999/(MAX-MIN)
0879   22337  025735          LDB  CPT       CPT=POINTER TO FIRST WORD IN
                                              R/W FOR X OR Y
0880   22340  062345          JSM  TR/W      PLACE THE S.F. IN THE STACK
0881   22341  023502          LDA  YMIN
0882   22342  160220          JSM  .FMPA,I   S.F. * MIN
0883   22343  024025          LDB  .8        SET(B)=ADJUST LOCATION POINTER
0884   22344  005735          ADB  CPT
0885   22345  005647  TR/W    ADB  T1
0886   22346  064406          JMP  XFAR1+1
```

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```
0888*
0889*          OFFSET COMMAND EXECUTION
0890*
0891   22347  062263  EOFF    JSM  FORM+2
0892   22350  062104          JSM  GETRW
0893   22351  023532          LDA  B24
0894   22352  062356          JSM  EOFF1
0895   22353  020033          LDA  .16
0896   22354  062356          JSM  EOFF1
0897   22355  164172          JMP  XEC4A,I
0898*
0899   22356  031735  EOFF1   STA  CPT
0900   22357  061220          JSM  FETCH+1
0901   22360  062343          JSM  TR/W-2
0902   22361  074117          LDA  B
0903   22362  002610          ADA  M8
0904   22363  160217          JSM  .FSBA,I
0905   22364  025735          LDB  CPT
0906   22365  066345          JMP  TR/W
0907*
```

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```
0909*
0910   22366  021646  PWHER   LDA  T3        PWHER IS USED BY AXIS EXCUTION
0911   22367  070352          SAM  PUNX+1
0912   22370  066372          JMP  PUNY+1
0913*
0914*  ROUTINE TO GET A PARAMETER AND CONVERT IT TO PLOTTER UNITS
0915*
0916   22371  061220  PUNY    JSM  FETCH+1
0917   22372  020021          LDA  .4
0918   22373  027502          LDB  YMIN
0919   22374  066400          JMP  PUNIT
0920*
0921*  PUNX FETCHES A PARAMETER AND CONVERTS IT TO PLOTTER UNITS
0922*
0923   22375  061220  PUNX    JSM  FETCH+1
0924   22376  070742          SAR  16        SET A=TO AN OFFSET SO THAT
                                                        A+T1=1ST WORD
0925   22377  027500          LDB  XHIN
0926   22400  001647  PUNIT   ADA  T1
0927   22401  031734          STA  CP2       STORE POINTER TO 1ST X OR Y VALUE
0928   22402  000033          ADA  .16
0929   22403  031736          STA  T4         SAVE POINTER TO PRESENT POSITION
0930   22404  035737          STB  T2        STORE POINTER TO XMIN OR YMIN
0931   22405  060406          JSM  XFAR1+1     TRANSFER AR2 TO XMIN OR YMIN
0932   22406  121736          LDA  T4,I       LOAD THE EXP WORD OF THE
                                                        PRESENT POSITION
0933   22407  070006          RAR  1
0934   22410  070231          SLA  .PUN,C     IS BIT 1=1?
0935   22411  070706          RAR  15         YES, CLEAR IT, AND GIVE PENUP
0936   22412  131736          STA  T4,I
0937   22413  062015          JSM  PENUP
0938   22414  021644  .PUN    LDA  CP3
0939   22415  070153          SAP  PUN1      SKIP IF IN ABS MODE
0940   22416  025736          LDB  T4
0941   22417  062133          JSM  TRANS-2   X/YMIN-LAST POSITION + DX/DY IF
                                                        IN INCR.
0942*
0943   22420  025736  PUN1    LDB  T4
0944   22421  060406          JSM  XFAR1+1   REPLACE PRESENY POSITION WITH
                                                        NEW VALUE
0945   22422  004025          ADB  .8
0946   22423  062133          JSM  TRANS-2   NEW POSITION + OFFSET
0947   22424  021734          LDA  CP2
0948   22425  160220          JSM  .FMPA,I   S.F.*NEW POSITION
0949   22426  062135          JSM  TRANS
0950   22427  074117          LDA  B
0951   22430  025734          LDB  CP2
0952   22431  004025          ADB  .8
0953   22432  160217          JSM  .FSBA,I   SUBTRACT THE ADJUST VALVE
0954   22433  062135          JSM  TRANS     SAVE THIS ANSWER (PLOTTER UNITS)
                                                        IN XMIN OR YMIN
0955   22434  074742          SBR  16        CLEAR (B) FOR A FALG IF OUT OF
                                                        RANGE
0956*
0957   22435  021754  LIMT    LDA  AR2
0958   22436  070451          SLA  XLT2      WAS THE RESULT NEGATIVE
0959   22437  021737          LDA  T2        YES — CLEAR X OR Y MIN
0960   22440  170000          CLR
0961   22441  024033  LFLAG   LDB  .16       FLAG PRESENT PEN POSITION
0962   22442  005734          ADB  CP2
0963   22443  074517          LDA  B,I
0964   22444  040017          IOR  .2
```

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```
0965   22445  074557          STA  B,I
0966   22446  170402          RET
0967*
0968   22447  003512  XLT2    ADA  EXPM4    THE RESULT WAS NOT NEGATIVE, NOW
                                             NOW CHECK IF
0969   22450  071712          SAM  *-2      <9999?
0970   22451  020021          LDA  .4       OTHERWISE SET XMIN OR YMIN
                                             (RELATIVE ADD. TO 9999)
0971   22452  041645          IOR  CP4
0972   22453  025737          LDB  T2       TO 9999
0973   22454  170004          XFR
0974   22455  066441          JMP  LFLAG    AND FLAG THE LAST POSITION
```

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```
0976*
0977   22456  075410  .XX     SZB  XLT2-1
0978   22457  024133          LDB  M2
0979   22460  035654          STB  XX
0980   22461  066015          JMP  PENUP
0981*     PLOT AND IPLOT EXECUTION
0982*
0983   22462  076052  EIPLT   SBM  *+1,S
0984   22463  035644  EPLOT   STB  CP3
0985   22464  074072          SBM  *+1,C
0986   22465  062652          JSM  CURPG
0987   22466  062263          JSM  FORM+2   STACK X, AND Y
0988   22467  021472          LDA  TEMPS
0989   22470  011421          CPA  PRADD    PEN CONTROL?
0990   22471  066474          JMP  *+3
0991   22472  061217          JSM FETCH
0992   22473  160225          JSM  FLTRA,I
0993   22474  024133          LDB  M2
0994   22475  035654          STB  XX
0995*
0996   22476  062104          JSM  GETRW
0997*
0998   22477  062371          JSM  PUNY     FETCH Y
0999   22500  062456          JSM  .XX      CHECK IF PEN IS OFF-SCALE
1000   22501  062375          JSM  PUNX     FETCH X
1001   22502  062456          JSM  .XX      CHECK IF PEN IS OFF-SCALE
1002   22503  062010          JSM  PNPAR    CHECK FOR ANY PEN CONTROL
                                             BEFORE MOVEMENT
1003   22504  062041          JSM  AMOVE    SET ABS FLAG AND MOVE PEN
1004   22505  025654          LDB  XX       LOAD THE PEN CONTROL WORD
1005   22506  074113          SBP  *+2
1006   22507  062013          JSM  .P1      AND CHECK FOR ANY PEN
                                             MOVEMENT AFTERWORDS
1007   22510  164172          JMP  XECA,I
```

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```
1009*
1010*      X AND Y AXIS EXECUTION
1011*
1012   22511  076053  EXAXE   SBP  *+1,S
1013   22512  035646  EYAXE   STB  T3
1014   22513  074072          SBM  *+1,C
1015   22514  062652          JSM  CURPG
1016   22515  035644          STB  CP3       SET PUNIT FOR ABS MODE
1017   22516  160201          JSM  FORMA,I   STACK ORIGIN
1018   22517  021472          LDA  TEMPS
1019   22520  011421          CPA  PRADD     ORIGIN ONLY?
1020   22521  066546          JMP  AX7
1021   22522  160201          JSM  FORMA,I   STACK TICK
1022   22523  021472          LDA  TEMPS
1023   22524  011421          CPA  PRADD     ORIGIN, TICK ONLY?
1024   22525  066556          JMP  AX3       YES
1025   22526  062263          JSM  FORM+2    STACK POINT 1 and 2
1026   22527  062103          JSM  GETRW-1   DO PENUP AND GET THE R/W
                                              ADDRESS
1027   22530  062604          JSM  CLIMT-2   RECALL POINT 2
1028   22531  035665          STB  YX+1
1029   22532  061220          JSM  FETCH+1
1030   22533  062127          JSM  TXX       SAVE THE STARTING POINT
1031   22534  062605          JSM  CLIMT-1
1032   22535  061220  .E1      JSM  FETCH+1   FETCH THE TICK PARAMETER
1033   22536  062131          JSM  TEMXX
1034*
1035*     YX = MIN VALUE IN PLOTTER UNITS
1036*     YX+1 = MAX VALUE IN PLOTTER UNITS
1037*     XMAX HAS PRESENT PEN POSITION
1038*     TEMX HAS THE TICK INCREMENT
1039*
1040*
1041   22537  062573  SLOOP   JSM  AX4
1042   22540  062633          JSM  .TICK     PUT PEN DOWN AND MAKE A TICK AT
                                              THE MIN POINT
1043   22541  022072  AX5     LDA  XMAX
1044   22542  027772          LDB  TEMX
1045   22543  160216          JSM  .FADA,I   COMPUTE THE NEXT POINT
1046   22544  062614          JSM  TICMK     GO TO THE TICMK ROUTINE TO
                                              CONVERT TO P.U.
1047   22545  066541          JMP  AX5       MOVE THE PEN AND MAKE A
                                              TIC THEN LOOP BACK
1048*
1049   22546  062560  AX7     JSM  AX2       NO TICKS OR NIN AND MAX
1050   22547  062573          JSM  AX4
1051*
1052   22550  025665  AX6     LDB  YX+1      TICMK WILL COME HERE IF IT GOES
                                              BEYOND MAX VALUE
1053   22551  160227          JSM  FXFLA,I
1054   22552  062115          JSM  WHERE
1055   22553  062602          JSM  .AX4
1056   22554  062015  EPEN    JSM  PENUP     DO PENUP, PEN EXCUTION ALSO
1057   22555  164172          JMP  XEC4A,I   AND RETURN
1058*
1059*
1060*        SUBROUTINES FOR AXIS EXECUTION
1061*
1062   22556  062560  AX3     JSM  AX2
1063   22557  066535          JMP  .E1
1064*
```

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```
1065  22560  062103  AX2     JSM  GETRW-1  DO PENUP AND GET THE R/W ADDRESS
1066  22561  023514          LDA  .9999
1067  22562  031665          STA  YX+1      (B) = POINTER TO SCALE FACTOR
1068  22563  021646          LDA  T3
1069  22564  070112          SAM  *+2
1070  22565  004021          ADB  .4
1071  22566  074117          LDA  B
1072  22567  000025          ADA  .8
1073  22570  160221          JSM  .FDVA,I   ADJUST/SCALE FACTOR
1074  22571  062127          JSM  TXX
1075  22572  066366          JMP  PWHER
1076*
1077  22573  061220  AX4     JSM  FETCH+1   RECALL THE OPPSITIE ORIGIN
1078  22574  021646          LDA  T3
1079  22575  031664          STA  YX        INITIALIZE YX TO A VALUE ABOVE 9999
1080  22576  070076          TCA
1081  22577  062367          JSM  PWHER+1
1082  22600  062606          JSM  CLIMT
1083  22601  035666          STB  YX+2
1084  22602  062041  .AX4    JSM  AMOVE
1085  22603  066021          JMP  PENDN
1086*
1087  22604  061220          JSM  FETCH+1
1088  22605  062366          JSM  PWHER
1089  22606  076210  CLIMT   RZB  .CL2      IF (B) ≠ 0, THEN OUT OF RANGE
1090  22607  160225  .CL1    JSM  FLTRA,I   PLOTTER UNITS DID NOT OVERFLOW,SO
1091  22610  177770  M8      DEC  -8
1092  22611  170402          RET            RETURN AFTER CONVERTING TO
                                                              INTEGER
1093  22612  160205  .CL2    JSM  AERRA,I
1094  22613  177656          DEC  -82       ERROR IF XO, YO, OR THE MIN, MAX
                                                              VALUES OFF-SCALE
1095*
1096*     TICMK MOVES PEN AND THEN MAKES A TICK MARK
1097*       AR2 HAS THE NEXT TICK POSITION, TEMY,I HAS THE CONSTANT ORIGIN
1098*
1099  22614  062127  TICMK   JSM  TXX
1100  22615  062366          JSM  PWHER
1101  22616  062607          JSM  .CL1
1102  22617  015664          CPB  YX        DID THE VALUE CHANGE?
1103  22620  066612          JMP  .CL2      NO, MUST BE A ZERO TICK OR
                                                          XMAX + TICK = XMAX
1104  22621  035664          STB  YX        STORE A GOOD VALUE FOR THE
                                                              1ST INCREMENT
1105  22622  021670          LDA  Z1        LOAD THE SIGN OF THE TICK
1106  22623  074076          TCB
1107  22624  005665          ADB  YX+1
1108  22625  074150          SZB  *+3       DO A TICK IF ZERO
1109  22626  070111          SLA  *+2
1110  22627  076212          SBM  .TICK,S   - DIRECTION
1111  22630  074153          SBP  .TICK     + DIRECTION
1112  22631  055777  TBL     DSZ  RSPTR
1113  22632  066550          JMP  AX6       FINISH THE AXIS AND RETURN
1114  22633  062041  .TICK   JSM  AMOVE
1115  22634  025666          LDB  YX+2      RECALL THE OPSITIE AXIS
1116  22635  004052          ADB  .48
1117  22636  074117          LDA  B
1118  26637  000161          ADA  MAXSN     (-10000)
1119  22640  070113          SAP  *+2
1120  22641  062647          JSM  .TIC      OUTPUT PLUS TICK
```

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```
1121   22642  024153          LDB  M48
1122   22643  005666          ADB  YX+2
1123   22644  074112          SBM  *+2
1124   22645  062647          JSM  .TIC
1125   22646  025666          LDB  YX+2
1126   22647  160227  .TIC    JSM  FXFLA,I
1127   22650  062123          JSM  OWHER
1128   22651  066041          JMP  AMOVE
1129*
```

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```
1131*
1132   22652  074442  CURPG  SBR  10
1133   22653  074304         SBL  10
1134   22654  035645         STB  CP4
1135   22655  170402         RET
1136*
1137   22656  026072  ROT2   LDB  XMAX
1138   22657  160221         JSM  .FDVA,I    / A.R
1139   22660  062131  ROT4   JSM  TEMXX
1140   22661  023504  ROT1   LDA  YMAX
1141   22662  160220         JSM  .FMPA,I    * HEIGHT
1142   22663  160225         JSM  FLTRA,I    CONVERT TO INTGER
1143   22664  066672         JMP  PRERR      OVERFLOW RETURN
1144   22665  074117         LDA  B
1145   22666  070112         SAM  *+2
1146   22667  070076         TCA
1147   22670  000122         ADA  B6K
1148   22671  071213         SAP  CURPG+3    RETURN
1149   22672  160205  PRERR  JSM  AERRA,I
1150   22673  177657         DEC  -81        CHARACTER SIZE TO BIG, OR BINARY
                                              FORMAT NOT ALLOWED
1151*
1152*     SET DEFAULT HEIGHT APPROX = 1.5%, A.R. = 2
1153*
1154   22674  062652  CDEF   JSM  CURPG
1155   22675  062015         JSM  PENUP
1156   22676  020112         LDA  B1760
1157   22677  160177         JSM  SSYMA,I    SERACH THE SYMBOL TABLE FOR CHAR
                                              DEFINITION
1158   22700  066720         JMP  .CDEF
1159   22701  062107         JSM  GE1        FOUND
1160   22702  035640         STB  YH
1161   22703  074070         SIB  *+1
1162   22704  035641         STB  XH
1163   22705  074070         SIB  *+1
1164   22706  035642         STB  XW
1165   22707  074070         SIB  *+1
1166   22710  035643         STB  YW
1167   22711  023502  GETLC  LDA  PPPOS
1168   22712  160177         JSM  SSYMA,I    SET UP A LOCATION FOR CRLF'S
1169   22713  066715         JMP  *+2
1170   22714  066107         JMP  GE1
1171   22715  160252         JSM  ENTEA,I
1172   22716  062107         JSM  GE1
1173   22717  067376         JMP  .PC
1174*
1175   22720  160252  .CDEF  JSM  ENTEA,I
1176   22721  062701         JSM  CDEF+5
1177   22722  021640         LDA  YH
1178   22723  170000         CLR
1179   22724  020105         LDA  B377
1180   22725  131640         STA  YH,I
1181   22726  020104         LDA  B177
1182   22727  131642         STA  XW,I
1183   22730  170402         RET
1184*
1185   22731  020020  ELAB3  LDA  ONE
1186   22732  060445         JSM  XFAR2+1
```

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```
1187   22733  066757            JMP  .ELAB
1188*
1189*      LETTING SUBROUTINE TO SET-UP CHARACTER DEFINITION
1190*
1191   22734  062652  ELAB      JSM  CURPG    SAVE CURRENT PAGE
1192   22735  045472            ISZ  TEMPS
1193   22736  023516            LDA  FMTOP
1194   22737  031640            STA  1640B    SET OP CODE FOR FORMAT SREACH
1195   22740  074742            SBR  16       SET REPEAT COUNT TO ZERO
1196   22741  163572            JSM  PLOTE,I  GO CHECK FOR FORMAT STATEMENT
1197   22742  074742            SBR  16       P+1, NOT FOUND
1198   22743  035646            STB  T3       P+2, FOUND
1199   22744  062675            JSM  CDEF+1
1200   22745  121472            LDA  TEMPS,I
1201   22746  050065            AND  OPMSK    CHECK IF THERE ARE MORE
                                               PARAMETERS
1202   22747  010004            CPA  RPOP     WAS IT A RIGHT PAREN
1203   22750  067023            JMP  DEFLT
1204*
1205   22751  062262            JSM  FORM+1   STACK 3 FORMULA'S
1206   22752  121472            LDA  TEMPS,I
1207   22753  050065            AND  OPMSK    GET NEXT OPERAND
1208   22754  010004            CPA  RPOP     WAS IT A PAREN
1209   22755  066731            JMP  ELAB3    DEFAULT THE PAPER RATIO
1210   22756  061217            JSM  FETCH    FETCH THE PAPER RATIO
1211   22757  062125  .ELAB     JSM  TXM
1212   22760  061220            JSM  FETCH+1  ROTATION
1213   22761  062117            JSM  TYM
1214   22762  061220            JSM  FETCH+1  ASPECT RATIO
1215   22763  062127            JSM  TXX
1216   22764  061220            JSM  FETCH+1  HEIGHT
1217   22765  063352            JSM  .MPY3    REDUCE HEIGHT BY 1/10
1218   22766  062121            JSM  TYX
1219*
1220*      PROCESS CHARACTER DIMENSION
1221*
1222   22767  021645            LDA  CP4
1223   22770  160220            JSM  .FMPA,I
1224   22771  062121            JSM  TYX
1225   22772  023502            LDA  YMIN
1226   22773  163566            JSM  SIN,I
1227   22774  027522            LDB  TEMY
1228   22775  060406            JSM  XFAR1+1
1229   22776  023502            LDA  YMIN
1230   22777  163570            JSM  COS,I
1231   23000  062117            JSM  TYM      YMIN = COS
1232*
1233   23001  062661            JSM  ROT1     YH = 9999/6 * H * COS TH
1234   23002  135640            STB  YH,I
1235*
1236   23003  023522            LDA  TEMY     SIN TH
1237   23004  062656            JSM  ROT2     XH = 9999/6 * H/A.R. * SIN TH
1238   23005  135641            STB  XH,I
1239*
1240   23006  023502            LDA  YMIN     COS TH
1241   23007  027500            LDB  XMIN
1242   23010  160220            JSM  .FMPA,I
```

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```
1243  23011  062131          JSM  TEMXX
1244  23012  023772          LDA  TEMX
1245  23013  062656          JSM  ROT2    XW = 9999/6 * H/A.R. * COS TH * PH/PW
1246  23014  135642          STB  XW,I
1247*
1248  23015  027500          LDB  XMIN
1249  23016  074637          ISZ  B,I     SET PAPER RATIO NEGATIVE FOR
                                                              -(RESULT)
1250  23017  023522          LDA  TEMY
1251  23020  160220          JSM  .FMPA,I YW = 9999/6 * H * SIN TH * PH/PW
1252  23021  062660          JSM  ROT4
1253  23022  135643          STB  YW,I
1254*
1255  23023  021646  DEFLT   LDA  T3
1256  23024  070110          SZA  ELAB6
1257  23025  067054          JMP  WREXC-3
1258*
1259*      PRINT SYNTAX EXECUTION
1260*
1261  23026  025416  ELAB6   LDB  MODE
1262  23027  076150          RZB  *+3
1263  23030  021622          LDA  TERM
1264  23031  072150          RZA  *+3
1265  23032  160170          JSM  CLERA,I
1266  23033  035622          STB  TERM
1267  23034  020146          LDA  M15
1268  23035  031453          STA  PRFLG
1269  23036  163510          JSM  CKEOL,I
1270  23037  067177          JMP  ELAB5
1271  23040  067177          JMP  ELAB5
1272  23041  163574  ELAB1   JSM  PRINN,I SET THE BUFFER
1273  23042  067177          JMP  ELAB5   END OF LINE
1274  23043  021625  ELAB4   LDA  FIRST
1275  23044  070076          TCA
1276  23045  001400          ADA  BADDR
1277  23046  071550          SZA  ELAB1
1278  23047  025625          LDB  FIRST
1279  23050  063203          JSM  OUTCH   OUTPUT THE BUFFER
1280  23051  021400          LDA  BADDR
1281  23052  031625          STA  FIRST
1282  23053  067041          JMP  ELAB1
1283*
1284*      FORMAT TYPE EXECUTION
1285*
1286  23054  163510          JSM  CKEOL,I
1287  23055  000153  B153    OCT  153
1288  23056  035472          STB  TEMPS
1289  23057  163652  WREXC   JSM  TYPEC,I GET NEXT FORMAT SPEC
1290  23060  067072          JMP  WRITN   P+1, END OF FORMAT
1291  23061  067102          JMP  WRITQ   P+2 QUOTE
1292  23062  074742          SBR  16      P+3 FIXED FORMAT
1293  23063  060563          JSM  SLWST   P+4 STACK FLAG 0-F; +=E, -=BINARY
1294  23064  067104          JMP  WRITF   P+5 (CODE 5 NOT USED)
1295  23065  066672          JMP  PRERR   BINARY MODE NOT ALLOWED
1296  23066  067077          JMP  WRITX   X;
1297  23067  163540          JSM  FSPR,I
1298  23070  063370          JSM  PCRLF+1/; CRLF
```

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```
1299   23071  067057          JMP  WREXC
1300*
1301   23072  075753  WRITN   SBP  *-1
1302   23073  074742          SBR  16          CLEAR FORMAT NESTING FLAG
1303   23074  035455          STB  FORMT
1304   23075  067026          JMP  ELAB6
1305*
1306   23076  000103  BLNKA   DEF  .32+.32+1
1307   23077  163540  WRITX   JSM  FSPR,I
1308   23100  020012          LDA  .1
1309   23101  027076          LDB  BLNKA
1310   23102  063203  WRITQ   JSM  OUTCH
1311   23103  067057          JMP  WREXC
1312*
1313*
1314   23104  025466  WRITF   LDB  LOCL1       STACK POINTER
1315   23105  060563          JSM  SLWST
1316   23106  163510          JSM  CKEOL,I
1317   23107  074742          SBR  16
1318   23110  067173          JMP  WREND-2
1319   23111  163564          JSM  QTCHK,I     QUOTE NEXT IN WRITE?
1320   23112  067115          JMP  WRIT5       P+1 NO
1321   23113  063203          JSM  OUTCH       P+2, YES (A) = LENGTH, (B) = POINTER
1322   23114  067106          JMP  WRITF+2
1323*
1324   23115  163526  WRIT5   JSM  PFORM,I
1325   23116  061220          JSM  FETCH+1
1326   23117  060567          JSM  UNSTK
1327   23120  031466          STA  LOCL1       RECALL FORMAT STATEMENT POINTER
1328   23121  060567          JSM  UNSTK
1329   23122  031705          STA  FLOAT       RECALL E, F OR B FLAG
1330   23123  045466          ISZ  LOCL1
1331   23124  121466          LDA  LOCL1,I
1332   23125  045466          ISZ  LOCL1
1333   23126  045466          ISZ  LOCL1
1334   23127  025456  WR'TB   LDB  FORMS
1335   23130  074073          SBP  *+1,C
1336   23131  035456          STB  FORMS       SET NUMERIC SPEC FOUND FLAG
1337   23132  125466          LDB  LOCL1,I     EGT DECIMAL SPEC
1338   23133  163540          JSM  FSPR,I      UPDATE FORMAT POINTERS
1339   23134  031704          STA  WIDTH
1340*
1341   23135  035703  WRIT7   STB  PLACE
1342   23136  021412          LDA  LSTPT       START TEMP BUFFER
1343   23137  070070          SIA  *+1
1344   23140  070744          SAL  1
1345   23141  031400          STA  BADDR
1346   23142  031706          STA  SBPTR
1347   23143  021413          LDA  HSTPT
1348   23144  070744          SAL  1
1349   23145  031623          STA  PEND
1350   23146  021416          LDA  MODE        SET END OF BUFFER AT HIGH STACK
1351   23147  031737          STA  T2
1352   23150  070742          SAR  16
1353   23151  031416          STA  MODE        SET FOR PROGRAM FORMAT
1354   23152  024215          LDB  TMPOP       *
```

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```
1355  23153  060406          JSM  XFARI+1   * OUTPUT NUMBER TO BUFFER
1356  23154  160234          JSM  NMOTA,I   *
1357  23155  021737          LDA  T2
1358  23156  031416          STA  MODE      RESTORE THE MODE FLAG
1359  23157  021400          LDA  BADDR
1360  23160  011623          CPA  PEND      OVERFLOW?
1361  23161  064561          JMP  MER8
1362  23162  025706          LDB  SBPTR
1363  23163  060374          JSM  WBUFF
1364  23164  063203          JSM  OUTCH
1365  23165  025625          LDB  FIRST
1366  23166  035400          STB  BADDR     RESET BADDR
1367*
1368  23167  163510  WRIT6    JSM  CKEOL,I   IS THIS THE END OF STATEMENT?
1369  23170  074742          SBR  16        P+1, YES CRLF NOT SURPPRESSED
1370  23171  067175          JMP  WREND     P+2, YES
1371  23172  067057          JMP  WREXC     P+3, NO RETURN FOR MORE
1372*
1373  23173  055412          DSZ  LSTPT
1374  23174  055412          DSZ  LSTPT
1375  23175  070742  WREND    SAR  16
1376  23176  031455          STA  FORMT
1377*
1378  23177  074110  ELAB5    SZB  *+2
1379  23200  066554          JMP  EPEN
1380  23201  063367          JSM  PCRLF
1381  23202  164172          JMP  XEC4A,I
1382*
1383  23203  031741  OUTCH    STA  XC+1
1384  23204  035740          STB  XC
1385  23205  062711          JSM  GETLC     SET-UP T1(POINTER TO CRLF) IT MAY
                                            BE KILLED
1386  23206  061053  .OUTC    JSM  GTMP
1387  23207  063213          JSM  PLET-1
1388  23210  055741          DSZ  XC+1
1389  23211  067206          JMP  .OUTC
1390  23212  170402          RET
1391*
1392*        CHARACTER ROUTINE
1393*
1394  23213  061363          JSM  GTCON+1   CONVERT FROM LOWER CASE
1395  23214  003620  PLET     ADA  M137B     CHECK IF > 137B
1396  23215  070153          SAP  *+3       SKIP IF THE CODE WAS >172B
1397  23216  000054          ADA  .63       (B77) WITHIN RANGE ADJUST SO
                                            THAT 40B =0
1398  23217  070113          SAP  *+2
1399  23220  170402          RET            RETURN IF NOT A VALID CHARACTER
1400  23221  155647          DSZ  T1,I      BUMP THE CHARACTER COUNT FOR
                                            CRLF
1401  23222  074742          SBR  16
1402  23223  035736          STB  CPX
1403  23224  035737          STB  CPY
1404  23225  070744          SAL  1         MULTIPLY BY 2
1405  23226  003476          ADA  VTABE     ADD IN THE VECTOR TABLE POINTER
1406  23227  001645          ADA  CP4       ADD IN CURRENT PAGE
1407  23230  024213          LDB  AR1A
1408  23231  170004          XFR            TRANSFER THE TWO WORD VECTOR
                                            TO AR1+1 AR1+2
1409  23232  024132          LDB  M1
1410  23233  035747          STB  AR1+3     SET THE 9TH BLOCK TO GIVE END OF
                                            CHAR
```

PAGE 385 EXECUTION PHASE OF 9830 PLOTTER BLOCK

```
1411  23234  175400  PL1     DLS
1412  23235  013530          CPA  B16      WAS THIS THE CCODE FOR SPEACIAL
                                                                    TABLE
1413  23236  067250          JMP  STABL     YES
1414  23237  070046          RAR  2
1415  23240  070137          LDB  A
1416  23241  074642          SBR  14
1417  23242  050020          AND  .3
1418  23243  010020          CPA  .3
1419  23244  067264          JMP  .PL2      END OF CHARACTER DEFINITION
1420  23245  063302          JSM  MPEN
1421  23246  062021          JSM  PENDN
1422  23247  067234          JMP  PL1
1423*
1424*        SPECIAL TABLE ROUTINE
1425*
1426  23250  021745  STABL    LDA  AR1+1
1427  23251  070142          SAR  4
1428  23252  050115          AND  B1777
1429  23253  041645          IOR  CP4
1430  23254  070744          SAL  1
1431  23255  031750          STA  YC
1432  23256  024057  STAB2    LDB  .1000
1433  23257  061041          JSM  GETCH
1434  23260  031466          STA  LOCL1
1435  23261  070306          RAR  7
1436  23262  070353          SAP  *+7
1437  23263  070251          SLA  *+5
1438*
1439  23264  062015  .PL2     JSM  PENUP
1440  23265  070004          SAL  16
1441  23266  024061          LDB  .10
1442  23267  067310          JMP  MPEN2
1443*
1444  23270  062021          JSM  PENDN
1445  23271  070111          SLA  *+2
1446  23272  062015          JSM  PENUP
1447  23273  021466          LDA  LOCL1
1448  23274  070106          RAR  3
1449  23275  070137          LDB  A
1450  23276  074602          SBR  13
1451  23277  050024          AND  .7
1452  23300  063310          JSM  MPEN2
1453  23301  067256          JMP  STAB2
1454*
1455  23302  031466  MPEN     STA  LOCL1
1456  23303  070744          SAL  1
1457  23304  001466          ADA  LOCL1     DELTA Y * 3 IN STANDARD MODE
1458  23305  035466          STB  LOCL1
1459  23306  074744          SBL  1
1460  23307  005466          ADB  LOCL1     DELTA X * 3 IN STANDARD MODE
1461*
1462  23310  031466  MPEN2    STA  LOCL1
1463  23311  021736          LDA  CPX
1464  23312  035736          STB  CPX
1465  23313  070076          TCA
1466  23314  074017          ADA  B
```

PAGE 386 EXECUTION PHASE OF 9830 PLOTTER BLOCK

```
1467   23315  031734          STA  DX        DELTA X
1468   23316  021466          LDA  LOCL1
1469   23317  025737          LDB  CPY
1470   23320  031737          STA  CPY
1471   23321  074076          TCB
1472   23322  070037          ADB  A
1473   23323  035735  MPEN3   STB  DY        DELTA Y
1474   23324  121640          LDA  YH,I
1475   23325  125641          LDB  XH,I
1476   23326  063336          JSM  MPY1      D.Y. = YH * D.Y. + XH * D.X.
1477   23327  062117          JSM  TYM
1478   23330  121643          LDA  YW,I
1479   23331  125642          LDB  XW,I
1480   23332  063336          JSM  MPY1      D.X. = YW * D.Y. + XW * D.X.
1481   23333  062125          JSM  TXM
1482   23334  020107          LDA  B1000
1483   23335  066042          JMP  MOVE-1
1484*
1485   23336  031470  MPY1    STA  L2T1
1486   23337  021734          LDA  DX
1487   23340  063355          JSM  MPY2
1488   23341  035471          STB  L2T2
1489   23342  025470          LDB  L2T1
1490   23343  021735          LDA  DY
1491   23344  063355          JSM  MPY2
1492   23345  005471          ADB  L2T2
1493   23346  160227          JSM  FXFLA,I
1494   23347  125647          LDB  T1,I
1495   23350  014017          CPB  .2        WAS THIS VECTOR FLAGED AS A CRLF
1496   23351  170402          RET            YES!
1497   23352  020157  .MPY3   LDA  M256
1498   23353  001754          ADA  AR2
1499   23354  066100          JMP  STOR2
1500*
1501   23355  070153  MPY2    SAP  *+3
1502   23356  070076          TCA
1503   23357  074076          TCB
1504   23360  035466          STB  LOCL1
1505   23361  074742          SBR  16
1506   23362  070076          TCA
1507   23363  070170          SIA  *+3
1508   23364  005466          ADB  LOCL1
1509   23365  073770          RIA  *-1
1510   23366  170402          RET
```

PAGE 387 EXECUTION PHASE OF 9830 PLOTTER BLOCK

```
1512*      LETTER AND LABEL ROUTINES
1513*
1514   23367  160170  PCRLF   JSM  CLERA,I
1515   23370  121647          LDA  T1,I
1516   23371  031734          STA  DX
1517   23372  020017          LDA  .2          SET THE FLAG SO MPEN3 DOESN'T
                                                REDUCE BY 1/10TH
1518   23373  131647          STA  T1,I
1519   23374  024132          LDB  M1
1520   23375  063323          JSM  MPEN3
1521   23376  074742  .PC     SBR  16
1522   23377  135647          STB  T1,I
1523   23400  170402          RET
1524*
1525*      LETTER EXECUTION
1526*
1527   23401  062674  EKEY    JSM  CDEF        GET CURRENT PAGE, CHARACTER
                                                LINKS AND CRLF
1528   23402  074742          SBR  16
1529   23403  035473          STB  CCNT
1530   23404  020054          LDA  .63
1531   23405  061016          JSM  ONEXT
1532   23406  163673  .EKEY   JSM  KEYIN,I
1533   23407  024141          LDB  M10
1534   23410  070346          RAR  8
1535   23411  070133          SAP  *+2,C
1536   23412  024132          LDB  M1
1537   23413  070346          RAR  8
1538   23414  010034          CPA  .21         UP ARROW (25B)
1539   23415  067446          JMP  .EK2
1540   23416  013532          CPA  B24         DOWN ARROW (24B)
1541   23417  067447          JMP  .EK1
1542   23420  010036          CPA  B27         RIGHT ARROW (27B)
1543   23421  067453          JMP  .EK4
1544   23422  010035          CPA  B26         LEFT ARROW (26B)
1545   23423  067454          JMP  .EK3
1546   23424  010104          CPA  B177        STOP KEY?
1547   23425  067442          JMP  .STOP       YES
1548   23426  010027          CPA  .11
1549   23427  067457          JMP  .RCRL
1550   23430  013534          CPA  B157
1551   23431  020071          LDA  E
1552   23432  074311          SLB  *+6
1553   23433  013055          CPA  B153
1554   23434  020101          LDA  B100
1555   23435  127506          LDB  VALUP,I
1556   23436  163524          JSM  TBSRH,I
1557   23437  067440          JMP  *+1
1558   23440  063214          JSM  PLET
1559   23441  067406          JMP  .EKEY
1560*
1561   23442  074742  .STOP    SBR  16
1562   23443  005442          STB  STPFL
1563   23444  160170          JSM  CLERA,I
1564   23445  164172          JMP  XEC4A,I
1565*
1566   23446  074076  .EK2     TCB              UP ARROW
1567   23447  070742  .EK1     SAR  16          ON ARROW
```

PAGE 388 EXECUTION PHASE OF 9830 PLOTTER BLOCK

```
1568   23450  031734          STA  DX
1569   23451  063323          JSM  MPEN3
1570   23452  067406          JMP  .EKEY
1571   23453  074076  .EK4    TCB                RIGHT ARROW
1572   23454  035734  .EK3    STB  DX            LEFT ARROW
1573   23455  074742          SBR  16
1574   23456  067451          JMP  .EK1+2
1575   23457  063367  .RCRL   JSM  PCRLF
1576   23460  067402          JMP  EKEY+1
1577*
1578*        CHARACTER PLOT
1579*
1580   23461  062674  CPLOT   JSM  CDEF
1581   23462  062263          JSM  FORM+2
1582   23463  063471          JSM  .CPLT
1583   23464  035735          STB  DY
1584   23465  063471          JSM  .CPLT
1585   23466  035734          STB  DX
1586   23467  063324          JSM  MPEN3+1
1587   23470  164172          JMP  XEC4A,I
1588*
1589   23471  061220  .CPLT   JSM  FETCH+1
1590   23472  020013          LDA  C7            MULT RESULT BY 10
1591   23473  063353          JSM  .MPY3+1
1592   23474  066663          JMP  ROT1+2
```

PAGE 389 LETTER AND NUMBER VICTOR TABLE

```
1594*
1595*  LETTER VECTOR TABLE
1596*
1597*
1598   23475  167715            JMP  BLKN,I      SPACE 40B
1599   23476  001474  VTABE     DEF  *-2-N9/6
1600   23477  167713            JMP  EXCM,I      !
1601   23500  001650  XMIN  DEF  XN
1602   23501  167746            JMP  QUOTE,I     "42B
1603   23502  001660  YMIN      DEF  YN
1604   23503  167716            JMP  NUMBR,I     #
1605   23504  001664  YMAX      DEF  YX
1606   23505  167734            JMP  DOLLR,I     $
1607   23506  002412  VALUP     DEF  2412B       ABS ADDRESS
1608   23507  167701            JMP  PERCT,I
1609   23510  007227  CKEOL     DEF  7227B       ABS ADDRESS
1610   23511  167723            JMP  AMP,I       &
1611   23512  176000  EXPM4     OCT  176000
1612   23513  112700            OCT  112700      '
1613   23514  023417  .9999      DEC  9999
1614   23515  167740            JMP  LPARN,I     S.T. POINTER FOR (
1615   23516  012025  FMTOP     OCT  12025
1616   23517  167743            JMP  RPARN,I     S.T. POINTER FOR )
1617   23520  177736  M34       DEC  -34
1618   23521  167674            JMP  MULT,I      *
1619   23522  001674  TEMY      DEF  Z2
1620   23523  167676            JMP  PLUS,I
1621   23524  003072  TBSRH     DEF  3072B
1622   23525  002700            DEC  1472        ,
1623   23526  006773  PFORM     DEF  6773B       ABS ADDRESS
1624   23527  043300            DEC  18112       -
1625   23530  000016  B16       OCT  16
1626   23531  016000            DEC  7168        .
1627   23532  000024  B24       OCT  24
1628   23533  005300            DEC  2752        /
1629   23534  000157  B157      OCT  157
1630   23535  004242            OCT  4242,5300   0
       23536  005300
1631   23537  014700            DEC  6592        1
1632   23540  007356  FSPR      DEF  7356B       ABS ADDRESS
1633   23541  105145            OCT  105145,1300 2
       23542  001300
1634   23543  105145            DEC  -30107,25100 3
       23544  061014
1635   23545  102152            DEC  -31638,11264 4
       23546  026000
1636   23547  124105            OCT  124105,203000 5
       23550  020300
1637   23551  124106            DEC  -22458,8268 6
       23552  020114
1638   23553  105034            OCT  105034      7
1639   23554  177741  M31  DEC  -31
1640   23555  044246            DEC  18598,16422 8
       23556  040046
1641   23557  001250            DEC  680,18112   9
       23560  043300
```

PAGE 390 LETTER AND NUMBER VECTOR TABLE

```
1642  23561  167710          JMP  COLON,I      :
1643  23562  004303  RITE    DEF  4303B        RITE+1 ABS ADDRESS
1644  23563  167707          JMP  SCOLN,I      ;
1645  23564  007240  QTCHK   DEF  7240B        ABS ADDRESS
1646  23565  112034          DEC  -27620       <
1647  23566  012761  SIN     DEF  12761B       ABS ADDRESS
1648  23567  167720          JMP  EQUAL,I      =
1649  23570  013007  COS     DEF  13007B       ABS ADDRESS
1650  23571  113034          DEC  -27108       >
1651  23572  007402  PLOTE   DEF  7402B       ABS ADDRESS
1652  23573  167727          JMP  QUES,I       ?
1653  23574  006656  PRINN   DEF  6656B
1654  23575  004242          OCT  4242,12554          @ 100B
      23576  012554
1655  23577  004242          DEC  2210,25792          A
      23600  062300
1656  23601  004245          DEC  2213,17952          B
      23602  043040
1657  23603  124501          DEC  -22207,11264        C
      23604  026000
1658  23605  004226          DEC  2198,4288           D
      23606  010300
1659  23607  124105          DEC  -22459,16428        E
      23610  040054
1660  23611  124105          DEC  -22459,16576        F
      23612  040300
1661  23613  124002          DEC  -22526,26048        G
      23614  062700
1622  23615  004106          DEC  2118,23872          H
      23616  121300
1663  23617  014700          DEC  6592                I
1664  23620  177641  M137B    OCT  -137
1665  23621  121004          DEC  -24060,-16384       J
      23622  140000
1666  23623  004112          DEC  2122,17088          K
      23624  041300
1667  23625  100054          DEC  -32724              L
1668  23626  000000          BSS  1           CHECK SUM WORD
1669  23627  004132          DEC  2138,11264          M
      23630  026000
1670  23631  004052          DEC  2090,-16384         N
      23632  140000
1671  23633  004242          DEC  2210,3072           O
      23634  006000
1672  23635  004246          DEC  2214,19456          P
      23636  046000
1673  23637  020212          DEC  8330,9664           Q
      23640  022700
1674  23641  004246          DEC  2214,17708          R
      23642  042454
1675  23643  001144          DEC  612,-30016          S
      23644  105300
1676  23645  105221          DEC  -30063-16384        T
      23646  140000
1677  23647  100052          DEC  -32726,-16384       U
      23650  140000
```

PAGE 391 LETTER AND NUMBER VECTOR TABLE

```
1678   23651  100654            DEC  -32340          V
1679   23652  007303   TYPEC    DEF  7303B      ABS ADDRESS
1680   23653  100122            DEC  -32686,-21504   W
       23654  126000
1681   23655  005130            DEC  2648,11264     X
       23656  026000
1682   23657  102645            DEC  -31323,7168    Y
       23660  016000
1683   23661  105002            DEC  -30206,-16384  Z
       23662  140000
1684   23663  010211            OCT  10211,140000   133B
       23664  140000
1685   23665  101300            OCT  101300
1686   23666  005555   MOVCK    DEF  5555B
1687   23667  011251            OCT  11251,140000   135 B
       23670  140000
1688   23671  014511            OCT  14511,66000    136B
       23672  066000
1689*
1690   23502           PPPOS     EQU  YMIN
1691*
1692*   MORE ABS ADRESSESS
1693*
1694   23673  002753   KEYIN    DEF  2753B
1695*
1696*        SPECIAL SYMBOL VECTOR TABLE
1697*
1698*        BIT 15=1 PENUP BEFORE MOVEMENT
1699*        BIT 14 = 1 PEN DOWN BEFORE MOVEMENT
1700*        BITS 13,12,11 = Y COOR. OF 1ST LOCATION
1701*        BIT 10,9,8    = X COOR. OF 1ST LOCATION
1702*        BIT 7 = 1 PENUP
1703*        BIT 6 = PEN DOWN
1704*        BIT 5,4,0 = Y OF 2ND
1705*        BIT 2,1,0 = X OF 2ND
1706*
1707*       PEN CONDITIONS
1708*
1709*     PEN UP ON ENTRY
1710*     PEN UP ON EXIT
1711*     A 7 IN Y INDICATES END OF CHAR.
1712*
1713*     THIS TABLE WORKS ON A 7X7 MATRIX (6-0)
1714*
1715   23674  104555   MULT     OCT  104555,124515
       23675  124515
1716   23676  101563   PLUS     OCT  101563,114136,140000  +
       23677  114136
       23700  140000
1717   23701  073161   PERCT    OCT  73161,24041,25061  %
       23702  024041
       23703  025061
1718   23704  112514            OCT  112514,2416,12700
       23705  002416
       23706  012700
1719   23707  000523   SCOLN    OCT  523          ; 73B
```

PAGE 392 LETTER AND NUMBER VECTOR TABLE

```
1720  23710  011523  COLON   OCT  11523,125553,140000  : 72B
      23711  125553
      23712  140000
1721  23713  031523  EXCM    OCT  31523               ! 41B
1722  23714  101503          OCT  101503
1723  23715  140000  BLKN    OCT  140000
1724  23716  131102  NUMBR   OCT  131102,102164      #
      23717  102164
1725  23720  110126  EQUAL   OCT  110126              =
1726  23721  123140          OCT  123140
1727  23722  140000          OCT  140000
1728  23723  003152  AMP     OCT  3152              &
1729  23724  031454          OCT  31454
1730  23725  010403          OCT  10403
1731  23726  012700          OCT  12700
1732  23727  024562  QUES    OCT  24562             ?
1733  23730  031454          OCT  31454
1734  23731  022033          OCT  22033
1735  23732  011603          OCT  11603
1736  23733  041700          OCT  41700
1737  23734  004515  DOLLR   OCT  4515              $ 44B
1738  23735  024455          OCT  24455
1739  23736  131503          OCT  131503
1740  23737  160000  SC16    OCT  160000
1741  23740  001511  LPARN   OCT  1511
1742  23741  014051          OCT  14051
1743  23742  031700          OCT  31700
1744  23743  001515  RPARN   OCT  1515
1745  23744  017055          OCT  17055
1746  23745  031700          OCT  31700             "
1747  23746  021162  QUOTE   OCT  21162
1748  23747  132144          OCT  132144
1749  23750  140000          OCT  140000
1750*
1751*
1752  23760                  ORG  23760B
1753*
1754*       STATEMENT EXECUTION JUMP TABLE
1755*
1756  23760  177421          ABS  EKEY-*
1757  23761  177500          ABS  CPLOT-*
1758  23762  176303          ABS  ESCAL-*
1759  23763  176527          ABS  EYAXE-*
1760  23764  176525          ABS  EXAXE-*
1761  23765  176476          ABS  EPLOT-*
1762  23766  176361          ABS  EOFF-*
1763  23767  176565          ABS  EPEN-*
1764  23770  176744          ABS  ELAB-*
1765  23771  176471          ABS  EIPLT-*
1766  23772  001670  TEMX    DEF  Z1          OP CODE 1 IS NOT USED, SO USE IT
                                                FOR A CONSTANT
1767*
1768  23773  176636          ABS  TBL-*
1769  23774  176635          ABS  TBL-*
1770  23775  176634          ABS  TBL-*
1771  23776  176154          ABS  SNAME-*
1772  23777  010000          OCT  10000       CODE TO IDENTIFY THE OPTION
                                                BLOCK
```

PAGE 393 CROSS-REFERENCE TABLE

.1	0020	1308					
.10	0071	0072	1441				
.100	0070						
.1000	0069	1432					
.11	0035	0043	1548				
.12	0036						
.13	0039						
.15	0048	0083					
.16	0049	0084	0871	0895	0928	0961	
.1E4	0068						
.2	0027	0610	0838	0964	1495	1517	
.21	0050	1538					
.22	0051	0087					
.23	0052	0088					
.28	0053						
.3	0028	0045	0614	1417	1418		
.31	0054	0090	0652				
.32	0055	1306	1306				
.33	0056						
.34	0057	0091					
.37	0058						
.4	0029	0857	0876	0917	0970	1070	
.40	0059						
.41	0060						
.43	0061						
.45	0062						
.46	0063						
.48	0064	1116					
.5	0030						
.58	0065	0094					
.6	0031	0044					
.63	0066	1397	1530				
.7	0032	1451					
.8	0033	0883	0945	0952	1072		
.9	0034						
.99	0074						
.9999	1613	0663	1066				
.AX4	1084	1055					
.BUFA	0180						
.CDEF	1175	1158					
.CL1	1090	1101					
.CL2	1093	1089	1103				
.CPLT	1589	1582	1584				
.E1	1032	1063					
.EK1	1567	1541	1574				
.EK2	1566	1539					
.EK3	1572	1545					
.EK4	1571	1543					
.EKEY	1532	1559	1570				
.ELAB	1211	1187					
.FADA	0185	0706	1045				
.FDVA	0188	0878	1073	1138			
.FMPA	0187	0882	0948	1141	1223	1242	1251
.FSBA	0186	0874	0904	0953			
.FSR	0190						

PAGE 394 CROSS-REFERENCE TABLE

PAGE 395 CROSS-REFERENCE TABLE

B24ØØ	Ø11Ø						
B26	ØØ87	1544					
B27	ØØ88	1542					
B3ØØØ	Ø111						
B36	ØØ89						
B37	ØØ9Ø						
B377	ØØ99	Ø638	Ø646	1179			
B4ØØ	Ø1ØØ	Ø639	Ø643	Ø647			
B4ØØØ	Ø112	Ø162					
B42	ØØ91						
B44	ØØ92						
B52	ØØ93						
B6K	Ø113	Ø167	1147				
B72	ØØ94						
B777	Ø1Ø1						
BADDR	Ø291	1276	128Ø	1345	1359	1366	
BADRP	Ø2Ø4						
BEND	Ø198	Ø199					
BHSTP	Ø444						
BLANK	Ø388						
BLKN	1723	1598					
BLNKA	13Ø6	13Ø9					
BUSY	Ø617	Ø619	Ø636	Ø64Ø	Ø644	Ø649	
C5	ØØ15						
C6	ØØ11	Ø114					
C7	ØØ22	Ø1ØØ	159Ø				
CCNT	Ø538	1529					
CDEF	1154	1176	1199	1527	158Ø		
CHRSA	Ø219						
CKEOL	16Ø9	1269	1286	1316	1368		
CLAR2	Ø492						
CLERA	Ø16Ø	1265	1514	1563			
CLIMT	1Ø89	1Ø27	1Ø31	1Ø82			
CLINE	Ø316						
CLP1A	Ø217						
COLON	172Ø	1642					
COMCE	Ø436	Ø791	Ø8Ø4	Ø8Ø6			
COMCK	Ø435	Ø759	Ø762	Ø777	Ø78Ø	Ø798	
CONST	Ø484						
COS	1649	123Ø					
CP2	Ø54Ø	Ø927	Ø947	Ø951	Ø962		
CP3	Ø517	Ø938	Ø984	1Ø16			
CP4	Ø518	Ø877	Ø971	1134	1222	14Ø6	1429
CPLAC	Ø331						
CPLOT	158Ø	1757					
CPT	Ø541	Ø866	Ø879	Ø884	Ø899	Ø9Ø5	
CPX	Ø535	Ø542	14Ø2	1463	1464		
CPY	Ø536	Ø543	14Ø3	1469	147Ø		
CRCKA	Ø228						
CRLF	Ø5Ø1						
CRLF1	Ø5Ø2						
CRTN	ØØ37	ØØ38	ØØ39				
CTYPE	Ø33Ø						
CURPG	1132	Ø819	Ø986	1Ø15	1148	1154	1191
DCOMA	Ø21Ø						
DEFLT	1255	12Ø3					

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DELSA	Ø175										
DFLAG	Ø39Ø										
DIGCK	Ø463										
DOLLR	1737	16Ø6									
DPERR	ØØ43										
DRQST	Ø317										
DSTRT	Ø3Ø3										
DX	Ø533	Ø54Ø	1467	1486	1516	1568	1572	1585			
DY	Ø534	Ø541	1473	149Ø	1583						
E	ØØ8Ø	1551									
E1	Ø235										
E1Ø	Ø244										
E15	Ø249										
E2Ø	Ø254										
E25	Ø259										
E3Ø	Ø264										
E35	Ø269										
E4Ø	Ø274										
E45	Ø279										
E5	Ø239										
E5Ø	Ø284										
ECALA	Ø215										
EIPLT	Ø983	1765									
EKEY	1527	1576	1756								
ELAB	1191	1764									
ELAB1	1272	1277	1282								
ELAB3	1185	12Ø9									
ELAB4	1274										
ELAB5	1378	127Ø	1271	1273							
ELAB6	1261	1256	13Ø4								
ELINA	Ø169										
ENDS	Ø48Ø	Ø754									
ENTEA	Ø218	1171	1175								
ENTFA	Ø189										
EOFF	Ø891	1762									
EOFF1	Ø899	Ø894	Ø896								
EOL	ØØ38										
EOLCK	Ø483										
EOST	Ø481	Ø76Ø	Ø763	Ø793	Ø799	Ø8Ø1					
EPEN	1Ø56	Ø653	1379	1763							
EPLOT	Ø984	1761									
EQUAL	1725	1648									
ERRA	Ø177										
ES1	Ø845	Ø825									
ESCAL	Ø819	1758									
EXAXE	1Ø12	176Ø									
EXCM	1721	16ØØ									
EXP	Ø4Ø1	Ø4Ø2									
EXPM4	1611	Ø968									
EXPOP	Ø118										
EYAXE	1Ø13	1759									
F	ØØ81										
FDAAA	Ø222										
FETCH	Ø488	Ø867	Ø869	Ø9ØØ	Ø916	Ø923	Ø991	1Ø29	1Ø32	1Ø77	1Ø87
	121Ø	1212	1214	1216	1325	1589					
FILLA	Ø2Ø1										

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FIRST	Ø367	1274	1278	1281	1365			
FIX	Ø5Ø5							
FLGBT	ØØ73							
FLOAT	Ø386	1329						
FLTFA	Ø193							
FLTRA	Ø192	Ø657	Ø992	1Ø9Ø	1142			
FLTSA	Ø195							
FMTOP	1615	1193						
FN	Ø148							
FND	Ø462							
FNDIA	Ø224							
FNDAA	Ø223							
FNDPS	Ø476							
FOPBS	Ø2Ø6							
FORM	Ø81Ø	Ø82Ø	Ø891	Ø987	1Ø25	12Ø5	1581	
FORM2	Ø8Ø5	Ø79Ø	Ø792	Ø797				
FORM3	Ø8Ø3	Ø779						
FORMA	Ø172	Ø81Ø	Ø811	Ø812	Ø813	1Ø17	1Ø21	
FORME	Ø336							
FORMS	Ø335	1334	1336					
FORMT	Ø334	13Ø3	1376					
FPAGE	Ø451							
FROMA	Ø122							
FSCA	Ø173	Ø758	Ø761	Ø782	Ø8ØØ	Ø8Ø3	Ø8Ø5	Ø8Ø7
FSCE2	Ø441							
FSCE4	Ø446							
FSPR	1632	1297	13Ø7	1338				
FTMP1	Ø337							
FTMP2	Ø338							
FWAM	Ø157							
FWUP	Ø296							
FXFLA	Ø194	1Ø53	1126	1493				
GE1	Ø675	Ø845	1159	117Ø	1172			
GETAD	Ø461							
GETCH	Ø471	1433						
GETLC	1167	1385						
GETRW	Ø672	Ø892	Ø996	1Ø26	1Ø65			
GETSK	Ø475							
GFLAG	Ø4Ø4							
GFRST	Ø474							
GNEXT	Ø473	Ø77Ø	Ø776					
GPARM	Ø424							
GSIGN	Ø486							
GTCON	Ø5Ø4	1394						
GTMP	Ø472	1386						
GTOPP	Ø466							
GTSTA	Ø213							
HFLG1	Ø321							
HSTPT	Ø3Ø2	1347						
I	ØØ67							
ICNT	Ø422							
IMPY	Ø487							
INF	ØØ77							
INITS	Ø456							
INREA	Ø226							
INTCK	Ø459							

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M36	Ø14Ø				
M4	Ø127				
M48	Ø141	1121			
M5	Ø128				
M6	Ø129				
M64	Ø142				
M8	1Ø91	Ø9Ø3			
M8Ø	Ø143				
M9	Ø13Ø				
MASK1	Ø153				
MASK5	Ø154				
MAW	Ø294				
MAXIN	Ø4ØØ				
MAXSN	Ø147	Ø661	1118		
MBIN1	Ø4Ø6				
MBIN2	Ø4Ø7				
MBOX1	Ø351				
MDIMA	Ø2Ø8				
MER8	Ø445	1361			
HINIT	Ø455				
MODE	Ø3Ø5	1261	135Ø	1353	1358
MOVCK	1686	Ø834			
MOVE	Ø633	1483			
MPEN	1455	142Ø			
MPEN2	1462	1442	1452		
MPEN3	1473	152Ø	1569	1586	
MPY1	1485	1476	148Ø		
MPY2	15Ø1	1487	1491		
MSFLG	Ø389				
MULT	1715	1618			
MVTOM	Ø477				
N976	Ø588	1599			
NDISP	Ø382				
NDWRT	Ø5ØØ				
NEXT1	Ø45Ø				
NEXTA	Ø467				
NEXTL	Ø449				
NMOTA	Ø2ØØ	1356			
NOEOF	Ø482				
NPRIN	Ø383				
NPWRT	Ø499				
NUM	Ø396	Ø397			
NUMBR	1724	16Ø4			
NUMCA	Ø211				
NUMOA	Ø212				
NXTDT	Ø3Ø4				
NXTST	Ø4Ø5				
OBLNK	Ø468				
ODGIT	Ø496				
OF	Ø493				
OFFS	Ø792	Ø713	Ø718	Ø764	
ONE	ØØ45	1185			
ONEXT	Ø469	1531			
OPCHA	Ø171				
OPDMK	ØØ79				
OPMSK	ØØ76	12Ø1	12Ø7		

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RESBP	Ø454				
RET2	Ø421				
RETN2	Ø42Ø				
RETN3	Ø419				
RITE	1643	Ø783			
ROT1	114Ø	1233	1592		
ROT2	1137	1237	1245		
ROT4	1139	1252			
ROUND	Ø495				
RPARN	1744	1616			
RPCK	Ø439				
RPCKE	Ø44Ø				
RPOP	Ø115	12Ø2	12Ø8		
RSAVE	Ø292				
RSLTE	Ø373				
RSPTR	Ø418	1112			
RSTAK	Ø416				
RSTKA	Ø158				
RSULT	Ø426				
RUNA	Ø163				
S	ØØ82				
SALTA	Ø2Ø7				
SAVBP	Ø452				
SAVEA	Ø325				
SAVEB	Ø326				
SAXIS	Ø758	Ø715	Ø716		
SBADR	Ø394				
SBPTR	Ø387	Ø784	1346	1362	
SBPUD	Ø431	Ø768	Ø771	Ø775	
SBUFA	Ø199				
SC16	174Ø	Ø62Ø	Ø622		
SCAL	Ø866	Ø858	Ø86Ø		
SCALE	Ø79Ø	Ø714			
SCOLN	1719	1644			
SEC	Ø32Ø				
SFLAG	Ø393				
SGNS	Ø497				
SIGN	Ø399	Ø4ØØ			
SIN	1647	1226			
SLCOD	Ø328				
SLEND	Ø2Ø2				
SLOCP	1Ø41				
SLWST	Ø447	1293	1315		
SNAME	Ø724	1771			
SNFLA	Ø197				
SPEN	Ø754	Ø712	Ø719		
SPLFA	Ø196				
SSBPT	Ø395				
SSYMA	Ø17Ø	Ø673	Ø823	1157	1168
ST	Ø377				
STAB2	1432	1453			
STABL	1426	1413			
STAR2	Ø49Ø				
START	Ø162	ØØØ7			
STATU	Ø622	Ø6Ø8	Ø612	Ø617	
STEAL	Ø817	Ø672	Ø822	Ø841	

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VALUP	16Ø7	1555									
VAROA	Ø214										
VTABE	1599	14Ø5									
WBUFF	Ø423	1363									
WHERE	Ø685	1Ø54									
WIDTH	Ø385	1339									
WREND	1375	1318	137Ø								
WREXC	1289	1257	1299	1311	1371						
WRIT5	1324	132Ø									
WRIT6	1368										
WRIT7	1341										
WRITB	1334										
WRITE	Ø159										
WRITF	1314	1294	1322								
WRITN	13Ø1	129Ø									
WRITQ	131Ø	1291									
WRITX	13Ø7	1296									
XC	Ø412	1383	1384	1388							
XEC4A	Ø164	Ø861	Ø897	1ØØ7	1Ø57	1381	1564	1587			
XEC6A	Ø221										
XFAR1	Ø425	Ø689	Ø692	Ø697	Ø7ØØ	Ø7Ø3	Ø7Ø8	Ø886	Ø931	Ø944	1228
	1355										
XFAR2	Ø429	Ø656	1186								
XH	Ø514	1162	1238	1475							
XLT2	Ø968	Ø958	Ø977								
XMAX	Ø658	Ø699	Ø873	1Ø43	1137						
XMIN	16Ø1	Ø633	Ø696	Ø925	1241	1248					
XN	Ø522	16Ø1									
XSCRA	Ø2ØØ										
XW	Ø515	1164	1182	1246	1479						
XX	Ø523	Ø6Ø2	Ø658	Ø979	Ø994	1ØØ4					
YC	Ø414	1431									
YM	Ø513	116Ø	1177	118Ø	1234	1474					
YMAX	16Ø5	Ø691	114Ø								
YMIN	16Ø3	Ø641	Ø688	Ø881	Ø918	1225	1229	124Ø	169Ø		
YN	Ø524	16Ø3									
YW	Ø516	1166	1253	1478							
YX	Ø525	1Ø28	1Ø52	1Ø67	1Ø79	1Ø83	11Ø2	11Ø4	11Ø7	1115	1122
	1125	16Ø5									
Z1	Ø527	11Ø5	1766								
Z2	Ø528	1619									
ZAP	Ø152										
ZONK	Ø491										

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```
0503                                LST
0504   22000                        ORG  22000PB
0505*
0506*  TERMINAL OPTION BLOCK
0507*
0508   22000  000052  ID      ABS  XTRM-*     COMMAND JUMP TABLE
0509*
0510   22001  052105  COMTB   OCT  052105     TE
0511   22002  051115         OCT  051115     RM
0512   22003  170400         OCT  170400       (1) END ALLOWS TWO INTEGERS
0513*
0514*
0515   22004  001757         ABS  ERRX-*     SYNTAX JUMP TABLE
0516   22005  000000         NCP             ** CHECKSUM WORD **
0517*
0518   22006  020302  SYSNT   OCT  020302       (2) END
0519*
0520*
0521   22007  000777  BN777   OCT  777
0522*
0523*
0524   22010  005032  VALUP   DEF  2415B+2415B
0525   22011  002617  PPEFD   DEF  2617B
0526   22012  002753  KEYIN   DEF  2753B
0527   22013  003647  GETLN   DEF  3647B
0528   22014  006036  LISTS   DEF  6036B
0529   22015  006306  MCOUT   DEF  6306B
0530*
0531*
0532*  SECONDARY ENTRY FROM MAIN SYSTEM THRU REED LINK
0533*
0534   22016  000017  RE1A    DEF  *+1-IO
0535*
0536   22017  023647         LDA  AT1S
0537   22020  027646         LDR  AT1
0538   22021  170004         XFR                 RESTORE CRITICAL PARAMETERS
0539   22022  170004         XFR
0540   22023  020062         LDA  FLGBT
0541   22024  031416         STA  MODE           RESTORE MODE FLAG
0542*
0543   22025  021433         LDA  TFLAG
0544   22026  010132         CPA  M1             CHECK FOR COMPILE
0545   22027  067104         JMP  XCOM1
0546   22030  070210         SZA  *+4            CHECK FOR PTAPE
0547   22031  162011         JSM  PREED,I
0548   22032  066031         JMP  *-1            (NULL RECORD)
0549   22033  066517         JMP  EOL1
0550*
0551   22034  024212         LDB  .SLBF-
0552   22035  074056         CMB
0553   22036  005400         ADB  BADDR
0554   22037  004132         ADB  M1             BADDR-, SLBF-2
0555   22040  074113         SBP  *+2            IS DISPLAY EMPTY?
0556   22041  066134         JMP  RE1            YES
0557   22042  066147         JMP  R17            NO, PRESERVE SYSTEM MESSAGE
```

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```
0559*
0560*  "WHAT?" MESSAGE
0561*
0562   22043  062542  WHAT    JSM  MTIB     SAVE MYSTERIOUS LINE
0563   22044  160170          JSM  CLERA,I  CLEAR THE DISPLAY
0564   22045  020022          LDA  .5
0565   22046  027765          LDB  WHAM
0566   22047  066145          JMP  R10
0567*
0568*
0569   22050  000156  .110    DEC  110      CONSTANTS USED TO CHECK BAUD
                                             RATE
0570   22051  174702  M1598   DEC  -1598
0571*
0572   22052  072110  XTRM    RZA  *+2      TEST FOR DEFAULT SELECT CODE (4)
0573   22053  020021          LDA  .4
0574   22054  070204          SAL  12       SAVE SELECT CODE
0575   22055  031651          STA  T1
0576   22056  014056          CPB  .1E4     TEST FOR DEFAULT BAUD RATE (110)
0577   22157  026050          LDB  .110
0578   22060  074117          LDA  B
0579   22061  000134          ADA  M3
0580   22062  070153          SAP  *+3
0581   22063  160205  TERR1   JSM  AERRA,I  ERROR, INVALID BAUD RATE
0582   22064  177662          DEC  -78
0583   22065  000351          ADA  M1598
0584   22066  071653          SAP  *-3
0585   22067  160227          JSM  FXFLA,I  CALCULATE TIMING CONSTANT
0586   22070  020214          LDA  AR2A
0587   22071  027650          LDB  TF1A
0588   22072  170004          XFR
0589   22070  021717          LDA  NUM
0590   22074  070442          SAR  10
0591   22075  070244          SAL  11
0592   22076  031654          STA  T4       SAVE PAGE INFO
0593   22077  070002          SAR  1
0594   22100  031655          STA  T5       TEMPORARY
0595   22101  003651          ADA  TCON
0596   22102  027650          LDB  TF1A
0597   22103  160221          JSM  .FDVA,I
0598   22104  160225          JSM  FLTRA,I
0599   22105  066105          JMP  *        OVERFLOW (SHOULD NEVER HAPPEN)
0600   22106  004025          ADB  .8
0601   22107  035652          STB  T2       SAVE TIMING CONSTANT
0602*
0603   22110  025655          LDB  T5
0604   22111  006016          ADB  RE1A     FORM NEW REED LINK
0605   22112  035462          STB  REEDL
0606*
0607   22113  021651          LDA  T1
0608   22114  070502          SAR  11       2 * SELECT CODE
0609   22115  003335          ADA  INTAD      + ADDRESS OF INTERRUPT TABLE
                                             - 1
0610   22116  025655          LDB  T5
0611   22117  007336          ADB  INTSA
0612   22120  070577          S1B  A,I      PUT INTERRUPT LINK ADDRESS IN
                                             TABLE
```

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```
0614   22121  070742          SAR  16
0615   22122  031653          STA  T3        SET TO "EVEN" PARITY
0616*
0617   22123  023641          LDA  B4001     TURN ON CARRIER
0618   22124  041651          IOR  T1
0619   22125  172741          STF  1
0620   22126  172141          OTA  1
0621   22127  173601          STC  1,C
0622*
0623   22130  070742  RE0     SAR  16
0624   22131  031430          STA  LNINC     GET OUT OF AUTO
0625   22132  031431          STA  CLINE     INDICATE TOP OF PROGRAM
0626   22133  031655          STA  T5        SET PRINT/STORE TO "PRINT"
0627*
0628   22134  160170  RE1     JSM  CLERA,I   CLEAR THE DISPLAY
0629   22135  021430          LDA  LNINC
0630   22136  070250          SZA  *+5       AUTO MODE?
0631   22137  025427          LDB  .LNUM     YES, OUTPUT LINE NUMBER
0632   22140  160210          JSM  OUTIA,I
0633   22141  045400          ISZ  BADDR       FOLLOWED BY ONE BLANK
0634   22142  066147          JMP  R17
0635*
0636   22143  020021          LDA  .4        NO, SUPPLY "TEXT" MESSAGE
0637   22144  027223          LDB  MSSG1
0638   22145  005654  R10     ADB  T4
0639   22146  061335          JSM  NPWRT
0640*
0641   22147  024236  R17     LDB  SLEND     SET UP FOR KEYBOARD INPUT
0642   22150  035623          STB  PEND        FOR OUTCR
0643   22151  070742          SAR  16
0644   22152  031442          STA  STPFL       CLEAR STOP FLAG
0645   22153  031473          STA  CCNT        MULTIPLE CHARACTERS VIA KEYIN
0646   22154  031704          STA  BKPTR       CURSOR POINTER
0647   22155  031707          STA  BLANK       DO NOT IGNORE BLANKS
0648   22156  031657          STA  T7        SAY OK TO CLEAR DISPLAY ON
                                                          INTERRUPT
0649   22157  031660          STA  T8        CLEAR NO-LINE-NUMBERS FLAG
0650*
0651   22160  162012          JSM  KEYIN,I   CALL FOR FIRST KEY
0652   22161  010105          CPA  B377      DUMP I/O BUFFER?
0653   22162  066346          JMP  DIOB      YES
0654   22163  010074          CPA  B22       BACKSPACE?
0655   22164  066420          JMP  BKSP      YES
0656   22165  031661          STA  T9
0657*
0658   22166  160170          JSM  CLERA,I   CLEAR THE DISPLAY
0659   22167  021430          LDA  LNINC
0660   22170  070210          SZA  *+4       AUTO MODE?
0661   22171  025427          LDB  .LNUM     YES, OUTPUT LINE NUMBER
0662   22172  160210          JSM  OUTIA,I
0663   22173  045400          ISZ  BADDR       FOLLOWED BY ONE BLANK
0664   22174  021661          LDA  T9
0665   22175  066204          JMP  R36
```

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```
0667  22176  020212  RE6    LDA  .SLBF
0668  22177  011400         CPA  BADDR     DISPLAY EMPTY?
0669  22200  066134         JMP  RE1
0670  22201  162012  R46    JSM  KEYIN,I   CALL FOR NEXT KEY
0671  22202  010105         CPA  B377      DUMP I/O BUFFER?
0672  22203  066346         JMP  DIOB      YES
0673  22204  024104  R36    LDB  B177
0674  22205  035663         STB  CTFLG     CLEAR ASCII-CNTRL FLAG
0675  22206  074742         SBR  16
0676  22207  035662         STB  SHFLG     CLEAR ASCII-SHIFT FLAG
0677  22210  074742  R26    SBR  16
0678  22211  070346         RAR  8
0679  22212  070133         SAP  *+2,C     TEST BIT 7 FOR SHIFT
0680  22213  024132         LDB  M1
0681  22214  035472         STB  TEMPS     SET SHIFT FLAG
0682  22215  070346         RAR  8
0683  22216  031661         STA  T9        INITIAL CODE WITHOUT SHIFT BIT
0684*
0685  22217  027656         LDB  EDITP
0686  22220  005654         ADB  T4
0687  22221  160175         JSM  TSRHA,I   CODE IN EDIT TABLE?
0688  22222  066245         JMP  R16       NO
0689  22223  002225         ADA  *+2
0690  22224  070016         EXA            YES, GO EXECUTE IMMEDIATELY
0691*
0692  22225  066226         JMP  *+1
0693  22226  066564         JMP  OTPT  0   EXECUTE
0694  22227  066043         JMP  WHAT  1   STEP
0695  22230  066402         JMP  RECL  2   RECALL
0696  22231  066420         JMP  BKSP  3   BACKSPACE
0697  22232  066435         JMP  FORD  4   FORWARDSPACE
0698  22233  066715         JMP  DNRW  5   DOWNARROW
0699  22234  066722         JMP  UPRW  6   UPARROW
0700  22235  066332         JMP  LEFT  7   LEFTARROW
0701  22236  066341         JMP  RITF  8   RIGHTARROW
0702  22237  066677         JMP  CLVR  9   CLEAR VAR
0703  22240  066450         JMP  INDL  10  INSERT/DELETE
0704  22241  066130         JMP  RE0   11  CLEAR
0705  22242  066662         JMP  REST  12  ACC
0706  22243  066622         JMP  PALL  13  PRINT ALL
0707  22244  066513         JMP  EOLL  14  EOL
```

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```
0709  22245  025472  R16   LDR  TEMPS
0710  22246  000141        ADA  M10      DEFINED KEY?
0711  22247  070253        SAP  RE2      NO
0712  22250  074150        SZB  *+3      SHIFT?
0713  22251  003644        ADA  .74      YES
0714  22252  031661        STA  T9
0715  22253  067122        JMP  KEYPR
0716*
0717  22254  003642  RE2   ADA  M22      CODE < 40B?
0718  22255  070612        SAM  R13      YES
0719  22256  000154        ADA  M64      CODE < 140B?
0720  22257  070353        SAP  RE3      NO
0721*
0722  22260  074250        SZB  *+5      SHIFT?
0723  22261  000040        ADA  .31      YES. LOWER CASE LETTER?
0724  22262  070212        SAM  RE3      NO
0725  22263  003645        ADA  .97      YES
0726  22264  031661        STA  T9
0727  22265  066314        JMP  RE5
0728*
0729  22266  021661  RE3   LDA  T9
0730  22267  026010        LDB  VALUP
0731  22270  160175        JSM  TSRHA,I  CODE IN VALUE TABLE?
0732  22271  066300  R13   JMP  RDD      NO
0733  22272  000151        ADA  M32      CODE < 40B?
0734  22273  070113        SAP  *+2      NO
0735  22274  000101        ADA  B100     YES
0736  22275  000041        ADA  .32
0737  22276  031661        STA  T9
0738  22277  066314        JMP  RE5
0739*
0740  22300  021661  RDD   LDA  T9
0741  22301  027676        LDB  MULTP
0742  22302  005654        ADB  T4
0743  22303  160175        JSM  TSRHA,I  CODE IN MULTI-CHARACTER TABLE?
0744  22304  066043        JMP  WHAT     NO. QUESTION IT
0745  22305  031661        STA  T9
0746  22306  160170        JSM  CLERA,I  CLEAR THE DISPLAY
0747  22307  021661        LDA  T9
0748  22310  027714        LDB  MULTN
0749  22311  005654        ADB  T4
0750  22312  162015        JSM  MCOUT,I  OUTPUT THE MNEMONIC
0751  22313  066176        JMP  RE6
```

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```
0753  22314  021661  RE5     LDA  T9      ALL CONVERSION COMPLETE
0754  22315  051662          AND  SHFLG   EXCEPT FOR ASCII-SHIFT &
                                                          ASCII-CNTRL
0755  22316  070056          CMA
0756  22317  070137          LDB  A
0757  22320  021661          LDA  T9
0758  22321  041662          IOR  SHFLG
0759  22322  074257          AND  B
0760  22323  051663          AND  CTFLG
0761  22324  025704          LDB  BKPTR
0762  22325  074210          SZB  RE9     CURSOR?
0763  22326  027637          LDB  BKPTA   YES
0764  22327  061017          JSM  OUTCR   REPLACE CHARACTER
0765  22330  066440          JMP  FW2     SCROLL IF NECESSARY
0766*
0767  22331  061016  RE9     JSM  OMEXT   PUT CHARACTER AT END OF LINE
0768*                                       AND SCROLL IF NECESSARY
0769*  LEFTARROW
0770*
0771  22332  021400  LEFT    LDA  BADDR   IS LAST CHARACTER AT RIGHT END OF
                                                              DISPLAY?
0772  22333  000151          ADA  M32
0773  22334  070076          TCA
0774  22335  001402          ADA  OTPTR
0775  22336  070113          SAP  *+2
0776  22337  045432          ISZ  OTPTR   NO, SCROLL
0777  22340  066176  JMP     RE6
0778*
0779*  RIGHTARROW
0780*
0781  22341  021402  RITF    LDA  OTPTR   IS FIRST CHARACTER AT LEFT END OF
                                                              DISPLAY?
0782  22342  010212          CPA  .SLRF
0783  22343  066176          JMP  RE6
0784  22344  055402          DSZ  OTPTR   NO, SCROLL
0785  22345  066176          JMP  RE6
```

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```
0787*
0788*  DUMP I/O BUFFER FOR MODEM MESSAGE
0789*
0790   22346  021655  DIOB   LDA  I5
0791   22347  070110         SZA  *+2
0792   22350  164203         JMP  ACTSA,I
0793*
0794   22351  024211         LDB  .BUFA
0795   22352  035740         STB  TMP
0796*
0797   22353  160261         JSM  IOSTA,I   IS PRINTER BUSY?
0798   22354  066147         JMP  R17       (STOP KEY RETURN)
0799*
0800   22355  021740  DIO2   LDA  TMP       GET A CHARACTER
0801   22356  025740         LDB  TMP
0802   22357  070002         SAR  1
0803   22360  070517         LDA  A,I
0804   22361  074111         SLB  *+2
0805   22362  070346         RAR  8
0806   22363  070342         SAR  8
0807   22364  010031         CPA  EOL       IS IT EOL?
0808   22365  066374         JMP  DIO3      YES
0809   22366  041447         IOR  SLCOD     NO, OUTPUT IT
0810   22367  172741         STF  1
0811   22370  172141         OTA  1
0812   22371  173601         STC  1,C
0813   22372  045740         ISZ  TMP
0814   22373  066355         JMP  DIO2
0815*
0816   22374  020061  DIO3   LDA  LNFD
0817   22375  041447         ICR  SLCOD
0818   22376  172741         STF  1
0819   22377  172141         OTA  1
0820   22400  173601         STC  1,C
0821   22401  066147         JMP  R17
```

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```
0825*
0826*  RECALL
0827*
0828   22402  160170  RECL   JSM  CLERA,I  CLEAR THE DISPLAY
0829   22403  024211         LDB  .BUFA
0830   22404  035740         STB  TMP
0831   22405  061053  REC1   JSM  GTMP      GET A CHARACTER
0832   22406  010031         CPA  EOL
0833   22407  066176         JMP  RE6       DONE
0834   22410  061016         JSM  ONEXT     OUTPUT TO DISPLAY
0835   22411  021400         LDA  BADDR
0836   22412  000151         ADA  M32
0837   22413  070076         TCA
0838   22414  001402         ADA  OTPTR
0839   22415  070113         SAP  *+2
0840   22416  045402         ISZ  OTPTR
0841   22417  066405         JMP  REC1
0842*
0843*  BACKSPACE CURSOR
0844*
0845   22420  021714  BKSP   LDA  BKPTR
0846   22421  072310         RZA  BK2       FIRST BACKSPACE?
0847   22422  021400         LDA  BADDR     YES
0848   22423  010212         CPA  .SLBF     NULL RECORD?
0849   22424  066176  BK3    JMP  RE6       YES
0850   22425  031704         STA  BKPTR
0851   22426  066433         JMP  BK1       PUT POINTER AT LAST CHARACTER
0852*
0853   22427  010212  BK2    CPA  .SLBF     ALREADY AT FIRST CHARACTER
0854   22430  066176         JMP  RE6       YES
0855   22431  011402         CPA  OTPTR     LEFTMOST ON SCREEN?
0856   22432  055402         DSZ  OTPTR     YES, SCROLL
0857   22433  055704  BK1    DSZ  BKPTR     BACKSPACE CURSOR
0858   22434  066176         JMP  RE6
0859*
0860*  FORWARDSPACE CURSOR
0861*
0862   22435  021704  FORD   LDA  BKPTR
0863   22436  071310         SZA  BK3       IGNORE IF NO BACKSPACE HAS
                                             OCCURRED
0864   22437  045704         ISZ  BKPTR
0865   22440  021402  FW2    LDA  OTPTR
0866   22441  000041         ADA  .32
0867   22442  011704         CPA  BKPTR     ON RIGHT OF SCREEN?
0868   22443  011400         CPA  BADDR     YES, LINE FULL?
0869   22444  066176         JMP  RE6
0870   22445  045402         ISZ  OTPTR     NO, SCROLL
0871   22446  066176         JMP  RE6
```

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```
0873*
0874*  INSERT/DELETE
0875*
0876   22447  066176          JMP  RE6
0877   22450  025704  INDL    LDB  BKPTR   CHECK CURSOR POSITION
0878   22451  075710          SZB  *-2      ANY BACKSPACE YET?
0879   22452  021472          LDA  TEMPS
0880   22453  070650          SZA  INSR     SHIFT FLAG SET?
0881*
0882*  DELETE
0883*
0884   22454  055400          DSZ  BADDR    YES, MOVE END-OF-LINE POINTER
0885   22455  035740          STB  TMP
0886   22456  015400  DLC1    CPB  BADDR    LAST CHARACTER?
0887   22457  066507          JMP  INS2+1   YES, OUTPUT A BLANK
0888   22460  045740          ISZ  TMP
0889   22461  061053          JSM  GTMP     GET CHARACTER
0890   22462  055740          DSZ  TMP
0891   22463  055740          DSZ  TMP
0892   22464  024111          LDB  TMPA     STORE SHIFTED LEFT ONE
0893   22465  061017          JSM  OUTCR
0894   22466  025740          LDR  TMP
0895   22467  066456          JMP  DLC1
0896*
0897*  INSERT
0898*
0899   22470  025400  INSR    LDB  BADDR
0900   22471  014236          CPB  SLEND
0901   22472  066176          JMP  RE6      LINE FULL
0902   22473  004132          ADB  M1
0903   22474  035740  INS1    STB  TMP
0904   22475  061053          JSM  GTMP     GET CHARACTER
0905   22476  025740          LDB  TMP
0906   22477  015704          CPB  BKPTP    AT CURSOR POSITION?
0907   22500  066506          JMP  INS2     YES
0908   22501  024111          LDB  TMPA     NO, MOVE RIGHT ONE
0909   22502  061017          JSM  OUTCR
0910   22503  025740          LDB  TMP
0911   22504  004134          ADB  M3       BACK UP TO NEXT CHARACTER TO LEFT
0912   22505  066474          JMP  INS1
0913*
0914   22506  045400  INS2    ISZ  BADDR    UPDATE END-OF-LINE POINTER
0915   22507  020041          LDA  .32
0916   22510  024111          LDB  TMPA
0917   22511  061017          JSM  OUTCR    INSERT A BLANK
0918   22512  066176          JMP  RE6
```

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```
0920*
0921*  PROCESS STORE KEY
0922*
0923   22513  062542  EOLL    JSM  MTIB       MOVE RECORD TO I/O BUFFER
0924   22514  060373          JSM  ICNT       GET CHARACTER COUNT
0925   22515  010012          CPA  .1
0926   22516  066134          JMP  RE1        IGNORE NULL RECORD
0927*
0928   22517  062552  FOL1    JSM  CRIT       SAVE CRITICAL PARAMETERS
0929   22520  061062          JSM  GFRST      GET FIRST CHARACTER
0930   22521  066134          JMP  RE1        (NULL RECORD RETURN)
0931   22522  060750          JSM  DIGCK      DIGIT?
0932   22523  066620          JMP  MAINS      NO, GIVE TO SYSTEM
0933*
0934   22524  060675          JSM  INTCK-1    BUILD LINE #
0935   22525  035427          STB  .LNUM      STORE LINE #
0936   22526  010031          CPA  EOL        END OF LINE?
0937   22527  164204          JMP  DELSA,I    YES. DELETE LINE
0938   22530  023640          LDA  B5K        OPCODE 2 W/SPECIAL BIT
0939   22531  131706          STA  SBPTR,I
0940   22532  045706          ISZ  SBPTR
0941   22533  023777          LDA  OPCOD
0942   22534  131706          STA  SBPTR,I
0943   22535  055400          DSZ  BADDR
0944   22536  020031          LDA  EOL
0945   22537  024012          LDB  .1
0946   22540  160253          JSM  CHRSA,I
0947   22541  164203          JMP  ACTSA,I
0948*
0949*
0950*  SUBROUTINE TO MOVE RECORD TO I/O BUFFER
0951*
0952   22542  045623  MTIR    ISZ  PEND       GUARANTEE ROOM FOR EOL
0953   22543  020031          LDA  EOL
0954   22544  061016          JSM  ONEXT      STORE EOL
0955   22545  024233          LDB  BEND
0956   22546  035476          STB  TEMP3
0957   22547  035477          STB  TEMP4
0958   22550  004046          ADB  .41
0959   22551  065122          JMP  MVTOH+1    MOVE THE RECORD AND RETURN
0960*
0961*  SUBROUTINE TO SAVE CRITICAL PARAMETERS (T1 THRU T7)
0962*
0963   22552  025450  CRIT    LDB  PMODE
0964   22553  076210          RZB  *+4        PRINT ALL?
0965   22554  024211          LDB  .BUFA      YES
0966   22555  061337          JSM  NDWRT      (A—REG HAS COUNT)
0967   22556  061344          JSM  CRLF1
0968*
0969   22557  023646          LDA  AT1
0970   22560  027647          LDB  AT1S
0971   22561  170004          XFR
0972   22562  170004          XFR
0973   22563  170402          RET
```

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```
0975*
0976*  PROCESS EXECUTE KEY
0977*
0978   22564  062542  OTPT    JSM  MTIB          MOVE RECORD TO I/O BUFFER
0979   22565  060373          JSM  ICNT          GET CHARACTER COUNT
0980   22566  010012          CPA  .1
0981   22567  066134          JMP  RE1           IGNORE NULL RECORD
0982*
0983   22570  062552          JSM  CRIT          SAVE CRITICAL PARAMETERS
0984   22571  061062          JSM  GFRST         GET FIRST CHARACTER
0985   22572  000000          NOP                (NULL RECORD RETURN)
0986   22573  027714          LDR  MULTN
0987   22574  005654          ADB  T4
0988   22575  160175          JSM  TSRHA,I       SEARCH MULTI-CHARACTER
                                                                  TABLE
0989   22576  066620          JMP  MAINS         NOT FOUND, GIVE TO MAIN
                                                                  SYSTEM
0990   22577  002601          ADA  *+2
0991   22600  070016          EXA
0992*
0993   22601  066602          JMP  *+1
0994   22602  067013          JMP  XLIST  0   LIST
0995   22603  066620          JMP  MAINS  1   CONT
0996   22604  066620          JMP  MAINS  2   TRACE
0997   22605  066620          JMP  MAINS  3   RUN
0998   22606  066710          JMP  XFECH  4   FETCH
0999   22607  066620          JMP  MAINS  5   LOAD
1000   22610  066620          JMP  MAINS  6   STORE
1001   22611  066620          JMP  MAINS  7   NORMAL
1002   22612  066620          JMP  MAINS  8   FIX
1003   22613  066620          JMP  MAINS  9   FLT
1004   22614  066620          JMP  MAINS  10  SCRATCH
1005   22615  066620          JMP  MAINS  11  AUTO
1006   22616  066701          JMP  XEXIT  12  EXIT ("STOP" KEY)
1007*
1008   22617  067067          JMP  XCOMP  13  COMP
1009*
1010   22620  045416  MAINS   ISZ  MODE          INDICATE CALC MODE
1011   22621  064357          JMP  RETN2         RETURN TO MAIN SYSTEM
```

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```
1013*
1014*  PRINT ALL
1015*
1016    22622  160170  PALL    JSM  CLERA,I     CLEAR THE DISPLAY
1017    22623  021450          LDA  PMODE       REVERSE THE FLAG
1018    22624  070130          SIA  *+2
1019    22625  070742          SAR  16
1020    22626  031450          STA  PMODE
1021    22627  026634          LDB  MON
1022    22630  070110          SZA  *+2
1023    22631  026637          LDB  MOF
1024    22632  020020          LDA  .3
1025    22633  066145          JMP  R10
1026*
1027    22634  001472  MON     DEF  *+*+2-ID-ID
1028    22635  047516          ASC  2,ON
        22636  020040
1029    22637  001500  MOF     DEF  *+*+2-ID-ID
1030    22640  047506          ASC  2,OFF
        22641  043040
1031*
1032*  CHANGE PARITY
1033*
1034    22642  160170  EVOD    JSM  CLERA,I     CLEAR THE DISPLAY
1035    22643  021653          LDA  T3          REVERSE THE FLAG
1036    22644  072113          SAP  *+2,S
1037    22645  070073          SAP  *+1,C
1038    22646  031653          STA  T3
1039    22647  026654          LDB  MEV
1040    22650  070113          SAP  *+2
1041    22651  026657          LDB  MOD
1042    22652  020021          LDA  .4
1043    22653  066145          JMP  R10
1044*
1045    22654  001532  MEV     DEF  *+*+2-ID-ID
1046    22655  042526          ASC  2,EVEN
        22656  042516
1047    22657  001540  MOD     DEF  *+*+2-ID-ID
1048    22660  047504          ASC  2,ODD
        22661  042040
```

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```
1050*
1051*  ACC
1052*
1053   22662  021472  REST    LDA  TEMPS      CHECK SHIFT FLAG
1054   22663  070210          SZA  *+4
1055   22664  020101          LDA  B100       USE "@"
1056   22665  031661          STA  T9
1057   22666  066314          JMP  RE5
1058*
1059   22667  020020          LDA  .3         USE "RES"
1060   22670  026674          LDB  RESM
1061   22671  005654          ADB  T4
1062   22672  061335          JSM  NPWRT
1063   22673  066176          JMP  RE6
1064*
1065   22674  001572  RESM    DEF  *+*+2-ID-ID
1066   22675  051105          ASC  2,RES
       22676  051440
1067*
1068*  CLEAR VAR
1069*
1070   22677  020056  CLVR    LDA  .1E4
1071   22700  164171          JMP  RUNA,I
1072*
1073*  EXIT FROM TERMINAL MODE
1074*
1075   22701  021651  XEXIT   LDA  T1         TURN OFF CARRIER
1076   22702  172741          STF  1
1077   22703  172141          OTA  1
1078   22704  173601          STC  1,C
1079   22705  024116          LDB  QTOP       (=2000B)
1080   22706  035462          STB  REEDL      RESTORE REED LINK
1081   22707  164174          JMP  RDYDA,I
```

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```
1083*
1084*  FETCH
1085*
1086   22710  162013  XFECH   JSM  GETLN,I GET PARAMETER
1087   22711  020012          LDA  .1
1088   22712  066713          JMP  +1      NOP
1089   22713  000132          ADA  M1
1090   22714  031431          STA  CLINF
1091*
1092*  DOWNARROW
1093*
1094   22715  025424  DNRW    LDB  PBUFF   CHECK FOR NULL PROGRAM
1095   22716  015423          CPB  PBPTR
1096   22717  066134          JMP  RE1
1097   22720  062731          JSM  DNRWS
1098   22721  066726          JMP  UPR1
1099*
1100*  UPARROW
1101*
1102   22722  025424  UPRW    LDB  PBUFF   CHECK FOR NULL PROGRAM
1103   22723  015423          CPB  PBPTR
1104   22724  066134          JMP  RE1
1105   22725  062737          JSM  UPRWS
1106   22726  070742  UPR1    SAR  16
1107   22727  031430          STA  LNINC   GET OUT OF AUTO
1108   22730  066147          JMP  R17
1109*
1110*  DOWNARROW SUBROUTINE
1111*
1112   22731  021431  DNRWS   LDA  CLINE
1113   22732  070070          SIA  *+1
1114   22733  061075          JSM  FNDPS   FIND LINE
1115   22734  066747          JMP  U3      PAST END OF PROGRAM
1116   22735  066753          JMP  U5      BETWEEN LINES
1117   22736  066753          JMP  U5
1118*
1119*  UPARROW SUBROUTINE
1120*
1121   22737  021431  UPRWS   LDA  CLINE
1122   22740  072110          RZA  *+2     CLINE=0?
1123   22741  020056          LDA  .1E4    YES, FIND LAST LINE OF PROGRAM
1124   22742  061075          JSM  FNDPS   FIND LINE
1125   22743  066747          JMP  U3      PAST END OF PROGRAM
1126   22744  066745          JMP  *+1     BETWEEN LINES
1127   22745  015424          CPB  PBUFF   FIRST LINE?
1128   22746  066753          JMP  U5      YES
1129*
1130   22747  021720  U3      LDA  LASTN   GET PREVIOUS LINE
1131   22750  060742          JSM  FND
1132   22751  070742          SAR  16
1133   22752  031656          STA  T6
1134*
1135   22753  035661  U5      STB  T9      SAVE ADDRESS
1136   22754  035472          STB  TEMPS
```

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```
1138*
1139*  SUBROUTINE TO OUTPUT A LINE TO DISPLAY BUFFER
1140*
1141*  LOCATION IS IN T3
1142*
1143   22755  160170  LNOUT   JSM  CLERA,I  CLEAR THE DISPLAY
1144   22756  125661         LDB  T9,I      GET LINE #
1145   22757  045661         ISZ  T9
1146   22760  035431         STB  CLINE     UPDATE CLINE
1147*
1148   22761  021661         LDA  T9
1149   22762  070070         SIA  *+1
1150   22763  070517         LDA  A,I
1151   22764  050065         AND  OPMSK     (076000)
1152   22765  013777         CPA  OPCOD     TEXT?
1153   22766  066771         JMP  *+3       YES
1154   22767  025472         LDB  TEMPS
1155   22770  166014         JMP  LISTS,I
1156*
1157   22771  021660         LDA  T8        GET NO-LINE-NUMBERS FLAG
1158   22772  072110         RZA  *+2
1159   22773  160210         JSM  OUTIA,I   OUTPUT LINE #
1160   22774  121661         LDA  T9,I
1161   22775  045661         ISZ  T9
1162   22776  025661         LDB  T9
1163   22777  050104         AND  B177      CALCULATE CHARACTER COUNT
1164   23000  000134         ADA  M3
1165   23001  070037         ADB  A
1166   23001  070744         SAL  1
1167   23003  074537         LDB  B,I
1168   23004  074404         SBL  8
1169   23005  074110         SZN  *+2
1170   23006  070070         SIA  *+1
1171   23007  125661         LDB  T9        CALCULATE CHARACTER POINTER
1172   23010  074744         SBL  1
1173   23011  074070         SIB  *+1
1174   23012  065335         JMP  NPWRT     OUTPUT TO BUFFER
```

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```
1176*
1177*  LIST ROUTINE
1178*
1179   23013  061055  XLIST   JSM  GNEXT   GET NEXT CHARACTER
1180   23014  013062         CPA  B130     "X"?
1181   23015  067051         JMP  XLIS3    YES
1182   23016  013063         CPA  B43      "#"?
1183   23017  067053         JMP  XLIS4    YES
1184   23020  055400         DSZ  BADDR    NO, RESET POINTER
1185   23021  162013  XLIS1  JSM  GETLN,I  GET OPTIONAL LINE NUMBERS
1186   23022  020012         LDA  .1
1187   23023  024056         LDB  .1E4
1188   23024  000132         ADA  M1
1189   23025  031431         STA  CLINE
1190   23026  035656         STB  T6       SAVE ENDING LINE NUMBER
1191   23027  025424         LDB  PBUFF    CHECK FOR NULL PROGRAM
1192   23030  015423         CPB  PBPTR
1193   23031  066130         JMP  RE0
1194*
1195   23032  062731  XLIS2  JSM  DNRWS    OUTPUT LINE TO DISPLAY BUFFER
1196   23033  025431         LDB  CLINE
1197   23034  074076         TCB
1198   23035  005656         ADB  T6       T6—CLINE
1199   23036  074152         SBM  *+3
1200   23037  025442         LDB  STPFL    CHECK STOP FLAG
1201   23040  014040         CPB  .31
1202   23041  067064         JMP  LOUT
1203   23042  021651         LDA  T1
1204   23043  011447         CPA  SLCOD    CHECK SELECT CODES
1205   23044  067057         JMP  XLIS5
1206*
1207   23045  060373         JSM  ICNT     GET CHARACTER COUNT
1208   23046  061337         JSM  NDWRT    PRINT THE LINE
1209   23047  061344         JSM  CRLF1
1210   23050  067032         JMP  XLIS2
1211*
1212   23051  045660  XLIS3  ISZ  T8       SET NO-LINE-NUMBERS FLAG
1213   23052  067013         JMP  XLIST
1214   23053  060664  XLIS4  JSM  LNUM     FETCH SELECT CODE
1215   23054  074204         SBL  12
1216   23055  035447         STB  SLCOD
1217   23056  067021         JMP  XLIS1
1218*
1219   23057  062542  XLIS5  JSM  MTIB     MOVE RECORD TO I/O BUFFER
1220   23060  063246         JSM  MDRVR    CALL MODEM DRIVER
1221   23061  067032         JMP  XLIS2
1222*
1223   23062  000130  B130   OCT  130
1224   23063  000043  B43    OCT  43
1225*
1226   23064  024127  LOUT   LDB  B170K
1227   23065  035447         STB  SLCOD
1228   23066  066130         JMP  RE0
```

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```
1230*
1231*  COMPILE ROUTINE
1232*
1233   23067  020132  XCOMP   LDA  M1
1234   23070  031433          STA  TFLAG
1235   23071  020041          LDA  .32
1236   23072  031707          STA  BLANK
1237   23073  162013          JSM  GETLN,I GET OPTIONAL LINE NUMBERS
1238   23074  020012          LDA  .1
1239   23075  024056          LDB  .1E4
1240   23076  000132          ADA  M1
1241   23077  031431          STA  CLINE
1242   23100  035656          STB  T6      SAVE ENDING LINE NUMBER
1243   23101  025424          LDB  PBUFF   CHECK FOR NULL PROGRAM
1244   23102  015423          CPB  PBPTR
1245   23103  067117          JMP  XCOM2   DONE
1246*
1247   23104  062731  XCOM1   JSM  DNRWS   OUTPUT LINE TO DISPLAY BUFFER
1248   23105  025431          LDB  CLINE
1249   23106  074076          TCB
1250   23107  005656          ADB  T6      T6—CLINE
1251   23110  074352          SBM  XCOM2
1252*
1253   23111  062542          JSM  MTIB    MOVE LINE TO I/O BUFFER
1254   23112  023646          LDA  AT1
1255   23113  027647          LDB  AT1S
1256   23114  170004          XFR
1257   23115  170004          XFR
1258   23116  064357          JMP  RETN2   GO COMPILE
1259*
1260   23117  070742  XCOM2   SAR  16
1261   23120  031433          STA  TFLAG
1262   23121  066130          JMP  RE0
```

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```
1264*
1265*  PROCESS DEFINED KEY
1266*
1267   23122  021661  KEYPR   LDA  T9      CHECK FOR SPECIAL FUNCTION
1268   23123  010022          CPA  .5
1269   23124  067212          JMP  SETAS    SET ASCII—SHIFT
1270   23125  010023          CPA  .6
1271   23126  067215          JMP  SETAC    SET ASCII—CNTRL
1272   23127  010024          CPA  .7
1273   23130  067226          JMP  PRST     SET PRINT/STORE
1274   23131  010025          CPA  .8
1275   23132  066642          JMP  EVOD     CHANGE PARITY
1276   23133  010026          CPA  .9
1277   23134  067237          JMP  XMIT     TRANSMIT
1278*
1279   23135  024166          LDB  FWAM     SEARCH FOR KEY, STARTING AT FWAM
1280   23136  015405  KEY1    CPB  FWUP
1281   23137  066043          JMP  WHAT     UNDEFINED
1282   23140  074517          LDA  B,I
1283   23141  074070          SIB  *+1
1284   23142  011661          CPA  T9
1285   23143  067146          JMP  *+3      FOUND IT
1286   23144  074437          ADB  B,I
1287   23145  067136          JMP  KEY1     KEEP SEARCHING
1288*
1289   23146  074517          LDA  B,I
1290   23147  074070          SIB  *+1
1291   23150  010012          CPA  .1       NULL DEFINITION?
1292   23151  066043          JMP  WHAT     YES
1293   23152  031466          STA  LOCL1    NO, SAVE LENGTH WORD
1294   23153  074517          LDA  B,I
1295   23154  074070          SIB  *+1
1296   23155  070110          SZA  *+2      IS THIS A TYPING AID?
1297   23156  066043          JMP  WHAT     NO
1298   23157  074744          SBL  1        YES
1299   23160  035740          STB  TMP      SAVE CHARACTER POINTER
1300   23161  021466          LDA  LOCL1
1301   23162  070744          SAL  1
1302   23163  000136          ADA  M5       ASSUME ODD COUNT
1303   23164  031473          STA  CCNT     SAVE CHARACTER COUNT
1304   23165  070037          ADB  A
1305   23166  074517          LDA  B,I      LOOK AT LAST WORD
1306   23167  050105          AND  B377
1307   23170  070450          SZA  *+9
1308   23171  045473          ISZ  CONT     CORRECT COUNT
1309   23172  010100          CPA  ASTR1    CHECK FOR *
1310   23173  067175          JMP  *+2
1311   23174  066201          JMP  R46
1312   23175  074517          LDA  B,I
1313   23176  050157          AND  M256
1314   23177  040027          IOR  AIEX1    IEX CODE
1315   23200  067206          JMP  *+6
1316   23201  074517          LDA  B,I
1317   23202  013210          CPA  ASTR2    CHECK FOR *
1318   23203  067205          JMP  *+2
1319   23204  066201          JMP  R46
```

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```
1320  23205  023211          LDA  AIEX2        IEX CODE
1321  23206  074557          STA  B,I
1322  23207  066201          JMP  R46          EXECUTE IMMEDIATELY
1323*
1324  001100          ASTR1   EQU  B52
1325  23210  025000  ASTR2   OCT  025000
1326  00027           AIEX1   EQU  .11
1327  23211  005400  AIEX2   OCT  005400
1328*
1329*
1330  23212  024033  SETAS   LDB  B20
1331  23213  035662          STB  SHFLG
1332  23214  067217          JMP  *+3
1333  23215  024054  SETAC   LDB  .63
1334  23216  035663          STB  CTFLG
1335  23217  162012          JSM  KEYIN,I
1336  23220  010105          CPA  B377         DUMP I/O BUFFER?
1337  23221  066346          JMP  DIOB         YES
1338  23222  066210          JMP  R26
1339*
1340  23223  002450  MSSG1   DEF  *+*+2-ID-ID
1341  23224  052105          ASC  2,TEXT
      23225  054124
1342*
1343  23226  160170  PRST    JSM  CLERA,I      CLEAR THE DISPLAY
1344  23227  020062          LDA  FLGBT
1345  23230  031655          STA  T5
1346  23231  027234          LDB  STMS
1347  23232  020021          LDA  .4
1348  23233  066145          JMP  R10
1349*
1350  23234  002472  STMS    DEF  *+*+2-ID-ID
1351  23235  051501          ASC  2,SAVE
      23236  053105
1352*
1353
1354  23237  062542  XMIT    JSM  MTIR         MOVE RECORD TO I/O BUFFER
1355  23240  060373          JSM  ICNT         GET CHARACTER COUNT
1356  23241  010012          CPA  .1
1357  23242  066134          JMP  RE1          IGNORE NULL RECORD
1358*
1359  23243  062552          JSM  CRIT
1360  23244  063246          JSM  MDRVR        CALL MODEM
1361  23245  066134          JMP  RE1
```

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```
1363*
1364*   MODEM OUTPUT DRIVER
1365*
1366   23246  021651  MDRVP   LDA  T1      GET SELECT CODE
1367   23247  043641          IOR  B4001
1368   23250  063625          JSM  IOST    WAIT FOR MODEM TO BE READY
1369   23251  170402          RET          STOP-FLAG RETURN
1370*
1371   23252  172741          STF  1       TURN OFF INTERRUPT
1372   23253  020211          LDA  .BUFA   SET TO START OF I/O BUFFER
1373   23254  031400          STA  BADDR
1374*
1375   23255  021400  MDR1    LDA  BADDR
1376   23256  025400          LDB  BADDR
1377   23257  070002          SAR  1
1378   23260  070517          LDA  A,I     FETCH TWO CHARACTERS
1379   23261  074111          SLR  *+2
1380   23262  070346          RAR  8
1381   23263  070342          SAR  8
1382   23264  010031          CPA  EOL     IS IT FOL?
1383   23265  067271          JMP  MDR3    YES
1384   23266  063277          JSM  MDRS    NO
1385   23267  045400          ISZ  BADDR
1386   23270  067255          JMP  MDR1
1387*
1388   23271  020031  MDR3    LDA  CRTN    OUTPUT CRTN
1389   23272  063277          JSM  MDRS
1390   23273  020174          LDA  B177    OUTPUT RUBOUT
1391   23274  063277          JSM  MDRS
1392   23275  173741          CLF  1
1393   23276  170402          RET
```

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```
1395*
1396*   SERIALIZING SUBROUTINE
1397*
1398   23277  031661  MDRS   STA  T9
1399   23300  025653         LDB  T3        INCLUDE PARITY
1400   23301  070111         SLA  *+2
1401   23302  004062         ADB  FLGBT
1402   23303  070002         SAR  1
1403   23304  073650         RZA  *-3
1404   23305  021661         LDA  T9
1405   23306  074342         SBR  8
1406   23307  074017         ADA  B
1407   23310  040110         IOR  B1400     INCLUDE STOP BITS
1408   23311  070744         SAL  1
1409   23312  031661         STA  T9
1410   23313  025652         LDB  T2        SET UP BIT COUNTER
1411   23314  004106         ADB  B777      SWITCH TO SINGLE STOP BIT @ 130
                                                                      BAUD
1412   23315  074700         ABR  15
1413   23316  004141         ADB  M10
1414   23317  035470         STB  L2T1
1415   23320  041651  MDR2   IOR  T1        "OR" IN SELECT CODE
1416   23321  040121         IOR  B4000     "OR" IN SO3
1417   23322  172141         OTA  1         LOAD I/O REGISTER
1418   23323  172601         STC  1         OUTPUT THE DATA
1419   23324  172741         STF  1
1420   23325  021661         LDA  T9        SHIFT DATA RIGHT
1421   23326  070002         SAR  1
1422   23327  031661         STA  T9        SAVE SHIFTED DATA
1423   23330  025652         LDB  T2        LOAD TIMING CONSTANT
1424   23331  076030         RIB  *         LOOP FOR TIMING
1425   23332  045470         ISZ  L2T1      INCREMENT BIT COUNTER
1426   23333  067320         JMP  MDR2
1427   23334  170402         RET
```

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```
1429*
1430    SERVICE MODEM INTERRUPTS
1431*
1432  23335  040377  INTAD   DEF  40377B     ADDRESS OF INTERRUPT TABLE—1
1433  23336  00137   INTSA   DEF  *+1—ID
1434*
1435  23337  074742          SBR  16         INITIALIZE DATA WORD
1436  23340  023643          LDA  M8         SET UP BIT COUNTER
1437  23341  031446          STA  ADRSS
1438  23342  021652          LDA  T2
1439  23343  070000          AAR  1          LOAD HALF-WAIT
1440  23344  000042          ADA  .33        ALLOW FOR DELAY IN INTERRUPT
                                               ROUTINE
1441  23345  072030          RIA  *          LOOP FOR TIMING
1442*
1443  23346  021651  MDU1    LDA  T1         GET SELECT CODE
1444  23347  043641          IOR  B4001
1445  23350  172141          OTA  1
1446  23351  172601          STC  1          SAMPLE
1447  23352  172741          STF  1
1448  23353  172241          LIA  1
1449  23354  074002          SBR  1          POSITION OLD DATA WORD
1450  23355  070111          SLA  *+2
1451  23356  004062          ADB  FLGBT
1452  23357  021652          LDA  T2         LOAD TIMING CONSTANT
1453  23360  072030          RIA  *          LOOP FOR TIMING
1454  23361  045446          ISZ  ADRSS
1455  23362  067346          JMP  MDU1
1456  23363  074402          SBR  9
1457  23364  035446          STB  ADRSS      SAVE CODE
1458*
1459  23365  021655          LDA  T5
1460  23366  070110          SZA  *+2
1461  23367  067507          JMP  MDSS
1462*
1463  23370  014031          CPB  CRTN
1464  23371  067463          JMP  SCRN
1465  23372  004151          ADB  M32        CODE < 40R?
1466  23373  074152          SBM  *+3        YES
1467  23374  004154          ADB  M64        CODE < 140B?
1468  23375  074112          SBM  *+2        YES
1469  23376  067450          JMP  INT2
1470*
1471  23377  021657          LDA  T7         OK TO CLEAR DISPLAY?
1472  23400  072210          RZA  *+4
1473  23401  160170          JSM  CLERA,I    CLEAR THE DISPLAY
1474  23402  020211          LDA  .BUFA
1475  23403  031657          STA  T7
1476*
1477  23404  021400          LDA  BADDR      STASH IN DISPLAY BUFFER
1478  23405  010236          CPA  SLEND
1479  23406  067450          JMP  INT2       AT END OF BUFFER
1480  23407  025400          LDB  BADDR
1481  23410  045400          ISZ  BADDR
1482  23411  074006          RBR  1
1483  23412  070002          SAR  1
1484  23413  070517          LDA  A,I        FETCH WORD IN BUFFER
```

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```
1485   23414  074112          SBM  *+2
1486   23415  070346          RAR  8
1487   23416  050157          AND  M256
1488   23417  041446          IOR  ADRSS
1489   23420  074132          SBM  *+2,C
1490   23421  070346          RAR  8
1491   23422  074577          STA  B,I
1492*
1493   23423  021400          LDA  BADDR     SCROLL IF NECESSARY
1494   23424  000151          ADA  M32
1495   23425  070076          TCA
1496   23426  001402          ADA  OTPTR
1497   23427  070113          SAP  *+2
1498   23430  045402          ISZ  OTPTR
1499*
1500   23431  021657  MDU2    LDA  T7        STASH IN I/Q BUFFER
1501   23432  013506          CPA  IOEND
1502   23433  067450          JMP  INT2      AT END OF BUFFER
1503   23434  025657          LDB  T7
1504   23435  045657          ISZ  T7
1505   23436  074006          RBR  1
1506   23437  070002          SAR  1
1507   23440  070517          LDA  A,I       FETCH WORD IN BUFFER
1508   23441  074112          SBM  *+2
1509   23442  070346          RAR  8
1510   23443  050157          AND  M256
1511   23444  041446          IOR  ADRSS
1512   23455  074132          SBM  *+2,C
1513   23446  070346          RAR  8
1514   23447  074557          STA  B.I
1515*
1516   23450  021651  INT2    LDA  T1        GET SELECT CODE
1517   23451  043641          IOR  B4001
1518   2345   172141          OTA  1
1519   23453  172601          STC  1
1520   23454  172741          STF  1
1521   23455  172241          LIA  1
1522   23456  071511          SLA  INT2      WAIT FOR STOP BIT
1523   23457  021444          LDA  SAVEA     RESTORE A-REG
1524   23460  025445          LDB  SAVEB     RESTORE B-REG
1525   23461  173741          CLF  1         RESTORE INTERRUPT
1526   23462  170402          RET
1527*
1528   23463  020105  SCRN    LDA  B377
1529   23464  031443          STA  KEYFG     SAY TO DUMP I/O BUFFER
1530*
1531   23465  021657          LDA  T7        PUT EOL IN I/O BUFFER
1532   23466  072110          RZA  *+2
1533   23467  020211          LDA  .BUFA
1534   23470  070137          LDB  A
1535   23471  074006          RBR  1
1536   23472  070002          SAR  1
1537   23473  070517          LDA  A,I
1538   23474  074112          SBM  *+2
1539   23475  070346          RAR  8
1540   23476  050157          AND  M256
```

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```
1541   23477  040031          ICR  EOL
1542   23500  074132          SBM  *+2,C
1543   23501  070346          RAR  8
1544   23502  074557          STA  B,I
1545   23503  070742          SAR  16
1546   23504  031657          STA  T7
1547   23505  067450          JMP  INT2
1548*
1549   23506  003320  IOEND   DEF  IOBUF+IOBUF+80
1550*
1551*
1552*  STORE FROM INTERRUPT
1553*
1554   23507  014031  MDSS    CPB  CRTN
1555   23510  067606          JMP  MDS5
1556   23511  004151          ADB  M32        CODE < 40B?
1557   23512  074152          SBM  *+3        YES
1558   23513  004154          ADB  M64        CODE < 140B?
1559   23514  074112          SBM  *+2        YES
1560   23515  067450          JMP  INT2
1561*
1562   23516  021657          LDA  T7
1563   23517  072610          RZA  MDS2
1654   23520  021446          LDA  ADRSS      PROCESS FIRST CODE
1565   23521  060750          JSM  DIGCK      DIGIT?
1566   23522  067530          JMP  MDS1       NO
1567   23523  035722          STB  INTGR      YES, SAVE IT
1568   23524  024233          LDB  SBUFA
1569   23525  035706          STB  SBPTR
1570   23526  020133          LDA  M2
1571   23527  067531          JMP  *+2
1572   23530  020132  MDS1    LDA  M1
1573   23531  031657          STA  T7
1574   23532  067450          JMP  INT2
1575*
1576   23533  010132  MDS2    CPA  M1         IGNORE?
1577   23534  067450          JMP  INT2       YES
1578   23535  010133          CPA  M2         IN LINE NUMBER?
1579   23536  067557          JMP  MDS3
1580   23537  021657  MDST    LDA  T7         NO, STORE CHARACTER
1581   23540  010236          CPA  SLEND
1582   23541  067450          JMP  INT2       AT END OF BUFFER
1583   23542  025657          LDB  T7
1584   23543  045657          ISZ  T7
1585   23544  074006          RBR  1
1586   23545  070002          SAR  1
1587   23546  070517          LDA  A,I        FETCH WORD IN BUFFER
1588   23547  074112          SBM  *+2
1589   23550  070346          RAR  8
1590   23551  050157          AND  M256
1591   23552  041446          IOR  ADRSS
1592   23553  074132          SBM  *+2,C
1593   23554  070346          RAR  8
1594   23555  074557          STA  B,I
1595   23556  067540          JMP  INT2
1596*
```

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```
1597   23557  021446  MDS3    LDA  ADRSS    PROCESS LINE NUMBER
1598   23560  060750          JSM  DIGCK    DIGIT?
1599   23561  067571          JMP  MDS4     NO
1600   23562  021722          LDA  INTGR
1601   23563  070704          SAL  2
1602   23564  001722          ADA  INTGR
1603   23565  070744          SAL  1
1604   23566  074017          ADA  B
1605   23567  013722          STA  INTGR
1606   23570  067450          JMP  INT2
1607*
1608   23571  021722  MDS4    LDA  INTGR
1609   23572  013427          STA  .LNUM
1610   23573  131706          STA  SBPTR,I   STORE LINE NUMBER
1611   23574  045706          ISZ  SBPTR
1612   23575  023640          LDA  B5K
1613   23576  131706          STA  SBPTR,I   STORE SPECIAL OPCODE
1614   23577  045706          ISZ  SBPTR
1615   23600  023777          LDA  OPCOD
1616   23601  131706          STA  SBPTR,I   STORE PAGE CODE
1617   23602  024212          LDB  .SLBF
1618   23603  004022          ADB  .5
1619   23604  035657          STB  T7
1620   23605  067537          JMP  MDST
1621*
1622   23606  021657  MDS5    LDA  T7        PROCESS CRTN
1623   23607  070550          SZA  MDS6
1624   23610  010132          CPA  M1
1625   23611  067622          JMP  MDS6
1626   23612  010133          CPA  M2
1627   23613  067622          JMP  MDS6
1628   23614  021657          LDA  T7
1629   23615  070002          .SAR 1
1630   23616  070070          SIA  *+1
1631   23617  031706          STA  SBPTR
1632   23620  020105          LDA  B377
1633   23621  031443          STA  KEYFG
1634   23622  070742  MDS6    SAR  16
1635   23623  031657          STA  T7
1636   23624  067450          JMP  INT2
1637*
1638*   I/O STATUS ROUTINE
1639*
1640*   LDA SELECT CODE (SAVED)
1641*   JSM IOST
1642*
1643*   RETURN TO P+1 IF STOP FLAG
1644*             P+2 OTHERWISE
1645*
1646   23625  025442  IOST    LDR  STPFL     CHECK STOP FLAG
1647   23626  014040          CPB  .31
1648   23627  170402          RET
1649*
1650   23630  172741          STF  1         TURN OFF INTERRUPT SYSTEM
1651   23631  172141          OTA  1         OUTPUT SELECT CODE
1652   23632  172741          STF  1         LOAD DEVICE STATUS
```

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```
1653   23633  177241          LIB  I,C      AND TURN ON INTERRUPT
1654   23634  074406          RBR  9
1655   23635  075413          SBP  IOST     LOOP IF BUSY (TESTS S10)
1656   23636  064357          JMP  RETN2
```

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```
1658   23637  001704  BKPTA   DEF  BKPTR
1659   23640  005000  B5K     OCT  5000
1660   23641  004001  B4001   OCT  4001
1661   23642  177752  M22     DEC  -22
1662   23643  177770  M8      DEC  -8
1663   23644  000112  .74     DEC  74
1664   23645  000141  .97     DEC  97
1665*
1666   23646  001651  AT1     DEF  T1
1667   23647  040424  AT1S    DEF  40424B
1668   23650  001662  TF1A    DEF  TF1
1669   23651  001652  TCON    DEF  *+1-ID       CONSTANT FOR TIMING LOOP
1670   23652  002001          OCT  002001  10↑4
1671   23653  062531          OCT  062531  6559
1672   23654  021451          OCT  021451  2329
1673   23655  104511          OCT  104511  8949
1674*
1675*  EDIT KEY TABLE (IMMEDIATE EXECUTION)
1676*
1677   23656  000536  EDITP   DEF  *+*+2-ID-ID
1678   23657  005600          OCT  05600 EXECUTE      13  0
1679   23660  006601          OCT  06601 STEP         15  1
1680   23661  010202          OCT  10202 RECALL       20  2
1681   23662  011203          OCT  11203 BACKSPACE    22  3
1682   23663  011604          OCT  11604 FORWARDSPACE 23  4
1683   23664  012205          OCT  12205 DOWNARROW    24  5
1684   23665  012606          OCT  12606 UPARROW      25  6
1685   23666  013207          OCT  13207 LEFTARROW    26  7
1686   23667  013610          OCT  13610 RIGHTARROW   27  8
1687   23670  015211          OCT  15211 CLEAR VAR    32  9
1688   23671  017612          OCT  17612 INSERT/DELETE 37 10
1689   23672  065213          OCT  65213 CLEAR       152 11
1690   23673  065614          OCT  65614 ACC         153 12
1691   23674  070215          OCT  70215 PRINT ALL   160 13
1692   23675  071316          OCT  71316 EOL         162 14   END
```

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```
1694*
1695*  MULTI-CHARACTER KEY TABLE
1696*
1697   23676  003576  MULTP   DEF  *+*+2-ID-ID
1698   23677  005200          OCT  05200 LIST      12 0
1699   23700  006201          OCT  06201 CONT      14 1
1700   23701  007202          OCT  07202 TRACE     16 2
1701   23702  007603          OCT  07603 RUN       17 3
1702   23703  010604          OCT  10604 FETCH     21 4
1703   23704  014205          OCT  14205 LOAD      30 5
1704   23705  014606          OCT  14606 STORE     31 6
1705   23706  017207          OCT  17207 NORMAL    36 7
1706   23707  072210          OCT  72210 FIX       164 8
1707   23710  072611          OCT  72611 FLT       165 9
1708   23711  073212          OCT  73212 SCRATCH   166 10
1709   23712  073613          OCT  73613 AUTO      167 11
1710   23713  077714          OCT  77714 EXIT      177 12   END
1711*
1712*  MULTI-CHARACTER MNEMONIC TABLE
1713*
1714   23714  003632  MULTN   DEF  *+*+2-ID-ID
1715   23715  046111          OCT  046111  L  I
1716   23716  051524          OCT  051524  S  T
1717   23717  100103          OCT  100103  (0) C
1718   23720  047516          OCT  047516  O  N
1719   23721  052201          OCT  052201  T  (1)
1720   23722  052122          OCT  052122  T  R
1721   23723  040503          OCT  040503  A  C
1722   23724  042602          OCT  042602  E  (2)
1723   23725  051125          OCT  051125  R  U
1724   23726  047203          OCT  047203  N  (3)
1725   23727  043105          OCT  043105  F  E
1726   23730  052103          OCT  052103  T  C
1727   23731  044204          OCT  044204  H  (4)
1728   23732  046117          OCT  046117  L  O
1729   23733  040504          OCT  040504  A  D
1730   23734  102523          OCT  102523  (5) S
1731   23735  052117          OCT  052117  T  O
1732   23736  051105          OCT  051105  R  E
1733   23737  103116          OCT  103116  (6) N
1734   23740  047522          OCT  047522  O  R
1735   23741  046501          OCT  046501  M  A
1736   23742  046207          OCT  046207  L  (7)
1737   23743  043111          OCT  043111  F  I
1738   23744  054210          OCT  054210  X  (8)
1739   23745  043114          OCT  043114  F  L
1740   23746  052211          OCT  052211  T  (9)
1741   23747  051503          OCT  051503  S  C
1742   23750  051101          OCT  051101  R  A
1743   23751  052103          OCT  052103  T  C
1744   23752  044212          OCT  044212  H  (10)
1745   23753  040525          OCT  040525  A  U
1746   23754  052117          OCT  052117  T  O
1747   23755  105505          OCT  105505  (11)E
1748   23756  054111          OCT  054111  X  I
1749   23757  052214          OCT  052214  T  (12)
```

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```
1750    23760  041517          OCT  041517  C  O
1751    23761  046520          OCT  046520  M  P
1752    23762  146400          OCT  146400  (13)      END
```

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```
1754    23763  160205  ERRX    JSM  AERRA,I     MODE ERROR
1755    23764  177661          DEC  -79
1756*
1757    23765  003754  WHAM    DEF  *+*+2-ID-ID
1758    23766  053510          ASC  3,WHAT?
        23767  040524
        23770  037440
1759    00000          LEFF    EQU  23771B-*
1760*
1761    01651                  ORG  1651B
1762*
1763    01740          TMP     EQU  XC
1764    01473          CCNT    EQU  TEMPS+1
1765    01704          BKPTR   EQU  WIDTH
1766*
1767    01651  000000  T1      NOP                SELECT CODE
1768    01652  000000  T2      NOP                TIMING CONSTANT
1769    01653  000000  T3      NOP                PARITY INDICATOR
1770    01654  000000  T4      NOP                PAGE INFO
1771    01655  000000  T5      NOP                PRINT/STORE FLAG
1772    01656  000000  T6      NOP                FOR LISTING
1773    01657  000000  T7      NOP                OK/NOT OK TO CLEAR DISPLAY ON
                                                  INTERRUPT
1774    01660  000000  T8      NOP                NO-LINE-NUMBERS FLAG
1775    01661  000000  T9      NOP
1776*
1777    01662  000000  TF1     BSS  4             FLOATING TEMPORARY
1778    01662          SHFLG   EQU  TF1
1779    01663          CTFLG   EQU  TF1+1
1780*
1781    23771                  ORG  23771B
1782*
1783    23771  177772          ABS  ERRX-*        EXECUTION JUMP TABLE
1784    23772  000000          NOP                ** CHECKSUM WORD **
1785*
1786    23773  176014          ABS  BN777-*       NON-FORMULA OPERATOR TABLE
                                                  (NULL TABLE)
1787    23774  176013          ABS  BN777-*       FUNCTION-NAME TABLE (NULL
                                                  TABLE)
1788    23775  176004          ABS  COMTB-*       COMMAND-NAME TABLE
1789    23776  176010          ABS  SYSNT-*       STATEMENT-NAME TABLE
1790    23777  016000  OPCOD   OCT  16000
1791                           END
*  NO ERRORS*
```

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CROSS-REFERENCE TABLE

.1	0020	0925	0945	0980	1087	1186	1238	1291	1356		
.10	0071	0072									
.100	0070										
.1000	0069										
.11	0035	0043	1326								
.110	0569	0577									
.12	0036										
.13	0039										
.15	0048	0083									
.16	0049	0084									
.1E4	0068	0576	1070	1123	1187	1239					
.2	0027										
.21	0050										
.22	0051	0087									
.23	0052	0088									
.28	0053										
.3	0028	0045	1024	1059							
.31	0054	0090	0723	1201	1647						
.32	0055	0736	0866	0915	1235						
.33	0056	1440									
.34	0057	0091									
.37	0058										
.4	0029	0573	0636	1042	1347						
.40	0059										
.41	0060	0958									
.43	0061										
.45	0062										
.46	0063										
.48	0064										
.5	0030	0564	1268	1618							
.58	0065	0094									
.6	0031	0044	1270								
.63	0066	1333									
.7	0032	1272									
.74	1663	0713									
.8	0033	0600	1274								
.9	0034	1276									
.97	1664	0725									
.99	0074										
.BUFA	0180	0794	0829	0965	1372	1474	1533				
.FADA	0185										
.FDVA	0188	0597									
.FMPA	0187										
.FSBA	0186										
.FSR	0190										
.LNUM	0314	0631	0661	0935	1609						
.NPWR	0494										
.SLBF	0181	0551	0667	0782	0848	0853	1617				
A	0000	0612	0756	0803	1150	1165	1304	1378	1484	1507	1534
	1537	1587									
ACTSA	0174	0792	0947								
ADRSS	0327	1437	1454	1457	1488	1511	1564	1591	1597		
AERRA	0176	0581	1754								
AIEX1	1326	1314									
AIEX2	1327	1320									

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CROSS-REFERENCE TABLE

AR1	Ø413	Ø182									
AR1A	Ø182										
AR2	Ø415	Ø183									
AR2A	Ø183	Ø586									
ARYAD	Ø4Ø3										
ASTR1	1324	13Ø9									
ASTR2	1325	1317									
AT1	1666	Ø537	Ø969	1254							
AT1S	1667	Ø536	Ø97Ø	1255							
B	ØØØØ	Ø578	Ø759	1167	1282	1286	1289	1294	13Ø5	1312	1316
	1321	14Ø6	1491	1514	1544	1594	16Ø4				
B1ØØ	ØØ95	Ø735	1Ø55								
B1ØØØ	Ø1Ø2										
B1ØK	Ø114	Ø115									
B12K	Ø116	Ø117	Ø2Ø6								
B13Ø	1223	118Ø									
B133	ØØ96										
B14Ø	ØØ97										
B14ØØ	Ø1Ø3	Ø2Ø4	14Ø7								
B17	ØØ83										
B17ØK	Ø121	1226									
B174Ø	Ø1Ø4	Ø2Ø3									
B176Ø	Ø1Ø5	Ø158									
B177	ØØ98	Ø673	1163	139Ø							
B1774	Ø1Ø6										
B1175	Ø1Ø7										
B1177	Ø1Ø8										
B2Ø	ØØ84	133Ø									
B22	ØØ85	Ø654									
B23	ØØ86										
B24ØØ	Ø11Ø										
B26	ØØ87										
B27	ØØ88										
B3ØØØ	Ø111										
B36	ØØ89										
B37	ØØ9Ø										
B377	ØØ99	Ø652	Ø671	13Ø6	1336	1528	1632				
B4ØØ	Ø1ØØ										
B4ØØØ	Ø112	Ø162	1416								
B4ØØ1	166Ø	Ø617	1367	1444	1517						
B42	ØØ91										
B43	1224	1182									
B44	ØØ92										
B52	ØØ93	1324									
B5K	1659	Ø938	1612								
B6K	Ø113	Ø167									
B72	ØØ94										
B777	Ø1Ø1	1411									
BADDR	Ø291	Ø553	Ø633	Ø663	Ø668	Ø771	Ø835	Ø847	Ø868	Ø884	Ø886
	Ø899	Ø914	Ø943	1184	1373	1375	1376	1385	1477	148Ø	1481
	1493										
BADRP	Ø2Ø4										
PEND	Ø198	Ø199	Ø955								
PHSTP	Ø444										
BK1	Ø857	Ø851									
BK2	Ø853	Ø846									

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CROSS-REFERENCE TABLE

BK3	Ø849	Ø863									
BKPTA	1658	Ø763									
BKPTR	1765	Ø646	Ø761	Ø845	Ø85Ø	Ø857	Ø862	Ø864	Ø867	Ø877	Ø9Ø6
	1658										
BKSP	Ø845	Ø655	Ø696								
BLANK	Ø388	Ø647	1236								
BN777	Ø521	1786	1787								
C5	ØØ15										
C6	ØØ11	Ø114									
C7	ØØ22	Ø1ØØ									
CCNT	1764	Ø645	13Ø3	13Ø8							
CHRSA	Ø219	Ø946									
CLAR2	Ø491										
CLERA	Ø16Ø	Ø563	Ø628	Ø658	Ø746	Ø828	1Ø16	1Ø34	1143	1343	1473
CLINE	Ø316	Ø625	1Ø9Ø	1112	1121	1146	1189	1196	1241	1248	
CLB1A	Ø217										
CLVR	1Ø7Ø	Ø7Ø2									
COMCE	Ø436										
COMCK	Ø435										
COMTB	Ø51Ø	1788									
CONST	Ø484										
CPLAC	Ø331										
CRCKA	Ø228										
CRIT	Ø963	Ø928	Ø983	1359							
CRLF	Ø497										
CRLF1	Ø498	Ø967	12Ø9								
CRTN	ØØ37	ØØ38	ØØ39	1388	1463	1554					
CTFLG	1779	Ø674	Ø76Ø	1334							
CTYPE	Ø33Ø										
DCOMA	Ø21Ø										
DELSA	Ø175	Ø937									
DFLAG	Ø39Ø										
DIGCK	Ø463	Ø931	1565	1598							
DIO2	Ø8Ø3	Ø814									
DIO3	Ø816	Ø8Ø8									
DIOB	Ø79Ø	Ø653	Ø672	1337							
DLC1	Ø886	Ø895									
DNRW	1Ø94	Ø698									
DNRWS	1112	1Ø97	1195	1247							
OPERR	ØØ43										
DROST	Ø317										
DSTRT	Ø3Ø3										
E	ØØ8Ø										
E1	Ø235										
E1Ø	Ø244										
E15	Ø249										
E2Ø	Ø254										
E25	Ø259										
E3Ø	Ø264										
E35	Ø269										
E4Ø	Ø274										
E45	Ø279										
E5	Ø239										
E5Ø	Ø284										
ECALA	Ø215										
EDITP	1677	Ø685									

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CROSS-REFERENCE TABLE

ELINA	Ø169							
ENDS	Ø48Ø							
ENTEA	Ø218							
ENTFA	Ø189							
EOL	ØØ38	Ø8Ø7	Ø832	Ø936	Ø944	Ø953	1382	1541
EOL1	Ø928	Ø549						
EOLCK	Ø483							
EOLL	Ø923	Ø7Ø7						
EOST	Ø481							
ERRA	Ø177							
ERRX	1754	Ø515	1783					
EVOD	1Ø34	1275						
EXP	Ø4Ø1	Ø4Ø2						
EXPOP	Ø118							
F	ØØ81							
FDAAA	Ø222							
FETCH	Ø488							
FILLA	Ø2Ø1							
FIRST	Ø367							
FIX	Ø5Ø1							
FLGBT	ØØ73	Ø54Ø	1344	14Ø1	1451			
FLOAT	Ø386							
FLTFA	Ø193							
FLTRA	Ø192	Ø598						
FLTSA	Ø195							
FN	Ø148							
FND	Ø462	1131						
FND1A	Ø224							
FNDAA	Ø223							
FNDPS	Ø476	1114	1124					
FOPBS	Ø2Ø6							
FORD	Ø862	Ø697						
FORMA	Ø172							
FORME	Ø336							
FORMS	Ø335							
FORMT	Ø334							
FPAGE	Ø451							
FROMA	Ø122							
FSCA	Ø173							
FSCE2	Ø441							
FSCE4	Ø446							
FTMP1	Ø337							
FTMP2	Ø338							
FW2	Ø865	Ø765						
FWAM	Ø157	1279						
FWUP	Ø296	128Ø						
FXFLA	Ø194	Ø585						
GETAD	Ø461							
GETCH	Ø471							
GETLN	Ø527	1Ø86	1185	1237				
GETSK	Ø475							
GFLAG	Ø4Ø4							
GFRST	Ø474	Ø929	Ø984					
GNEXT	Ø473	1179						
GPARM	Ø424							
GSIGN	Ø486							

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CROSS-REFERENCE TABLE

GTCON	Ø5ØØ										
GTMP	Ø472	Ø831	Ø889	Ø9Ø4							
GTOPP	Ø466										
GTSTA	Ø213										
HFLG1	Ø321										
HSTPT	Ø3Ø2										
I	ØØ67										
ICNT	Ø422	Ø924	Ø979	12Ø7	1355						
ID	Ø5Ø8	Ø534	1Ø27	1Ø27	1Ø29	1Ø29	1Ø45	1Ø45	1Ø47	1Ø47	1Ø65
	1Ø65	134Ø	134Ø	135Ø	135Ø	1433	1669	1677	1677	1697	1697
	1714	1714	1757	1757							
IMPY	Ø487										
INDL	Ø877	Ø7Ø3									
INF	ØØ77										
INITS	Ø456										
INREA	Ø226										
INS1	Ø9Ø3	Ø912									
INS2	Ø914	Ø887	Ø9Ø7								
INSR	Ø899	Ø88Ø									
INT2	1516	1469	1479	15Ø2	1522	1547	156Ø	1574	1577	1582	1595
	16Ø6	1636									
INTAD	1432	Ø6Ø9									
INTCK	Ø459	Ø934									
INTEA	Ø178										
INTEL	Ø34Ø										
INTFL	ØØ75										
INTGR	Ø4Ø2	1567	16ØØ	16Ø2	16Ø5	16Ø8					
INTSA	1433	Ø611									
IOBUF	Ø359	1549	1549								
IOEND	1549	15Ø1									
IOHEA	Ø229										
IOST	1646	1368	1655								
IOSTA	Ø225	Ø797									
KEY1	128Ø	1287									
KEYFG	Ø324	1529	1633								
KEYIN	Ø526	Ø651	Ø67Ø	1335							
KEYPR	1267	Ø715									
L2T1	Ø347	1414	1425								
L2T2	Ø348										
LASTN	Ø398	113Ø									
LBOP	Ø119										
LDEF	Ø489										
LEFF	1759										
LEFT	Ø771	Ø7ØØ									
LETCK	Ø464										
LIMIT	Ø465										
LISTA	Ø167										
LISTS	Ø528	1155									
LNFD	ØØ72	Ø816									
LNINC	ØØ15	Ø624	Ø629	Ø659	11Ø7						
LNOUT	1143										
LNUM	Ø457	1214									
LOCL1	Ø345	1293	13ØØ								
LOCL2	Ø346										
LOUT	1226	12Ø2									
LPCK	Ø437										

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LPCKE	Ø438										
LPOP	Ø12Ø										
LROMA	Ø123										
LSTAK	Ø299										
LSTPT	Ø3Ø1										
LTR	Ø479										
LWAM	Ø295										
M1	Ø124	Ø544	Ø554	Ø68Ø	Ø9Ø2	1Ø89	1188	1233	124Ø	1572	1576
	1624										
M1Ø	Ø131	Ø71Ø	1413								
M1ØØ	Ø144										
M1Ø24	Ø146										
M11	Ø132										
M12	Ø133										
M13	Ø134										
M14	Ø135										
M15	Ø136										
M1598	Ø57Ø	Ø583									
M2	Ø125	157Ø	1578	1626							
M22	1661	Ø717									
M23	Ø137										
M25	Ø138										
M256	Ø145	1313	1487	151Ø	154Ø	159Ø					
M3	Ø126	Ø579	Ø911	1164							
M32	Ø139	Ø733	Ø772	Ø836	1465	1494	1556				
M36	Ø14Ø										
M4	Ø127										
M48	Ø141										
M5	Ø128	13Ø2									
M6	Ø129										
M64	Ø142	Ø719	1467	1558							
M8	1662	1436									
M8Ø	Ø143										
M9	Ø13Ø										
MAINS	1Ø1Ø	Ø932	Ø989	Ø995	Ø996	Ø997	Ø999	1ØØØ	1ØØ1	1ØØ2	1ØØ3
	1ØØ4	1ØØ5									
MASK1	Ø153										
MASK5	Ø154										
MAW	Ø294										
MAXIN	Ø4ØØ										
MAXSN	Ø147										
MBIN1	Ø4Ø6										
MBIN2	Ø4Ø7										
MBOX1	Ø351										
MCOUT	Ø529	Ø75Ø									
MDIMA	Ø2Ø8										
MDR1	1375	1386									
MDR2	1415	1426									
MDR3	1388	1383									
MDRS	1398	1384	1389	1391							
MDRVR	1366	122Ø	136Ø								
MDS1	1572	1566									
MDS2	1576	1563									
MDS3	1597	1579									
MDS4	16Ø8	1599									
MDS5	1622	1555									

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MDS6	1634	1623	1625	1627							
MDSS	1554	1461									
MDST	158Ø	162Ø									
MDU1	1443	1455									
MDU2	15ØØ										
MER8	Ø445										
MEV	1Ø45	1Ø39									
MINIT	Ø455										
MOD	1Ø47	1Ø41									
MODE	Ø3Ø5	Ø541	1Ø1Ø								
MOF	1Ø29	1Ø23									
MON	1Ø27	1Ø21									
MSFLG	Ø389										
MSSG1	134Ø	Ø637									
MTIB	Ø952	Ø562	Ø923	Ø978	1219	1253	1354				
MULTN	1714	Ø748	Ø986								
MULTP	1697	Ø741									
MVTOH	Ø477	Ø959									
NDISP	Ø382										
NDWRT	Ø496	Ø966	12Ø8								
NEXT1	Ø45Ø										
NEXTA	Ø467										
NEXTL	Ø449										
NMOTA	Ø2ØØ										
NOEOF	Ø482										
NPRIN	Ø383										
NPWRT	Ø495	Ø639	1Ø62	1174							
NUM	Ø396	Ø397	Ø589								
NUMCA	Ø211										
NUMOA	Ø212										
NXTDT	Ø3Ø4										
NXTST	Ø4Ø5										
OBLNK	Ø468										
ODGIT	Ø492										
ONE	ØØ45										
ONEXT	Ø469	Ø767	Ø834	Ø954							
OPCHA	Ø171										
OPCOD	179Ø	Ø941	1152	1615							
OPDMK	ØØ79										
OPMSK	ØØ76	1151									
OPTYP	Ø397										
OTPT	Ø978	Ø693									
OTPTR	Ø293	Ø774	Ø776	Ø781	Ø784	Ø838	Ø84Ø	Ø855	Ø856	Ø865	Ø87Ø
	1496	1498									
OUTCR	Ø47Ø	Ø764	Ø893	Ø9Ø9	Ø917						
OUTIA	Ø179	Ø632	Ø662	1159							
OVCHA	Ø216										
PALL	1Ø16	Ø7Ø6									
PARMA	Ø3Ø6										
PARMN	Ø3Ø7										
PBPTO	Ø313										
PBPTR	Ø31Ø	1Ø95	11Ø3	1192	1244						
PBUFF	Ø311	1Ø94	11Ø2	1127	1191	1243					
PBUFO	Ø312										
PEND	Ø365	Ø642	Ø952								
PEXMA	Ø165										

PAGE 441 CROSS-REFERENCE TABLE

PAGE 442 CROSS-REFERENCE TABLE

PAGE 443 CROSS-REFERENCE TABLE

PAGE 444 CROSS-REFERENCE TABLE

```
XSCRA   0220
XTRM    0572   0508
YC      0414
ZAP     0152
ZONK    0490
```

PAGE 445 EXTENDED I/O BLOCK'S CONSTANTS, SYNTAX, AND LINKAGES

```
0508                                LST
0509*     BASE PAGE EQUATES AND TEMPORARIES
0510*
0511    01641                       ORG  1641B
0512*
0513    01641  000000  T5           BSS  1
0514    01642  000000  T8           BSS  1
0515    01643  000000  TBEND        BSS  1
0516    01644  000000  T1           BSS  1
0517    01645  000000               BSS  1
0518    01645          PTR1         EQU  1645B
0519    01646  000000  RLFLG        BSS  1
0520    01647  000000  TW           BSS  1
0521    01647          TMPRE        EQU  1647B
0522    01650  000000  TX           BSS  1
0523    01651  000000  TD           BSS  1
0524    01652  000000  MF           BSS  1
0525    01653  000000  SD           BSS  1
0526    01654  000000  DP           BSS  1
0527    01654          TNULL        EQU  1654B
0528    01655  000000  EX           BSS  1
0529    01656  000000  T2           BSS  1
0530    01657  000000  T3           BSS  1
0531    01660  000000  T6           BSS  1
0532    01661  000000  T7           BSS  1
0533    01662  000000  T9           BSS  1
0534    01663  000000  .FLP         BSS  1
0535*
0536    01665                       ORG  1665B
0537    01665  000000  FLOOP        BSS  1
0538*
0539*     LOCAL TEMPORARIES FOR IMLIED "FOR" LOOP IS AS FOLLOWS:
0540*
0541*     WORD 1 ADDRESS OF VARIABLE
0542*     WORD 2 NAME OF VARIABLE
0543*     WORD 3 FINAL VALUE (INTEGER FORM)
0544*     WORD 4 STEP SIZE                  "              "
0545*     WORD 5 ADDRESS OF 1ST WORD AFTER FOR STMT.
0546*
0547    01666  000000  .FLOP        BSS  5          FIRST LOOP BLOCK
0548    01673  000000               BSS  5           SECOND LOOP BLOCK
0549*
0550    01700  000000  .BADR        BSS  1
0551    00051          ASC.         EQU  .46
0552    00047          ASCP         EQU  .43
0553    00050          ASCM         EQU  .45
0554    01712          .SIGN        EQU  1712B
0555    00074          .18          EQU  B22
```

PAGE 446 EXTENDED I/O BLOCK'S CONSTANTS, SYNTAX, AND LINKAGES

```
0557   22000                    ORG  22000B
0558*
0559*  FORMATTED I/O BLOCK
0560*
0561   12001          QUOTE     EQU  12001B
0562   12007          ASSOP     EQU  QUOTE+6
0563*
0564*
0565   22000  000213   ID       ABS  SOUT-*      OUTPUT SYNTAX
0566   22001  000117            ABS  SGET-*
0567   22002  000270            ABS  CMDS-*
0568   22003  000000            BSS  1
0569*
0570   22004  041515   SYSNT    ASC  1,CMD
0571   22005  042242            OCT  42242       D; OPCODE 2
0572   22006  042516            ASC  2,ENTER
       22007  052105
0573   22010  051243            OCT  51243       R; OP CODE 3
0574   22011  047525            ASC  3,OUTPUT
       22012  052120
       22013  052524
0575   22014  162377   NULL     OCT  162377      OP CODE 4; NULL
0576*
0577*
0578   22015  043117   NFOPT    OCT  043117        FO    NON-FORMULA OPERATOR
                                                                    TABLE
0579   22016  051220            OCT  051220        R (16)
0580   22017  052117            OCT  052117        TO
0581   22020  110523            OCT  110523          (17) S
0582   22021  052105            OCT  052105        TE
0583   22022  050322            OCT  50322       P (18)
0584*
0585*
0586   22023  000331            ABS  EIAND-*
0587   22024  000324            ABS  EIOR-*
0588   22025  000313            ABS  EROT-*
0589   22026  000441            ABS  STAT-*
0590   22027  000452            ABS  CHAR-*
0591   22030  000500            ABS  BIN-*
0592   22031  000457            ABS  LIN-*
0593   22032  000472            ABS  SPA-*
0594   22033  000410            ABS  EOCT-*
0595*
0596   22034  001661   FLOP     DEF  .FLOP-5
0597   22035  150000   .SC13    OCT  150000
0598   22036  177770   M8       DEC  -8
0599   22037  154000   SC13     OCT  154000      SELECT CODE 13 FOR ASCII BUSS
0600   22040  001652   AMF      DEF  MF
0601   22041  000137   AROW     OCT  137         LEFT ARROW
0602   22042  000176   ALTM     OCT  176         ALT MODE
0603   22043  000033   ESCM     OCT  33          ESC MODE
0604   22044  000105   ASCE     OCT  105         E
0605   22045  031166   B3116    OCT  31166
0606   22046  000120   .80      DEC  80
0607   22047  002001   B2001    OCT  2001
0608   22050  100700   STEC     OCT  -77100
0609   22051  012025   FMTOP    OCT  12025
```

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```
0610   22052  000021  .17      DEC  17
0611   22053  007777  BIT12    OCT  7777
0612   22054  000032  NFOPA    DEF  NFOPT+NFOPT-ID-ID
0613*
0614*
0615   22055  047503  FUNNT    ASC  1,OCT
0616   22056  052222           OCT  52222      T;22
0617   22057  051520           ASC  1,SPA
0618   22060  040623           OCT  40623      A;23
0619   22061  046111           ASC  1,LIN
0620   22062  047224           OCT  47224      N;24
0621   22063  041111           ASC  1,BIN
0622   22064  047225           OCT  47225      N;25
0623   22065  041510           ASC  2,CHAR
       22066  040522
0624   22067  113123           OCT  113123     26;STAT
0625   22070  052101           ASC  1,TAT
0626   22071  052227           OCT  52227      T;27
0627   22072  051117           ASC  1,ROT
0628   22073  052230           OCT  52230      T;30
0629   22074  044516           ASC  2,INOR
       22075  047522
0630   22076  114502           OCT  114502     31;BIAND
0631   22077  044501           ASC  2,IAND
       22100  047104
0632   22101  155000           OCT  155000     32: NULL
0633*
0634*
0635*  MORE ABSOLUTE LINKS TO THE BASIC SYSTEM
0636*
0637   22102  004304  RITE     DEF  4304B
0638   22103  007474  MOUTA    DEF  7474B
0639   22104  006656  PRINN    DEF  6656B
0640   22105  007366  SFMT     DEF  7366B
0641   22106  007303  TYPEC    DEF  7303B
0642   22107  007240  QTCHK    DEF  7240B
0643   22110  006773  PFORM    DEF  6773B
0644   22111  007007  PRCHK    DEF  7007B
0645   22112  007227  CKEOL    DEF  7227B
0646   22113  011444  OPCHI    DEF  11444B
0647   22114  007356  FSPR     DEF  7356B
0648   22115  012233  VAR01    DEF  12233B     ADDRESS OF VAROP+2
0649   22116  016504  IOHED    DEF  16504B
0650   22117  007402  PLOTE    DEF  7402B
```

```
0652*
0653*  GET STATEMENT SYNTAX
0654*
0655   22120  070742  SGET   SAR  16
0656   22121  031656         STA  T2          CLEAR NEST COUNTER
0657   22122  021717         LDA  NUM
0658   22123  050065         AND  OPMSK
0659   22124  070744         SAL  1
0660   22125  031642         STA  T8          SAVE PAGE INFO
0661   22126  062247         JSM  STBLK
0662*
0663   22127  062434         JSM  IOHD        GET (S.C.,FMT#
0664*
0665   22130  060513  SGP1   JSM  LPCK        LOOK FOR LEFT BRACKET
0666   22131  066171         JMP  SGP4        NOT FOUND
0667   22132  061055         JSM  GNEXT
0668   22133  045706         ISZ  SBPTR
0669   22134  062422         JSM  NFOP        LOOK FOR "FOR"
0670   22135  164307         JMP  E15+1,I     NOT FOUND
0671   22136  010033         CPA  .16         FOR?
0672   22137  066141         JMP  *+2         YES
0673   22140  164307         JMP  E15+1,I     NO, ERROR
0674   22141  045656         ISZ  T2          INCREMENT NEST COUNTER
0675   22142  160246         JSM  VAROA,I     GO LOOK FOR A VARIABLE
0676   22143  164321         JMP  E25+1,I     NONE FOUND, ERROR
0677   22144  164321         JMP  E25+1,I     SUBSCRIPT, ERROR
0678   22145  060463         JSM  SYMC1       FOUND ONE, LOOK FOR "="
0679   22146  012006         DEF  ASSOP-1
0680   22147  164324         JMP  E25+4,I
0681   22150  160202         JSM  FSCA,I      GO LOOK FOR A FORMULA
0682   22151  062422         JSM  NFOP        LOOK FOR "TO"
0683   22152  164322         JMP  E25+2,I     NOT FOUND, ERROR
0684   22153  012052         CPA  .17         TO?
0685   22154  066156         JMP  *+2         YES
0686   22155  164322         JMP  E25+2,I     NO, ERROR
0687   22156  160202         JSM  FSCA,I      GO LOOK FOR A FORMULA
0688   22157  062422         JSM  NFOP        LOOK FOR "STEP"
0689   22160  066165         JMP  SGP2        NOT FOUND
0690   22161  010074         CPA  .18         STEP?
0691   22162  066164         JMP  *+2         YES
0692   22163  164323         JMP  E25+3,I     NO, ERROR
0693   22164  160202         JSM  FSCA,I      GO LOOK FOR FORMULA
0694   22165  060510  SGP2   JSM  COMCE       DEMAND A COMMA
0695   22166  061055  SGP3   JSM  GNEXT
0696   22167  045706         ISZ  SBPTR
0697   22170  066130         JMP  SGP1
0698*
0699   22171  055400  SGP4   DSZ  BADDR
0700   22172  055706         DSZ  SBPTR
0701   22173  062233         JSM  SVARA       LOOK FOR A VARIABLE (STRING
                                               ALLOWED)
0702   22174  010031  BACK   CPA  EOL           END-OF-STATEMENT?
0703   22175  066201         JMP  NESC        YES
0704   22176  060504         JSM  COMCK       LOOK FOR A COMMA
0705   22177  066205         JMP  SGP5        NOT FOUND
0706   22200  066166         JMP  SGP3
0707*
```

```
0708   22201  021656  NESC    LDA  T2          CHECK NEST COUNTER
0709   22202  072110          R2A  *+2
0710   22203  164203          JMP  ACTSA,I     STATEMENT IS OK
0711   22204  164301          JMP  E10,I
0712*
0713   22205  060534  SGP5    JSM  RPCKE       DEMAND A RIGHT BRACKET
0714   22206  055656          DSZ  T2          DECREMENT NEST COUNTER
0715   22207  066210          JMP  *+1         ALLOW FOR SKIP
0716   22210  025656          LDB  T2
0717   22211  075153          SBP  BACK
0718   22212  164302          JMP  E10+1,I
0719*
0720*     OUTPUT STMT SYNTAX
0721*
0722   22213  062247  SOUT    JSM  STBLK
0723   22214  072150          RZA  *+3
0724   22215  062434          JSM  IOHD        STRING BLOCK NOT IN DO STRANDED
                                                SYNTAX
0725   22216  166102          JMP  RITE,I
0726   22217  045706          ISZ  SBPTR
0727   22220  060520          JSM  LPCKE-1     STRING BLOCK IN, TRY INTERNAL
                                                CONVERSION
0728   22221  161641          JSM  T5,I        LOOK FOR STRING VARIABLE
0729   22222  066230          JMP  SOUT2       P+1
0730   22223  066227          JMP  SOUT1       P+2
0731   22224  162116  SOUT3   JSM  IOHED,I    P+3, STRING ARRAY NAME FOUND
0732   22225  062435          JSM  IOHD+1
0733   22226  166102          JMP  RITE,I
0734*
0735   22227  154110  SOUT1   DSZ  BADRP,I
0736   22230  154110  SOUT2   DSZ  BADRP,I
0737   22231  160202          JSM  FSCA,I      CHECK SELECT CODE
0738   22232  066224          JMP  SOUT3
0739*
0740*     CHECK SYNTAX ON NUMERIC OR STRING VARIABLES
0741*
0742   22233  025641  SVARA   LDB  T5
0743   22234  076250          RZB  RECO2       IS STRING BLOCK IN?
0744   22235  160246          JSM  VAROA,I     NO, ERROR IF ANY STRINGS
0745   22236  164307          JMP  E15+1,I     P+1, NO LETTER FOUND
0746   22237  170402          RET              P+2, ARRAY VARIABLE FOUND AND
                                                STORED
0747   22240  170402          RET              P+3, SIMPLE VARIABLE FOUND AND
                                                STORED
0748*
0749   22241  161641  RECO2   JSM  T5,I        YES, TRY STRING BLOCK FIRST
0750   22242  164307          JMP  E15+1,I     P+1, NO LETTER FOUND
0751   22243  162115          JSM  VAR01,I     P+2, MUST BE NUMERIC OR ARRAY
                                                VARIABLE
0752   22244  170402          RET              P+3, STRING VARIABLE FOUND AND
                                                STORED
0753   22245  170402          RET
0754   22246  170402          RET
0755*
0756*     LOOK FOR THE STRING BLOCK ANS SAVE IT'S ADDRESS
0757*
0758   22247  020121  STBLK   LDA  B4000
0759   22250  024130          LDB  FROMA
0760   22251  074457          CPA  B,I
0761   22252  066264          JMP  FPAG2
0762   22253  014131          CPB  LROMA
0763   22254  066257          JMP  FPAG1
```

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```
Ø764   22255  ØØ4116          ADB  QTOP
Ø765   22256  Ø66251          JMP  *-5
Ø766   22257  Ø254Ø3  FPAG1   LDB  MAW
Ø767   2226Ø  111Ø3Ø          CPA  MAW,I
Ø768   22261  Ø66264          JMP  FPAG2
Ø769   22262  Ø74742          SBR  16
Ø77Ø   22263  Ø66267          JMP  *+4
Ø771   22264  Ø74442  FPAG2   SBR  1Ø
Ø772   22265  Ø743Ø4          SBL  1Ø
Ø773   22266  Ø74Ø7Ø          SIB  *+1
Ø774   22267  Ø35641          STB  T5
Ø775   2227Ø  Ø74117          LDA  B
Ø776   22271  17Ø4Ø2          RET
```

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```
0778*
0779*      CMD STATEMENT SYNTAX
0780*
0781   22272  062247  CMDS    JSM  STBLK
0782   22273  025641          LDB  T5
0783   22274  076150          RZB  *+3
0784   22275  061055          JSM  GNEXT
0785   22276  066300          JMP  *+2
0786   22277  161641          JSM  T5,I
0787   22300  045706          ISZ  SBPTR
0788   22301  160245          JSM  GTSTA,I
0789   22302  060504          JSM  COMCK
0790   22303  065151          JMP  EOST
0791   22304  066273          JMP  CMDS+1
0792*
0793*
0794*      CMD STATEMENT EXECUTION
0795*
0796   22305  062247  CMD     JSM  STBLK
0797   22306  022035          LDA  .SC13
0798   22307  031656          STA  T2
0799   22310  020013          LDA  B400
0800   22311  063342          JSM  OTPT
0801   22312  162107          JSM  QTCHK,I QUOTE NEXT?
0802   22313  062331          JSM  SVAR    NO — TRY STRINGS
0803   22314  063374          JSM  .OUTP
0804   22315  020107          LDA  B1000
0805   22316  063342          JSM  OTPT
0806   22317  021472          LDA  TEMPS
0807   22320  011421          CPA  PRADD   DONE WITH STMT?
0808   22321  164172          JMP  XEC4A,I YES
0809   22322  162107          JSM  QTCHK,I QUTOE NEXT?
0810   22323  062331          JSM  SVAR    NO — TRY STRINGS
0811   22324  063374          JSM  .OUTP
0812   22325  021472          LDA  TEMPS
0813   22326  011421          CPA  PRADD   DONE WITH STMT?
0814   22327  164172          JMP  XEC4A,I
0815   22330  066310          JMP  CMD+3   NO LOOP
0816*
0817   22331  025641  SVAR    LDB  T5
0818   22332  076110          RZB  *+2
0819   22333  164275          JMP  E5+1,I
0820   22334  074071          SLB  *+1,C
0821   22335  074717          JSM  B,I
0822   22336  170402          RET
0823   22337  170402          RET
0824*
0825*
0826*      FUNCTION EXECUTION
0827*
0828*
0829   22340  062361  EROT    JSM  SCHK    GO CHECK IF SYNTAX OR EXECUTION
0830   22341  074076          TCB          EXECUTION
0831   22342  021644          LDA  T1      LOAD THE ARGUMENT INTO (A)
0832   22343  074153          SBP  *+3     EXIT IF ARG WAS NEGATIVE OR ZERO
0833   22344  074070          SIB  *+1
```

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```
0834   22345  070006          RAR  1
0835   22346  077770          RIB  *-1        LOOP, ROTATING (A) ONE BIT
                                                        UNTIL DONE
0836   22347  066357          JMP  ESTO       EXIT LOOP
0837*
0838   22350  062361  EIOR    JSM  SCHK
0839   22351  021644          LDA  T1         T1 IOR T2
0840   22352  041656          IOR  T2
0841   22353  066357          JMP  ESTO
0842*
0843   22354  062361  EIAND   JSM  SCHK
0844   22355  021644  EAND    LDA  T1          T1 AND T2
0845   22356  051656          AND  T2
0846   22357  070137  ESTO    LDB  A
0847   22360  164227          JMP  FXFLA,I
0848*
0849   22361  021416  SCHK    LDA  MODE
0850   22362  070552          SAM  .SCHK      SKIP IF SYNTAX PHASE
0851*
0852   22363  061217          JSM  FETCH
0853   22364  160225          JSM  FLTRA,I
0854   22365  024062          LDB  FLGBT      IF OVERFLOW USE 100000 OCTAL
0855   22366  035644          STB  T1
0856   22367  061217          JSM  FETCH
0857   22370  160225          JSM  FLTRA,I
0858   22371  164273          JMP  E5-1,I
0859   22372  035656          STB  T2
0860   22373  045472          ISZ  TEMPS
0861   22374  170402          RET
0862*
0863*      CHECK SYNTAX OF FUNCTIONS
0864*
0865   22375  055777  .SCHK    DSZ  RSPTR
0866   22376  121472          LDA  TEMPS,I
0867   22377  031641          STA  ST+1       SAVE LEFT BRACKET COUNT
0868   22400  061055          JSM  GNEXT
0869   22401  045706          ISZ  SBPTR
0870   22402  060521          JSM  LPCKE
0871   22403  160202          JSM  FSCA,I
0872   22404  060510          JSM  COMCE
0873   22405  160202          JSM  FSCA,I
0874   22406  025641          LDB  ST+1
0875   22407  135472          STB  TEMPS,I
0876   22410  060534          JSM  RPCKE
0877   22411  064356          JMP  RETN3
0878*
```

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```
0880*
0881*  MISCELLANEOUS ROUTINES & ETC.
0882*
0883*  SUBROUTINE TO RECORD CODE-CONVERSION TABLE
0884*
0885   22412  060510  RTBL    JSM  COMCE     DEMAND COMMA
0886   22413  061140            JSM  LTR       LETTER?
0887   22414  164307            JMP  E15+1,I   NO, ERROR
0888   22415  021474            LDA  TEMP1     RECORD ARRAY IDENTIFIER
0889   22416  024020            LDB  .3        OF UNKNOWN DIMENSIONS
0890   22417  060451            JSM  STROP+1
0891   22420  021475            LDA  TEMP2     RETRIEVE FOLLOWING CHARACTER
0892   22421  170402            RET
0893*
0894*  SUBROUTINE TO FIND A NON-FORMULA OPERATOR
0895*
0896   22422  026054  NFOP      LDB  NFOPA     GET NON-FORMULA OPERATOR
                                                          TABLE ADDRESS
0897   22423  005642            ADB  T8
0898   22424  060546            JSM  STEXP     DO TABLE SEARCH
0899   22425  170402            RET            NOT FOUND
0900   22426  060456            JSM  SBPUD
0901   22427  074742            SBR  16
0902   22430  135706            STB  SBPTR,I
0903   22431  070202            SAR  5
0904   22432  050040            AND  .31
0905   22433  064357            JMP  RETN2
0906*
0907*  RECORD I/O HEADING
0908*
0909   22434  160265  IOHD      JSM  IOHEA,I   GET (S.C.,*
0910   22435  060524            JSM  RPCK      RIGHT PAREN?
0911   22436  066440            JMP  *+2       NO
0912   22437  065153            JMP  EOLCK     YES, IF EOL RETURN TO BASIC SYSTEM
0913   22440  062412            JSM  RTBL      CHECK FOR CONVERSION TABLE
0914   22441  060534            JSM  RPCKE     DEMMAND RIGHT BRACKET
0915   22442  065153            JMP  EOLCK     CHECK FOR EOL AND RETURN IF NOT
```

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```
Ø917*
Ø918*  EVALUATE OCT EXPRESSION
Ø919*
Ø92Ø   22443  Ø6Ø445  EOCT   JSM  XFAR2+1
Ø921   22444  Ø74742         SBR  16
Ø922   22445  Ø21754         LDA  AR2        GET EXPONENT
Ø923   22446  Ø7Ø652         SAM  *+13        AND TEST IT
Ø924   22447  ØØØ157  EQC1   ADA  M256
Ø925   22450  Ø31466         STA  LOCL1
Ø926   22451  Ø74117         LDA  B          CHECK FOR POSSIBLE OVERFLOW
Ø927   22452  Ø7Ø6Ø2         SAR  13
Ø928   22453  Ø7255Ø         RZA  *+11
Ø929   22454  171ØØØ         MLS             GET NEXT DIGIT
Ø93Ø   22455  Ø746Ø6         RBR  13
Ø931   22456  Ø7ØØ37         ADB  A          ADD IN NEW DIGIT
Ø932   22457  Ø5ØØ25         AND  .8         TEST FOR LEGAL OCTAL DIGIT
Ø933   2246Ø  Ø72310         RZA  *+6
Ø934   22461  Ø21466         LDA  LOCL1
Ø935   22462  Ø71253         SAP  EOC1
Ø936*
Ø937   22463  Ø7Ø111         SLA  *+2        SKIP IF +
Ø938   22464  Ø74Ø76         TCB
Ø939   22465  164227         JMP  FXFLA,I    DONE
Ø94Ø*
Ø941   22466  164273         JMP  E5-1,I     ERROR
Ø942*
Ø943   22467  Ø6Ø445  STAT   JSM  XFAR2+1
Ø944   2247Ø  Ø63461         JSM  UNNM+1
Ø945   22471  Ø4Ø121         IOR  B4ØØØ
Ø946   22472  172741         STF  1
Ø947   22473  172141         OTA  1
Ø948   22474  172741         STF  1
Ø949   22475  177241         LIB  1,C
Ø95Ø   22476  Ø746Ø4         SBL  4
Ø951   22477  Ø74542         SBR  12
Ø952   225ØØ  164227         JMP  FXFLA,I
Ø953*
Ø954   2251Ø  Ø6Ø445  CHAR   JSM  XFAR2+1
Ø955   2252Ø  Ø63461         JSM  UNNM+1
Ø956   2253Ø  Ø4Ø121         IOR  B4ØØØ
Ø957   2254Ø  Ø63447         JSM  .CHAR
Ø958   2255Ø  Ø74Ø73         SBP  *+1,C
Ø959   2256Ø  Ø743Ø2         SBR  7
Ø96Ø   2257Ø  164227         JMP  FXFLA,I
Ø961*
Ø962   2251Ø  Ø62536  LIN    JSM  .LIN       OUTPUT X LINE FEEDS AND CARRIAGE
                                              RETURN
Ø963   22511  Ø7615Ø         RZB  *+3
Ø964   22512  Ø62546         JSM  .LIN2
Ø965   22513  Ø66533         JMP  .LIN1      IF ARG=Ø, GIVE CARRIAGE RETURN
Ø966   22514  Ø7Ø112         SAM  *+2
Ø967   22515  Ø62546         JSM  .LIN2      IF ARG IS NEGATIVE SKIP CARRIAGE
                                              RETURN
Ø968   22516  Ø2ØØ61         LDA  LNFD
Ø969   22517  162111         JSM  PRCHK,I
Ø97Ø   2252Ø  Ø61353         JSM  TTY
Ø971   22521  Ø55644         DSZ  T1
Ø972   22522  Ø66516         JMP  *-4
```

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```
0973    22523   066533          JMP   .LIN1
0974*
0975    22524   062536  SPA     JSM   .LIN        OUTPUT X SPACES
0976    22525   070312          SAM   .LIN1
0977    22526   162103          JSM   MOUTA,I
0978    22527   066533          JMP   .LIN1
0979*
0980    22530   062536  BIN     JSM   .LIN        OUTPUT THE BINARY CODE FOR X
0981    22531   052053          AND   BIT12
0982    22532   061353          JSM   TTY
0983    22533   020132  .LIN1   LDA   M1
0984    22534   031755          STA   AR2+1
0985    22535   170402          RET
0986*
0987    22536   060445  .LIN    JSM   XFAR2+1
0988    22537   160226          JSM   FLTFA,I
0989    22540   164273          JMP   E5-1,I
0990    22541   074117          LDA   B
0991    22542   074113          SBP   *+2
0992    22543   074076          TCB
0993    22544   035644          STB   T1
0994    22545   170402          RET
0995*
0996    22546   020031  .LIN2   LDA   CRTN
0997    22547   162111          JSM   PRCHK,I
0998    22550   061353          JSM   TTY
0999    22551   070742          SAR   16
1000    22552   031622          STA   TERM
1001    22553   170402          RET
```

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```
1003*
1004*  EXECUTE GET STATEMENT
1005*
1006   22554  062247  EGET    JSM  STBLK    CHECK IF STRING BLOCK IS IN.
1007   22555  045472          ISZ  TEMPS
1008   22556  063460          JSM  UNNM
1009   22557  040121          IOR  B4000
1010   22560  031644          STA  T1
1011   22561  022051          LDA  FMTOP
1012   22562  031640          STA  ST
1013   22563  074742          SBR  16
1014   22564  162117          JSM  PLOTE,I
1015   22565  074742          SBR  16      P+1, NOT FOUND — FREE FIELD INPUT
1016   22566  035662          STB  T9      P+2, FOUND FORMATTED INPUT
1017*
1018   22567  063471          JSM  .CTBL   CHECK FOR CONVERSION TABLE
1019*
1020   22570  022034          LDA  FLOP
1021   22571  031665          STA  FLOOP   INITIALIZE FOR LOOP POINTER
1022*
1023   22572  063073          JSM  RREC      READ AN INPUT RECORD
1024   22573  025662          LDB  T9
1025   22574  076510          RZB  EGE1
1026*
1027*     FREE FIELD INPUT
1028*
1029   22575  062723          JSM  NADD    GET THE VARIABLE
1030   22576  061156  .EGE1    JSM  CONST   FETCH A NUMBER
1031   22577  066603          JMP  *+4     NO NUMBER FOUND, ZERO IT, AND THE
                                                          REMAINING NOS.
1032   22600  060412          JSM  RSULT   NO — STORE IT
1033   22601  066575          JMP  .EGE1-1 LOOP
1034   22602  062723          JSM  NADD
1035   22603  061256          JSM  CLAR2   SET THE REMAINING VARIABLES TO
                                                                ZERO
1036   22604  060412          JSM  RSULT
1037   22605  066602          JMP  *-3     LOOP
1038*
1039*     FORMATTED INPUT
1040*
1041   22606  021456  EGE1    LDA  FORMS
1042   22607  070073          SAP  *+1,C
1043   22610  031456          STA  FORMS
1044   22611  062723  EGE2    JSM  NADD
1045   22612  162106  EGE3    JSM  TYPEC,I GET A FORMAT SPEC.
1046   22613  066631          JMP  ESLH+1  P+1, END OF FORMAT, READ NEXT
                                                  RECORD AND JUMP TO EGE
1047   22614  066623          JMP  E71     P+2, QUOTE FIELD NOT ALLOWED
1048   22615  066642          JMP  EFMT      3 F
1049   22616  066642          JMP  EFMT      4 E
1050   22617  066623          JMP  E71       5 $
1051   22620  066633          JMP  BFMT      6 B
1052   22621  066625          JMP  ESKP      7 X
1053   22622  066630          JMP  ESLH      8 /
1054   22623  160205  E71     JSM  AERRA,I INVALID FORMAT SPECIFICATION
1055   22624  177654          DEC  -84
1056*
```

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```
1Ø58   22625  162114  ESKP    JSM   FSPR,I
1Ø59   22626  Ø63Ø55          JSM   NBYT
1Ø6Ø   22627  Ø66612          JMP   EGE3
1Ø61*
1Ø62   2263Ø  162114  ESLH    JSM   FSPR,I
1Ø63   22631  Ø63Ø73          JSM   RREC      READ A NEW RECORD
1Ø64   22632  Ø66612          JMP   EGE3
1Ø65*
1Ø66   22633  162114  BFMT    JSM   FSPR,I
1Ø67   22634  Ø63Ø55          JSM   NBYT      GET NEXT BYTE
1Ø68   22635  Ø1ØØ61          CPA   LNFD      IF LINE FEED USE ZERO
1Ø69   22636  Ø7Ø742          SAR   16
1Ø7Ø   22637  Ø7Ø137          LDB   A
1Ø71   2264Ø  16Ø227          JSM   FXFLA,I   CONVERT TO F.P.
1Ø72   22641  Ø6667Ø          JMP   EFM3+1
1Ø73*
1Ø74   22642  Ø45466  EFMT    ISZ   LOCL1
1Ø75   22643  121466          LDA   LOCL1,I   GET W SPEC
1Ø76   22644  Ø45466          ISZ   LOCL1
1Ø77   22645  Ø45466          ISZ   LOCL1
1Ø78   22646  Ø7ØØ76          TCA
1Ø79   22647  Ø31647          STA   TW
1ØSØ   2265Ø  125466          LDB   LOCL1,I   GET D SPEC
1Ø81   22651  Ø74Ø17          ADA   B
1Ø82   22652  Ø7ØØ56          CMA
1Ø83   22653  Ø7Ø4Ø4          SAL   8
1Ø84   22654  Ø31651          STA   TD
1Ø85   22655  162114          JSM   FSPR,I
1Ø86   22656  Ø21647          LDA   TW        SET FIELD WIDTH
1Ø87   22657  Ø3165Ø          STA   TX
1Ø88   2266Ø  Ø7Ø742          SAR   16        CLEAR IGNORE-D FLAG
1Ø89   22661  Ø31662          STA   T9
1Ø9Ø   22662  Ø63153          JSM   NMBR      CALL FOR REAL NUMBER
1Ø91   22663  Ø21662          LDA   T9        ANY . OR E?
1Ø92   22664  Ø7215Ø          RZA   EFM3      YES
1Ø93   22665  Ø21651          LDA   TD        NO, ADJUST EXPONENT
1Ø94   22666  Ø31754          STA   AR2
1Ø95   22667  Ø61254  EFM3    JSM   ZONK
1Ø96   2267Ø  Ø6Ø412          JSM   RSULT
1Ø97   22671  Ø66611          JMP   EGE2
1Ø98*
```

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```
1100*
1101   22672  050040  .NADD   AND  B37        FIND NUMERIC OR STRING VARIABLE
1102   22673  010076          CPA  B36        STRING NEXT?
1103   22674  066676          JMP  *+2        YES
1104   22675  164201          JMP  FORMA,I    NO, GET THE VARIABLE 'S ADDRESS
1105   22676  021641          LDA  T5
1106   22677  072110          RZA  *+2
1107   22700  164311          JMP  E15+3,I    STRINGS NOT AVAILABLE
1108   22701  000012          ADA  .1         JSM GADD ON THE STRING BLOCK
1109   22702  070717          JSM  A,I
1110   22703  021400          LDA  BADDR
1111   22704  031645          STA  PTR1       PTR1=CURRENT WORD OF BUFFER
1112   22705  070076          TCA
1113   22706  001623          ADA  PEND
1114   22707  031647          STA  TMPRE      TMPRE=REMAINING LENGTH OF THE
                                               BUFFER
1115   22710  024132          LDB  M1
1116   22711  020017          LDA  .2         JSM PSTR (S.B.), PREPARE DESTINATION
1117   22712  001641          ADA  T5
1118   22713  070717          JSM  A,I
1119   22714  021654          LDA  TNULL
1120   22715  070056          CMA
1121   22716  001400          ADA  BADDR
1122   22717  031400          STA  BADDR
1123   22720  020020          LDA  .3         JSM TRSTR(S.B.), TRANSFER DATA
1124   22721  001641          ADA  T5
1125   22722  070717          JSM  A,I
1126*
1127*       TRANSFER COMPLETE GO GET NEXT VARIABLE
1128*
1129*
1130*  SUBROUTINE TO GET AN ADDRESS
1131*
1132   22723  021472  NADD    LDA  TEMPS
1133   22724  011421          CPA  PRADD      DONE?
1134   22725  067443          JMP  FXIT
1135   22726  121472  NAD1    LDA  TEMPS,I
1136   22727  010121          CPA  B4000      ","?
1137   22730  066742          JMP  PFOR       GO SET UP FOR LOOP
1138   22731  010004          CPA  B10K       RIGHT PAREN.?
1139   22732  066734          JMP  *+2
1140   22733  066672          JMP  .NADD
1141*
1142   22734  021472          LDA  TEMPS      IS IT
1143   22735  070070          SIA  *+1        FOLLOWED BY
1144   22736  070517          LDA  A,I
1145   22737  010126          CPA  LPOP       (LEFT PAREN.?
1146   22740  066742          JMP  PFOR       YES, GO SET FOR LOOP
1147   22741  067003          JMP  TFOR       NO, MUST BE DURING EXCUTION OF
                                               FOR LOOP
1148*
1149   22742  021665  PFOR    LDA  FLOOP
1150   22743  000022          ADA  .5         BUMP FOR LOOP POINTER
1151   22744  031665          STA  FLOOP
1152   22745  021472          LDA  TEMPS
1153   22746  000020          ADA  .3
1154   22747  031472          STA  TEMPS      MOVE TEMPS PASS "FOR"
1155   22750  160201          JSM  FORMA,I    EVALUATE STARTING VALUE
```

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```
1156   22751  021413          LDA  HSTPT
1157   22752  000133          ADA  M2
1158   22753  025665          LDB  FLOOP
1159   22754  170004          XFR                 MOVE THE VARIABLE NAME AND
                                                                ADDRESS TO
1160   22755  004132          ADB  M1             THE LOOP BLOCK
1161   22756  035663          STB  .FLP           SET .FLP TO FLOOP+2
1162   22757  045472          ISZ  TEMPS          "TO"
1163   22760  061217          JSM  FETCH          EVALUATE FINAL VALUE
1164   22761  160225          JSM  FLTRA,I
1165   22762  164273          JMP  E5-1,I
1166   22763  074076          TCB
1167   22764  135663          STB  .FLP,I         SAVE "FINAL"
1168   22765  045663          ISZ  .FLP
1169   22766  024012          LDB  .1
1170   22767  121472          LDA  TEMPS,I
1171   22770  002050          ADA  STEC
1172   22771  072250          RZA  *+5            ANY STEP ?
1173   22772  045472          ISZ  TEMPS          YES, MOVE PASS "STEP"
1174   22773  061217          JSM  FETCH
1175   22774  160225          JSM  FLTRA,I
1176   22775  164273          JMP  E5-1,I
1177   22776  135663          STB  .FLP,I         SAVE STEP
1178   22777  045663          ISZ  .FLP
1179   23000  025472          LDB  TEMPS
1180   23001  135663          STB  .FLP,I         SAVE THE ADDRESS AFTER FOR LOOP
                                                                INFORMATION
1181   23002  066726          JMP  NAD1
1182*
1183*
1184   23003  025665   TFOR   LDB  FLOOP
1185   23004  074070          SIB  *+1
1186   23005  061372          JSM  FIX+1
1187   23006  031660          STA  T6
1188   23007  010025          CPA  .8             WAS IT AN INTEGER?
1189   23010  067015          JMP  *+5            YES
1190   23011  162113          JSM  OPCH1,I
1191   23012  074117          LDA  B
1192   23013  060445          JSM  XFAR2+1
1193   23014  160225          JSM  FLTRA,I
1194   23015  074537          LDB  B,I             FOR VARIABLE IN (B), NO OVERFLOW
1195   23016  021665          LDA  FLOOP
1196   23017  000020          ADA  .3
1197   23020  070437          ADB  A,I             ADD THE STEP SIZE TO B
1198   23021  021660          LDA  T6
1199   23022  002036          ADA  M8
1200   23023  072210          RZA  *+4            IF NOT AN INTEGER SKIP 4
1201   23024  121665          LDA  FLOOP,I        YES IT WAS AN INTEGER
1202   23025  070577          STB  A,I
1203   23026  067036          JMP  .TFOR
1204   23027  035660          STB  T6
1205   23030  160227          JSM  FXFLA,I
1206   23031  025665          LDB  FLOOP
1207   23032  074070          SIB  *+1
1208   23033  061372          JSM  FIX+1
1209   23034  060416          JSM  STORE
1210   23035  025660          LDB  T6
1211   23036  021665   .TFOR  LDA  FLOOP
```

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```
1212   23037  000017          ADA  .2
1213   23040  070437          ADB  A,I        CHECK IF AT FINAL VALUE
1214   23041  074110          SZB  *+2
1215   23042  074313          SBP  *+6
1216   23043  021665          LDA  FLOOP      NO
1217   23044  000021          ADA  .4
1218   23045  070517          LDA  A,I
1219   23046  031472          STA  TEMPS
1220   23047  066726          JMP  NAD1
1221*
1222   23050  045472          ISZ  TEMPS
1223   23051  021665          LDA  FLOOP
1224   23052  000136          ADA  M5
1225   23053  031665          STA  FLOOP      DONE WITH LOOP BUMP TEMPS, AND
                                                          LOOP POINTER
1226   23054  066723          JMP  NADD
1227*
```

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```
1229*
1230*  SUBROUTINE #1 TO GET A BYTE
1231*
1232   23055  061040  NBYT    JSM  GETCH-1    GET A CHARACTER
1233   23056  010061          CPA  LNFD
1234   23057  155466          DSZ  LOCL1,I
1235   23060  170402          RET
1236*
1237*  SUBROUTINE #2 TO GET A BYTE
1238*
1239   23061  021650  NBYB    LDA  TX           CHECK FIELD WIDTH COUNTER
1240   23062  072170          RIA  *+3
1241   23063  020061          LDA  LNFD         RETURN LINEFEED IF AT END
1242   23064  170402          RET
1243*
1244   23065  031650          STA  TX
1245   23066  063055          JSM  NBYT         GET CHARACTER
1246   23067  010041          CPA  .32
1247   23070  067061          JMP  NBYB         IGNORE BLANKS
1248   23071  170402          RET
```

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```
1250  23072  164271  MEOV   JMP  E1+1,I     MEMORY OVERFLOW
1251*
1252* SUBROUTINE TO READ ONE ASCII RECORD INTO BUFFER
1253*
1254  23073  021412  RREC   LDA  LSTPT
1255  23074  000061         ADA  .10         ALLOW 10 WORDS IN LOW-STACK FOR
                                                                    FORMT
1256  23075  070744         SAL  1
1257  23076  031400         STA  BADDR
1258  23077  031706         STA  SBPTR
1259  23100  002046         ADA  .80
1260  23101  031623         STA  PEND
1261  23102  070002         SAR  1
1262  23103  070076         TCA
1263  23104  001413         ADA  HSTPT
1264  23105  071252         SAM  MEOV
1265*
1266  23106  020141         LDA  M10         SET FOR 10 BLANKS
1267  23107  031466         STA  LOCL1        THE CARD READER ONLY GIVES 10
1268  23110  063321         JSM  INPT
1269  23111  072310         RZA  RRE1+1      SKIP IF NOT A BLANK
1270  23112  045466         ISZ  LOCL1
1271  23113  067110         JMP  *-3
1272*
1273  23114  160205         JSM  AERRA,I     ERROR 83 — END OF TAPE
1274  23115  177655         DEC  -83
1275*
1276*
1277  23116  063321  RRE1   JSM  INPT          CALL FOR INPUT
1278  23117  010061         CPA  LNFD          IS IT LINEFEED?
1279  23120  067131         JMP  BFND          YES STORE IN BUFFER AND RETURN
1280  23121  012041         CPA  AROW          IS IT LEFT-ARROW?
1281  23122  067142         JMP  BKUP          YES, BACK UP
1282  23123  012042         CPA  ALTM          IS IT ALT MODE?
1283  23124  067147         JMP  SKND          YES, RE-READ RECORD
1284  23125  012043         CPA  ESCM          IS IT ESC MODE?
1285  23126  067147         JMP  SKND          YES, RE-READ RECORD
1286  23127  061016         JSM  ONEXT         NO, STORE IN BUFFER
1287  23130  067116         JMP  RRE1
1288*
1289  23131  045623  BFND   ISZ  PEND          MOVE END POINTER
1290  23132  020031         LDA  EOL
1291  23133  061016         JSM  ONEXT
1292  23134  021400         LDA  BADDR
1293  23135  000132         ADA  M1          SET PEND TO THE EOL CHAR.
1294  23136  031623         STA  PEND
1295  23137  021706         LDA  SBPTR
1296  23140  031400         STA  BADDR
1297  23141  170402         RET
1298*
1299  23142  021400  BKUP   LDA  BADDR
1300  23143  011706         CPA  SBPTR
1301  23144  067116         JMP  RRE1          DON'T GO BEYOND START OF BUFFER
1302  23145  055400         DSZ  BADDR       BACK UP
1303  23146  067116         JMP  RRE1
1304*
1305  23147  063321  SKND   JSM  INPT          SKIP TO END OF RECORD
```

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```
1306    23150  010061          CPA  LNFD
1307    23151  067073          JMP  RREC     RE-READ
1308    23152  067147          JMP  *-3
1309*
```

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```
1311*
1312*  SUBROUTINE TO BUILD A NUMBER IN AR2
1313*
1314   23153  061256  NMBR   JSM  CLAR2     SET AR2 = 0.
1315   23154  022040         LDA  AMF
1316   23155  170000         CLR            CLEAR WORK AREA
1317   23156  020132         LDA  M1
1318   23157  031660         STA  T6        M = -1
1319   23160  020030         LDA  .12
1320   23161  031661         STA  T7        N = 12
1321*
1322   23162  063061         JSM  NBYB      GET FIRST CHARACTER
1323   23163  024132         LDB  M1
1324   23164  010050         CPA  ASCM      IS IT -?
1325   23165  074742         SBR  16        YES
1326   23166  035712         STB  .SIGN
1327   23167  010050         CPA  ASCM      BYPASS-OR+
1328   23170  067172         JMP  *+2
1329   23171  010047         CPA  ASCP
1330*
1331   23172  063061  NMB1   JSM  NBYB      GET NEXT CHARACTER
1332   23173  060750         JSM  DIGCK     IS IT A DIGIT?
1333   23174  067222         JMP  NMB3      NO
1334   23175  045652         ISZ  MF        YES
1335   23176  076350         RZB  NMB2      IS IT ZERO?
1336   23177  021653         LDA  SD        YES, ANY SIGNIFICANT DIGITS YET?
1337   23200  072310         RZA  NMB2+1     YES
1338   23201  021654         LDA  DP        NO, ANY DECIMAL POINT YET?
1339   23202  071410         SZA  NMB1      NO, IGNORE THIS ZERO
1340   23203  055660         DSZ  T6        YES, M=M-1
1341   23204  067172         JMP  NMB1
1342*
1343   23205  045653  NMB2   ISZ  SD        SIGNIFICANT DIGIT (1—9)
1344   23206  021654         LDA  DP
1345   23207  072150         RZA  *+3       IS DP=0?
1346   23210  045660         ISZ  T6        YES, M=M+1
1347   23211  067212         JMP  *+1       (NOP)
1348   23212  021661         LDA  T7        IS N=0?
1349   23213  070310         SZA  *+6       YES, IGNORE REMAINING DIGITS
1350   23214  055661         DSZ  T7        NO, N=N-1
1351   23215  067216         JMP  *+1       (NOP)
1352   23216  171400         MLS
1353   23217  005757         ADB  AR2+3     INCLUDE DIGIT IN AR2
1354   23220  035757         STB  AR2+3
1355   23221  067172         JMP  NMB1
1356*
1357   23222  010051  NMB3   CPA  ASC.      DECIMAL POINT?
1358   23223  067251         JMP  NMB5      YES
1359   23224  012044         CPA  ASCE      EEX?
1360   23225  067256         JMP  NMB6      YES
1361   23226  021652         LDA  MF        NO, IS MF=0?
1362   23227  072150         RZA  *+3       IF MF IS ZERO,AND THERE WAS A (-)
                                                    SIGN — ERROR
1363   23230  025712         LDB  .SIGN
1364   23231  074710         SZB  E73
1365   23232  021660         LDA  T6        NO, TEST FOR EXPONENT OVERFLOW
1366   23233  070137  NMB4   LDB  A
```

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```
1367  23234  074113          SBP  *+2
1368  23235  074076          TCB
1369  23236  004156          ADB  M100
1370  23237  074413          SBP  E73        OVERFLOW. ERROR
1371  23240  171450          NRM
1372  23241  070254          SES  *+5        SKIP IF ZERO MANTISSA
1373  23242  070404          SAL  8
1374  23243  045712          ISZ  .SIGN      TEST MANTISSA SIGN (-1=*)
1375  23244  070070          SIA  *+1
1376  23245  031754          STA  AR2
1377  23246  170402          RET
1378*
1379  23247  160205  E73     JSM  AERRA,I    NUMBER SYNTAX ERROR
1380  23250  177652          DEC  -86
1381  23251  031662  NMB5    STA  T9         SET IGNORE—D FLAG
1382  23252  021654          LDA  DP         TEST DP FLAG
1383  23253  073610          RZA  E73        SET ALREADY, ERROR
1384  23254  045654          ISZ  DP
1385  23255  067172          JMP  NMB1
1386*
1387  23256  031662  NMB6    STA  T9         SET IGNORE—D FLAG
1388  23257  021652          LDA  MF
1389  23260  072250          RZA  *+5        MANTISSA DIGITS ENTERED
1390  23261  021654          LDA  DP         ANY DECIMAL POINT?
1391  23262  073250          RZA  E73        YES, BUT NO MANTISSA DIGITS,
                                                                    ERROR
1392  23263  020020          LDA  ONE        NO, SET AR2=1.
1393  23264  060445          JSM  XFAR2+1
1394  23265  063061          JSM  NBYB       GET NEXT CHARACTER
1395  23266  024132          LDB  M1
1396  23267  010050          CPA  ASCM       IS IT -?
1397  23270  074742          SBR  16         YES
1398  23271  035654          STB  DP         USE DP FOR EXPONENT SIGN
1399  23272  010050          CPA  ASCM       BYPASS - OR +
1400  23273  067275          JMP  *+2
1401  23274  010047          CPA  ASCP
1402  23275  063061          JSM  NBYB       GET NEXT CHARACTER
1403  23276  060750          JSM  DIGCK      DIGIT?
1404  23277  067247          JMP  E73        NO, ERROR
1405  23300  035655  NMB7    STB  EX         YES
1406  23301  063061          JSM  NBYB       GET NEXT CHARACTER
1407  23302  060750          JSM  DIGCK      DIGIT?
1408  23303  067313          JMP  NMB8       NO
1409  23304  021655          LDA  EX         YES
1410  23305  070744          SAL  1
1411  23306  031466          STA  LOCL1
1412  23307  070704          SAL  2
1413  23310  001466          ADA  LOCL1
1414  23311  070037          ADB  A
1415  23312  067300          JMP  NMB7
1416*
1417  23313  021655  NMB8    LDA  EX
1418  23314  025654          LDB  DP
1419  23315  076110          RZB  *+2        ADJUST EXPONENT SIGN
1420  23316  070076          TCA
1421  23317  001660          ADA  T6
1422  23320  067233          JMP  NMB4
```

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```
1424*
1425*  INPUT DRIVER
1426*
1427*  T1 HAS SELECT CODE
1428*
1429   23321  021644  INPT    LDA  T1
1430   23322  063447          JSM  .CHAR      GET A CHAR IN B
1431   23323  074117          LDA  B
1432   23324  070073          SAP  *+1,C
1433   23325  070302          SAR  7            MASK DATA
1434   23326  025642          LDB  T8           CONVERSION NEEDED?
1435   23327  070510          SZA  RET1      IF(A)=0, DON'T CONVERT
1436   23330  074310          SZB  *+6       IF(B) IS 0, SKIP CONVERSION
1437   23331  000132          ADA  M1
1438   23332  070037          ADB  A            YES, TREAT INPUT CODE AS
                                                                ADDRESS
1439   23333  074517          LDA  B,I
1440   23334  070113          SAP  *+2
1441   23335  067505          JMP  E79
1442   23336  050104          AND  B177
1443   23337  010031          CPA  CRTN
1444   23340  067321          JMP  INPT         IGNORE CARRIAGE RETURNS
1445   23341  170402  RET1    RET            RETURN DATA IN A—REGISTER
1446*
1447*  OUTPUT DRIVER
1448*
1449*  T2 HAS SELECT CODE
1450*
1451*  LDA DATA
1452*  JSM OTPT
1453*
1454   23342  031466  OTPT    STA  LOCL1
1455   23343  021656          LDA  T2
1456   23344  063431          JSM  IOST         CHECK I/O STATUS
1457   23345  041466          IOR  LOCL1     GET DATA
1458   23346  065356          JMP  TTY+3      STF 1, OTA 1, STC 1, AND RETURN
1459*
1460   23347  000143  LINEF   DEF  .10+.10+1
1461   23350  000063  CARRF   DEF  CRTN+CRTN+1
1462*
1463   23351  027350  .CRLF   LDB  CARRF       CARRIAGE RETURN
1464   23352  063354          JSM  *+2
1465   23353  027347          LDB  LINEF        LINE FEED
1466   23354  020012          LDA  .1
1467   23355  067374          JMP  .OUTP
1468*
1469   23356  025642  .OUT.   LDB  T8
1470   23357  074510          SZB  OUT1
1471   23360  074457          CPA  B,I
1472   23361  067365          JMP  *+4
1473   23362  015643          CPB  TBEND
1474   23363  170402          RET            IF NO MATCH FOUND — ASSUME A
                                                          NULL CHARACTER
1475   23364  077630          RIB  *-4
1476   23365  021642          LDA  T8
1477   23366  070076          TCA
1478   23367  074017          ADA  8
1479   23370  070070          SIA  *+1
```

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```
1480   23371  065353  OUT1    JMP  TTY
1481*
1482   23372  025706          LDB  SBPTR
1483   23373  060374          JSM  WBUFF
1484   23374  031741  .OUTP   STA  XC+1
1485   23375  035740          STB  XC
1486   23376  025641          LDB  T5
1487   23377  076350          RXB  XFTOS      ANY INTERNAL CONVERSION
1488   23400  070250          SZA  *+5
1489   23401  061053          JSM  GTMP
1490   23402  063356  .OUTT   JSM  .OUT.      NO — OUTPUT THE DATA TO THE
                                               DEVICE
1491   23403  055741          DSZ  XC+1
1492   23404  067401          JMP  *-3
1493   23405  170402          RET
1494*
1495   23406  031647  XFTOS   STA  TMPRE
1496   23407  025740          LDB  XC
1497   23410  035645          STB  PTR1       PLACE THE COUNT AND ADDRESS IN
                                               TMPRE, PTR1
1498   23411  022034          LDA  FLOP
1499   23412  025412          LDB  LSTPT      TRANSFER THE SUBSCRIPTS TO THE
                                               LSTPT
1500   23413  074070          SIB  *+1
1501   23414  170004          XFR
1502   23415  004132          ADB  M1
1503   23416  035412          STB  LSTPT      BUMP THE LOW STACK POINTER
1504   23417  021647          LDA  TMPRE
1505   23420  001662          ADA  T9
1506   23421  031662          STA  T9
1507   23422  021641          LDA  T5
1508   23423  000017          ADA  .2          JSM PSTR
1509   23424  024132          LDB  M1
1510   23425  070717          JSM  A,I        PREPARE THE DESTINATION
1511   23426  021641          LDA  T5
1512   23427  000020          ADA  .3          JSM TRSTR, TRANSFER DATA
1513   23430  070737          JMP  A,I
```

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```
1515*
1516*  CHECK I/O STATUS
1517*
1518*  LDA SELECT CODE (SAVED)
1519*  JSM IOST
1520*
1521  23431  025442  IOST   LDB  STPFL     CHECK STOP FLAG
1522  23432  014040         CPB  .31
1523  23433  067443         JMP  FXIT
1524  23434  172741         STF  1         TURN OFF INTERRUPT SYSTEM
1525  23435  172141         OTA  1         OUTPUT SELECT CODE
1526  23436  172741         STF  1         LOAD DEVICE STATUS
1527  23437  177241         LIB  1,C         AND TURN ON INTERRUPT
1528  23440  074406         RBR  9
1529  23441  075413         SBP  IOST      LOOP IF BUSY
1530  23442  170402         RET
1531*
1532*  EXIT ROUTINE
1533*
1534  23443  070742  FXIT   SAR  16
1535  23444  031455         STA  FORMT
1536  23445  160170         JSM  CLERA,I
1537  23446  164172         JMP  XEC4A,I
1538*
1539  23447  012037  .CHAR   CPA  SC13      SELECT CODE 13 ?
1540  23450  067452         JMP  *+2       YES, SKIP
1541  23451  063456         JSM  CEO-1     NO, SET CONTROL FIRST
1542  23452  063431         JSM  IOST      GET A BYTE
1543  23453  012037         CPA  SC13      SELECT CODE 13 ?
1544  23454  065356         JMP  TTY+3     YES, SET CONTROL AFTER
1545  23455  170402         RET
1546*
1547  23456  063431         JSM  IOST
1548  23457  065356  CEO    JMP  TTY+3     SET CONTROL
```

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```
1550*
1551*  SAVE STACK POINTERS
1552*  EVALUATE AND CHECK UNIT #
1553*
1554   23460  061217  UNNM   JSM   FETCH
1555   23461  160225         JSM   FLTRA,I
1556   23462  164342         JMP   E40+3,I
1557   23463  074117         LDA   B
1558   23464  075710         SZB   *-2          ERROR, ZERO SELECT CODE
1559   23465  074142         SBR   4
1560   23466  077610         RZB   *-4          ERROR, SELECT CODE >15 OR <0
1561   23467  070146         RAR   4
1562   23470  170402         RET
1563*
1564*  GET OPTIONAL CONVERSION TABLE
1565*
1566   23471  121472  .CTBL  LDA   TEMPS,I
1567   23472  050065         AND   OPMSK
1568   23473  010004         CPA   RPOP         ANY CONVERSION TABLE
1569   23474  067514         JMP   CTB1         NO, STORE ZERO
1570   23475  121472         LDA   TEMPS,I      YES, GET ARRAY NAME
1571   23476  050115         AND   B1777
1572   23477  160177         JSM   SSYMA,I      SEARCH TABLE
1573   23500  067505         JMP   E79          ERROR, NOT FOUND
1574   23501  074517         LDA   B,I          GET TYPE INFORMATION
1575   23502  050037         AND   .28
1576   23503  010025         CPA   .8           INTEGER?
1577   23504  067507         JMP   *+3
1578*
1579   23505  160205  E79    JSM   AERRA,I      NO SUCH TABLE OR UNSUITABLE
                                                                    TABLE
1580   23506  177651         DEC   -87
1581*
1582   23507  004132         ADB   M1
1583   23510  074517         LDA   B,I          GET BASE ADDRESS OF TABLE
1584   23511  063515         JSM   CTB1+1       GO COMPUTE LAST ADDRESS
1585   23512  045472         ISZ   TEMPS
1586   23513  170402         RET
1587*
1588   23514  070742  CTB1   SAR   16
1589   23515  031642         STA   T8
1590   23516  071650         SZA   CTB1-1       RETURN IF NOT CONVERSION
1591   23517  000132         ADA   M1
1592   23520  070517         LDA   A,I
1593   23521  070137         LDB   A            GET ROW AND COLUMN IMFORMATION
1594   23522  074342         SBR   8
1595   23523  074070         SIB   *+1          (B) = # OF ROW
1596   23524  050105         AND   B377
1597   23525  070070         SIA   *+1          (A) = # OF COLUMNS
1598   23526  061201         JSM   IMPY
1599   23527  001642         ADA   T8
1600   23530  031643         STA   TBEND        SAVE THE END OF TABLE ADDRESS
1601   23531  170402         RET
```

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```
1603*
1604*     PREPARE FOR INTERNAL CONVERSION
1605*
1606   23532  072110  INTCV   RZA   *+2
1607   23533  164311          JMP   E15+3,I   STRING BLOCK NOT AVAILABE
1608   23534  000012          ADA   .1
1609   23535  070717          JSM   A,I       JSM GADD , PROCESS POINTERS TO
                                                          DESTINATIONS
1610   23536  021412          LDA   LSTPT     GADD SET'S UP STRING POINTERS ON
                                                          LOW STACK.
1611   23537  000133          ADA   M2        THEY MUST BE SAVED.
1612   23540  026034          LDB   FLOP
1613   23541  170004          XFR
1614   23542  000135          ADA   M4
1615   23543  031412          STA   LSTPT
1616   23544  022051          LDA   FMTOP
1617   23545  031640          STA   ST
1618   23546  074742          SBR   16
1619   23547  162117          JSM   PLOTE,I   LOOK FOR A FORMAT STATEMENT
1620   23550  067722          JMP   EWRI1-1   P+1, NOT FOUND, USE PRINT EXECUTION
1621   23551  067567          JMP   .EOUT+1   P+2, FOUND
1622*
1623*       OUTPUT STATEMENT EXECUTION
1624*
1625   23552  062247  EOUT    JSM   STBLK     LOOK FOR THE STRING BLOCK
1626   23553  045472          ISZ   TEMPS
1627   23554  125472          LDB   TEMPS,I
1628   23555  074244          SBL   11
1629   23556  074542          SBR   12
1630   23557  014032          CPB   .15       STRING ARRAY ROOM?
1631   23560  067532          JMP   INTCV     YES
1632   23561  055472          DSZ   TEMPS     NO
1633   23562  074742          SBR   16
1634   23563  035641          STB   T5
1635   23564  022051          LDA   FMTOP
1636   23565  162105          JSM   SFMT,I    SET UP DEVICE AND FORMAT CODES
1637   23566  067722  .EOUT   JMP   EWRI1-1   NO FORMAT SPECIFIED
1638   23567  063471          JSM   .CTBL     CHECK CONVERSION TABLE
1639   23570  162112          JSM   CKEOL,I   NULL LIST?
1640   23571  000103  BLNKA   DEF   .32+.32+1 IMPOSSIBLE STATE — WORD USED AS A
                                                          CONSTANT
1641   23572  035472          STB   TEMPS     YES, SET TEMPS=PRADD
1642   23573  162106  WRIT2   JSM   TYPEC,I   GET NEXT FORMAT SPEC
1643   23574  067606          JMP   WRITN     END OF FORMAT
1644   23575  067615          JMP   WRITQ     QUOTE FIELD
1645   23576  074742          SBR   16        SET FLAG FOR FIXED
1646   23577  060563          JSM   SLWST     STACK FLAG: 0=F, +=E, -=B
1647   23600  067617          JMP   WRITF     (CODE 5 IS NOT USED)
1648   23601  077713          SBP   *-2,S     SET B FLAG
1649   23602  067612          JMP   WRITX     X;
1650*    END OF FORMAT STATEMENT
1651   23603  162114          JSM   FSPR,I    /; UPDATE FORMAT POINTER
1652   23604  063351  WRITS   JSM   .CRLF
1653   23605  067573          JMP   WRIT2
1654   23606  075713  WRITN   SBP   WRITS     ANY NUMERIC SPEC FOUND?
1655   23607  074742          SBR   16
1656   23610  035455          STB   FORMT     CLEAR FORMAT NESTING FLAG
1657   23611  067723          JMP   EWRI1     NO, GOTO STANDARD FORMAT
1658*    X FIELD
```

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```
1659   23612  162114  WRITX  JSM  FSPR,I     UPDATE FORMAT POINTER
1660   23613  020012         LDA  .1
1661   23614  027571         LDB  BLNKA
1662*    QUOTE FIELD
1663   23615  063374  WRITQ  JSM  .OUTP      OUTPUT TO DEVICE
1664   23616  067573         JMP  WRIT2
1665*
1666*    OUTPUT F,E, OR B FIELD
1667   23617  025466  WRITF  LDB  LOCL1
1668   23620  060563         JSM  SLWST      STACK FORMAT STMT POINTER
1669   23621  162112  WRIT4  JSM  CKEOL,I    END OF WRITE STMT?
1670   23622  074742         SBR  16         YES, CRLF NOT SUPRESSED
1671   23623  067715         JMP  WRIT8-2    YES
1672   23624  162107         JSM  QTCHK,I    QUOTE NEXT IN WRITE
1673   23625  067630         JMP  WRIT5      NO
1674   23626  063374         JSM  .OUTP      YES, OUTPUT IT
1675   23627  067621         JMP  WRIT4
1676*
1677   23630  162110  WRIT5  JSM  PFORM,I    SAVE FLAGS AND
1678   23631  061220         JSM  FETCH+1      EVALUATE FORMULA
1679   23632  060567         JSM  UNSTK      RECALL FORMAT STMT POINTER
1680   23633  031466         STA  LOCL1
1681   23634  060567         JSM  UNSTK      RECALL E,F, OR B FLAG
1682   23635  031705         STA  FLOAT
1683   23636  070252         SAM  WRITB      SKIP IF B
1684   23637  045466         ISZ  LOCL1
1685   23640  121466         LDA  LOCL1,I    GET FIELD WIDTH SPEC
1686   23641  045466         ISZ  LOCL1
1687   23642  045466         ISZ  LOCL1
1688   23643  025456  WRITB  LDB  FORMS
1689   23644  074073         SBP  *+1,C
1690   23645  035456         STB  FORMS      SET NUMERIC SPEC FOUND FLAG
1691   23646  125466         LDB  LOCL1,I    GET DECIMAL SPEC
1692   23647  162114         JSM  FSPR,I     UPDATE FORMAT POINTERS
1693   23650  031704         STA  WIDTH
1694   23651  070353         SAP  WRIT7      SKIP IF E OR F
1695*    OUTPUT B FIELD CHARACTER
1696   23652  160225         JSM  FLTRA,I    CONVERT TO ROUNDED INTEGER
1697   23653  074742         SBR  16         OVERFLOW: USE 0
1698   23654  074117         LDA  B
1699   23655  052053         AND  BIT12      MASKTHE LOWER 12 BITS
1700   23656  061353         JSM  TTY        OUTPUT SINGLE CHAR
1701   23657  067711         JMP  WRIT6
1702*    OUTPUT E OR F NUMBER
1703   23660  035703  WRIT7  STB  PLACE
1704   23661  021412         LDA  LSTPT      START TEMP BUFFER
1705   23662  000061         ADA  .10
1706   23663  070070         SIA  *+1
1707   23664  070744         SAL  1
1708   23665  031400         STA  BADDR        ABOVE LOW STACK
1709   23666  031706         STA  SBPTR
1710   23667  021413         LDA  HSTPT
1711   23670  070744         SAL  1
1712   23671  031623         STA  PEND       SET END OF BUFFER AT H-STACK
1713   23672  021416         LDA  MODE
1714   23673  031641         STA  ST+1
```

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```
1715   23674  070742          SAR  16
1716   23675  031416          STA  MODE     SET FOR PROGRAM FORMAT
1717   23676  024215          LDB  TMPOP
1718   23677  060406          JSM  XFAR1+1
1719   23700  160234          JSM  NMOTA,I  OUTPUT A NUMBER TO THE BUFFER
1720   23701  021641          LDA  ST+1
1721   23702  031416          STA  MODE
1722   23703  021400          LDA  BADDR
1723   23704  011623          CPA  PEND     OVERFLOW?
1724   23705  064561          JMP  MER8
1725   23706  063372          JSM  .OUTP-2  COMPUTE LENGTH AND OUTPUT THE
                                             BUFFER
1726   23707  025625          LDB  FIRST
1727   23710  043500          STB  BADDR    RESET BADDR
1728   23711  162112  WRIT6   JSM  CKEOL,I   END OF STMT?
1729   23712  074742          SBR  16       YES, CRLF NOT SUPRESSED
1730   23713  067717          JMP  WRIT8    YES
1731   23714  067573          JMP  WRIT2    NO
1732*    END OF WRITE STMT
1733   23715  055412          DSZ  LSTPT
1734   23716  055412          DSZ  LSTPT    UNSTACK FLAGS
1735   23717  070742  WRIT8   SAR  16
1736   23720  031455          STA  FORMT    SET FORMAT COMPLETE FLAG
1737   23721  067747          JMP  PR2+1
1738*
1739   23722  063471          JSM  .CTBL
1740   23723  025416  EWRI1   LDB  MODE
1741   23724  076150          RZB  *+3
1742   23725  021622          LDA  TERM
1743   23726  072150          RZA  *+3
1744   23727  160170          JSM  CLERA,I
1745   23730  162112          JSM  CKEOL,I
1746   23731  067745          JMP  PR2-1
1747   23732  067745          JMP  PR2-1
1748   23733  162104  PR3     JSM  PRINN,I
1749   23734  067746          JMP  PR2
1750   23735  021625          LDA  FIRST
1751   23736  070076          TCA
1752   23737  001400          ADA  BADDR
1753   23740  025625          LDB  FIRST
1754   23741  063374          JSM  .OUTP
1755   23742  021400          LDA  BADDR
1756   23743  031625          STA  FIRST
1757   23744  067733          JMP  PR3
1758*
1759   23745  074742          SBR  16
1760   23746  035622  PR2     STB  TERM
1761   23747  076150          RZB  PRI7
1762   23750  162111          JSM  PRCHK,I
1763   23751  063351          JSM  .CRLF
1764   23752  164172  PRI7    JMP  XEC4A,I
1765*
1766*
1767*
1768   23767                  ORG  23767B
1769   23767  177563          ABS  EOUT-*
1770   23770  176564          ABS  EGET-*   GET EXECUTION
```

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```
1771    23771   176314          ABS  CMD-*      ASCII BUSS EXECUTION
1772    23772   000000          BSS  1            ** CHECKSUM WORD******
1773*
1774    23773   176022          ABS  NFOPT-*       NON-FORMULA OPERATOR TABLE
1775    23774   176061          ABS  FUNNT-*       FUNCTION-NAME TABLE
1776    23775   176017          ABS  NULL-*     COMMAND-NAME TABLE (NULL)
1777    23776   176006          ABS  SYSNT-*       STATEMENT-NAME TABLE
1778    23777   026000  PAGE    OCT  26000
1779*
1780                    END
*  NO ERRORS*
```

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.1	0020	1108	1169	1466	1608	1660	
.10	0071	0072	1255	1460	1460	1705	
.100	0070						
.1000	0069						
.11	0035	0043					
.12	0036	1319					
.13	0039						
.15	0048	0083	1630				
.16	0049	0084	0671				
.17	0610	0684					
.18	0555	0690					
.1E4	0068						
.2	0027	1116	1212	1508			
.21	0050						
.22	0051	0087					
.23	0052	0088					
.28	0053	1575					
.3	0028	0045	0889	1123	1153	1196	1512
.31	0054	0090	0904	1522			
.32	0055	1246	1640	1640			
.33	0056						
.34	0057	0091					
.37	0058						
.4	0029	1217					
.40	0059						
.41	0060						
.43	0061	0552					
.45	0062	0553					
.46	0063	0551					
.48	0064						
.5	0030	1150					
.58	0065	0094					
.6	0031	0044					
.63	0066						
.7	0032						
.8	0033	0932	1188	1576			
.80	0606	1259					
.9	0034						
.99	0074						
.BADR	0550						
.BUFA	0180						
.CHAR	1539	0957	1430				
.CRLF	1463	1652	1763				
.CTBL	1566	1018	1638	1739			
.EGE1	1030	1033					
.EOUT	1637	1621					
.FADA	0185						
.FDVA	0188						
.FLOP	0547	0596					
.FLP	0534	1161	1167	1168	1177	1178	1180
.FMPA	0187						
.FSBA	0186						
.FSR	0190						
.LIN	0987	0962	0975	0980			
.LIN1	0983	0965	0973	0976	0978		

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M9	Ø13Ø						
MASK1	Ø153						
MASK5	Ø154						
MAW	Ø294	Ø766	Ø767				
MAXIN	Ø4ØØ						
MAXSN	Ø147						
MBIN1	Ø4Ø6						
MBIN2	Ø4Ø7						
MBOX1	Ø351						
MDIMA	Ø2Ø8						
MEOV	125Ø	1264					
MER8	Ø445	1724					
MF	Ø524	Ø6ØØ	1334	1361	1388		
MINIT	Ø455						
MODE	Ø3Ø5	Ø849	1713	1716	1721	174Ø	
MOUTA	Ø638	Ø977					
MSFLG	Ø389						
MVTOH	Ø477						
NAD1	1135	1181	122Ø				
NADD	1132	1Ø29	1Ø34	1Ø44	1226		
NBYB	1239	1247	1322	1331	1394	14Ø2	14Ø6
NBYT	1232	1Ø59	1Ø67	1245			
NDISP	Ø382						
NDWRT	Ø5ØØ						
NESC	Ø7Ø8	Ø7Ø3					
NEXT1	Ø45Ø						
NEXTA	Ø467						
NEXTL	Ø449						
NFOP	Ø896	Ø669	Ø682	Ø688			
NFOPA	Ø612	Ø896					
NFOPT	Ø578	Ø612	Ø612	1774			
NMB1	1331	1339	1341	1355	1385		
NMB2	1343	1335	1337				
NMB3	1357	1333					
NMB4	1366	1422					
NMB5	1381	1358					
NMB6	1387	136Ø					
NMB7	14Ø5	1415					
NMB8	1417	14Ø8					
NMBR	1314	1Ø9Ø					
NMOTA	Ø2ØØ	1719					
NOEOF	Ø482						
NPRIN	Ø383						
NPWRT	Ø499						
NULL	Ø575	1776					
NUM	Ø396	Ø397	Ø657				
NUMCA	Ø211						
NUMOA	Ø212						
NXTDT	Ø3Ø4						
NXTST	Ø4Ø5						
OBLNK	Ø468						
ODGIT	Ø496						
OF	Ø493						
ONE	ØØ45	1392					
ONEXT	Ø469	1286	1291				
OPCH1	Ø646	119Ø					

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OPCHA	Ø171						
OPDMK	ØØ79						
OPMSK	ØØ76	Ø658	1567				
OPTYP	Ø397						
OTPT	1454	Ø8ØØ	Ø8Ø5				
OTPTR	Ø293						
OUT1	148Ø	147Ø					
OUTCR	Ø47Ø						
OUTIA	Ø179						
OVCHA	Ø216						
PAGE	1778						
PARMA	Ø3Ø6						
PARMN	Ø3Ø7						
PBPTO	Ø313						
PBPTR	Ø31Ø						
PBUFF	Ø311						
PBUFO	Ø312						
PEND	Ø365	1113	126Ø	1289	1294	1712	1723
PEXMA	Ø165						
PFLAG	Ø391						
PFOR	1149	1137	1146				
PFORM	Ø643	1677					
PGINØ	Ø478						
PGINT	Ø458						
PI/2	ØØ44						
PLACE	Ø384	17Ø3					
PLOTE	Ø65Ø	1Ø14	1619				
PMODE	Ø329						
PPFF	Ø366						
PR17	1764	1761					
PR2	176Ø	1737	1746	1747	1749		
PR3	1748	1757					
PRADD	Ø3Ø8	Ø8Ø7	Ø813	1133			
PRCHK	Ø644	Ø969	Ø997	1762			
PRFLG	Ø332						
PRINN	Ø639	1748					
PTRI	Ø518	1111	1497				
QTCHA	Ø23Ø						
QTCHK	Ø642	Ø8Ø1	Ø8Ø9	1672			
QTOP	Ø1Ø9	Ø161	Ø764				
QUOTE	Ø561	Ø562					
RBOP	Ø117						
RBUFF	Ø36Ø						
RCOUT	Ø333						
RDYDA	Ø166						
RECO2	Ø749	Ø743					
REED	Ø161						
REEDL	Ø339						
RES	Ø417						
RESB1	Ø453						
RESBP	Ø454						
RET1	1445	1435					
RET2	Ø421						
RETN2	Ø42Ø	Ø9Ø5					
RETN3	Ø419	Ø877					
RITE	Ø637	Ø725	Ø733				

PAGE 482 CROSS-REFERENCE TABLE

PAGE 483 CROSS-REFERENCE TABLE

PAGE 484 CROSS-REFERENCE TABLE

UKPTR	Ø3Ø9						
UNITS	Ø319						
UNNM	1554	Ø944	Ø955	1Ø08			
UNSTK	Ø448	1679	1681				
UPARA	Ø191						
VALUE	Ø297						
VARØ1	Ø648	Ø751					
VAROA	Ø214	Ø675	Ø744				
WBUFF	Ø423	1483					
WIDTH	Ø385	1693					
WRIT2	1642	1653	1664	1731			
WRIT4	1669	1675					
WRIT5	1677	1673					
WRIT6	1728	17Ø1					
WRIT7	17Ø3	1694					
WRIT8	1735	1671	173Ø				
WRITB	1688	1683					
WRITE	Ø159						
WRITF	1667	1647					
WRITN	1654	1643					
WRITQ	1663	1644					
WRITS	1652	1654					
WRITX	1659	1649					
XC	Ø412	1484	1485	1491	1496		
XEC4A	Ø164	Ø8Ø8	Ø814	1537	1764		
XEC6A	Ø221						
XFAR1	Ø425	1718					
XFAR2	Ø429	Ø92Ø	Ø943	Ø954	Ø987	1192	1393
XFTO$	1495	1487					
XSCRA	Ø22Ø						
YC	Ø414						
ZAP	Ø152						
ZONK	Ø491	1Ø95					

MICROPROCESSOR

All of the above-listed routines and subroutines of basic instructions are implemented by the basic computing system shown in Figures 3A—B. Central control of this system is achieved by microprocessor 120. As shown in the block diagram of Figure 27 and in the detailed schematic diagram of Figures 28A—D, the microprocessor comprises a bipolar ROM 300 including seven ROM chips organized into 256 words of 28 bits. Eight J—K flip-flops contain the ROM address; (i.e. a 4-bit primary address and a 4-bit secondary address). A single chip 16-bit data selector permits any one of 16 different qualifier lines to be tested with a 4-bit qualifier code. This 4-bit qualifier code ROM chip serves a dual function in that it provides a complementing code to the 4 primary address flip-flops as well as selecting the proper qualifier to be tested. If branching in any ROM state is desired, the microinstruction BRC must also be given, BRC occurring with a QN (qualifier not met) signal from the data selector will cause the least significant bit of the address code to be inhibited to the secondary address flip-flop, thus causing the address to "branch" according to the state of the qualifier.

An additional feature of this ROM organization is the IQN microinstruction (inhibit if qualifier not met). When the IQN is given and the qualifier selected by the qualifier code is not met, the signal CCO (clock code zero) goes low. This inhibits all shift clock pulses from the clock decoder which in effect prevents execution of microinstructions in the ROM state.

To minimize the ROM word length, two 3-to-8 line decoders are used to expand 3 R-code outputs and 3 X-code outputs into a total of 14 microinstructions. Also the SCO and SCI outputs from ROM #5 are decoded in the Memory. The ALU outputs AC0, AC1, and AC2 are treated as address inputs to the ALU ROM and therefore need no decoding.

The microprocessor is responsible for the following:

1. Issuing a four-bit clock code to the clock decoder during each ROM state.
2. Issuing microinstructions to the memory, including the read and write microinstructions.
3. Issuing microinstructions to the shift registers for gating serial data into or out of the proper registers.
4. Issuing a four-bit ALU code to the Arith Logic Unit to select the proper binary or BCD arithmetic function.
5. Performing logical decisions (branching) based on the states of 16 qualifier inputs to the microprocessor.
6. Issuing next address information to the ROM address flip-flops in the microprocessor.
7. Transferring control to the input/output controller via the I/O strobe for execution of input or output instructions.

The full set of 28 ROM outputs with their associated microinstructions, the list of 16 qualifiers and assigned codes, and the microprocessor mnemonics are contained in the following tables:

MICRO - INSTRUCTION SCT TABLE

	← POSITIVE TRUE →	← NEGATIVE TRUE OUTPUTS →	
CONTROL FIELD	ROM OUTPUT	DECODED μ-INSTRUCTION OUTPUT	FUNCTION
GENERAL	1. IQN		INHIBIT SHIFT CLOCK IF QUALIFIER NOT MET.
	2. $\overline{\text{BRC}}$		BRANCH: INHIBITS S00 IF QUALIFIER NOT MET.
	3. $\overline{\text{TTT}}$		T BUS → T REG
	4. $\overline{\text{TTM}}$		T BUS → M REG
	5. $\overline{\text{XTR}}$	DECODED IN MEMORY	A/B REG → R BUS
		SC1 SC0	
S-CODE	6. SC1	ZTS 0 0	ZERO → S BUS
	7. SC0	MTS 0 1	M REG → S BUS
		TTS 1 0	T REG → S BUS
		UTS 1 1	ONE → S BUS
		DECODED IN MICROPROCESSOR	
		RC2 RC1 RC0	
R-CODE	8. RC2	UTR 0 0 0	ONE → R BUS
	9. RC1	PTR 0 0 1	P REG → R BUS
	10. RC0	TRE 0 1 0	T REG → E REG → R BUS
		WTM–ZTR 0 1 1	STORE CONTENTS T REG → MEMORY
		TQ6–ZTR 1 0 0	T BUS → Q REG (BIT 6)
		QTR 1 0 1	Q REG → R BUS
		RDM–ZTR 1 1 0	READ MEMORY < M > → T REG
		ZTR 1 1 1	ZERO → R BUS

MICRO - INSTRUCTION SET TABLE

	POSITIVE TRUE	NEGATIVE TRUE OUTPUTS			
CONTROL FIELD	ROM OUTPUT	DECODED μ-INSTRUCTION OUTPUT			FUNCTION
		DECODED IN MICROPROCESSOR	XC2	XC1	XC0	
X-CODE	11. XC2	TTQ	0	0	0	T BUS → Q REG
	12. XC1	QAB	0	0	1	Q REG (BIT 11) → AB FLIP-FLOP
	13. XC0	BCD	0	1	0	BCD ARITHMETIC MODE OF ALU
		TBE	0	1	1	T BUS → E REG → R BUS
		CAB	1	0	0	COMPLEMENT THE AB FLIP-FLOP
		TTP	1	0	1	T BUS → P REG
		TTX	1	1	0	T BUS → A/B REG
		NOP	1	1	1	NONE OF THE ABOVE
		DECODED IN ALU	AC2	AC1	AC0	
ALU	14. AC2	XOR	0	0	0	EXCLUSIVE OR.....R ⊕ S → T BUS
	15. AC1	AND	0	0	1	LOGICAL AND.....R . S → T BUS
	16. AC0	IOR	0	1	0	INCLUSIVE OR.....R + S → T BUS
		ZTT	0	1	1	ZERO → T BUS
		ZTT . CBC	1	0	0	ZERO → T BUS, CLEAR BINARY CARRY
		IOR . CBC	1	0	1	INCLUSIVE OR, CLEAR BINARY CARRY
		IOR . SBC	1	1	0	INCLUSIVE OR, SET BINARY CARRY
		ADD	1	1	1	BINARY ADD

MICRO - INSTRUCTION SET TABLE (Continued)		
CONTROL FIELD	ROM OUTPUT	FUNCTION
CLOCK	17. CC1 18. CC2 19. CC4 20. CC8	THIS 4-BIT CODE INITIALIZES A PRESETTABLE DOWN COUNTER TO GENERATE ANY NUMBER OF SHIFT CLOCKS FROM 1 THROUGH 16. SHIFT IS INHIBITED BY IQN IF QUALIFIER NOT MET.
QUALIFIER	21. QC3 22. QC2 23. QC1 21. QC0	THIS 4-BIT CODE PERFORMS TWO FUNCTIONS: (1.) ADDRESSING THE DATA SELECTOR TO SELECT ONE OF SIXTEEN QUALIFIER INPUTS. (2.) PROVIDES COMPLEMENT CODE TO PRIMARY FLIP-FLOPS.
SECONDARY ADDRESS	25. SO3 26. SO2 27. SO1 28. SO0	THIS 4-BIT CODE PROVIDES COMPLEMENT CODE TO THE SECONDARY FLIP-FLOPS. IF BRC IS GIVEN AND QUALIFIER IS NOT MET, THE SO0 BIT IS INHIBITED.

SPECIAL MICRO - INSTRUCTIONS:

TQR = UTR . XTR..... TRANSFERS Q-REGISTER TO PRIMARY ADDRESS AS SHOWN

- Q14 . Q11 → PO4
- Q12 → PO5
- Q13 → PO6
- Q14 → PO7

IOS = PTR . XTR..... INITIATES:
a) TRANSFER IF CONTROL TO I/O IF Q10 = 1
b) SETS "SINGLE SERVICE" FF IN I/O VIA $\overline{SRA}$ IF Q10 = 0

SPECIAL OPERATIONS:

BCD SUM → A < 0−3 > = BCD . $\overline{UTR}$. TOM CLOCK

CLEAR DECIMAL CARRY = QAB . ROM CLOCK

SET DECIMAL CARRY = UTR . BCD . ROM CLOCK

DECIMAL ADD = BCD . ZTT..... T < 0−3 > + A < 0−3 > → Q < 0−3 >

10's COMPLEMENT W/DECIMAL ADD = BCD . ADD..... $\overline{T_{<0-3>}}$ + A < 0−3 > → Q < 0−3 >

QUALIFIER SET TABLE

QUALIFIER CODE

QC3 QC2 QC1 QC0	MNEMONIC	FUNCTION
0000	Q00	Shift/Skip One Bit
0001	Q01	Shift/Skip Two Bits
0010	Q02	Shift/Skip Four Bits
0011	Q03	Shift/Skip Eight Bits
0100	Q04	Fast Square Root Qualifier
0101	Q05	Set Bit in A/S Group; FDV qualifier
0110	Q06	T-Bus Qualifier via TQ6
0111	QBC	Binary Carry from ALU
0110	QBC	Binary Carry from ALU
1000	QP0	P Register, Bit 0, for BCD counting
1001	Q15	Indirect Address, Clear Bit in P/S Group
1010	QMR	Memory Reference qualifier
1011	Q10	Current Page Qualifier, FXA Qualifier
1100	QNR	Non-Service Request Qualifier
1101	Q08	FMP Qualifier
1110	QDC	Decimal Carry from ALU
1111	*QRD	ROM Disable (Normally Zero)

POP will preset ROM address Flip-Flops at turn-on.
*QRD may be used with IQN to insure zero shift except when in I/O loop.

MICROPROCESSOR MNEMONICS

Clock Signals

$\overline{MCK}$	Memory Clock
SCK	Shift Clock
XTC	External Clock
RCF	ROM Clock for Flip Flops
RCA	ROM Clock for Address Flip Flops
$\overline{IIC}$	Inhibit Internal Clock
$\overline{INH}$	Inhibit Clock
$\overline{IPS}$	Inhibit ROM Clock (Also primary and secondary Flip Flop)
CC8 CC4 CC2 CC1	Clock Code: Binary Code that programs the number of shift clocks
$\overline{CC\emptyset}$	Inhibits Shift Clocks

Address Mnemonics

$\overline{POP}$	Power on Preset
IQN	Inhibit if Qualifier not met
BRC	Branch

MICROPROCESSOR MNEMONICS (Continued)

Q-Register	
$\overline{TQR}$	Transfer Q11, Q12, Q13, Q14 to primary addr. Flip Flops
$\overline{TTQ}$	T-Bus to Q-Register
$\overline{QTR}$	Q-Register to R-Bus
Q10, Q9, Q8, Q7, Q6, Q5, Q4, Q3, Q2, Q1, Q0	Bits 1Ø — Ø of Q-Register
Data Qualifiers	
QPØ	Bit Ø of P-Register
QRD	Qualifier ROM Disable (I/O interupt)
QNR	Qualifier No Request (Keyboard Interupt)
QDC	Decimal Carry
QBC	Binary Carry
Memory	
SCØ, SCI	S-Bus Code
$\overline{TTT}$	T-Bus to T-Register
$\overline{TTM}$	T-Bus to M-Register
$\overline{RDM}$	Read Memory
$\overline{WTM}$	Write Memory
A, B, P, E-Registers	
QAB	Q-Register to AB Flip Flop
AB=Ø	A-Register Operation
$\overline{AB}$=Ø	B-Register Operation
$\overline{TTM}$ (ROM)	T-Bus to A or B Register (Originates at ROM Decoder)
$\overline{XTR}$	A or B Register to $\overline{R}$-Bus
$\overline{TTP}$	T-Bus to P-Register

MICROPROCESSOR MNEMONICS (Continued)

$\overline{PTR}$	P-Registers to $\overline{R}$-Bus
$\overline{TBE}$	T-Bus to E-Register to $\overline{R}$-Bus
$\overline{TRE}$	T-Register to E-Register
$\overline{UTR}$	Units to $\overline{R}$-Bus
AC2 AC1 AC0	Arithmetic Codes for Arithmetic Logic Unit
$\overline{BCD}$	Decimal Arithmetic
SDR	Disables ROMs for Single Step Tester Operation

End of the ROM chips of Figures 27 and 28A—D is organised into 256 words of 4 bits each constructed in accordance with the following table, where each "L" represents a low (or "0") state and each "H" represents a high or ("1") state:

ROM CHIP 3

0016	000—007	LLLL	LLHL	HHHH	LHHL	HHHH	LHHH	HHLH	HHLH
0017	008—015	LLHL	LHLL	HLHH	HLLH	HLHL	LHLH	LLLL	LLLL
0018	016—023	LHHH	LHHH	LLLL	LHHH	LLLL	LLLL	LHLL	HHLL
0019	024—031	LLHL	LLHL	LHLH	HLHL	LHLL	HLHL	LLLL	LLLL
0020	032—039	LHLL	LLLL	HHLL	LLLL	HLLL	HLLL	LLHL	HLLH
0021	040—047	LLHH	LLHH	LLLL	LLLL	LHLH	HLLL	HHLH	LHHH
0022	048—055	HLLL	HHLL	LLLH	LLLH	LHHL	LLLH	HLHH	HLHH
0023	056—003	LLLH	LLLH	HHLL	LHLH	LLLH	HHLH	HLHH	LHLL
0024	064—071	LHHL	LHHH	HLHH	HHHL	LLLL	HLLL	LHHL	HLHH
0025	072—079	LLLH	LLLH	LHLL	LHLL	HLLL	LLHL	LLLL	HLLH
0026	080—087	LHHH	LHLH	HLLL	LHHL	HLHH	HHLL	LLLL	LLLL
0027	088—095	LLHH	LLLL	HHHH	LHHH	LLLL	LLHH	LLLL	LHLL
0028	096—103	HHHL	HLLL	LHHL	LHHH	LHHH	LHHH	LHHH	HHHH
0029	104—111	LLHH	LLHL	LHLL	LLLL	LLLL	LHLH	HHLL	HHLL
0030	112—119	LLLH	LLLH	LLLL	LHLH	LHLH	LHLH	HLLH	LHHH
0031	120—127	LLLL	LHLH	HHHH	LHHL	LLLH	LHLL	LLLL	LHLH
0032	128—135	HLHL	LHLL	HHLL	LHLH	LHHH	HLHH	LLLL	LLLL
0033	136—143	LHLH	LLHL	LLHH	HHLH	LLHL	HLHL	HLLH	LHLL
0034	144—151	LLLL	LLHL	HLLH	HLLL	HLLH	LLLH	HLLH	HLLH
0035	152—159	HHHL	LHHH	HLHH	HLLH	LLLH	LLLL	LHHH	HHLH
0036	160—167	HLLL	HHHL	LLLH	HHHL	LHHH	LLHL	LLHL	HHHH
0037	168—175	LHHL	HLLL	LHLL	HLHL	LLLL	LLLH	LHLL	HLLL
0038	176—183	LLLL	LHHL	LLHL	HLLH	LHHH	LLHH	HLHH	HLHH
0039	184—191	LHHH	HLLL	LLHL	LLHL	LHLH	LLLL	LLHL	LLLL
0040	192—199	LLLH	LLLL	LLLH	LLLH	HHLH	HHLH	LLHH	HLHH
0041	200—207	HHHH	LHLH	HLLH	LHLL	HHLH	LHLH	LLLL	LLLL
0042	208—215	HLHH	HLLL	LHHL	LLLH	HHHL	LLHL	HLHL	HLHL
0043	216—223	HHHH	HHLH	LLLL	LLLL	LLLL	LHLL	LLLH	HLLH
0044	224—231	HLLH	HLLH	LLLL	LLLL	HHLH	HLLL	LHHL	HHHL
0045	232—239	LLLL	HHHL	HLLL	HLLH	HHLL	HLHL	LLLL	LHHH
0046	240—247	LLHL	LLHL	LLHH	LLLL	LLLH	HHLH	LLHL	LHLL
0047	248—255	LHLL	LHLH	HLLL	LHHH	LLLL	LLLL	LHLH	LLLL
0048									

ROM CHIP 4

0053	000—007	HLHL	HLLH	LLLH	HLLL	LHHL	HLLL	HLHH	LLHH
0054	008—015	LHHH	HHLH	HLLL	HLLL	HLLH	LHHL	HLLL	LHHH
0055	016—023	HLLL	LLHH	LLHL	LLLL	HLHH	HLLH	LLLL	LLLH
0056	024—031	LLLL	LLLL	HLHL	LLHL	LLLL	LLLH	LHLL	LHHH
0057	032—039	LHLH	HLLH	HLLL	HLHH	LHLH	HHLH	HHLL	HLLL
0058	040—047	LLLL	LLLL	HHLH	HHLL	HHLH	HHLL	HLLH	HLHL
0059	048—058	HHHH	LLHH	LLLL	HLLL	LLLL	HLHH	HHLL	LHLL
0060	056—063	LLLH	LLLH	HHHL	HHHL	LLLL	HLLL	HLHL	LLLL
0061	064—071	LLLH	HHLH	HHLH	HLLL	HLHL	LLLL	HHHH	HLHH
0062	072—079	LLLL	LLLL	HLHL	LLHL	LLHH	HLLL	LHLH	LLHH
0063	080—087	HHHL	HLHH	HLHL	HLLL	LLLL	HHLH	LHLL	LLLH
0064	088—095	HLLL	LHLH	HHHL	HHLL	LHHH	LHLL	HLLL	LLLL
0065	096—103	HHHL	HLHH	HLLL	HLHL	HHHH	HHLL	HHHL	LLHL
0066	104—111	LLLL	LLLL	LHLL	LLHL	HLLL	LLLL	HLHL	LLHH
0067	112—119	LHHH	LHLH	HLLL	HLLL	LLHH	HLHH	HHHH	LHLL
0068	120—127	LLHL	HHHH	HLLL	HLHH	LHLL	HLLH	HLLH	HHHL
0069	128—135	LLLH	HLHH	LHHL	HLHH	HLHH	HLLH	HLHH	LLHH
0070	136—143	HLLH	LHLL	HLHL	LLHH	LLLL	HHHH	LLLL	HLLH
0071	144—151	HLHL	HLHL	HLLL	HLLH	HLHH	LHLL	HHLL	HHLL
0072	152—159	HLLL	HLLH	HLHL	HHHH	LLLL	HLLL	HLHL	LHLL
0073	160—167	LLLH	HHHL	HHHL	LLHH	HHHL	HLHH	HHHH	HHHL
0074	168—175	HLLL	HHLH	LHLL	HLLL	HLLL	LLLL	LLHL	LLLH
0075	176—183	HHLL	HLLH	HLLH	HLLL	HHHH	HLLL	HHLL	LHLL
0076	184—191	HLLL	LLHH	LHLL	HHLL	LLHH	HLLL	LHLH	LHHH
0077	192—199	LHHL	HLLH	LLLL	HLLL	HLHH	HLLL	HHHL	HHHL
0078	200—207	LLHL	HHHH	HHHL	HHHL	LLHH	LLLH	HLLL	LHHH
0079	208—215	LHHH	HLLL	HLLL	LLLH	HLHL	LLLH	LHLL	LHHL
0080	216—223	LLHL	HLHL	HLHL	LLHL	HLLL	LLLL	LLLL	HLHL
0081	224—231	HLLL	HLLH	LHHL	HHLL	HLLL	LHLL	LHLL	LHHH
0082	232—239	HHLL	LLHH	LLHL	LHLH	LHHH	LLLL	HLLL	LLHH
0083	240—247	HHLL	LHLL	LLHH	HLLL	HLLL	HLHH	LHLL	LHLL
0084	248—255	LLHH	HHLH	LLLH	LLLL	HHLL	HHLH	LHLL	HLLL
0085									

ROM CHIP 5

0090	000—007	HHHH	LLLL	LLLL	HHHH	LLLL	LLLL	LLLH	LLLH
0091	008—015	HHHH	LLLL	HLLH	LLLL	HHHH	HHHH	LLLL	LLHH
0092	016—023	LLLL	LLLL	LLLL	LLHH	LLLL	HHHH	HLHH	LLLL
0093	024—031	LLHH	LLHH	LLLL	LHLH	LLHH	LHLH	HLHH	HLHH
0094	032—039	HHHH	LLLL	LLLL	LLLL	HLHH	HLHH	HHHL	LLLL
0095	040—047	LHHH	LHHH	LLLL	LLLL	LLHH	HLHH	LLLL	LLLH
0096	048—055	LHLH	HLHH	LLLL	HHHH	LLLL	LLLL	LLLL	LLLL
0097	056—063	LLLH	LLLH	LLHH	LLHH	LLLL	HLHH	HHHH	HHHH
0098	064—071	HHHH	HLHH	LLHH	LLLL	LLLH	LLLL	LLLL	LHLH
0099	072—079	HHHH	LLLH	HHHH	LLLL	HHHH	HHHH	LLLH	HHHL
0100	080—087	LLLL	LLLL	HLHH	LLLL	HHHH	HHHH	HHHH	HHHH
0101	088—095	LHHH	LLLL	LLLH	LLLL	LHLL	LLHH	LLHL	HHLL
0102	096—103	HHHH	HLHH	HLHH	HLHH	LLHH	HLHH	LLLL	LLLH
0103	104—111	LLLL	LLHH	HHHH	HHHH	HLHH	HHHH	HHHH	LLLL
0104	112—119	HHHH	HLHH	HHHL	LLLL	LLHL	LLLL	LLHH	LLLL
0105	120—127	HLHH	LLLL	LLHH	HLHH	LLHH	HHLH	LLLL	HHHH
0106	128—135	HHHH	LHLH	HHHH	LLLL	LLLH	LLHH	LLLL	LLLL
0107	136—143	HHHH	HHHH	LHLH	HLHH	HLHH	HLHH	LLLL	LLLH
0108	144—151	LLLL	LLHH	HLHH	LLHH	LLLL	HHHL	LLLL	HHHL
0109	152—159	LLLL	LLLL	LLLL	LHLL	HHHH	HLHH	LLHH	LHLL
0110	160—167	HHHH	HHHH	LHLH	LLHL	HHHH	LLLL	HHHH	LLLH
0111	168—175	HHHH	HHHH	HHHH	LLLL	HHHH	HHHH	HHHH	LHLL
0112	176—183	HHHH	LHLH	HHHH	HHHH	LLLL	LLHL	HHHL	LLLL
0113	184—191	HHHH	HLHH	LHLH	LHLH	HHHH	HLHH	LLHH	LLHH
0114	192—199	HHHH	HLHH	HHHH	HHHH	LHLH	HLHH	LHLH	LHLH
0115	200—207	LLLL	HHHL	HHHH	LLLH	HHHH	LLLL	HLHH	HHHH
0116	208—215	HHHH	LLHH	HLHH	HHHH	LLHH	HHHH	LLLL	HHHH
0117	216—223	LLLL	HLHH	LLLL	LLLL	HLLH	LHLH	LHLH	LLLL
0118	224—231	LLLL	LLLL	LLLL	HHHL	HLHH	HLHH	LLHL	LLLL
0119	232—239	HHHH	LLLL	HLHH	HHHH	LLLL	LLLL	HHHL	HHHL
0120	240—247	LLHH	LLLL	LHLL	LLLH	HHHH	HHHH	HLHH	LHLH
0121	248—255	HHHH	LLLL	HLHH	LLHH	HHHH	LLLL	HHHH	HHHH
0122									

ROM CHIP 6

Ø127	ØØØ—Ø07	LHHL	LHHH	HHHL	LLHH	HHHL	HLHH	HHHL	HHHL
Ø128	Ø08—Ø15	LLHL	LLHH	LLHH	LHLH	LHLH	LHLL	LHHH	LHLH
Ø129	Ø16—Ø23	LHHH	LHHH	LHHH	LHHL	LLLH	LHHL	LHHH	LHHH
Ø13Ø	Ø24—Ø31	HHHH	HLHH	LLHH	LLLH	LHLH	LLLH	LHHH	LHHH
Ø131	Ø32—Ø39	LLLL	LHHH	LHHH	LHHH	LHLH	LHHH	LHHL	HHHH
Ø132	Ø4Ø—Ø47	HHHH	HLNH	HHHH	HLHH	HLHH	LHLH	LHHH	HHHL
Ø133	Ø48—Ø55	LLLH	LHLH	LHHH	LHLL	LHHH	LLLH	LLHH	LLHH
Ø134	Ø56—Ø63	HHHH	HLHH	LHHH	LHHH	LHHH	LLHH	LHLH	LLLH
Ø135	Ø64—Ø71	LLHH	LHHL	LHHH	LHHH	LHHL	LHLH	HLHH	LLLH
Ø136	Ø72—Ø79	LHHH	HLHL	LHHL	LHHH	LHLH	LHHL	LLHL	LHHH
Ø137	Ø8Ø—Ø87	LHHH	LHHH	LLHH	HHHL	LHHH	LHHL	LHLH	LHHH
Ø138	Ø88—Ø95	HLHL	HLHL	LLHH	LHHH	LHHH	LHHL	LLHH	LHHH
Ø139	Ø96—1Ø3	LLHL	LHHH	LHHH	LHHL	LHLH	LHHL	LHHH	HHHL
Ø14Ø	1Ø4—111	LLHH	HLHL	LHHH	LLHL	LLHH	LHHL	LHLH	LHHH
Ø141	112—119	LHLL	LHHH	LHHL	LHLH	LLLH	LHHH	HHLH	LHHH
Ø142	12Ø—127	LHLH	HLHH	LHLL	LHHH	LHHH	LHHH	LHLH	LHHH
Ø143	128—135	LLHL	LHHH	LHHL	LHHH	LHLH	LHHH	LHLH	LHLH
Ø144	136—143	LHHL	LLHH	LLLH	LHLH	LHLH	LHHH	LHHH	LLLH
Ø145	144—151	LHHH	LHHH	LLLH	LHLL	LHHH	LHHH	LLHH	HHHL
Ø146	152—159	HLHL	HHHL	LHHH	LHHH	LHHH	LLHH	LHHH	LLHH
Ø147	16Ø—167	LHLL	LLLL	LLLH	LLHH	LHHH	LLHH	LHLH	LLHH
Ø148	168—175	LLLL	LLHL	LHHH	LHHH	LHHH	LHLH	LHHH	LHHH
Ø149	176—183	LHHH	LHHH	LHLH	LHLH	LHLH	LLHH	LHHL	LHHH
Ø15Ø	184—191	LLHL	LLHH	LHHH	LHHH	LHLH	LHHH	LHHH	LLHH
Ø151	192—199	LHLH	LLHH	LHLH	LHHH	LHLH	LHHH	LLLH	LLLH
Ø152	2ØØ—2Ø7	HLLH	HHHL	LHHL	LHHH	LHHL	LHHH	LHLH	LHHH
Ø153	2Ø8—215	LHLH	LHLL	LHLH	LHLH	HHHH	LHLH	LHHH	LHHH
Ø154	216—223	HLHH	LHHH	LHHH	LHHH	LLHH	LHHH	LHLH	LLHH
Ø155	224—231	HLHH	HHHL	LHHH	LHHH	LLHH	LHLH	LHHH	HLHH
Ø156	232—239	HLLL	LHHH	LLLH	LLHH	LLLH	LHHH	LLHH	LHHH
Ø157	24Ø—247	LHLL	LHHH	LHLH	LLLH	LHLL	LHLH	LLHH	LLLH
Ø158	248—255	LLHL	LHHH	LHHH	LHLL	LHLH	LHLH	LHHH	LHHH
Ø159									

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Ø164	ØØØ—ØØ7	LHHH	HHHH	LLLL	LLLH	LLLL	HHHH	LHHH	LHHH
Ø165	ØØ8—Ø15	LLLH	HLLH	HHHH	HHHH	LLHL	LHHH	LHHH	LHLH
Ø166	Ø16—Ø23	LHLL	LHLL	LHHH	LHHH	LHHH	LHHH	LLHH	LHHH
Ø167	Ø24—Ø31	LHHH	LLLL	LHHH	LHHH	LLHL	LHHH	LHHH	LLHH
Ø168	Ø32—Ø39	LHHH	LHHH	LHLL	HHHH	LLLL	LHHH	LHHH	HHHH
Ø169	Ø4Ø—Ø47	LHHH	LLLL	LHHH	LLLL	HHHH	HHHL	HHLH	LHLL
Ø17Ø	Ø48—Ø55	LHHH	LHHL	LHHH	LHHH	LHLH	LHHH	LHHH	LLLL
Ø171	Ø56—Ø63	LHHH	LLLL	LHHH	LLLL	LHHH	HHHL	HLHL	LLLL
Ø172	Ø64—Ø71	LHHH	HHHH	LHHH	HHHH	LHHH	LHLL	HLLL	HHHH
Ø173	Ø72—Ø79	LLLH	LHHH	LHHH	LHHH	LHLL	LHHH	LHHH	LHHH
Ø174	Ø8Ø—Ø87	LHLL	HHLL	HHHL	HHHH	LHHH	LHLL	LLLL	LLLL
Ø175	Ø88—Ø95	LHHH	LHHH	LHHH	LHHH	LHLL	LHHH	LHHH	LHHH
Ø176	Ø96—1Ø3	LHHH	HHHL	HLHH	HHHH	HHHH	HHHH	HHLL	LHHH
Ø177	1Ø4—111	LLLH	LHHH	LLLL	LHHH	LLHH	LHHH	HLLL	LHHH
Ø178	112—119	LHHH	LHHL	LHHH	LHHH	LHHH	LHHH	LHHH	LHHH
Ø179	12Ø—127	LHHH	HLLL	LHHH	LLHH	LLLL	LHHH	LHLL	LHHH
Ø18Ø	128—135	LHHH	HLLL	LHHH	HHHH	HHHH	HHHH	LLLL	LHHH
Ø181	136—143	HHHH	LHHH	LHHH	LLHH	LHHL	LHHL	LHHH	HLLL
Ø182	144—151	LLLL	HHHH	HLHH	HHHH	HHHH	LHHH	LLLL	HHHH
Ø183	152—159	LLLH	LHLL	HHHH	LHLH	LHHH	LLHH	HHHH	HLLL
Ø184	16Ø—167	LHHH	LHHH	LHHH	LLLL	LLLL	HLLH	LHLL	HHHH
Ø185	168—175	LLLH	LHHH	LHLL	HHHH	LLLL	LHLL	LHLL	LHLL
Ø186	176—183	LLLL	HHHH	LLLL	LLLL	LLLH	HLLH	LHHH	LHHH
Ø187	184—191	LLLH	LHHL	LHHH	LHHH	LHLH	LHHL	LHLH	LLLL
Ø188	192—199	LLLL	HHHL	LLLL	LHHH	HHHH	HHHH	HHHH	HHHH
Ø189	2ØØ—2Ø7	LLLH	HHHH	LHLH	HLLL	LHHH	LHHH	LLHH	LLLL
Ø19Ø	2Ø8—215	LHHH	HHHH	HLHH	LHLL	HHHH	LLHL	LHHH	LHHH
Ø191	216—223	LLLH	HLHH	LLLH	LLLH	LLLL	LHHH	LHHH	HHHH
Ø192	224—231	HLLL	HHHH	LHHH	LHLL	HHHL	LLHH	LLLL	LHHH
Ø193	232—239	HHHH	LHHH	LLHH	LLLL	LHHH	LHLH	LHHH	LHHH
Ø194	24Ø—247	LHHH	LHHH	LLLL	LLLL	HHHH	LLHL	LLLH	LHHH
Ø195	248—255	LHHH	HHHH	LLHH	LHHH	HHHH	HLLH	LHHH	LHHH
Ø196									

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Ø2Ø1	ØØØ—Ø07	LHHH	HHHL	HHHL	HHHL	HHHL	HLHL	LLHL	LLHH
Ø2Ø2	Ø08—Ø15	HHHL	HHHL	HHHL	HHHH	HHHL	LHHL	LHHL	HHHH
Ø2Ø3	Ø16—Ø23	HHHL	HHHL	HHHL	LHHH	HHHH	LHHH	LHLL	LHLL
Ø2Ø4	Ø24—Ø31	LHHL	LHHL	HHHH	HHHH	HHHL	HHHH	HHHL	HHHL
Ø2Ø5	Ø32—Ø39	HHHL	LHHL	HHLH	HHHL	HHHH	HHHL	HHHL	LHHL
Ø2Ø6	Ø4Ø—Ø47	LHHL	LHHL	LHHL	LHHL	HLHL	HHHH	HHHL	HHHL
Ø2Ø7	Ø48—Ø55	HHHH	HHHH	HHHL	LHHL	HHHL	HHHH	HHHH	HHHH
Ø2Ø8	Ø56—Ø63	LHHL	LHHL	HLHH	HHHH	HHHL	LHLH	HLHL	HHHL
Ø2Ø9	Ø64—Ø71	LHHL	HHHL	HLHH	HHHL	HHHH	HHHL	LHHL	HHHH
Ø21Ø	Ø72—Ø79	HHHL	HHHL	LHHH	HHHL	LLLH	LHHH	HHHH	HHHH
Ø211	Ø8Ø—Ø87	HHHL	HHHL	HHHH	HHHL	HHHH	HHHH	LHHL	LHLH
Ø212	Ø88—Ø95	HHHL	HHHL	HHHL	HHHL	HHHL	LHHH	HHHH	HHHH
Ø213	Ø96—1Ø3	HHHL	LHLL	HHHL	HHHL	LHHL	HHHL	HHHL	LLHL
Ø214	1Ø4—111	HHHL	HHHL	HHHH	HHHL	LHLH	LHHH	LLLL	LHLL
Ø215	112—119	HHHH	HHHL	LHHH	HHHH	HLHH	HHHL	HLHL	HHHL
Ø216	12Ø—127	LHHL	LHHL	HLHL	LHLL	HHHH	HHHL	HHHL	HHHH
Ø217	128—135	LHHL	HHHH	LHHH	HHHL	HHHL	HLHL	HHHH	HHHH
Ø218	136—143	HHHH	LHHL	HHHH	LHLH	HHHH	HHHL	HHHH	LLHL
Ø219	144—151	HHHH	HLHH	HHHH	HHHL	HLLL	HHHH	LHHL	HHHL
Ø22Ø	152—159	HHHL	HHHL	HHHL	HHHL	HHHH	HHHH	HLHL	HHHL
Ø221	16Ø—167	LHHL	HHLL	HHHH	HHHH	HHHH	HHHH	LHLL	HHHL
Ø222	168—175	HHHL	HHHL	HHLH	HLLL	HHHH	HHHH	HHLH	HHHL
Ø223	176—183	HHHH	LHLL	HHLL	HHLL	HHHH	HHHL	HHHL	HHHL
Ø224	184—191	HHHL	HHHH	HHHL	HHHL	HHLL	HHHL	HHHL	HLLL
Ø225	192—199	LLLL	HHHH	HHHL	HHHH	HLHL	HLLL	HLHH	HLHH
Ø226	2ØØ—2Ø7	HLHL	HHHL	HHHH	HHHH	HHHH	HHHL	HHHH	HHHH
Ø227	2Ø8—215	HHLH	HHHL	HHHH	HHHL	HLHH	HLHL	LHLL	LHLH
Ø228	216—223	HLHL	HHHL	HHHH	HHHH	HHHL	HHHL	HHHL	HHHH
Ø229	224—231	HHHL	LHHH	LLLL	HHLH	HHHH	LHLH	HHHH	HHHH
Ø23Ø	232—239	LHHL	HHHL	HHHH	LLLL	HHHH	HHHL	LLLH	HHHH
Ø231	24Ø—247	HLHL	HHHL	LHLH	LLHL	HHHL	HLHL	HHHL	HHHH
Ø232	248—255	HHHL	HHHL	LHLL	HLHL	HHHL	HHHL	LHHL	LHHL
Ø233									

ROM CHIP 9

Ø238	ØØØ—ØØ7	HHLH	HHLL	HHLL	LHLH	HHLL	HHHH	HHLH	HHLH
Ø239	ØØ8—Ø15	HHLL	HHHH	LHLH	HHLL	HLHH	HHLL	HHLL	LHLL
Ø24Ø	Ø16—Ø23	HHLL	HHLL	HHLL	HHHH	HHLL	HHLL	HHLL	HHLL
Ø241	Ø24—Ø31	HHLL	HHHH	HHHL	LHLL	HLHH	LHLL	HHHL	HHLL
Ø242	Ø32—Ø39	HLLH	HHLL	LHHH	HHLL	LHHH	LHLL	HHLL	HHLL
Ø243	Ø4Ø—Ø47	HHLL	HHHH	HHLL	HHHH	HHHH	HHLL	HHLL	HHLL
Ø244	Ø48—Ø55	LHLL	HHLL	HHLL	HHLH	HHLL	HHLL	LHLL	LHHH
Ø245	Ø56—Ø63	HHLL	HHHH	HHLL	HHLH	HHLL	HHLL	HHHH	HLLH
Ø246	Ø64—Ø71	HHLH	HHLH	HHLL	HHLL	HHLL	LHLL	HHHH	LHLL
Ø247	Ø72—Ø79	HLLL	HLHH	HHLL	HHLL	HHLH	LHLL	HHLL	LHHL
Ø248	Ø8Ø—Ø87	HHLL	HHLL	HHLL	HHLL	LHHL	HHHH	HHLH	HHLH
Ø249	Ø88—Ø95	HLHH	HLHH	HHLL	HHLL	HHLL	HHHH	HHHL	LHHL
Ø25Ø	Ø96—1Ø3	HLLL	HHLL	HHLL	HHLL	HHLL	HHLL	HHLL	HHLH
Ø251	1Ø4—111	HHHH	HLHH	HHLH	LHLL	HHLL	LHLL	HHLH	HHLL
Ø252	112—119	HLLL	HHLL	HHLL	HHLL	HHLL	HHLL	HHLL	HHLL
Ø253	12Ø—127	HHLH	HHHH	HHHH	HHLL	HHLH	HHHL	LHLL	HLLH
Ø254	128—135	HHLH	LHHH	HHLL	HHLL	LHLL	HHLL	LHHH	LHLL
Ø255	136—143	HHHH	HHHL	LHLL	HHLL	HHLL	HHLL	LHHL	HHLL
Ø256	144—151	HLLH	HHHH	HHLL	HLHH	HHLL	HLLH	HHHH	HHLL
Ø257	152—159	HHLL	HHLL	HHLL	HHLL	HLLH	HHLL	HHLL	LHHH
Ø258	16Ø—167	HHLH	HHHL	LHLL	LHHH	LHHL	HHHH	LLLL	HHLL
Ø259	168—175	HHHH	LHLL	HHHH	HHLL	LHLH	HLLL	LHHL	HHLL
Ø26Ø	176—183	HLLH	LHLL	HHLH	HHLH	LHHH	LHHH	HHLL	HHLL
Ø261	184—191	HHLL	HHLL	LHLL	HHHL	LHHH	HHLL	HHLL	LHHH
Ø262	192—199	HHHL	HHLL	LHLH	LHLL	LHLL	HHHL	LHLL	LHLL
Ø263	2ØØ—2Ø7	HHHH	HHLL	HLHL	LHHH	LHLL	LHLL	HHLL	HLLH
Ø264	2Ø8—215	HHHL	HLHH	HHLL	HLHH	HLLL	HHHH	HHHL	LHHL
Ø265	216—223	HHLL	HHLL	HHLL	HHHH	LHHH	LHLL	LHLL	HHLL
Ø266	244—231	LHHH	HHHH	LHLL	LHLL	HHLL	HHLL	LHHL	HHLL
Ø267	232—239	HHHH	HHLL	HHLL	LLHH	HHLL	HHLL	HHLL	LHLL
Ø268	24Ø—247	HHHH	HHLL	LHHH	HHLL	LHHH	HHHH	LHHH	LHLL
Ø269	248—255	HLLL	HHLL	HHLL	HHHH	HLLL	HHLL	HHLL	HHLL
Ø27Ø									

Each of the 71 basic instructions employed by the calculator is implemented by one or more of the above-described microinstructions and associated control signals issued by the microprocessor. The manner in which this is accomplished is shown and described in detail in the flow charts of Figures 29A—H. Each rectangular box of these flow charts represents a state of ROM 300 of the microprocessor and includes the mnemonic of the microinstructions and control signals stored in that ROM state. The number at the upper right-hand corner of each of these rectangular boxes represents the number of shift clock pulses required by the microinstructions of that ROM state. A simplified overview of these detailed flow charts is shown in Figures 6A—B.

PROGRAMMABLE CLOCK

Given a computing system organized to process binary data serially and under control of microinstructions stored in ROM 300 as shown in Figures 3A—B and 27, the implementation of a general purpose instruction set requires that some number of bits be shifted into or out of the storage registers. Depending on the operation being performed, the number of bits may vary from zero to n, where n is the number of bits in a single machine word.

If each clock period of the ROM clock corresponds to a one bit shift, a count loop must be employed to provide the desired number of shifts. A rather large number of such count loops would exist in order to implement an entire instruction set. An alternative method is to provide additional hardware which permits assignment of the desired number of shifts in a single state of ROM 300. Such an arrangement requires a variable cycle time for each state of ROM 300, but results in a very substantive saving in total number of ROM states.

To implement a variable number of shift clocks in a single state of the microprocessor, two separate clocks are required. The shift clock is applied to the data

storage registers in the memory, the shift register block, the arithmetic logic unit and the input/output block. The ROM clock is applied to the ROM address flip-flops in the microprocessor, and occurs once for each state in the microprogram. The number of shift clock pulses that occurs in any given ROM state is determined by a 4-bit clock code sent to the clock decoder from the microprocessor.

If no shift clocks are desired, a separate signal $\overline{CC\emptyset}$ from the microprocessor inhibits the shift clock output, independent of the clock code issued in that state. In this way, any number of shifts between and including zero and 16 may be implemented with a 4-bit clock code and an inhibit signal.

This inhibit signal offers an additional powerful feature when gated by the qualifier test logic in the microprocessor as shown in Figure 3A. The qualifier test logic includes a 4-bit qualifier code from ROM 3 that selects one of 16 qualifier inputs to the data selector. The data selector output QN (qualifier not met) will be high if the selected qualifier input was low. By using the QN signal to gate the inhibit microinstruction, IQN, the shift clock will be inhibited only when the qualifier is not met. Thus, all microinstructions requiring shift clocks that are issued in a given ROM state may be either executed or inhibited, depending on the logical state of the qualifier under test.

The ROM clock is applied to the eight J—K flip-flops which address the 256 word microprocessor ROM. During any given state, the complementing (J—K) inputs to the 4 primary address flip-flops are set up by the qualifier code or q-register code. The 4 secondary address flip-flop inputs are determined by the ROM 4 outputs, the BRC microinstruction, and the data selector output QN. Where ROM clock goes low, the negative edge-triggered flip-flops will cause transition of the ROM address to the next ROM state.

As shown in the block diagram of Figure 30 and the detailed schematic diagram of Figures 31A—C, a crystal controlled system clock output is inverted to generate memory clock, MCK. This signal is again inverted to clock a D flip-flop having an output (control clock), which will go low if the end-of-count signal (borrow) from the down counter has occurred at the D input. The ROM clock will also go low at this time, initiating a new ROM state in the microprocessor. Control clock will normally remain low for one system clock period, and in turn generates a load signal which is delayed a half period from control clock by means of a second D flip-flop. The 4-bit clock code from the microprocessor is preset into the counter while the load signal is low.

As the load signal goes high, ROM clock also goes high, completing the fixed interval protion of ROM clock and shift clock as shown in Figure 32. A series of clock pulses are now gated onto shift clock, SCK, until the preset counter has counted down to zero, causing control clock to again go low, completing the ROM cycle.

The inhibit signal, INH, from memory may lengthen the normal fixed interval of ROM clock by clearing the D flip-flop and holding control clock low. This may occur during memory refresh or external test operations. In this situation, the counter remains preset and the correct number of shifts will be generated when the inhibit goes away.

SHIFT REGISTER UNIT

As shown in the detailed schematic diagrams of Figures 28A—D and 33A—D, A-register 122, B-register 124, P-register 126, Q-register 128, and E-register 130 of Figures 3A—B comprise bipolar status registers, the contents of which are recirculated when data is output to the R-bus or the S-bus. Full control of these registers in use and type of operations performed is maintained by the micro-instructions from the microprocessor. The number of bits to be shifted in any one ROM state of the microprocessor is determined by the number of shift clocks from the clock decoder. This shift clock appears at the shift clock input of each shift register that is enabled by the microprocessor during that ROM cycle.

ARITHMETIC LOGIC UNIT

The development of complex read-only memory arrays on a single chip have made possible a hardware implementation of central processing units (CPUs) and arithmetic logic units (ALUs) with far fewer components than were previously possible. In this application, two bipolar read-only memory chips are combined with carry flip-flops and adapted to perform one-bit binary logic and arithmetic operations as well as four-bit binary-coded-decimal (BCD) arithmetic operations.

The two bipolar read-only memory chips may comprise, for example, Hewlett-Packard 16-pin dual-in-line packaged bipolar ROMs organized into 256 words by 4-bits and of the same type as shown and described in U.S. Patent No. 3,721,964.

The binary/BCD Arithmetic Logic Unit consists of five integrated circuits connected as shown in the block diagram of Figure 34 and the detailed schematic diagram of Figures 33A—D. Specifically, the packages consist of two 1024-bit ROMs, a dual D-type flip-flop and two quad two-input NAND gates.

Internally the desired binary logical function, binary arithmetic operation or BCD operation is selected by the ALU code as shown below.

	ALU CODE					
	BCD	AC2	AC1	AC0	ALU FUNCTION	DESCRIPTION
Binary Functions	0	0	0	0	XOR	Exclusive OR....R ⊕ S → T
	0	0	0	1	AND	Logical AND.... R . S → T
	0	0	1	0	IOR	Inclusive OR....R + S → T
	0	0	1	1	ZTT	Zero → T-BUS
	0	1	0	0	ZTT.CBC	Zero → T-BUS, Clear Binary Carry
	0	1	0	1	IOR.CBC	Inclusive OR, Clear Binary Carry
	0	1	1	0	IOR.SBC	Inclusive OR, Set Binary Carry
	0	1	1	1	ADD	Binary ADD....B + S + BC → T, C
BCD Functions	1	0	1	1	BCD ADD	BCD ADD.... T_{0-3} + A_{0-3} → Σ_{0-3}
	1	1	1	1	BCD COMP/ADD	IO's Complement and BCD ADD

ALU FUNCTION CODE ASSIGNMENTS

The function code input "BCD" selects between the binary mode and BCD mode of operation.

In the binary mode, the function code inputs AC0, AC1, and AC2 select the desired logical function or arithmetic operation. The binary input data enters ROM #1 on the carry, S-bus and R-bus input lines, and the binary result appears on the T-bus and binary carry output lines. ROM #2 is not used in the binary mode.

In the BCD mode of operation, the two function code lines AC0 and AC1 are disabled from the Micro-processor and these two lines carry the T02 and T03 bits of BCD data from the T-Register. The ALU function code line AC2 is used to select the desired BCD operation. If AC2 is low, the four-bit output Σ0,Σ1,Σ2,Σ3

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will be the BCD sum of the two BCD data inputs. If AC2 is high and decimal carry has been set, the four-bit output Σ0,Σ1,Σ2,Σ3 will be the BCD Tens Complement of the BCD data from the T-Register. In the BCD mode, the binary carry output will be disabled and the decimal carry output will be enabled to ROM #1.

Although only one-fourth of the available registers in ROM #1 are required for the eight binary operations, the concept of adding a second 1024-bit ROM to perform the BCD operations grew from several basic concepts:

1) The least significant BCD sum bit, Σ0, is always identical to the binary sum bit; therefore, only three additional outputs, Σ1, Σ2, and Σ3 need be generated. For BCD complement operations, the decimal carry flip-flop defines whether or not the least significant bit should be complemented.
2) In forming the "nine's complement" of the T-Register BCD data in ROM #1, it can be seen that for 8421 code the second least significant bit T01 is the same before and after forming the complement. Thus only two bits, T02 and T03 need be complemented prior to input into ROM #2. The ten's complement with add is then found by presetting decimal carry and performing a BCD sum of the three most significant digits in ROM #2.
3) With only eight ROM inputs available, some sharing of inputs is required for ROM #1. During binary operations, all four function codes and only one bit of T-Register data is required. During BCD operations, all four bits of T-Register data and only two function codes are required. Use of two NAND gates in wire-OR connection with the open collector function codes AC0 and AC1 permits sharing of the two inputs.

This arrangement left one input still available to ROM #2. By programming this input to always make output DCI true, the micro-instruction $\overline{UTR}$ can serve two purposes — placing units on the R-bus and also set decimal carry if BCD is true. When BCD is false, clock is inhibited to decimal carry. This feature permits saving decimal carry information during all binary operations. Similarly, binary carry is saved during the four binary operations AND, IOR, XOR, and ZTT by connecting AC2 such that when AC2 is false the shift clock is inhibited to the binary carry flip-flop.

In summary, the mode select input "BCD" performs the following functions:

1) Addresses the proper 128 word set of word lines in ROM #1.
2) Enables the TO2 and TO3 data lines to ROM #1 only in BCD mode.
3) Enables clock to decimal carry flip-flop only in BCD mode.
4) Selects binary carry or decimal carry into ROM #1 as appropriate.
5) Transfers outputs Σ0, Σ1, Σ2, Σ3, to A-Register only in BCD mode.

The remaining three ALU function codes select the proper set of word lines in ROM #1 to perform the eight binary functions. In addition, the AC2 input performs the following functions.

1) Enables clock to binary carry flip-flop only during the four carry-related binary functions and the BCD comp/add function.
2) In the BCD mode, AC2 causes BCD data bit TOO, TO2 and TO3 to convert to nine's complement form.

The ALU has a total of 15 inputs which include 8 data inputs, 2 clock inputs and 5 microinstructions. Four data output lines are required, and two additional output lines from carry flip-flops are available as qualifier inputs to the microprocessor. The ALU and shift register mnemonics are listed in the following table:

SHIFT REGISTERS & ALU BOARD MNEMONICS

$\overline{TRE}$	T-Register to E-Register to $\overline{R}$-Bus
TOØ	Bit Ø of T-Register
$\overline{TBE}$	T-Bus to E-Register to $\overline{R}$-Bus
$\overline{TTX}$ — TEST	T-Bus to A/B-Register from Tester
$\overline{TTX}$ — I/O	T-Bus to A/B-Register from I/O (Board #12)
$\overline{TTX}$ — ROM	T-Bus to A/B-Register from ⊢ Processor (Board #13)

SHIFT REGISTERS & ALU BOARD MNEMONICS (Continued)

$\overline{TTX}$	Logical "OR" of Three $\overline{TTX}$ Signals
AB	Status of AB-Flip-Flop AB = 0 A-Reg. Operation AB – 1 B-Reg. Operation
$\overline{XTR}$	A/B Register to $\overline{R}$-Bus
$\overline{UTR}$	Logical "I" to $\overline{R}$-Bus
$\overline{TQR}$	Q-Register to Primary Address Flip-Flop
$\overline{AB}$	Complement of AB
$\overline{TTP}$	T-Bus to P-Register
SCK	Shift Clock
QPØ	Qualifier, Bit Ø of P-Register
$\overline{PTR}$	P-Register to $\overline{R}$-Bus
QOØ	Q-Register Bit Ø
$\overline{QTR}$	Q-Register to $\overline{R}$-Bus
RCK	ROM Clock
QAB	Q-Register to AB-Flip-Flop, also clears decimal carry.
SCB	Set Binary Carry
$\overline{BCD}$	Decimal Arithmetic
AC2	ALU Operation Code
QBC	Qualifier, Binary Carry
$\overline{S}$-Bus	Data Bus
AC1	ALU Operation Code
ACØ	ALU Operation Code
TO2	Bit 2 of T-Register
TO3	Bit 3 of T-Register
SDR	Signal to Disable ROMs
TO1	Bit 1 of T-Register
T-Bus	Data Bus
ALU	Arithmetic Logic Unit

(———) Indicates Negative True Signal

The following table gives an example of how the two ALU ROM chips shown in Figures 33A—D and 34 can be constructed to implement the above described ALU functions (in this table each "1" represents a "low" state and each "0" represents a "high" state):

ROM #1

/	1000;	1/	0000;	2/	0000;	3/	1000
4/	1000;	5/	0000;	6/	0000;	7/	1000
8/	0000;	9/	0000;	10/	0000;	11/	1000
12/	0000;	13/	0000;	14/	0000;	15/	1000
16/	0000;	17/	1000;	18/	1000;	19/	1000
20/	0000;	21/	1000;	22/	1000;	23/	1000
24/	1000;	25/	1000;	26/	1000;	27/	1000
28/	1000;	29/	1000;	30/	1000;	31/	1000
32/	1000;	33/	0000;	34/	0000;	35/	1000
36/	1000;	37/	0000;	38/	0000;	39/	1000
40/	0000;	41/	0000;	42/	0000;	43/	1000
44/	0000;	45/	0000;	46/	0000;	47/	1000
48/	0000;	49/	1000;	50/	1000;	51/	1000
52/	0000;	53/	1000;	54/	1000;	55/	1000
56/	1000;	57/	1000;	58/	1000;	59/	1000
60/	1000;	61/	1000;	62/	1000;	63/	1000
64/	1100;	65/	1100;	66/	1100;	67/	1100
68/	1100;	69/	1100;	70/	1100;	71/	1100
72/	0000;	73/	0000;	74/	0000;	75/	1000
76/	0000;	77/	0000;	78/	0000;	79/	1000
80/	0100;	81/	0100;	82/	0100;	83/	1100
84/	0100;	85/	0100;	86/	0100;	87/	1100
88/	0000;	89/	1000;	90/	1000;	91/	0100
92/	1000;	93/	0100;	94/	0100;	95/	1100
96/	1100;	97/	1100;	98/	1100;	99/	1100
100/	1100;	101/	1100;	102/	1100;	103/	1100
104/	0000;	105/	0000;	106/	0000;	107/	1000
108/	0000;	109/	0000;	110/	0000;	111/	1000
112/	0100;	113/	0100;	114/	0100;	115/	1100
116/	0100;	117/	0100;	118/	0100;	119/	1100
120/	0000;	121/	1000;	122/	1000;	123/	0100
124/	1000;	125/	0100;	126/	0100;	127/	1100
128/	0000;	129/	0000;	130/	0000;	131/	0000
132/	0000;	133/	0000;	134/	0000;	135/	0000
136/	0010;	137/	1010;	138/	1010;	139/	0110
140/	1010;	141/	0110;	142/	0110;	143/	1110
144/	0001;	145/	1001;	146/	1001;	147/	0101
148/	1001;	149/	0101;	150/	0101;	151/	1101
152/	0011;	153/	1011;	154/	1011;	155/	0111
156/	1011;	157/	0111;	158/	0111;	159/	1111
160/	0000;	161/	0000;	162/	0000;	163/	0000
164/	0000;	165/	0000;	166/	0000;	167/	0000
168/	0010;	169/	1010;	170/	1010;	171/	0110
172/	1010;	173/	0110;	174/	0110;	175/	1110
176/	0000;	177/	0000;	178/	0000;	179/	0000
180/	0000;	181/	0000;	182/	0000;	183/	0000
184/	0011;	185/	1011;	186/	1011;	187/	0111
188/	1011;	189/	0111;	190/	0111;	191/	1111
192/	0000;	193/	0000;	194/	0000;	195/	0000
196/	0000;	197/	0000;	198/	0000;	199/	0000
200/	1010;	201/	0010;	202/	0110;	203/	1010
204/	0110;	205/	1010;	206/	1110;	207/	0110
208/	1011;	209/	0010;	210/	0111;	211/	1011
212/	0111;	213/	1011;	214/	1111;	215/	0111
216/	1001;	217/	0001;	218/	0101;	219/	1001
220/	0101;	221/	1001;	222/	1101;	223/	0101
224/	0000;	225/	0000;	226/	0000;	227/	0000
228/	0000;	229/	0000;	230/	0000;	231/	0000
232/	1011;	233/	0011;	234/	0111;	235/	1011
236/	0111;	237/	1011;	238/	1111;	239/	0111
240/	0000;	241/	0000;	242/	0000;	243/	0000
244/	0000;	245/	0000;	246/	0000;	247/	0000
248/	1010;	249/	0010;	250/	0110;	251/	1010
252/	0110;	253/	1010;	254/	1110;	255/	0110

ROM #2

```
/  0000;   1/  0000;   2/  0000;   3/  0000
4/  0000;   5/  0000;   6/  0000;   7/  0000
8/  0000;   9/  0000;  10/  0000;  11/  0000
12/  0000;  13/  0000;  14/  0000;  15/  0000
16/  0000;  17/  0000;  18/  0000;  19/  0000
20/  0000;  21/  0000;  22/  0000;  23/  0000
24/  0000;  25/  0000;  26/  0000;  27/  0000
28/  0000;  29/  0000;  30/  0000;  31/  0000
32/  0000;  33/  0000;  34/  0000;  35/  0000
36/  0000;  37/  0000;  38/  0000;  39/  0000
40/  0000;  41/  0000;  42/  0000;  43/  0000
44/  0000;  45/  0000;  46/  0000;  47/  0000
48/  0000;  49/  0000;  50/  0000;  51/  0000
52/  0000;  53/  0000;  54/  0000;  55/  0000
56/  0000;  57/  0000;  58/  0000;  59/  0000
60/  0000;  61/  0000;  62/  0000;  63/  0000
64/  0000;  65/  0000;  66/  0000;  67/  0000
68/  0000;  69/  0000;  70/  0000;  71/  0000
72/  0000;  73/  0000;  74/  0000;  75/  0000
76/  0000;  77/  0000;  78/  0000;  79/  0000
80/  0000;  81/  0000;  82/  0000;  83/  0000
84/  0000;  85/  0000;  86/  0000;  87/  0000
88/  0000;  89/  0000;  90/  0000;  91/  0000
92/  0000;  93/  0000;  94/  0000;  95/  0000
96/  0000;  97/  0000;  98/  0000;  99/  0000
100/  0000;  101/  0000;  102/  0000;  103/  0000
104/  0000;  105/  0000;  106/  0000;  107/  0000
108/  0000;  109/  0000;  110/  0000;  111/  0000
112/  0000;  113/  0000;  114/  0000;  115/  0000
116/  0000;  117/  0000;  118/  0000;  119/  0000
120/  0000;  121/  0000;  122/  0000;  123/  0000
124/  0000;  125/  0000;  126/  0000;  127/  0000
128/  1111;  129/  1101;  130/  1011;  131/  1001
132/  0111;  133/  0000;  134/  0000;  135/  0000
136/  1101;  137/  1011;  138/  1001;  139/  0111
140/  1110;  141/  0000;  142/  0000;  143/  0000
144/  1011;  145/  1001;  146/  0111;  147/  1110
148/  1100;  149/  0000;  150/  0000;  151/  0000
152/  1001;  153/  0111;  154/  1110;  155/  1100
156/  1010;  157/  0000;  158/  0000;  159/  0000
160/  0111;  161/  1110;  162/  1100;  163/  1010
164/  1000;  165/  0000;  166/  0000;  167/  0000
168/  0000;  169/  0000;  170/  0000;  171/  0000
172/  0000;  173/  0000;  174/  0000;  175/  0000
176/  0000;  177/  0000;  178/  0000;  179/  0000
180/  0000;  181/  0000;  182/  0000;  183/  0000
184/  0000;  185/  0000;  186/  0000;  187/  0000
188/  0000;  189/  0000;  190/  0000;  191/  0000
192/  1101;  193/  1011;  194/  1001;  195/  0111
196/  1110;  197/  0000;  198/  0000;  199/  0000
200/  1011;  201/  1001;  202/  0111;  203/  1110
204/  1100;  205/  0000;  206/  0000;  207/  0000
208/  1001;  209/  0111;  210/  1110;  211/  1100
212/  1010;  213/  0000;  214/  0000;  215/  0000
216/  0111;  217/  1110;  218/  1100;  219/  1010
220/  1000;  221/  0000;  222/  0000;  223/  0000
224/  1110;  225/  1100;  226/  1010;  227/  1000
228/  0110;  229/  0000;  230/  0000;  231/  0000
232/  0000;  233/  0000;  234/  0000;  235/  0000
236/  0000;  237/  0000;  238/  0000;  239/  0000
240/  0000;  241/  0000;  242/  0000;  243/  0000
244/  0000;  245/  0000;  246/  0000;  247/  0000
248/  0000;  249/  0000;  250/  0000;  251/  0000
252/  0000;  253/  0000;  254/  0000;  255/  0000
```

MEMORY UNIT

The calculator uses an all semiconductor memory system. Peripheral circuitry is bipolar and the memory consists of n-channel MOS read-only memory (ROM) and p-channel MOS read/write memory (RWM).

Addressing and physical layout of the memory module is done so that the number of words can be increased from 5K in the basic machine to 9K in the largest machine. The smallest increment of memory that can be added is 512 words.

The basic machine contains 9.5K words of memory, organized into 7.5K x 16 ROM, and 2K x 16 RWM. The 16-bit RWM words are divided into user registers and processor words.

The largest machine contains 15.5K words of ROM and 4K words of RWM.

Read/Write Memory

As shown in Figures 35—37B memory is made up of 1024 x 1, dynamics, read/write memory chips (Intel 1103). These devices are P-channel, MOS using silicon gate technology. To maintain the contents of memory, the device must be refreshed every 2 ms. This is accomplished by performing a read cycle at a given address. On each chip are 32 refresh amplifiers so that each read cycle, 32 cells get refreshed. The entire chip is then refreshed by cycling through the lower 5 address bits and reading each distinct address. The refresh period is 20 μs at least every 2 ms.

Logic levels on all input lines to the RWM chips are 0 to + 16v. This includes the 3 clock lines (chip select, Y-enable or write, and precharge), 10 address lines, and input data. The output data, however, is a current of 600 μa or more into 1K ohms or less. This low level output is "wire-or able" with other chips to build larger systems.

Read Only Memory

As shown in Figures 35 and 38—40 ROM chips are 4096 bit, n-channel MOS arranged 512 x 8. The devices are static and consume no power when not enabled. Data is retrieved from the ROMs by pulling the chip enable line from 0 to + 12v (turning the chip on), addressing the desired cells (0 or 4v levels) and selecting which output devices are to be enabled (4v or 0v). The output levels are sufficient to drive one TTL gate directly, and can be "wire-or/ed" for large systems.

As further shown in Figures 41 and 42A—D each ROM chip comprises six input buffers. These input buffers generate both the input and its complement. On the basis of the 64 possible combinations of the 6-inputs I_0—I_5, one of the 64 lines in the decoder is selected. The selected line enables one of the vertical lines in the 64 x 64 bit storage array. For example, let I_0—I_5=0 and I_6—I_8 be "don't cares". This means line X00 (octal) is selected.

The two 8 out of 32 select decoders must choose 16 lines from the 64 horizontal lines selected by the vertical line X00. (The 8 out of 32 select decoder is actually a 2 out of 8 decoder repeated 4 times in each of the sections A—B). The output from four MOS Fet's a, b, c, and d are "wire or/ed." MOS devices a', b', c', and d' are also connected similarly. If I_6 and $I_7 = 0$, horizontal lines 1XX, 2XX, 3XX, 5XX, 6XX, 7XX are grounded in each of the four sections A—B. This insures that MOS FET's b, c, d, b', c', and d' are non-conductive. This allows signals on lines 0XX and 4XX to pass into the output sections through transistors a and a'.

The output section contains the output buffer, 1 of 2 decoder, and the output drivers s. The output buffer provides a stage of gain and "wire or 's" 4 lines from the storage array. The 1 of 2 decoder clamps the gates of 2 of the 4 output drivers in each section A—B by enabling either line I_8 or its complement ($\overline{I_8}$). This disables 1 of 2 signals coming from the output buffer. The output drivers then can be tied together with line (e) for a 512 x 8 organization.

Each of the above-listed constants and routines and subroutines of basic instructions employed by the calculator is stored in these ROM chips. The sixteen bits of each constant and basic instruction are stored in the $512_{10} \times 8_{10}$ ROM chips by organizing the ROM chips into 64 x 64 bit matrices and computing the row and column numbers of each bit of each matrix by operating on each address and the particular bit (15 through 8, or 7 through 0). The column number is computed by subtracting the last two digits of the address from 100_8. For example, the column number of address $000=100_8-00_8=100=64_{10}$ and the column number of address $777=100_8-77_8=1$. The computation of the row number (referred to as IR in the

flowchart of Figure 44) can best be described by referring to the flowchart of Figure 44 and the associated table of Figure 45. Once the row and column numbers are found it is a simple matter of storing in that location of the matrix that particular bit (i.e., a "1" or a "0"). A "0" is stored at a designated location by forming a metal gate to complete a MOS FET device at that location, and a "1" is stored at a designated location by leaving off the metal gate so that a MOS FET device is not formed at that location.

M-Register

As shown in Figures 35 and 46 A—B included on the M-Register board is the 16-bit Address or M-Register, all chip enable decoding and buffering, and address buffers for both ROM and RWM. The register uses four, four bit, serial in and out, parallel in and out shift Registers. Upon receipt of a TTM instruction from the microprocessor, serial data from the T-Bus is accepted into the M-register. Nothing is done with this data until either a read or write instruction is received, then one of two decoders are enabled. These chip Enable decoders uniquely decode which block of 512 words, either ROM or RWM, is being addressed. If ROM is being addressed, the signal is inverted and amplified to +12v. For RWM the Chip Enable enables a gate, which allows a 16 Volt clock signal to reach the enabled RWM chips. The clock wave-form is generated on the control card.

The dynamic characteristic of the RWM chips, requires that all chips be enabled simultaneously during a refresh cycle, to refresh the entire read/write memory. The buffer circuits in the output of the Chip enable decoders allow the chip select clock to reach all of the RWM chips during refresh but only those being accessed, during a read or write cycle.

Totem Pole outputs or gates with resistor pull-ups are used as buffers for the ROM address lines. Using the totem pole output gates, the effects of crosstalk can be minimized while the resister pullup lifts the address lines above the required 4v level. The nand gates are enabled during a memory cycle so that the ROM address lines are inhibited at a 5v level. The RWM address lines must pull from 0v to + 16v. High voltage, open collector, inverters with discrete transistor pull-ups are used as buffers for all the address bits.

Control

A memory cycle consists of a read or write instruction from the processor accompanied by 12 clock pulses from the shift clock. As shown in Figures 35, 46 A—B and 74A—B, control uses these pulses and instructions to generate the clocks required by the RWM chips. A synchronous system of flip-flops and gates are used. The outputs from the flip-flops are then buffered to become the required clock signals (Pre-charge, Y-enable, chip select).

Refreshing the read/write memory is also taken care of by the control. An astable multivibrator with a repetition rate of 500 HZ minimum generates a signal which allows a refresh cycle to occur. A flip-flop generates the actual signal (REF), but only if the astable multivibrator signal is high, there is no read or write cycle in progress and the processor signal, $\overline{CCT}$, is high. $\overline{CCT}$ goes high between processor instructions, thus it is known that nothing is going to be interrupted when REF is generated. REF is then buffered by an open collector inverter and given to the processor $\overline{INH}$. $\overline{INH}$ halts the machine and the refresh cycle begins.

The same system used for a memory cycle is used during refresh to again generate the necessary clocks (Precharge and chip select). When the system returns to state 0 and REF is present, a counter is advanced one count. This counter provides the refresh addresses which go to the RWM only if REF is present. When this counter returns to state 0, it causes REF and $\overline{INH}$ to return to preset conditions and the machine continues normal operation.

Another function of the control is to provide for extended memory capability. The control handles any external memory as if it were an extension of the internal memory. From the user's point of view, he does not need to know if an extended memory is connected other than the fact that available memory has increased.

In addition, the control has the provision for extracting information from or loading information into the calculator T-Register through the D-Bus (data bus).

Other signals generated on the control are employed to direct the flow of data in the T-register.

T-Register

Data to and from the memory is temporarily stored in the T-register. As

shown in Figures 35 and 48A—B four 4-bit, serial in and out, parallel in and out shift registers make up the actual T-register. The registers have a mode control (TMC) which when low, allows serial data flow and when high, allows parallel data flow.

Serial data enters the T-register in the presence of the $\overline{TTT}$ instruction, and in the presence of a $\overline{TTS}$ recirculated in the T-register to prevent loss of data.

Parallel data is accepted from either ROM or RWM during a read cycle. The ROM data is buffered by NAND gates and the RWM by sense amplifiers followed by the same NAND gates. All 16 bits are read from the ROM simultaneously. Eight bits are read from RWM twice during a read cycle. The eight bits to be written into RWM have their own discrete buffer stage that translates T^2L logic levels into 16v logic levels used by the RWM.

MEMORY STYSTEM MNEMONIC TABLE

SIGNALS GENERATED OUTSIDE MEMORY I/O CONNECTOR

$\overline{CCT}$ —	Control clock-not, the inverted envelop of SCK.
SCK —	Shift clock.
MCK —	Memory clock, a continuous pulse train, used by the memory control for timing of the memory and refresh cycles.
IOD —	I/O Data. Goes to control board to be gated to $\overline{S}$-BUS.
ITS —	I/O to $\overline{S}$—BUS, the signal which gates IOD to $\overline{S}$-BUS.
SCO & SCI —	Coded signals which generate UTS — Units to $\overline{S}$-BUS ZTS—Zero to $\overline{S}$-BUS MTS — M-Reg to $\overline{S}$-BUS TTS — T-Reg to $\overline{S}$-BUS
$\overline{TTT}$ —	T—BUS to T-Reg, OV=True.
T—BUS	Data on this bus acts as inputs to M & T registers.
$\overline{RDM}$ —	Read memory, negative true. Lasts for 12 clock pulses.
$\overline{WTM}$ —	Write memory, negative true. Lasts for 12 clock pulses.
$\overline{INH}$ —	Inhibit, negative true. The processor is stopped whenever $\overline{INH}$ is at zero volts. The memory control generates this signal while a R/W memory refresh cycle is present. I/O also generates it.

OTHER SIGNALS AT I/O CONNECTOR

Name	Source
T00	T-Register
T01	,, ,,
T02	,, ,,
T03	,, ,,

D-BUS —	Data Bus — external data (extended memory data) enters machine via this bus.
$\overline{EDT}$ —	External Data Transfer gates D-Bus data into machine O^v=True.
$\overline{EMB}$ —	Extended memory busy. Signal provided by extended memory that tells memory control.

a. Extended memory cycle is complete
b. Extended memory is present.

SIGNALS GENERATED ON READ/WRITE MEMORY CARDS

RWD(XX) — Read/Write data. Output from the 1103 memory.

600μa into 150~=~1
0 current =0

OTHER SIGNALS USED BY (RWM)

Name	Source
AØØ-A04	CONTROL
A05-A09	M-REG
CEN	M-REG
RWI(XX)	T-REG
R/W	CONTROL
PCG	CONTROL

SIGNALS GENERATED ON T-REGISTER CARD

T00-T15 — T-register data bits. Used as data into memory T00-T03 are also outputs to the CPU. (4 bit processing).

RWI(XX) — Read/Write inputs. T-register data gates to Read/write memory. +16V→GND.

OTHER SIGNALS USED BY T-REGISTER

Name	Source
ROD(XX)	ROM
TRI	CONTROL
TSC	CONTROL
$\overline{\text{TMC}}$	CONTROL
TPC	CONTROL
RWD(XX)	R/W MEM
RWE	M-REG

SIGNALS GENERATED ON M-REGISTER CARD

M00-M15 — M-register data bits. Used to generate address and chip select information. (M00 also is gated out on $\overline{\text{S}}$-BUS by MTS).

I00-I07 — ROM address bits. Decodes down to two bits available at ROM output buffers.

I08-$\overline{\text{I08}}$ — Selects which ROM output buffers are enabled.

SIGNALS GENERATED ON M-REGISTER CARD (Continued)

CS(XX) — Chip enable, basic machine selects which ROM chips are turned on (+12V—ON)

AEN — Address enable. AEN=RDM+WTM

A05-A09 — Address bits for R/W memory. (+16V & GND)

CEN — Chip select, basic machine a negative true clock which selects which R/W chips are turned on. (+16V & GND)

RWE — Read/Write enable. A+5V signal any time a R/W chip is addressed for a machine memory cycle.

OTHER SIGNALS USED BY THE M-REGISTER

Name	Source
T-BUS	PROCESSOR
SCK	,,
$\overline{\text{RDM}}$	,,
$\overline{\text{WTM}}$	,,
$\overline{\text{TTM}}$	,,
VLD	CONTROL
MTS	,,
$\overline{\text{REF}}$	,,

SIGNALS GENERATED BY CONTROL

VOR — A signal generated half way through the memory cycle to disable the active pull up devices on the ROM outputs.

TRI — T-Register input TRI=(T-BUS) . (TTT)+(T00) . (TTS)

MTS — M-register to $\overline{\text{S}}$-BUS. Generated from SC0, $\overline{\text{SC1}}$

A00-A04 — Address bits for R/W memory also used during memory refresh.

$\overline{\text{TSC}}$ — T-Register series clock. $\overline{\text{TSC}}=\overline{\text{SCK}}.(\text{TTS}+\text{TTT}+\text{EDT})$

TPC — T-Register parallel clock. (Strobes in data from memory) only only during internal memory read cycle.

R/W — Read/Write. A clock which left at+16V for a read and clocked to GND during a write. (R/W memory only)

PCG — Precharge. The 3rd 16V clock required by the 1103 R/W memory chips.

$\overline{\text{REF}}$ — Refresh. OV when the memory is in a refresh cycle.

SIGNALS GENERATED BY CONTROL (Continued)

$\overline{CEM}$ — Call extended memory. Prevents ROM clock from changing μ processor states. Given for all read and write commands. Signal is removed if the memory cycle is not extended memory cycle. If extended memory cycle, $\overline{CEM}$ is removed after extended memory has completed cycle. O^V=True.

$\overline{S}$-BUS — Gates I/O register, data, T00, M00 or ones onto $\overline{S}$-BUS and sent to processor. 0=True.

$\overline{INH}$ — Inhibit, negative true. The processor is stopped whenever $\overline{INH}$ is at zero volts. The memory control generates this signal while a R/W memory refresh cycle is present. I/O also generates it.

$\overline{TMC}$ — T-reg mode control. $\overline{TMC}$=0; T-reg is set up to accept information from memory. TMC=1; T-reg. is set up to shift serially.

$\overline{EMC}$ — Extended memory cycle. $+5^V$ signal used to signal extended memory to begin its cycle. 0^V=True.

VOR — A signal generated half way thru memory cycle to allow data to flow out of ROM.

OTHER SIGNALS USED BY THE CONTROL

Name	Source
$\overline{CCT}$	PROCESSOR
TOO	T-REG
IOD	PROCESSOR
ITS	,,
SCO	,,
SCI	,,
$\overline{TTT}$	,,
T-BUS	,,
SCK	,,
$\overline{RDM}$	,,
$\overline{WTM}$	,,
MCK	,,
M00-M04	M-REG
AEN	M-REG
$\overline{EDT}$	EXTENDED MEMORY
D-BUS	I/O CONNECTOR
$\overline{EMB}$	EXTENDED MEMORY

SIGNALS GENERATED ON ROM BOARD

ROD(XX) — Read Only Data

OTHER SIGNALS USED BY ROM

Name	Source
CS(XX)	M-REG
100—107	M-REG
108 $\overline{108}$	M-REG
VOR	CONTROL

INPUT-OUTPUT CONTROL UNIT

The input-output control unit allows the calculator to communicate with the internal input, input-output, and output units and with external peripheral devices. As shown in Figures 31 A—C and 49 A—D, the input-output control unit is contained on two printed circuit boards, the "control and system clock" board and the "I/O register and gate interface" board. A third board, shown in Figure 50, is an I/O motherboard providing room for connecting four external interface cards to the calculator.

The internal input, input-output, and output units are distinguished from peripheral devices by the fact that the I/O language set addresses them directly. Hence, each I/O instruction contains an internal peripheral address as part of its makeup. The four internal directly-addressable input, input-output, and output units are the I/O register, the magnetic card reading and recording unit, the output printer unit and display unit.

The external peripheral devices are indirectly addressable and are connected via cable to an interface card which is plunged into the I/O motherboard at the rear of the calculator. The term indirectly addressable is defined here to mean the external peripheral devices are addressed by lines leading from the four most significant bits in the I/O register, thereby requiring an address word to be loaded into the directly addressable I/O register.

I/O CONTROL AND SYSTEM CLOCK SECTION

The function of the I/O control and system clock section is to provide control to the I/O register and gate interface section. This is accomplished by use of an I/O instruction set stored in the main memory of the calculator.

The microprocessor causes instructions from the memory unit to be loaded into the T-Register and then to be transferred to the Q-Register. The microprocessor determines the type of instruction and causes the proper execution of the instruction. If the instruction is an I/O type, control is transferred by the microprocessor to the I/O control and system clock section.

The microprocessor remains in a two-state waiting loop while the I/O control section is active. Time in the wait loop is between .72 micro seconds and 6.5 micro seconds.

Bits 5 through 10 from the Q-Register are connected to the I/O control section and remain constant during an I/O instruction execution time. Bits 5 through 8 representing the I/O instruction code are gated to the I/O address flip flops and entered on each clock time while the I/O is inactive. The four outputs of the address flip flops are connected to the address input of a 1 of 16 decoder and represent the starting state address of the I/O instruction to be executed. When the I/O control section is enabled, the input gates passing bits 5 through 8 to the I/O address flip flops are closed and the 1 of 16 decoder enabled. This allows the starting state I/O micro instructions to come from the 1 of 16 decoder. The next state address coming from the closed input gates will be the exit state ($1111=17_8$) unless modified by reopening the gates to let the original starting state code through or by modifying the output of one or more of the input gates using a "wire or" connection coming from the 1 of 16 decoder output. This address is sent to the I/O address flip flops inputs and clocked in on the leading edge of the first half

clock cycle. The first half clock cycle turns off the 1 of 16 decoder and the address changes. The second half clock cycle enables the 1 of 16 decoder, allowing the next state micro instruction to appear. (See Figure 51 for the timing described above). This process continues until the exit state is encountered. On the exit state, the I/O Control is disabled and control is returned to the microprocessor.

The I/O instructions involving the transfer of data between the I/O and the CPU (OT, LI, MI), require 16 passes through the same state (1 pass for each of 16 bits). This is achieved by checking the output of a 16-bit down counter and then decrementing after each pass through the state. If the counter indicates "O" has not been reached, it causes the starting state address to be reloaded into the address flip flops by opening the input gates. When 16 passes have been indicated by the counter, the input gates are not allowed to open; however, the next state (1111) is modified by the output of the 1 of 16 decoder through a "wire or" connection on the 2nd bit to give state 1101. This address is input to the I/O address flip flops as in the preceeding paragraph.

The above-described operation of the I/O control section is also illustrated and further described in the flow chart of Figure 52.

Bit 9 is called a hold/clear bit. It allows a clear flag (CLF) to take place or not to take place after execution of the other I/O instructions (STF excepted).

Bit 10 is used in conjunction with the micro instructions $\overline{\text{PTR}}$ and $\overline{\text{XTR}}$ to give control to the I/O.

The I/O control and programmable clock mnemonics are given in the following table:

I/O CONTROL BOARD MNEMONICS

$\overline{\text{CC}\emptyset}$	Clock Code Zero
CC1	„ „ One
CC2	„ „ Two
CC4	„ „ Four
CC8	„ „ Eight
CCT	Control Clock to Tester
CEM	Call Extended Memory
$\overline{\text{CLC}}$	Clear Control
CLF	Clear Flag
DRC	Data Register Clock
EBT	Eight Bit Transfer
EOW	End of Word
$\overline{\text{IIO}}$	Inhibit Internal OSC
$\overline{\text{INH}}$	Inhibit Clock
$\overline{\text{IPS}}$	Inhibit Primary/Secondary
ITS	Input to S-Bus
MCK	Memory Clock
$\overline{\text{POP}}$	Power On Pulse
$\overline{\text{PTR}}$	P-Reg to R-Bus

I/O CONTROL BOARD MNEMONICS (Continued)

QFG	Qualifier Flag
Q5	,, Five
Q6	,, Six
Q7	,, Seven
Q8	,, Eight
Q9	,, Nine
Q10	,, Ten
QRD	,, ROM Disable
RCA	ROM Clock Address
RCF	ROM Clock Flip Flop
SCB	Set Carry Bit
SCK	Shift Clock
SCT	,, ,, to Tester
$\overline{\text{SRA}}$	Service Request Acknowledge
STC	Set Control
STF	Set Flag
TCK	Tester Clock
TTO	T-Bus to Output
$\overline{\text{TTX}}$	T-Bus to A/B Reg.
XTO	External OSC
$\overline{\text{XTR}}$	A/B Reg. to R-Bus

Note:

($\overline{\quad}$) indicates negative true signal

I/O REGISTER AND GATE INTERFACE SECTION

As shown in Figures 49 A—D, the directly addressable I/O register (address 01) is a 16 bit universal parallel in/out, serial in/out) register that is connected to the calculator processor by the serial-in S-Bus and the serial-out T-Bus. Information is passed non-inverted from the A or B registers bit serial to the I/O register with the I/O instruction OXT Ø1. Sixteen lines connected to the parallel outputs of the I/O register provide data out to the internal input, input-output, and output units and to the external output interfaces. (NOTE: each I/O unit or interface may place only 1 TTL load on the output lines.)

Parallel entry to the I/O register is through 12 party lines connected to the 12 least significant parallel inputs. The input lines are negative true with all input interfaces tying to the lines through open collectors. Care must be taken to insure there is no disturbance to the lines while an interface is inactive. Input information is passed inverted to the A or B register bit serially with the I/O instructions LIX Ø1 or MIX Ø1. (The inversion puts positive true information into the A or B register).

Input information is entered into the I/O register in three ways:

a) Service Request.

Entry by the service request method is controlled by a service inhibit flip flop. When the service inhibit flip flop has been cleared with the I/O instruction CLF Ø1, a service request may be initiated by returning the $\overline{SSI}$ (Service Strobe Input) party line to ground through an open collector on the interface. This signal causes the parallel inputs to be strobed into the I/O register and sends a request for service (QNR) to the microprocessor. The microprocessor prior to receiving a request for service would have been cycling through various instruction paths and checking for a service request after execution of each instruction. Upon receipt of a request for service, the processor interrupts the sequence of instructions it was doing and loads an address into the M-Register which contains the starting address of the service routine. At the same time a signal, $\overline{SRA}$ (Service Request Acknowledge), turns off the service inhibit flip flop and also sets the single service flip flop which permits only one service interrupt to the processor per service strobe input. The single service flip flop is reset when the service strobe is removed. All lines from an interface using the service request method for entering information are inhibited when the service inhibit flip flop is set.

b) Return of Channel Flag After Command is Given to an External Peripheral Device.

This method implies the calculator must control the peripheral. That is to say the calculator transmits the indirect address and control enable ($\overline{CEO}$) from the "I/O Register and gate interface" section to the interface with the expectation of information being returned by the peripheral through the interface to the I/O register. Because of this expectation, only limited instructions may be performed by the calculator while waiting. The service request method must be inhibited during this wait so that input information is not destroyed by another peripheral using service request. When a controlled peripheral responds, its flag and data are processed at the interface. The signal $\overline{CFI}$ (Channel Flag In) causes the loading of parallel data from the interface into the I/O register and clears the control enable flip flop so that the $\overline{CEO}$ signal is removed from the interface. The calculator can interrogate the control enable flip flop with the instructions SFS Ø1 or SFC Ø1 to determine when data has been loaded in.

c) Giving the I/O Instruction STF Ø1.

The instruction STF Ø1 as described in (a) sets the service inhibit flip flop inhibiting the service request mode of entry. The STF Ø1 instruction also causes a parallel load of the input lines into the I/O register.

The output display (address 08) receives information from the I/O register. A 16 bit word is transferred to the I/O register with the instruction OTX Ø8. The address Ø8 allows the display enable flip flop to be set with the micro-instruction EOW after the 16th bit has been transferred. The display enable flip flop sends a signal $\overline{DEN}$ to the display indicating information is ready in the I/O Register. The display enable flip flop is cleared with the I/O instruction CLF Ø8.

The keyboard operates as described below. 7 bit ASCII assigned keycodes are entered into the calculator by an interrupt process. When a key on the keyboard is depressed the keyboard interface card requests service. Input data is stored along with the request for service on the keyboard interface card. The stored signal for service is gated with the Prevent Interrupt signal through an open collector NAND gate onto the Service Request party line (SSI = Low for service). The giving of Service Request causes the I/O register to be loaded. However, input data from the keyboard interface card is not enabled yet. Thus all status and data inputs are high. This indicates to the CPU that a keyboard is interrupting. An OT x 16 instruction is given by the firmware. The select code of 16 enables the gate of the data input lines by a STF 1 instruction and data is loaded into the I/O register. LIA Ø allows data to be taken from the I/O register.

All external peripheral interfaces are indirectly addressed from the four most significant bits in the I/O register. Thus to communicate with an external peripheral, an address (ØØØØ excluded) must be loaded into the I/O register. Data and status will be loaded at the same time if the peripheral is to act as a receiver. If the peripheral is to act as a transmitter, only the address and status need be loaded. Next, the I/O instruction STC Ø1 sets the Control Enable Out flip flop. This flip

flop sends a signal $\overline{CEO}$ to all external interface slots. The $\overline{CEO}$ signal and the decoded (from the 4 bit address) address allows the interface to command the peripheral. After the peripheral has responded, information given back to the interface by the peripheral is processed to the I/O register in the manner described above under (b) "Return of Channel Flag After Command is Given to an External Peripheral Device".

The I/O register and gating control circuit mnemonics are given in the following table:

I/O REGISTER AND GATE BOARD

$\overline{CEO}$	Control Enable Out
$\overline{CFI}$	Channel Flag In
CLF	Clear Flag
CO∅, 1, 2, 3	Code Out
$\overline{DEN}$	Display Enable
DI∅, 1,2,3,4,5,6,7	Data In
DO∅, 1,2,3,4,5,6,7	Data Out
DRC	Data Register Clock
EBT	Eight Bit Transfer
EOW	End of Word
IOD	I/O Data
KLS	Key Lights Strobe
MCR	Mag Card Reset
$\overline{MFL}$	Mag Flag
MLS	Mag Latch Strobe
PEN	Printer Enable
$\overline{POP}$	Power On Pulse
$\overline{PTF}$	Printer Flag
Q∅	Qualifier Bit ∅
Q1	,, ,, 1
Q2	,, ,, 2
Q3	,, ,, 3
Q4	,, ,, 4
QFG	,, Flag
QNR	,, Not Request
$\overline{SIH}$	Service Inhibit
SI∅, 1,2,3	Status In

I/O REGISTER AND GATE BOARD (Continued)

SOØ, 1,2,3	Status Out
$\overline{SRA}$	Service Request Acknowledge
$\overline{SSI}$	Service Strobe In
STC	Set Control
STP	Stop
STF	Set Flag
T-Bus	T-Bus
TTO	T-Bus to Output

NOTE: ($\overline{\quad}$) indicates negative true signal

As shown in Figure 53, when addressing a peripheral device, bits loaded into the 4 most significant locations in the I/O register from the CPU constitute the peripheral address code. As part of the output party line system the address code is routed to all I/O interface slots. Each I/O interface card decodes the 4 line address code to a unique single line for use on that particular I/O card. The binary codes 10 through 15 have been reserved for dedicated peripheral addresses which are used by dedicated keys (from the keyboard) and dedicated I/O drivers. Binary codes 1 through 9 are for general use. Code "0" is a non-addressing code and is used in operations that do not involve addressing a specific peripheral. The following table summarizes the address code assignments:

ADDRESS CODE ASSIGNMENTS

ADDRESS	4-BIT CODE	ASSIGNED PERIPHERAL
15	HHHH	TYPEWRITER
14	HHHL	PLOTTER
13	HHLH	
12	HHLL	KEYBOARD & KEYBOARD-LIKE PERIPHERALS
11	HLHH	
10	HLHL	
9	HLLH	GENERAL USE; ONE OF NINE SELECTABLE
8	HLLL	,,
7	LHHH	,,
6	LHHL	,,
5	LHLH	,,
4	LHLL	,,
3	LLHH	,,
2	LLHL	,,
1	LLLH	,,
Ø	LLLL	USED ON INTERRUPT I/O INTERFACE CARDS WHEN THE INTERRUPT BECOMES ENABLED

The general usage codes (1—9) are decoded outputs from a 4 line to 1 of 10 decoder (SN 7442 for exampie). It is intended that the codes 1 through 9 be jumper selectable. This would allow the user to select a code for his system peripherals or allow him to use more than one of the same peripheral by selecting different address codes.

Since the I/O register is used to communicate with the internal input, input-

output, and output units as well as peripheral devices, a given peripheral's address code will appear randomly in the I/O register address field with there being no intention of expecting the peripheral to respond: Therefore, a second piece of information is necessary for the I/O interface card to form a unique signal which will indicate to the peripheral to respond. This second piece of information is control information and is described hereinafter.

The I/O interface cards contain TTL compatible logic for manipulating control and data from the calculator and/or the peripheral. All I/O interface cards which are intended to be used with the calculator must provide storage either on the I/O interface card or in the peripheral. Thus data being transferred from the calculator to the I/O card must be stored at the instant the peripheral is requested to respond. Likewise data coming from a peripheral must be stored until the calculator accepts it. This requirement is important and must be considered on all compatible interface cards.

The calculator can supply up to 100 ma. maximum at +5 volts to each I/O interface card. Power exceeding this absolute maximum must be supplied by the peripheral.

The following table lists the pin assignments for all I/O lines at the plug-in slots on the calculator back plane, as viewed from the rear of the calculator, left to right.

EXTERNAL I/O INTERFACE PIN ASSIGNMENTS

1	⊥	A	⊥
2	+5	B	+5
3	USED	C	USED
4	USED	D	10/20
5	USED	E	USED
6	DI Ø	F	DO Ø
7	DO 1	H	DO 2
8	DI 3	J	DO 3
9	DI 2	K	DI 1
10	DO 4	L	DI 4
11	DO 5	M	DI 5
12	DO 6	N	DI 6
13	DO 7	P	DI 7
14	SO Ø	R	SI Ø
15	SO 1	S	SI 1
16	SO 2	T	SI 2
17	SO 3	U	SI 3
18	CO Ø	V	CO 1
19	CO 2	W	CO 3
20	$\overline{\text{SSI}}$	X	$\overline{\text{SIH}}$
21	$\overline{\text{CEO}}$	Y	$\overline{\text{CFI}}$
22	⊥	Z	$\overline{\text{STP}}$

The chart below lists all I/O lines with brief definitions and specifications and Figure 50 shows the source and relative relationship of the I/O lines. The output address data lines (Co 0—3) transmit the address code along the party lines to all interface slots. These lines will go high and low according to information being shifted in or out of the I/O Register. At anytime a peripheral is addressed the lines will become steady 1 instruction time (8 μs) before control information is passed to the I/O interface card or before data or status is taken from the I/O interface card and will remain constant until the control information is removed. After the control information is removed, the state of the I/O lines become unpredictable until the next addressing takes place. Address data coming to the I/O interface card is positive true and each interface may place 1 TTL load on each address line.

I/O Line Specification Chart

	Name of Line	Line Definition	Direction	Load/Loading	Voltage		# of Lines
					High	Low	
1	Address Data (CO Ø–3)	Transmits a 4 bit address from the I/O Register to be recognized by an interface card. (Data = High)	Out	1 TTL (1.6 ma) allowed per interface.	≥2.4v	≤.4v	4
2	Device Ready $\overline{\text{CEO}}$	Indicates calculator is ready for information interchange with an addressed peripheral. (Active State = Low)	Out	1 TTL (1.6 ma) allowed per interface.	≥2.4v	≤.4v	1
3	Device Request $\overline{\text{(CFI)}}$	Acknowledges receipt of data by a peripheral from the calculator or indicates data is to be input to the calculator. (Active State = Low)	In	Loading of 6.6 ma to the interface card.	1k resistor to + 5v. use open collector.	Must be driven below .4v.	1
4	Halt Status $\overline{\text{(STP)}}$	Indicates stop key has been depressed. (Active State = Low)	Out	1 TTL (1.6 ma) Allowed/interface.	≥2.4v	≤.4	1
5	Input Data (DI Ø–7, SI Ø–3)	Receives input data to I/O register. (Data = Low)	In	Loading of 6.1 ma	1k Res. To + 5v	Driven ≤.4v	12
6	Output Data (DO Ø–7, SO Ø–3)	Transmits Data from the I/O register. (Data =High)	Out	1 TTL (1.6 ma) Allowed/interface.	≥2.4v	≤.4v	12
7	Prevent Interrupt $\overline{\text{(SIH)}}$	Indicates data cannot be entered under service request. (Interrupt) (Active State =Low)	Out	1 TTL (1.6 ma) Allowed/interface.	≥2.4v	≤.4	1
8	Service Request (Lo) $\overline{\text{(SSI)}}$	Indicates a CPU interrupt is to take place to allow data to enter. (Active State = Low)	In	Loading of 6.6 ma	1k Res. to + 5v	Driven ≤.4	1

The output data lines (DO 0—7) output data from the A or B accumulator in 8 bit bytes from the 8 least significant locations in the I/O register to all interface card slots. The logic state is positive true (Data = 1 = High). Each interface card may place 1 standard TTL load on each data line.

The output data status lines (SO 0—3) output status data from the A or B accumulator and are driven from the next four locations above the data out positions in the I/O register. (DO positions = 0 to 7; SO positions = 8 to 11). These lines are used for sending additional information to a peripheral. The logic state is positive true. One standard TTL load may be placed on each output data status line. (Special drivers, fast data transfer, and interrupt do not make use of SO 3).

The input data lines (DI 0—7) transmit input data in 8 bit bytes to the 8 least significant bit positions of the I/O register (Locations 0 to 7) from the I/O interface card. Each "Data In" line has a 1K pull up resistor to +5 volts and under the party line system must be driven low for a logical 1 from open collector gates on each addressed I/O interface card. The logic state is negative true.

The input data status lines (SI 0—3) receive information from the I/O interface cards and transmit it to location 8 through 11 in the I/O register. Each line has a 1K pull us resistor to +5 volts. These lines are used to provide additional information to the calculator about the state of a peripheral. The logic state is negative true.

The negative true "Device Ready" output line ($\overline{CEO}$) transmits a control signal, which when combined with an address code will initiate a peripheral response on the addressed I/O interface card. "Device Ready" is controlled by the I/O interface driver and therefore may look different depending upon the driver. For example, when the calculator wishes to transmit data to the I/O interface card or to initiate a peripheral response prior to receiving data from the peripheral, the calculator causes the "Device Ready" output line to go low and stay low until the peripheral response is over and the calculator receives the signal "Device Request" ($\overline{CFI}$) from the I/O interface card. The "Device Ready" flip-flop always receives a clear signal whenever the I/O interface completes a parallel load.

The "Device Request" party line $\overline{CFI}$ when driven low from an open collector gate on the I/O interface card will cause the loading to parallel input information into the 12 least significant locations of the I/O register. The active state of the line is low (negative true).

The peripheral flag, indicating to the I/O interface card the peripheral has received data/control or is ready to input data, is gated through an open collector nand gate onto the "Device Request" ($\overline{CFI}$) party line. The open collector gate is enabled by the I/O interface card's address and "Device Ready" ($\overline{CEO}$). The "Device Request" line is pulled up inside the calculator by a 1K resistor to +5 volts.

The "Device Request" (CFI) signal must stay low until "Device Ready" ($\overline{CEO}$) has been cleared (goes high). At this time data transfer has terminated and peripheral's flag and control must be cleared in preparation for the next pass. Since a parallel load in the I/O register causes the "Device Ready" flip-flop to receive a clear signal, when a "Device request" ($\overline{CFI}$) is entered, a parallel load takes place and afterwards "Device Ready" ($\overline{CEO}$) is cleared. The calculator uses "Device Request" in its general mode of data transfer.

The "Halt Status" output line ($\overline{STP}$) is a line that goes low when the STOP key on the calculator is depressed. It will stay low for the duration of the key depression. One standard TTL load may be placed on this line by each I/O interface card.

The "Prevent Interupt" output line ($\overline{SIH}$), when low indicates to the I/O interface card that a request for service must not be given to the calculator. One standard TTL load may be placed on this line by each I/O interface card.

The "Service Request" (Lo) line ($\overline{SSI}$), when driven low causes the loading of parallel input information into the 12 least significant locations of the I/O register and causes a CPU interrupt for service. The peripheral's request for service is gated with the "Prevent Interrupt" (SIH) line onto the "Service Request" party line through an open collector nand gate. A 1K pull-up resistor to +5 volts is connected to the line inside the calculator.

The general format for all data transfer consists of 8 bit parallel bytes. Other data formats are handled by specially developed drivers, such as the ROM plug-in module employed for driving the typewriter.

The state of a peripheral is generally checked before attempting an output. This is done by first inhibiting the interrupt system. The address of the I/O

interface card is shifted into the I/O register. The decoded address code enables the open collector gates on the I/O interface card. The status of the peripheral is passed to the "Status In" lines and loaded into the I/O register with an I/O instruction issued by the calculator. The I/O register information is transferred to the A or B accumulator and processed. If the peripheral is ready, the output data word consisting of the address code, output status (if necessary) and the eight bit data byte is formed in the A or B accumulator. The output data word is transferred to the I/O register after which the "Device Ready" ($\overline{CEO}$) flip-flop is set. The I/O interface card receives the data, address code and "Device Ready" and a peripheral response is initiated. The calculator interrogates the state of the "Device Ready" flip-flop to determine when the I/O interface card has received the information and the peripheral response is done. The peripheral I/O interface card signals the calculator it is done by transmitting the "Device Request" ($\overline{CIF}$) signal to the calculator. The output waveforms are shown in Figure 54.

Before inputing data from the I/O interface card it is necessary to determine if the peripheral has responded and is ready to input data. After a peripheral response has been initiated, as described previously, the calculator waits for the "Device Request" ($\overline{CFI}$) which loads the data into the I/O register and clears the "Device Ready" ($\overline{CEO}$). The calculator checks the state of "Device Ready" and when it goes false ($\overline{CEO}$ = HIGH), the calculator knows data is present in the I/O register and proceeds to shift it into the A or B accumulators for processing. The input waveforms are shown in Figure 61.

When blocks of data are to be transferred between a peripheral and the calculator, the interrupt is turned off, and transfer rates as high as 100,000 bits/sec may be possible. Before either input or output of a block of data can start, it is necessary for the calculator to check the status of the peripheral to see if it is turned on and ready. The address locations of the I/O register will remain unchanged during the block transfer. A single I/O instruction shifts the 8 bit byte of data from the 8 least significant locations in A or B to the 8 data locations in the I/O register; gives :Device Ready ($\overline{CEO}$ goes low) 120 nanoseconds after the shift is completed; and shifts the 8 most significant bits in A or B to the 8 least significant locations in A or B in preparation for the next transfer. (Note the address and status field in the I/O register are not disturbed in the shifting). "Device Ready" stays true (low) until the peripheral has received the data and is ready for more. The I/O interface card then returns "Device Request" ($\overline{CFI}$) to the calculator. The receiving the "Device Request" ($\overline{CFI}$) to the calculator causes loading of the parallel input party lines into the input status and input data locations of the I/O register, and clears the "Device Ready" signal ($\overline{CEO}$ goes high). The logic sense of "Device Ready" is observed by the calculator and when it goes false ($\overline{CEO}$ = High) the CPU proceeds to output the next 8-bit byte of data.

If the output I/O interface card is not returning information on the input lines all input lines will be high when the loading, described in the preceeding paragraph, takes place. Therefore, if at the beginning the code in the output status field is being used by the I/O interface card and must remain something other than all high it will be necessary for the I/O interface card to receive the output status from the calculator and return it back to the status inputs so that when "Device Request" occurs the status field does not get changed in the I/O register.

Input: After determining if the peripheral is ready to start transferring a block of data the calculator turns off the interrupt and shifts the address code into the I/O Register. (The address code remains unchanged during the block transfer). The "Device Ready" is given ($\overline{CEO}$ = Low) to the calculator when the 8-bit data byte is ready for input. The "Device Request" signal causes the input data and status to be loaded into the I/O register and causes "Device Ready" to go false ($\overline{GEO}$=High). The calculator by checking when "Device Ready" goes false knowns the data has been loaded. A single I/O instruction shifts the 8-bit data byte from the I/O register into the 8 most significant locations in the A or B accumulators (Shifting the previous information in A or B 8 places to the right) and causes "Device Ready" to go true ($\overline{CEO}$ = Low) 120 ns after the last bit has been shifted into A or B. As before if output status is to be retained on the I/O interface card it must be returned to the I/O register upon each input data transfer. Wave forms illustrating high speed operations are shown in Figures 56 and 57.

The calculator software makes use of the interrupt system in two different manners. The first is for remote keyboard like peripherals.

These are those peripherals which logically resemble the calculator keyboard. Only 7-bit ASCII assigned keycodes are recognized by the calculator. The

interrupt takes place by the peripheral indicating to the I/O interface card that a request for service exists. Input data must be stored along with the request for service on the I/O interface card or in the peripheral itself. The stored signal for service is gated with the "Prevent Interrupt" signal through an open collector NAND gate onto the "Service Request" party line ($\overline{SSI}$ = Low for service). The giving of "Service Request" causes the I/O register to be loaded. However, input data from the I/O interface card is not enabled yet. Thus all status and data inputs are high. This indicates to the CPU that a keyboard-like peripheral is interrupting and address code 12 is shifted into the I/O register. The decoded address 12 on the I/O interface card enables the gates to the data in lines and data is now loaded into the I/O register. After the data has been taken from the I/O register address 12 is again put into the I/O register and "Device Ready" is given as a 360 nanosecond pulse to clear all stored keyboard-like requests for service. This implies all keyboard-like peripherals must be user controlled such that only one interrupt at a time is taking place.

The second is nonkeyboard-like peripherals.

These peripherals will output or enter standard ASCII codes for data by using a special ROM (others ROMs may be developed to handle different codes). When a request for service is given to the I/O interface card by a peripheral the request and all data must be stored until serviced by the calculator. The interface card may have any of 9 addresses (1 to 9). The stored request for service is gated with "Prevent Interrupt" through an open collector NAND gate onto the "Service Request" party line. At the time "Service Request" is recognized address "Ø" is gated with the stored request for service through an open collector onto an input data or status line which corresponds with the address of the I/O interface card. For example, "Data In" Ø which is the 1st position in the I/O register represents card address 1, and 2nd positon is card address 2, etc. When the I/O register is loaded as a result of the "Service Request" the interrupting I/O car's address is loaded into the I/O register and "Prevent Interrupt" enabled ($\overline{SIH}$ = Low). The contents of the I/O register are processed by the CPU which then shifts the interrupting card's address into the I/O register. The address enables the gates to the data-in lines and data is loaded into the I/O register. After the data is processed by the CPU the interrupting card's address is shifted from the CPU into the I/O register and a 360 nanosecond "Device Ready" pulse ($\overline{CEO}$ = Low) given to clear the stored request for service on the I/O interface card, after which the "Prevent Interrupt" is disabled and the next interrupt allowed to take place. Under this system, multiple interrupts may take place without consequence. Each will be serviced in turn from low to high address postion. An interrupting peripheral may also interrupt to request outpuut data from the I/O register. The interrupting process is the same as above except the calculator transmits data rather than receives data. Figure 58 shows waveforms illustrating the interrupt.

The following table lists the general I/O instruction set and the associated codes:

I/O INSTRUCTION SET

NAME	INSTRUCTION EXECUTION TIME	INSTRUCTION CODE 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
STF	9 μs	H H H H – H L H H H H SELECT CD
CLF	9 μs	H H H H – H H H H H H ,,
SFC	9 μs	H H H H – H H/C H H H L ,,
SFS	9 μs	H H H H – H H/C H L H L ,,
CLC	9 μs	H H H H – H H/C H L H H ,,
STC	9 μs	H H H H – H H/C H H L L ,,
OT*	15 μs	H H H H A/B H H/C L L H H ,,
LI*	15 μs	H H H H A/B H H/C L H L H ,,
MI*	15 μs	H H H H A/B H H/C L L L H ,,

The following describes the function of each I/O instruction with the 5 allowable select codes.

STF	<SC>	Set the flag. STF is a 240 nanosecond positive true pulse which accomplishes the following with the various select codes.
	STF ØØ	Not used by the calculator.
	STF Ø1	a. Sets the Service Inhibit" flip-flop to the true state ($\overline{SIH}$=Low; interrupt not allowed). b. Causes parallel input data and status to be loaded into the I/O register.
	STF Ø2	Generates a 240 nanosecond positive true MCR pulse.
	STF Ø4, Ø8, 16	Not used by the calculator.
CLF	<SC>	Clear the flag. CLF is a 240 ns positive true pulse which accomplishes the following with the various select codes.
	CLF ØØ	Not used by the calculator
	CLF Ø1	a. Clears the "Service Inhibit" flip-flop to the false state. ($\overline{SIH}$=High; interrupt allowed.) b. Loads address locations in I/O register gister with Ø's. (Ø=Low) c. Clears "Device Ready" flip-flop ($\overline{CEO}$=High).
	CLF Ø2	Clears MCR flag flip-flop.
	CLF Ø4	Clears PEN flip-flop (PEN=Low).
	CLF Ø8	Clears DEN flip-flop ($\overline{DEN}$=High).
	CLF 16	Generates a 240 nanosecond positive true KLS pulse.
SFC	<SC> H/C	Skip if flag clear. SFC is a 240 ns positive true pulse which accomplishes the following with the various select codes. If C is given a 240 nanosecond CLF pulse is given after SFC.
	SFC ØØ	Causes the next instruction to be skipped if the STOP key has not been depressed.
	SFC Ø1	Causes the next instruction to be skipped if Device Ready is true ($\overline{CEO}$=Low).
	SFC Ø2	Causes the next instruction to be skipped if the MCR flag flip-flop is clear.
	SFC Ø4	Causes the next instruction to be skipped if the PEN flip-flop is clear. (PEN=Low).
SFS	<SC> H/C	Skip is flag set. SFS is a 240 nanosecond positive true pulse which accomplishes the following with the various codes. If C is given then a 240 nanosecond CLF Pulse is issued after SFS.
	SFS ØØ	Causes the next instruction to be skipped if the STOP key is depressed.
	SFS Ø1	Causes the next instruction to be skipped if "Device Ready" is false ($\overline{CEO}$=High).

SFS Ø2	Causes the next instruction to be skipped if the MCR flag flip-flop is set.	
SFS Ø4	Causes the next instruction to be skipped if the PEN flip-flop is set (PEN = High).	
$\overline{CLC}$ <SC> H/C	Clear Control. $\overline{CLC}$ is a 240 nanosecond negative true pulse and is not used by the calculator. If C is given then a 240 nanosecond positive true CLF pulse is given after $\overline{CLC}$.	
STC <SC> H/C	Set the Control. STC is a 240 nanosecond positive true pulse which accomplishes the following with the various select codes. If C is given a 240 nanosecond CLF pulse is issued after STC.	
STC ØØ	Not used by the calculator.	
STC Ø1	Sets the "Device Ready" flip-flop ($\overline{CEO}$=Low).	
STC Ø2	Generates a 240 nanosecond positive true MLS pulse for the magnetic card reader.	
STC Ø4, Ø6, 16	Not used by the calculator.	
OTX <SC> H/C	Output A or B causes data bits from A or B to be shifted to the I/O register and accomplishes the following with the various select codes. If C if given, a 240 nanosecond CLF pulse is given after OTX is executed.	
OTX ØØ	The 8 least significant bits in the A or B register are shifted non-inverted to the 8 least significant locations in the I/O register, and 120 nanosecond after the 8th shift the "Device Ready" flip-flop is set ($\overline{CEO}$=Low). The 8 most significant bits are shifted right 8 places and the 8 significant bits are recirculated to the 8 most significant locations in the A or B registers. The 8 most significant bits in the I/O register are untouched.	
OTX Ø1	Sixteen bits from the A or B register are shifted non-inverted to the I/O register. The data in A or B recirculates.	
OTX Ø2	Not used by the calculator.	
OTX Ø4	Same as OTX Ø1 and in addition, 120 ns after the 16th bit has been shifted nanoseconds printer enable flip-flop is set.	
OTX Ø8	Same as OTX Ø1 and in addition, 120 nanoseconds after the 16th bit has been shifted the display enable flip-flop is set.	
OTX 16	Same as OTX Ø1 and in addition, 120 nanoseconds after the 16th bit has been shifted the 240 nanosecond signal is generated.	
LIX <SC> H/C	Load into A or B. Loads data bits from the I/O register into the A or B register and accomplishes the following with the various select codes. If C is given, a 240 nanosecond CLF pulse is given after LIX is executed.	
LIX ØØ	The eight least significant bits in the I/O register are shifted inverted to the eight most significant locations of A or B, and 120 nanoseconds after the 8th shift the	

"Device Ready" flip-flop is set ($\overline{CEO}$=Low). A or B is shifted right eight places as the I/O register data comes in. The 8 most significant bits in the I/O register are untouched.

LIX Ø1 — The 16 bits of the I/O register are transferred inverted to the A or B register. Data in the I/O register is lost.

LIX Ø2, Ø4, Ø8, 16 — Not used by the calculator.

MIX <SC> H/C — Merge into A or B. Merges data from the I/O register into A or B registers and accomplishes the following with various select codes. If C is given, a 240 nanosecond CLF pulse is given after MIX is executed.

MIX ØØ — The eight least significant bits in the I/O register are merged with the eight least significant bits of the A or B register and shifted to the 8 most significant locations of A or B; 120 nanosecond the merge takes place the Device Ready flip-flop is set ($\overline{CEO}$=Low). A or B shifts right 8 places as the data is merged and shifted to the most significant locations. The 8 most significant bits of the I/O register are untouched.

MIX Ø1 — The 16 bits of the I/O register are merged with the 16 bits of the A or B register and contained in the A or B register.

MIX Ø2, Ø4, Ø8, 16 — Not used by the calculator.

Examples of various drivers which transfer data are given below:

Example 1.

Typical Subroutine to Get Status of I/O Device.

Calling Sequence:

```
        LDB   Select Code
        JSM   Stat
Stat    STF   1      Turn off the interrupt system.
        OBT   1      Load I/O register with select code.
        STF   1      Load I/O register with status of I/O device.
        LIA   1      Load A-Register with status information.
        CLF   1      Turn on interrupt.
        RET          Return.
```

Example 2.

Typical Subroutine to Output an 8 bit character.

Calling Sequence:

```
        OTA   1      Output 16 bits to the I/O register.
        STC   1
        SFS   1      Loop until I/O flag is set by the
        JMP   *-1      output device.
        CLF   1
```

Example 3.

High Speed Output Where the Calculator is Faster than Output Device.

Calling Sequence:

```
        ST*   I      —(Number of 16 bit words to be output) + 1.
        ST*   J      Address of first word in the array.
        LDB   SC     Select Code
        JSM   OUT2
OUT2    JSM   STAT   Get status of output device
        RAR   9        and position it.
```

Example 4A.

Typical Subroutine to Input an 8-bit Character.

Calling sequence is:

```
        LDB   Select code
        JSM   In
        ...   Return is made with the data in the A Register.
In      STF   1      Turn off interrupt system
        OTB   1      Load I/O register with the select code
        STC   1, C   Pulse the flag and turn interrupt system on
        JSM   STAT   Get status off the input device
        RAR   9        and position it.
        SAP   *–2, C If device is busy then continue to loop
        SAR   7        else position data bits
        RET          Return.
        SAP   OUT2   If device is busy, continue to loop
        STF   1      Turn off interrupt system.
        OTB   1      Output select code
        LDB   1      B←Counter for number of words to be output
        LDA   J, I   Load next data word
        SEC   *+1, C E←Ø
        OTA   Ø      Output 8 bits from A
        SFS   1      Loop until device sets
        JMP   *–1      flag.
```

Example 4A (continued).

```
        SEC   *-3, S   If E=Ø and E←J then loop to output last 8 bits
        ISZ   J        Increment array address pointer
        RIB   *-7      Increment count and loop if not finished.
        CLF   1        Turn on interrupt system
        RET            Return
```

Example 3B.

If the Output Device is Faster than the Calculator then Fewer Instructions can be Used.

```
        OTA   Ø        Output first 8 bits
        OTA   Ø        Output second 8 bits.
         .
         .
         .
```

Example 5A.

High speed input where the calculator is faster than the input device.

Calling sequence:

```
        ST*   I        —(Number of 16 bit words to be input) + 1
        ST*   J        Address
        LDB   SC       Select code
        JSM   In2
In 2    JSM   STAT     Get status of input device
        RAR   9          and position it.
        SAP   In2      If device is busy, continue to loop
        STF   1        Turn off interrupt system
        OTB   1        Output select code
        STC   1        Command device to read
        LDB   I        R←Counter for number of words to be input
        SEC   *+1, C   E←Ø
        SFS   1        Loop until input
        JMP   *-1        device sets flag
        LIA   Ø        Load 8 bits from I/O register
        SEC   *-3, S   If E=Ø and E←1 then loop to input last 8 bits
        STA   J, I     Save data word in array
        ISZ   J        Increment array address pointer
        RIB   *-7      Increment count and loop if not finished.
```

Example 5A (continued).

```
CLF  1      Turn on interrupt system

RET         Return
```

Example 5B.

If the input device is faster than the calculator then the number of instructions can be reduced.

```
LIA Ø    Input first 8 bits
LIA Ø    Input second 8 bits
```

All output I/O interface cards which are to be fully interchangeable with both the present and other calculators must have storage either on the I/O interface card or in the peripheral to which information is being transmitted.

Blocks (A) and (B) are the storage latches which store information coming from the I/O register. When the output of gate (C) goes high, data is latched; when low, the outputs of the latch track the inputs. Gates (D) decode the address code (14=111Ø) and pass it positive tru to gate (E). "Device Ready" ($\overline{CEO}$) is also passed positive true to gate (E). Gates (H) are open collector and pass status and "Device Request" ($\overline{CFI}$) onto the input party lines.

An example of a calculator output would be: Output the address 14 which enables status gates (H) and see if the power is on. If on, output address, status, and data to gates (A), (B), and (D). The output of (C) is low allowing data and status to pass. Next give "Device Ready" ($\overline{CEO}$=Low); this enables flip-flop (G), clocks flip-flop (F) which causes (A) and (B) to latch, and sends control to the peripheral. The peripheral acknowledges receipt of control by returning FLAG (FLAG=High) in a busy state this continues to keep (A) and (B) latched and clears control flip-flop (F). When the peripheral is done acting, the FLAG is returned to the not busy state (FLAG=Low) which clocks flip-flop (G) and causes output at (C) to go low enabling (A) and (B). The output of (G) drives the $\overline{CFI}$ gate which has been enabled from (E) and $\overline{CFI}$ goes low. $\overline{CFI}$ is received by the calculator which responds by returning $\overline{CEO}$ high. This causes the output of (E) to go low, clearing flip-flop (G) and returning $\overline{CFI}$ high. This completes 1 output cycle.

All input I/O interface cards which are to be fully interchangeable with both the present and other calculators must have storage either on the I/O interface card or in the peripheral from which information is being received.

Block (A) is used to store information coming from the peripheral. (B) stores status coming from the I/O register which may be needed by the peripheral. The output tracks the input whenever the enable on the latch is low. Block (C) decodes the address code into one of 10 addresses which are jumper selectable. An example of a calculator input would be as follows: the address code would be decoded by (C); the calculator would load status through the open collector input status gates (D). If the peripheral is on and ready, the address code and output status (if necessary) would be sent to (B) and (C). The decoded address is passed, positive true, to gate (E). The enable at (B) is low so that status is passed to the peripheral. The "Device Ready" is given ($\overline{CEO}$=Low) and comes to (E) positive true. The output of (E) clocks flip-flop (F) through gate (H). The output of (F) gives control to the peripheral and also enables (A) to receive data. The peripheral responds in a busy state (FLAG=High). When data is ready to be input the FLAG is driven low. Data is latched when the FLAG goes low in (A). Also when FLAG goes low, (G), having been enabled by the output of (H), is clocked driving (J) from its Q output. (I) is enabled by the output of (H) and so $\overline{CFI}$ is driven low. Data is loaded into the I/O register from open collector gates (I) and $\overline{CEO}$ driven high as a result of the calculator receiving $\overline{CFI}$. This clears flip-flop (G) and disables the input gates (I) completing an input cycle.

Figure 59 illustrates the logic required on an I/O interface module to interface the calculator with an external X—Y plotter.

Figure 60 illustrates the logic required on an I/O interface module to interface the calculator with an external line printing unit.

Figure 61 illustrates the logic required on an I/O interface module to interface the calculator with an external modem for transmitting and receiving information via telephone lines.

Figure 62 illustrates the logic required on an I/O interface module to input or output any eight-bit code.

A power preset circuit is employed on interface modules using the interrupt

system to prevent an interrupt when the peripheral power is turned off or on. This can usually be done by sensing the peripherals' +5 volts and presetting when the voltage drops below 3 to 4 volts.

An example of a calculator interrupt would be as follows: (B) may be clocked at any time storing the data is (E) and (F). The calculator enables the interrupt to take place by making "Prevent Interrupt" false ($\overline{SIH}$=High) and outputting address Ø to decoder (L). (G) is enabled when $\overline{SIH}$ goes high through gate (M) causing $\overline{SSI}$ to be driven low. The calculator responds by loading the I/O register. Gates (H) are inhibited by gates (N) and (J) and gate (K) is enabled because of address Ø, thus DIØ is the only true signal loaded into the I/O register. The calculator interprets this to mean the I/O interface card at address 1 has caused the interrupt. The calculator outputs address 1 to the decoder which enables gates (H) with (N) and (J) and then loads the data. After the data is stored the calculator outputs address 1 and sends "Device Ready" ($\overline{CEO}$=Low) as a 360 nanosecond pulse which is used to clear (B) through gates (O) and (D). This completes an input cycle.

KEYBOARD INPUT UNIT

The keyboard input unit is shown in Figure 63 and is designed around a 128-position matrix. Each position is scanned sequentially. When a key is depressed, the counter, which drives the scanner, is stopped. The address of the 7-bit counter corresponds to the ASCII code of the key depressed. The entire scan period is four milliseconds. Two key rollover is incorporated in this design.

When a key is depressed, $\overline{SSI}$ is generated unless inhibited by either $\overline{SIH}$ or KLS. As soon as the service request is acknowledged, the CPU will give a select code of 12 which will gate the ASCII keycode onto the date lines.

Another feature of this keyboard is automation repeat. If a key is depressed for more than 1.5 seconds, the keycode will be entered repeatedly at a rate of 15 entries per second until the key is released.

OUTPUT DISPLAY UNIT

Referring to Figures 72A—F and 73A—B, there is shown the hardware associated with the calculator display. The display comprises a single register 400 of thirty-two alpha-numeric characters, each character position of which is a seven row by five column matrix of light emitting diodes (LED). In addition to the display hardware illustrated, the complete calculator display system comprises a firmware display routine which is detailed on page 35 of the basic system firware listing and an I/O register shown in Figures 49A—D. The firmware display routine delivers a sixteen-bit word to the display circuitry. Four of these bits 402 and 404 are decoded into one of sixteen character positions. The remaining twelve bits 422 are two six-bit ASCII coded characters which are alternately decoded in ROM 430 into their row and column information. A seven-bit data latch 432 is provided to allow the ROM 430 to decode both the nth and the (n=16)th characters which are displayed simultaneously.

An assymmetrical clock circuit 426 drives input gating circuitry 436 and counter-decoder circuitry 434 to decode the row information of the nth and the (n+16)th characters. Protection circuitry 428 is provided to blank the display in case of failure of either logic signal $\overline{DEN}$ 424 or CAØ 438.

Three-bit column data 410 and three of the four-bit character position bits 402 are applied to a one-of-four decoder circuit 420. The output of circuit 420 is fed to the column drivers. 418. Four columns eight emitting diodes 400 are driven by each of the forty column driver. Thus, all, one hundred sixty columns of the display can be scanned. The remaining character position but 404 enables alternate sections of row drivers 416 to complete the one-of-sixteen character position decoding.

MAGNETIC TAPE CASSETTE READING AND RECORDING UNIT

The magnetic tape cassette reading and recording unit is shown in the block diagram of Figure 64 and in the detailed schematic diagram of Figures 65—69. Operation of the magnetic tape cassette reading and recording unit is largely automatic. It is only necessary to specify the type of operation to be performed and the limits desired. The commands for doing this may either be entered directly from the keyboard input unit or as part of a program. The calculator then determines the necessary commands required to cause the magnetic tape cassette reading and recording unit to perform the desired operation.

Several modes of operation are possible. Secure and unsecure programs, data, and sets of user definable key definitions may be recorded on the magnetic tape and subsequently loaded back into the calculator.

Referring now to Figures 64 and 65, the operation of the interface portion of the magnetic tape cassette reading and recording unit will be described.

I. *Address Decoder*

IC 6 and IC 7 are used to detect a select code of 10 when the cassette is accessed. When a select code of 10 is detected, and the control line $\overline{CEO}$ is true the cassette is enabled.

II. *Enabling Input Data Bits*

The open collector nands in IC 2 and IC 3 allow the input data bits (ID Ø through ID 7) to be gated onto the calculator input bus when the card is selected by the address and control line as described in Section I.

III. *Enabling Input Status Bits*

The open collector nands in IC 1 allow the input status bits (IS Ø through IS 3) to be gated onto the calculator input bus when a select code of 10 is given and the control line is true.

IV. *Flag*

D type flip-flop 10 is the flag flip-flop. It is held cleared except when the I/O card is selected as described in Section I. When the I/O card is selected the flip-flop is set by the trailing edge of the flag pulse from the cassette. In addition, the flag flip-flop is held preset (at pin 5) when the cassette door is open, clear leader is detected, or an interrupting character is read. A simultaneous preset and clear results in a true output from the flip-flop. The flag flip-flop signal is gated to the calculator ($\overline{CIF}$, pin 2-m) by the open collector nand gate only when the I/O card is selected.

V. *Interrupt*

D-type flip-flop 13 is the interrupt flip-flop.It is held cleared whenever the I/O card is selected as described in Section I. The interrupt is allowed only if the cassette is in control mode (pin 2—3). An interrupt signal comes whenever the cassette goes onto clear leader, the cassette door is opened, or an interrupting character is read. An interrupting character is a character with data bits 2, 3, 4, 5 all ones, read when the cassette is in control mode. When the signal Service Interrupt Inhibit is false ($\overline{SIH}$=1, pin 2—1) the interrupt signal is gated through IC 4 pin 6 and 8 to the calculator. The data bit SI 1, (Pin 1—4) is pulled low to tell the calculator the address of the peripheral which interrupted.

Referring to Figures 64, 66A—B, and 66′ the operation of the control logic portion of the magnetic tape cassette reading and recording unit will be described.

I.1 *Power on Preset*

Transistor Q1 and diodes CR1 and CR2 are part of the power on circuit which makes sure that the cassette powers up in the proper modes.

I.2 *Control Signal*

The control signal (YCNT on pin 11) comes from the Interface card as a positive true signal telling the Logic card to process the command on the input lines. The positive going edge of the control signal fires the one-shot (IC 7) giving a 300 nsec. control Pulse used to strobe storage elements.

I.3 *Decode and Storage of Commands*

The 1-of-10 open collector decoder (IC 19) is strobed on its D input by the control pulse. (See Section I.2) On the A, B, and C inputs of the decoder are output status bits OSØ through OS2. Those output status bits contain commands for the transport as follows:

OS2 (Write)	OS1 (Reverse)	OSØ (Fast)	Command
Ø	Ø	Ø	Read-Forward-Slow
Ø	Ø	1	Read-Forward-Fast
Ø	1	Ø	Read-Reverse-Slow
Ø	1	1	Read-Reverse-Fast
1	Ø	Ø	Write-Forward-Slow
1	Ø	1	STOP
1	1	Ø	Continue Present Command
1	1	1	Continue Present Command

Output status bit 3 (OS3) indicates if the cassette should be in control mode or data mode. Control mode is explained in Section I.12.

If when the decoder is strobed, the command on the output status lines is other than "STOP" or "CONTINUE", the open collector wired-or decoder outputs Ø through 4 are low for the width of the control pulse. This wire-or output pulse strobes the command on the output status bits into the Quad Latch, IC20, and preset the run flip-flop 15—2. The command on the run lines are gated off the logic card to the motor control card, and cassette motion begins.

If the command is "STOP", the decoder output 5 (pin 6) goes low, which clears both the run flip-flop (15—2) and the Quad Latch (IC20). If the command is "CONTINUE", both the Quad Latch and the run flip-flop remain unchanged.

The run flip-flop and the Quad Latch are also cleared by power on preset.

I.4 *Run Flip-Flop*

The run flip-flop (1502) is preset by the issuing of a command as described in Section 6.3. It is cleared by an interrupt signal from the I/O card, a stop command, power on preset, or a cassette not being in place. The run flip-flop is also cleared by the clear leader signal on its clock input, whenever the cassette runs into clear leader. Since the clock input of the flip-flop is edge senstive, the transport is stopped only when it first goes onto clear leader, and tape motion is allowed by the issuing of a new command even when on clear leaderr.

The Schmidt-triggered gates 1—1 and 1—2 are used to filter noise on the interrupt, clear leader, and cassette in place lines.

I.5 *Rewind Mode*

D type flip-flop 15—1 is the rewind flip-flop. It is held preset as long as the rewind button is held in. It is cleared by clear leader detection, cassette not in place, power on preset, stop command, or on interrupt from the I/O card. The rewind flip-flop is also cleared through its clock input, whenever a new command is issued. A simultaneous preset and clear results in the Q output of the flip-flop being true. When the transport is stopped (flip-flop 15—2 cleared) and the rewind flip-flop is set the output of gate 16—3 will be true, which will force the NOR gates 17—1, 17—2, and 17—3 to Ø outputs. These outputs will cause the tape to be rewound in high speed reverse to clear reader, unless the rewind flip-flop is cleared as described above.

I.6 *Transport Status*

Input status bits; YIS3 (pin F), YIS2 (pin 6), YIS1 (pin E), and YISØ (pin 5), reflect the status of the transport as follows:

YIS3 — Negative true, cassette in place
YIS2 — Positive true, clear leader detected
YIS1 — Negative true, writing on cassette permitted
YISØ — Positive true, control mode

I.7 *Internal Clock*

The internal clock used for writing data is generated by the two one-shots IC6 and IC13. The clock is not symmetrical, but IC6 is true for 133 μsec and IC13 is true for 220 μsec. Padding resistor R10 is then used to adjust the total time of 333 μsec for a 3KC clock rate. The internal clock is enabled only when the cassette command is write as detected at pin 5 of IC13.

I.8 *Nine Bit Shift Register*

A nine bit shift register is made from IC3, IC4, and flip-flop 5—2. In write operations this register is loaded parallel by a pulse from gate 16—1, and then shifts the data serially to IC3 pin 10 for writing on the tape. In read mode the data is clocked from the tape, serially, to IC5 pin 12 where it is serially loaded into the register. From the shift register it is read as parallel data, at the flag, by the calculator.

I.9 *Data, Clock Mark Sequence*

During write operation a write clock, a write data, and a write mark signal are sent from the logic card. During read operations a read clock, a read data, and a read mark signal are received by the logic card. The data lines are NRZ; clocked by the appropriate clock. When clock pulses and marker pulses are properly sequenced they constitute a character. The sequence is 9 data bits per character, separated by marks.

Mark - 9 data bits - mark - 9 data bits - mark.

BIT-MARK-SEQUENCE CODE

Three types of information	Track	
"1"	A	
	B	
"0"	A	
	B	
Mark	A	
	B	

10 bit character

M D_7 D_6 D_5 D_4 C D_3 D_2 D_1 D_0 M

8 data bits

1 marker

1 control bit

I.10 *Divide by 10 Counter During Write*

The divide by 10 counter (IC14) is used to sequence the clock and mark pulses during write (See section 6.9 for a sequence description). When the counter is at counts Ø through 8 the internal clock pulses generated by IC6 and IC13 are gated through gate 18—4 from where it goes off the card as the write clock, and through gate 18—2 to shift the shift register. When the divide by 10 counter is at count 9, the internal clock pulse is inhibited at gate 18—4, but is enabled at gate 10—2 from where it passes off the board as a write mark pulse. Since the counter "wraps around" from count 9 to count Ø, we get the repeating sequence, marker — 9 bits — marker.

Each time the counter goes to 9, a character is completed and the write mark pulse, in addition to going off the board, is gated through gate 12—3 to make up a flag, telling the calculator that the character has been written. The calculator will then send another parallel character to the shift register and the sequence will be repeated.

Special conditions prevail for the writing of the first of a string of characters. When the transport goes from read to write mode, flip-flops 8—1 and 8—2 are set in their edge sensitive clock inputs. Flip-flop 8—2 presets the counter to count 9, making sure the sequence begins with a mark pulse. The same flip-flop 8—2 is cleared by this first mark pulse, after which the counter continues its "wrap around" sequence. Flip-flop 8—2 being set, inhibits this first leading write mark pulse from passing through gate 12—3 and becoming a flag. Flip-flop 8—2 is cleared by the first write pulse, after which the write sequence continues as normal.

I.11 *Divide by Ten Counter During Read*

Only a sequence of 9 data bits followed by a mark is to be recognized as a character during read. The divide by 10 counter is used to detect this sequence.

Whenever the transport is stopped, flip-flop 5—1 is held preset. The output of flip-flop 5—1, presets the counter to a count of Ø. Flip-flop 5—1 is cleared with the leading edge of the read date clock and the counter counts on the trailing edge. The read date pulses are counted by the counter and also pass through gate 18—2 to shift the shift register. When the counter has counted 9 read pulses, its count of 9 puts a true signal on pin 13 gate 19—1. If a read mark pulse comes next, pin 1 of gate 19—1 is true for the width of the read mark pulse. These two signals make up part of the flag signal which tells the calculator a valid character is in the shift register. The trailing edge of the read marker pulse, sets flip-flop 5—1, which presets the counter to Ø and the sequence is ready to be repeated.

If a marker is read when the counter is at a count other than 9; no flag is given, flip-flop 5—1 is set, and the counter is preset to Ø. If 10 read pulses come in a row, the counter wraps around to Ø and no flag is given. Thus nothing but 9 read clock pulses, followed by a read mark pulse, generates a flag and is recognized as a character.

I.12 *Control Mode and Flags*

Each character contains 8 data bits. The middle bit of the 9 bit character is a control bit. If the center bit is a 1, the character is a control character. If the center bit is a Ø, the character is a data character. If the transport is in control mode during write, the center bit is loaded as a 1 at IC4 pin 5, and the character is written as a control character. In data mode the center bit of each character written is Ø.

If the transport is reading in control mode, flags are sent to the calculator only when a control character is in the shift register. If the transport is in control mode, and a data character is in the shift register, the read flag is inhibited at IC9—1 pin 2. This IC9—1 pin 2 is always true, except when the cassette is in control mode and the center bit of the shift register is Ø. In data mode, flags are sent to the calculator for both data and control characters.

The flag circuitry on the interface card is trailing edge sensitive, making sure the character is completely written or completely read before the calculator is flagged.

Referring now to Figures 64 and 67A—B, the operation of the read/write portion of the magnetic tape cassette reading and recording unit will be described.

I. *General Description*

The read/write board has two main functions. In the WRITE mode it encodes bit serial data into two-channel Bit-Mark-Sequence (BMS) data to be fed to the head driver and written on tape.

In the READ mode it decodes the two-channel analog BMS data from the head preamplifier into clock, mark, and bit-serial data pulses from the tape signals.

II. *WRITE Mode*

When Write Permit is true (YWPT=1) and Write Command is true (YWTC=1) then Write Enable is true (YWEN=1; Q7 on) and writing on the tape is allowed. The 3-input NAND gates of IC2 are used to encode the bit-serial data (YWDT) into BMS. Logic 1's (YWDT=1) are written on Channel A. Logic Ø's (YWDT=Ø) are written on Channel B. A mark is written when Write Mark is true (YWMK=1). The data and marks are clocked in by means of the Write Clock (YWCL).

III. *READ Mode*

The two amplifiers of IC6 and their associated circuitry comprise two threshold detectors that convert the analog signals from the head (ARA, ARB) to

digital signals. The amplifiers switch between their positive and negative saturated states. The thresholds are adjusted so that the amplifiers switch states when the analog signal is approximately 30% of its peak value measured near BOT, moving forward.

The head signal amplitude is proportional to tape speed. Therefore, the thresholds are adjusted high for fast tape motion and low for slow tape motion by switching Q1 and Q2 with the Fast Command (NFTC) line. The positive and negative references for the thresholds are derived from the 12 volt power supplies.

The two channels of digital data are gated to the decode circuitry through IC1. The decoder consists of IC3, IC5, IC8, and IC9.

IC8 is a 0.5 μs one-shot that is fired once for each data bit or mark that is gated in from the threshold detectors. This one-shot pulse comprises a read clock signal that is gated to NRCL by IC5 when the bit associated with the pulse is not a mark.

IC9—1 is a flip-flop that serves three functions. First, it provides a Read Mark pulse (YRMK) whenever a mark is read from the tape, Second, it controls IC5 to allow the one-shot pulse to appear as Read Clock (NRCL). Third, it controls IC3 and IC5 to allow data to be gated through to the data output flip-flop, IC9—2.

Referring now to Figures 64 and 68A—B, the operation of the motor control portion of the magnetic tape cassette reading and recording unit will be described.

I'. *Speed Reference*

Resistors R1, R2, and R3 are used to generate a reference voltage proportional to the desired motor speed. The voltage seen at the positive input of U3 is about 3.0 volts for low speed and 8.0 volts for high speed.

II'. *Comparator-Amplifier*

Op Amp U3 compares the speed reference with a signal representing the actual motor speed (see Item IV' below). The difference signal is amplified and fed to the driver circuitry which increases or decreases the drive voltage available to the motor.

Resistor R8 and capacitor C1 create negative feed back around U1, resulting in a DC gain of 26 db and a single pole at about 100 Hz. This "tailors" the servo loop frequency response to provide stable operation with rapid error correction.

III'. *Motor Driver*

Diode D1 shifts the DC drive level by about 7 volts. Transistors Q1, Q2, and the Motor Pass Transistor (located on the Regulator Board) furnish current gain to drive the motor. Resistor R7 ensures turnoff for the Motor Pass Transistor. Transistor Q3 is used to dynamically brake the motor if its speed is greater than desired.

Diode D3 reduces the maximum voltage at the motor when on clear leader. This voltage limit effectively reduces the motor torque, preventing damage to the motor, friction drive, or tape cassette should the tape by pulled against the hub. Diode D2 prevents damage to Q1 during this reduced torque condition.

IV. *Back-EMF Amplifier*

The motor terminal voltage is composed of two parts — the "IR" voltage drop in the motor armature resistance, and the motor generated voltage, or Back-EMF. Back-EMF is directly proportional to motor speed, and is used as the motor speed feedback signal.

Sense resistor R9 produces a voltage proportional to the motor armature current, and therefore proportional to the "IR" voltage drop. Op amp U4 and resistors R10 thru R14 subtract the "IR" voltage drop from the motor terminal voltage, resulting in a voltate proportional to the motor speed. This signal is about 3.0 volts for low speed and 8.0 volts for high speed; it is fed back and compared with the reference voltage, as described in Item II' above.

The process of sensing the "IR" voltage drop, as described above, is accurate only for a single winding temperature. Because lower armature resistances (caused by lower temperatures) could cause instability in the servo, this "perfect compensation" point is placed at the bottom of the operating range — 0°C in this case. Increasing temperature causes reduced load regulation (greater motor current causes reduced speed), but servo operation remains stable.

V'. *Motor and Solenoid Selector*

The selector circuitry activates the proper motor and solenoid. When in "Run

Fwd" mode, Q4, Q5, and Q8 are saturated "on"; in "Run Rev" mode Q6, Q7, and Q9 are saturated. When in "Stop" mode, all devices are off.

Referring now to Figures 64 and 69, the operation of the interconnect portion of the magnetic tape cassette reading and recording unit will be described.

I. *Connection From Transport to Mother Board*

The main function of the Interconnect Board is to electrically connect the transport mechanism to the Mother Board. There are four groups of wires coming from the transport: the Motor wires, the Solenoid and Switch wires, the Head Board wires, and the Photosensor wires. Each group of wires is terminated on a Pin Board which plugs into the Interconnect Board; this partitioning allows for ease of assembly and service.

II. *Clear Leader Signal*

Most of the circuitry on the Interconnect Board is used to generate the "Clear Leader" signal. The photosensor assembly on the transport contains an incandescent lamp and a photoconductive cell. When magnetic tape is over the photosensor, no optical coupling occurs, resulting in a high photoconductor impedance. When clear leader is over the photosensor, light is reflected off the light colored plastic of the cassette and onto the photoconductor, resulting in a low photoconductor impedance.

Integrated circuit U1 and resistors R4, 5, and 6 form a comparitor which switches when the photoconductor impedance is approximately 25k~. Capacitor C5 filters the output of U1 to eliminate false signals of less than 5ms. duration; transistor Q1 amplifies this signal.

Under certain conditions when the tape stops or changes direction a tape loop may form over the photosensor; a reflection can result which causes the same photoconductor impedance as a clear leader. IC's U2, 3, and 4 are used to prevent a "tape loop" from giving a false clear leader indication. Flip-flop U4 stores the clear leader signal; this flip-flop may be turned "on" when the cassette has been running on clear leader for the duration of one-shot U2 (85 ms). This delay period ensures that any loop has been pulled out of the tape, preventing reflection problems.

A "mag tape" (Clear Leader Not) indication is always accurate; therefore it directly resets flip-flop U4. The gates tied to the preset of U4 force the flip-flop "on" during power turn on and when the cassette loader is open; if the tape is, in fact, on "mag tape", this signal persists after preset is removed and resets U4.

III. *Solenoid Turnoff*

Diodes D1 and D2 and resistor R1 limit the peak solenoid flyback voltage during turnoff to about 24 volts. This also provides rapid solenoid dropout by applying up to −12 volts across the solenoid during turnoff.

IV. *Motor Padding Resistors*

Resistors R2 and R3 are selected to trim a given motor to between 10.30 and 10.60 ohms effective armature resistance. Capacitors C1 and C2 are used to suppress motor brush noise.

V. *Cassette Sense Switches*

Resistors R11 and R12 and "pullup" resistors for the mechanical cassette sense switches. "Cassette In" (positive true) and "Write Permit" (positive true) are the signals generated.

POWER SUPPLY

The power supply system employed in the calculator is constructed as shown in Figures 74 and 75A—B. As shown in Figures 75A—B, a centertapped transformer secondary is connected to supply the unregulated DC voltages indicated. Referring to Figure 75A, the AC voltage from the transformer is rectified by diodes 454 and 456 and filtered by capacitor 478. The output of this rectifier/filter circuit is nominally 19 volts DC at 2.7 amps with a 2 volt peak-to-peak ripple. Transistors 440 and 442 serve as a switch to connect the five-volt output bus to the 19 volt unregulated supply through inductors 450 and 452. Diode 444 serves to clamp the input of inductor 450 to ground when transistors 440 and 442 are switched off. Current flow in inductors 450 and 452 is substantially constant and equal to the load current.

Loss in high current transistor 440 is minimized because it can be completely saturated. Loss in driver transistor 442 is minimized because it can also be saturated. Resistor 446 limits the maximum drive current to transistor 440. Losses in resistor 446 can be minimized by proper positioning of the tap on inductor 450 consistent with transistor parameters and circuit requirements.

Integrated circuit 448 is a linear differential amplifier to drive Q1 and Q2. Any differential amplifier with sufficient voltage capability and bandwidth will work. Since the amplifier employed is linear, R7 and R4 have been included in the circuit to provide sufficient hysteresis for reliable switching. This hysteresis stabilizes the switching frequency and thus stabilizes the switching losses.

Because hysteresis has been added to the circuit, a significant ripple signal (at switching frequency) must be present on the feedback signal to the amplifier. This need for a ripple signal limits the amount of capacitance that can appear between the output of inductor 450 and ground. Inductor 452 serves to isolate this point from the rest of the system. The amount of capacitance that can appear between the output of inductor 452 and ground is essentially unlimited and significantly reduces power supply ripple, and greatly improves response to load transients.

The second winding of inductor 452 is a path for the feedback from the remote sensing. The required ripple signal is added to the feedback signal by transformer action in inductor 452.

The power supply also includes an overvoltage crowbar circuit comprising transistor 458, diode 460, and resistor 462 and a short circuit shut-down circuit (using transistor 464). In the event that the +5 volt bus is grounded, or the crowbar is triggered, transistor 464 saturates and locks integrated circuit 448 off.

The resistor 466 makes a current generator of integrated circuit 448. Resistors 468 and 470 discharge the bases of transistors 450 and 452, respectively. Integrated circuit 472 and its associated components generate a "power on pulse", $\overline{POP}$, to initialize the instrument. Integrated Circuit 448 is referenced and powered from an external +12 volt supply. Powering the IC from +12 rather than the unregulated +19 reduces power dissipation in IC 448.

The +12 volt supply of Figures 75A—B references the −12, +5, and +16 supplies directly. The +12 amplifier 448 may be biased either from the unregulated supply for the +12 volt supply or from the operating +16 volt supply. Diodes 474 and 476 determine the appropriate source. This provides a greater power supply margin for the +12 volt supply.

All supplies except the +20 volt supply are current limited. All supplies except the +20 volt supply are crowbar protected against over-voltage.

TYPEWRITER INTERFACE

This interface couples the Facit-Odhner model 3841 (Facit is a RTM) output typewriter to the calculator.

The unit mounts directly on the back of the typewriter. Communications with the calculator are made through about five feet of cable which is terminated by the I/O plug containing a board for buffering and some logic.

Referring to Figures 76A—82, characters from the calculator appear on the data lines as ASCII codes. These codes are recoded by a ROM into the six bit Facit typewriter code for the 46 type bars, and one bit for upper case shift. Functions such as space, tab, line feed, etc. are recoded for easy recognition in the interface since each function must be driven by a separate line. A data latch after the ROM holds codes for processing. If new data arrives during this processing, the two codes are compared to determine if they both drive the same type bar and if they are both numbers. Non-repeating numbers can be typed at 14.5 characters per second, otherwise typing speed is 12 characters per second (reduce these speeds 17% for 50HZ operation). Codes in the latch are gated to the program solenoids or the function solenoids by the control logic.

To understand the coding, notice that two blocks of codes on the Facit typewriter code map are empty. If all function codes are put in these blocks, they can be identified by control logic by testing for (6·4). Each function code puts a 1 on one of five lines and this line opens the correct solenoid gate. Bit 8 is used to discriminate between two sets of function gates. In the case of a program solenoid code, bit 8 identifies numerals.

The control clock is provided by a synchronizing pulse which is generated in the typewriter by a vaned wheel attached to the end of the main drive shaft. The vanes interrupt a light beam. When a type cycle is initiated, a modulo eight counter counts synchronizing pulses and the count is decoded by a 1-of-8 decoder.

At each of the eight states, combinational logic can enable solenoid gates, set or clear flag flip-flops or change the counter to state zero, or state 6, or inhibit the counter.

The tables below contain a guide for interpretation of bit pattern data as well as the actual bit patterns for ROM #10 and ROM #11 as shown in Figure 81.

INTERPRETATION OF BIT PATTERN DATA
(Bipolar ROM of Figure 81)

1. *FORMAT*

The bit pattern information is in the following format:

$X_1X_2X_3$—$X_5X_6X_7$ B B $X_{10}X_{11}X_{12}X_{13}$ B $X_{15}X_{16}X_{17}X_{18}$ B...$X_{45}X_{46}X_{47}X_{48}$

A. $X_1X_2X_3$ — Three digits indicating the address (decimal) of the first word of that line. *1

B. $X_5X_6X_7$ — Three digits indicating the address of the last word in that line. *1

C. $X_9X_{10}X_{11}X_{12}$ — Four characters indicating the output states of the first word of that line (corresponding to address $X_1X_2X_3$). *2

D. $X_{15}X_{16}X_{17}X_{18}$ through $X_{40}X_{41}X_{42}X_{43}$ indicate successive output states. *2

E. $X_{45}X_{46}X_{47}X_{48}$ — Four characters indicating the output states of the last word of that line (corresponding to address $X_5X_6X_7$). *2

F. B = Blank or space between group of characters.

2. *TRUTH TABLE*

Logic level definition

L — Output Low (Logic Ø)

H — Output High or Open Collector (Logic 1)

X — Don't Care — Output may be High or Low

*1. Addresses are the digital equivalent of the binary address $A_7A_6A_5A_4A_3A_2A_1A$. Where a low input address equals a binary Ø and a high input equals a binary one.

*2. Groups of output states are listed $O_4O_3O_2O_1$ respectively.

BIPOLAR ROM 10 OF FIGURE 81

000—007	LLLL	LLLH	LLLL	LLLL	LLLL	LLLL	HLLL	LHLL
008—015	HLLL	LLLL	LHLL	LLHL	LLLL	LLHL	LLLL	LLLL
016—023	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
024—031	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
032—039	LLLH	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH
040—047	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
048—055	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH
056—063	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
064—071	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH
072—079	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
080—087	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH
088—095	HLLL	HLLH	HLHL	HLHH	LLLL	HHLH	HHHL	LLLL
096—103	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH
104—111	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
112—119	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH
120—127	HLLL	HLLH	HLHL	HLHH	LLLL	HHLH	HHHL	LLLL
128—135	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
136—143	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
144—151	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
152—159	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
160—167	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
168—175	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
176—183	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
184—191	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
192—199	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
200—207	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
208—215	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
216—223	LLLL	LLLL	LLLL	HHLH	HLHH	LLLL	HHHL	HHHL
224—231	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
232—239	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
240—247	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
248—255	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL

BIPOLAR ROM 11 OF FIGURE 81

000—007	LLLL	HLLL	LLLL	LLLL	LLLL	LLLL	HLLL	HLLL
008—015	LLLL	LHLL	LLLL	HLLL	HHLL	LLLL	LLLL	LLLL
016—023	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
024—031	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
032—039	LLLL	LHLH	LHLH	LHLH	LHLH	LHLH	LHLH	LHLH
040—047	LHLH	LHLH	LHLH	LHLH	LLLH	HLLH	LLLH	LLLH
048—055	HLLH	HLLH	HLLH	HLLH	HLLH	HLLH	HLLH	HLLH
056—063	HLLH	HLLH	HLLH	LLLH	LHLH	LHLH	LHLH	LHLH
064—071	LLHL	LHHL	LHHL	LHHL	LHHL	LHHL	LHHL	LHHL
072—079	LHHL	LHHL	LHHL	LHHL	LHHL	LHHL	LHHL	LHHL
080—087	LHHH	LHHH	LHHH	LHHH	LHHH	LHHH	LHHH	LHHH
088—095	LHHH	LHHH	LHHH	LLHH	LLLL	LLHH	LLHH	LHLH
096—103	LHHL	LLHL	LLHL	LLHL	LLHL	LLHL	LLHL	LLHL
104—111	LLHL	LLHL	LLHL	LLHL	LLHL	LLHL	LLHL	LLHL
112—119	LLHH	LLHH	LLHH	LLHH	LLHH	LLHH	LLHH	LLHH
120—127	LLHH	LLHH	LLHH	LHHH	LLLL	LHHH	LHHH	LLLL
128—135	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
136—143	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
144—151	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
152—159	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
160—167	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
168—175	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
176—183	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
184—191	LLLL	LLLL	LLLL	LLLL	LHHL	LLLL	LLLL	LLLL
192—199	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
200—207	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
208—215	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
216—223	LLLL	LLLL	LLLL	LHHH	LHHH	LLLL	LLHH	LHHH
224—231	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
232—239	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
240—247	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL
248—255	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL	LLLL

WHAT WE CLAIM IS:—

1. An electronic calculator comprising:

keyboard input means including a plurality of alphameric keys for entering one or more BASIC language statements into the calculator, an execute control key for initiating execution of a BASIC language statement entered into the calculator, and a store control key for initiating storage of a BASIC language statement entered into the calculator;

memory means, coupled to said keyboard input means, for storing a program of BASIC language statements entered into the calculator;

processing means coupled to said keyboard input means and said memory means, said processing means being responsive to actuation of said execute control key, following entry of a BASIC language statement into the calculator, for executing that BASIC language statement, said processing means being further responsive to actuation of said store control key, following entry of a BASIC language statement into the calculator, for storing that BASIC language statement as part of a program in said memory means; and

output means, coupled to said memory means, for providing an output indication of the result of execution of a BASIC language statement.

2. A calculator according to claim 1 wherein:

said processing means includes a read-only memory storing a plurality of routines and subroutines to be selectively performed by the calculator in executing and storing one or more BASIC language statements;

said processing means is responsive to actuation of said execute control key, following entry of a BASIC language statement into the calculator, for selectively performing one or more of the routines and subroutines stored in said read-only memory to execute that BASIC language statement; and

said processing means is responsive to actuation of said store control key, following entry of a BASIC language statement into the calculator, for selectively

performing one or more of the routines and subroutines stored in said read-only memory to store that BASIC language statement in said memory means.

3. A calculator according to either one of claims 1 and 2 wherein:

said keyboard input means includes a space key; and

said processing means is responsive to actuation of said space key during entry of a BASIC language statement into the calculator for introducing a blank character at selected locations within that BASIC language statement.

4. A calculator according to any one of the preceding claims wherein said output means comprises

output printing means, coupled to said keyboard input means and memory means, for printing lines of one or more alphameric characters each;

said keyboard input means including memory listing means for initiating the listing of any designated number of lines of one or more alphameric characters each then stored in said memory means; and

said processing means also being coupled to said output printing means for causing said output printing means to selectively print out the designated lines of one or more alphameric characters each in response to actuation of said memory listing means.

5. A calculator according to claim 1 wherein said keyboard input means also comprises a plurality of keys that may be associated with user-definable functions;

said memory means can store a program of one or more lines of one or more alphameric characters each as aforesaid and user-definable functions associated with said plurality of keys;

said keyboard input means including memory erase means for selectively initiating the erasure of said program and/or said user-definable functions stored in said memory means; and

said processing means is capable of selectively erasing a portion or all of said program, any one or all of said user-definable functions, or all of said program and all of said user definable functions as specified by actuation of said memory erase means.

6. A calculator according to any one of the preceding claims wherein every stored line is associated with a separate line number; said keyboard input means includes a halt execution key for designating the line number associated with a line at which execution is to be halted;

and said calculator further comprises a program counter, coupled to said processing means, for storing the line number associated with the line currently being executed;

temporary storage means, coupled to said keyboard input means and memory means, for storing the line number associated with the line at which execution is to be halted; and said processing means includes

logic means, coupled to said keyboard input means, program counter, and temporary storage means, and capable of storing the line number associated with the line at which execution is to be halted in said temporary storage means in response to actuation of said halt execution key, followed by actuation of one or more alphameric keys designating that line number, prior to execution of the lines stored in said memory means and also capable of subsequently halting the execution of those lines in response to the occurrence of a condition of equality between the contents of said program counter and said temporary storage means.

7. A calculator according to claim 6 wherein

said keyboard input means includes a first program control key; and said logic means is responsive to actuation of said first program control key, followed by actuation of one or more numeric keys designating the line number of a starting line of the program stored in said memory means, for initiating execution of the program stored in said memory means at that starting line.

8. A calculator according to claim 7 wherein:

said keyboard input means includes a second program control key;

said memory means can store variables employed in the program stored in said memory means;

said logic means is responsive to actuation of said first program control key for setting all of the variables of the program stored in said memory means to an initial state prior to initiating execution of the program; and

said logic means is further responsive to actuation of said second program control key, followed by actuation of one or more numeric keys designating the line number of a line in the program stored in said memory means,

for initiating execution of the program at that line number without altering the variables stored in said memory means.

9. A calculator according to claim 1 wherein:

said keyboard input means includes an initialize key; said memory means, coupled to said keyboard input means, is capable of storing a program of one or more lines of one or more alphameric characters each entered into said calculator and of storing variables associated with that program;

and said processing means includes logic means, coupled to said keyboard input means and memory means, for setting all of the variables of the program stored in said memory means to an initial state in response to actuation of said initialize key.

10. A calculator according to claim 9 wherein:

said logic means is responsive to entry of an array definition command by actuation of said keyboard input means to store said array definition command in said memory means; and

said logic means is responsive to said array definition command, when encountered during a program execution mode of said calculator, for dedicating a portion of said memory means as storage for the previously defined array.

11. A calculator according to claim 10 wherein said logic means is responsive to actuation of said initialize key for executing an array definition command previously stored in said memory means.

12. A calculator according to claim 1 wherein every stored statement is associated with a different number;

said calculator further comprises magnetic reading and recording means, coupled to said memory means, for transferring lines of one or more alphameric characters between said memory means and a magnetic record member, said keyboard input means being operable for entering control commands into the calculator to control the operation of said magnetic reading and recording means; and said processing means includes

logic means, coupled to said keyboard input means, memory means, and magnetic reading and recording means, said logic means being responsive to one of said control commands for securing any portion of said program designated by a beginning line number and an ending line number, said logic means thereafter being responsive to another of said control commands for inhibiting transfer of the secured portion of said program from said memory means to a magnetic record member.

13. A calculator according to claim 1 wherein:

said keyboard input means includes a second plurality of keys each of which may be associated with a function of one argument,

and said processing means includes logic means, coupled to said keyboard input means and memory means, for associating a selected function with a selected one of said second plurality of keys in response to sequential actuation of selected ones of the first and said second pluralities of keys designating the selected function and the selected one of said second plurality of keys and for storing the selected function as part of the program stored in said memory means in response to actuation of said store control key.

14. A calculator according to claim 13 wherein:

said logic means is responsive to actuation of said execute control key, following actuation of a selected one of said second plurality of keys with which a selected function has previously been associated, for initiating execution of that selected function by said processing means.

15. A calculator according to claim 1 wherein:

said keyboard input means comprises a plurality of user-definable keys each of which may be associated with one or more lines of BASIC language program statements;

said memory means is capable of storing lines of BASIC language program statements associated with selected ones of said plurality of definable keys;

and said processing means includes logic means, coupled to said keyboard input means and memory means, for initiating execution of the BASIC language program statements associated with a selected one of said definable keys in response to actuation thereof.

16. A calculator according to claim 1 wherein:

said processing means is capable of defining a square matrix in response to a matrix command entered into the calculator from said keyboard input means,

for thereafter storing the matrix elements in said memory means as designated from said keyboard input means, and for thereafter evaluating the determinant of the previously defined square matrix in response to a determinant command entered into the calculator from said keyboard input means.

17. A calculator according to claim 16 wherein said processing means includes a read-only memory in which routines and subroutines for defining the square matrix, storing the matrix elements, and evaluating the determinant of the defined square matrix are stored.

18. A calculator according to claim 1 and further comprising a print control key for designating a print-all mode of calculator operation; and wherein said processing means includes

logic means, coupled to said keyboard input means, memory means, and display means, for initiating the display of lines of one or more alphameric characters entered into the calculator, alphameric error messages generated during execution of lines of one or more alphameric characters by said processing means, and executed display commands; and

printing means for printing lines of one or more alphameric characters, said logic means being responsive to actuation of said print control key for initiating the printing of lines of one or more alphameric characters entered into the calculator, error messages generated during execution of lines of one or more alphameric characters by said processing means, and executed display commands.

19. A calculator according to claim 1 wherein each of said alphameric keys is also representative, either alone or in combination with others of said alphameric keys, of an ASCII character;

and said calculator further comprises

buffer storage means, coupled to said keyboard input means and to said memory means, for storing a line of alphameric information entered into the calculator;

said memory means being also coupled to said buffer storage means for storing a program of one or more lines of alphameric information entered into the calculator; and said processing means being also coupled to said buffer storage means for executing the line of alphameric information then stored in said buffer storage means or a program of one or more lines of alphameric information then stored in said memory means; and said processing means includes

logic means coupled to said keyboard input means and responsive to actuation of selected ones of said plurality of alphameric keys, singly or in combination, for generating binary codes representative of every ASCII character and for storing those binary codes in said buffer storage means.

20. A calculator according to claim 19 wherein:

said keyboard input means includes a terminal transit key;

said calculator includes a modem for transmitting and receiving alphameric information over telephone lines; and

said logic means is responsive to actuation of said terminal transmit key for transmitting through said modem the ASCII codes represented by the binary codes then stored in said buffer storage means.

21. A calculator according to claim 1 and further comprising:

input/output interface means, including a plurality of input/output channels, for coupling selected peripheral input/output units to the calculator; and said processing means includes

logic means coupled to said keyboard input means, memory means, and input/output interface means, said logic means being responsive to execution of a binary output statement, including a base ten number and entered from said keyboard input means or stored in said memory means, for converting said base ten number to a corresponding twelve-bit binary code for transmitting said twelve bit binary code to a selected one of said input/output channels.

22. A calculator according to claim 1 and further comprising:

input/output interface means, including a plurality of input/output channels, for coupling seleced peripheral input/output units to the calculator; and said processing means includes

logic means coupled to said keyboard input means, memory means, and input/output interface means, said logic means being responsive to execution of a binary read statement, entered from said keyboard input means or stored in said memory means, for reading an eight-bit word on a selected one of said input/output channels, for converting said eight-bit word to a base ten number, and for associating said base ten number with a designated variable.

23. A calculator according to claim 1 and further comprising:

input/output interface means, including a plurality of input/output channels, for coupling selected peripheral input/output units to the calculator; and said processing means includes

logic means coupled to said keyboard input means, memory means, and input/output interface means, said logic means being responsive to execution of a status statement, entered from said keyboard input means or stored in said memory means, for interrogating a selected input/output channel to obtain an indication of the operating state of a selected peripheral input/output unit associated therewith.

24. A calculator according to claim 23 wherein said logic means is operable for generating a number indicative of the operating state of the interrogated peripheral input/output unit.

25. A calculator according to claim 1 wherein said processing means includes

logic means coupled to said keyboard input means and memory means, said logic means being responsive to execution of a rotate statement, entered from said keyboard input means or stored in said memory means, for rotating a specified number of the individual bits of a designated sixteen-bit integer word entered into the calculator or stored in said memory means.

26. A calculator according to claim 25 wherein said logic means is responsive to execution of an AND statement for performing, according to the rules of Boolean algebra, the logical AND operation on the corresponding bits of two designated sixteen-bit integer words entered into the calculator or stored in said memory means and for associating the resulting sixteen-bit word with a specified variable.

27. A calculator according to claim 25 wherein said logic means is responsive to execution of an OR statement for performing, according to the rules of Boolean algebra, the logical OR operation on the corresponding bits of two designated sixteen-bit integer words entered into the calculator or stored in said memory means and for associating the resulting sixteen-bit word with a specified variable.

28. A calculator according to claim 1 wherein said keyboard input means employs ASCII coding;

and said calculator further comprises

input/output interface means, including a plurality of input/output channels, for coupling selected peripheral input/output units to the calculator; and said processing means includes

logic means coupled to said keyboard input means, memory means, and input/output interface means, said logic means being responsive to execution of an enter statement, entered from said keyboard input means or stored in said memory means, for receiving information from a selected peripheral input/output unit and for converting the received information to ASCII code when it is received from a peripheral input/output unit employing a non-ASCII code, said logic means being further responsive to execution of an output statement, entered from said keyboard input means or stored in said memory means, for transmitting information from the calculator to a selected peripheral input/output unit and for converting such information from ASCII code to any non-ASCII code employed by the selected peripheral input/output unit.

29. A calculator according to claim 1 substantially as hereinbefore described with reference to the accompanying drawings.

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1444141
233 SHEETS
COMPLETE SPECIFICATION
This drawing is a reproduction of the Original on a reduced scale
Sheet 1

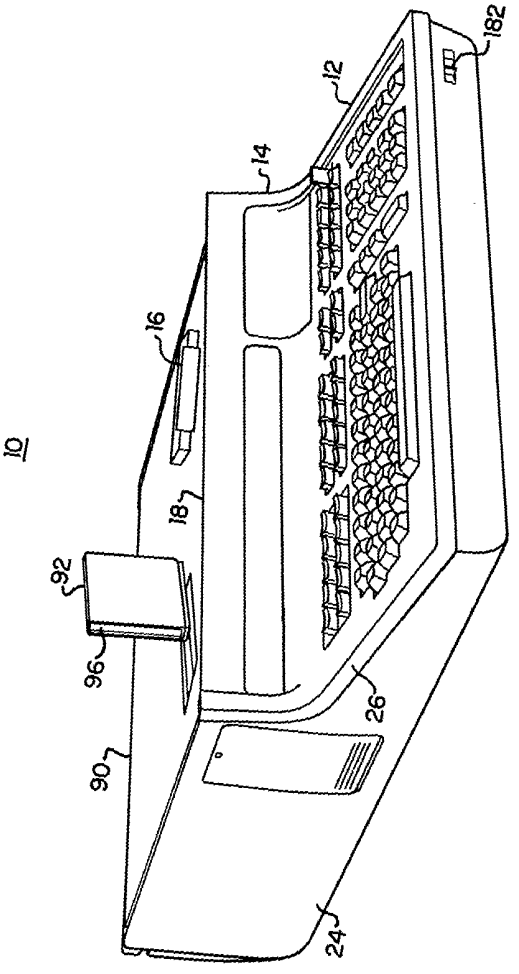


FIG 1

1444141 COMPLETE SPECIFICATION
233 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

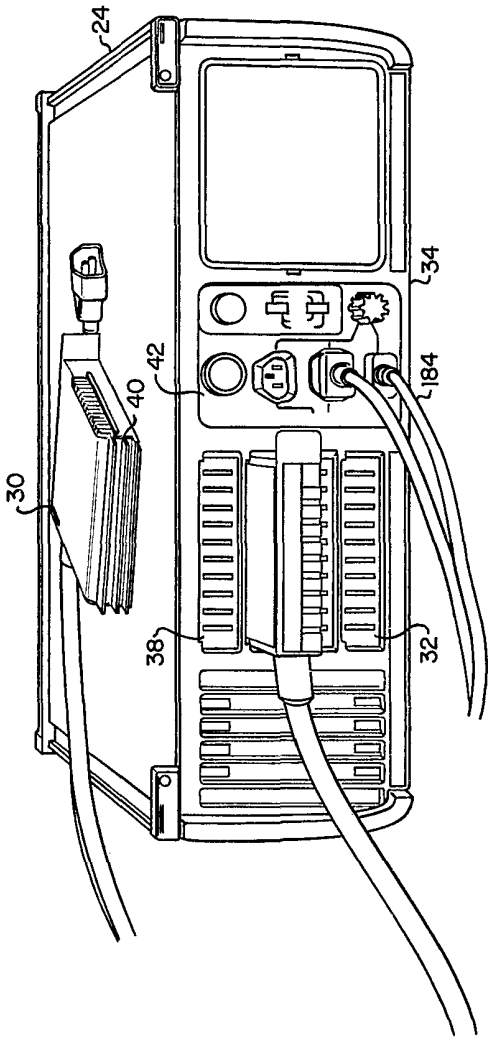


FIG 2

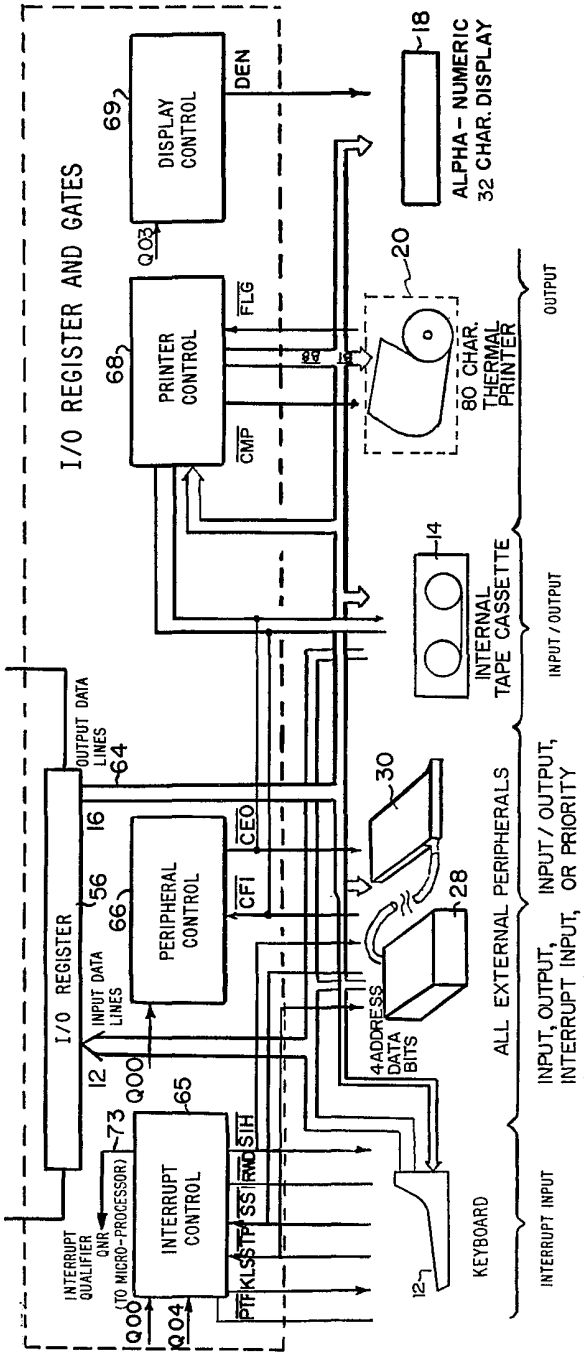

I/O REGISTER AND GATES
DISPLAY CONTROL
69
DEN
Q03
18
ALPHA - NUMERIC
32 CHAR. DISPLAY
PRINTER CONTROL
68
FLG
CMP
20
80 CHAR. THERMAL PRINTER
OUTPUT
INTERNAL TAPE CASSETTE
14
INPUT / OUTPUT
OUTPUT DATA LINES
64
I/O REGISTER
16
56
INPUT DATA LINES
PERIPHERAL CONTROL
66
CE0
CF1
30
28
4 ADDRESS DATA BITS
12
Q00
65
73
INTERRUPT CONTROL
SIH
RMD
SS
STP
KLS
PTP
INTERRUPT QUALIFIER QNR
(TO MICRO-PROCESSOR)
Q00
Q04
12
KEYBOARD
ALL EXTERNAL PERIPHERALS
INPUT, OUTPUT, INTERRUPT INPUT, OR PRIORITY INTERRUPT
INPUT / OUTPUT
INTERRUPT INPUT

FIG 3B

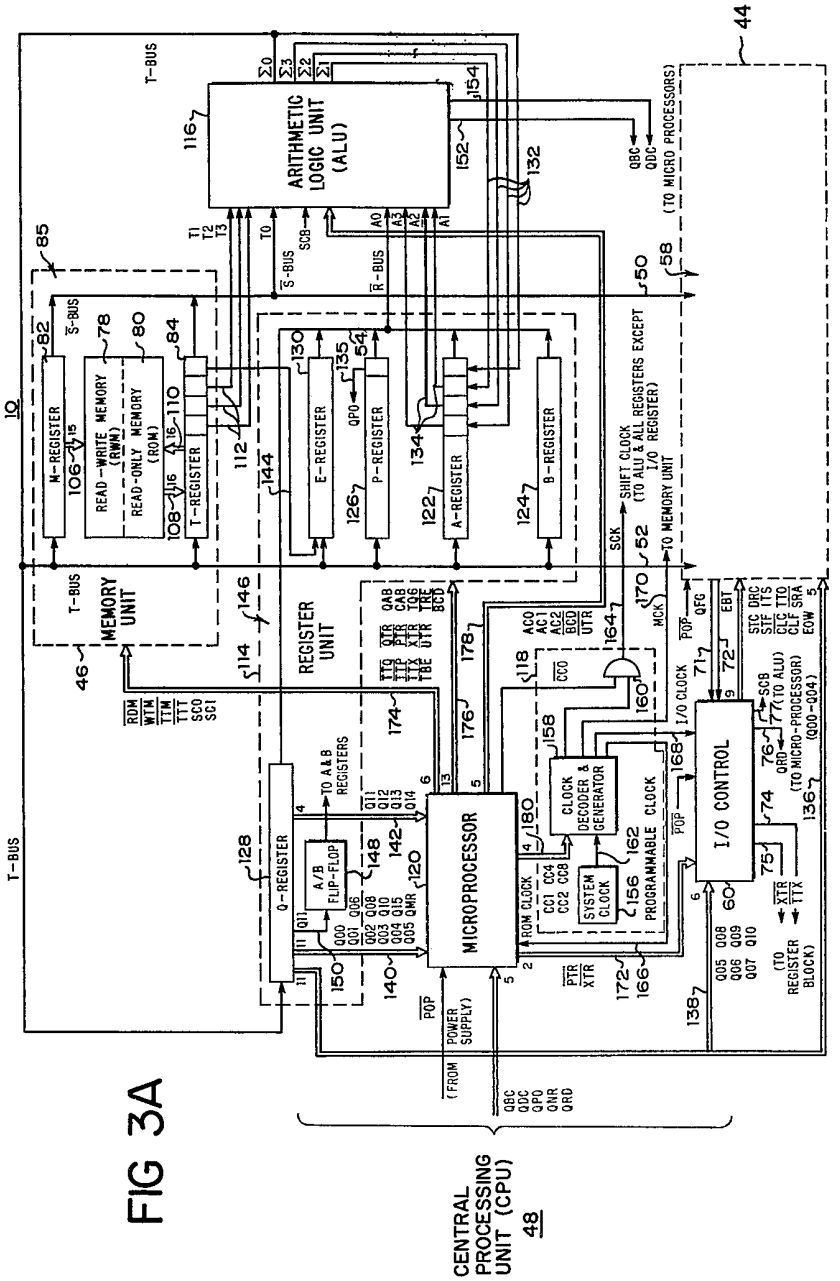

ARITHMETIC LOGIC UNIT (ALU)
MEMORY UNIT
REGISTER UNIT
MICROPROCESSOR
I/O CONTROL
M-REGISTER
READ-WRITE MEMORY (RWM)
READ-ONLY MEMORY (ROM)
T-REGISTER
E-REGISTER
P-REGISTER
A-REGISTER
B-REGISTER
Q-REGISTER
A/B FLIP-FLOP
CLOCK DECODER & GENERATOR
SYSTEM CLOCK
PROGRAMMABLE CLOCK
POWER SUPPLY
T-BUS
S-BUS
R-BUS
SHIFT CLOCK (TO ALU & ALL REGISTERS EXCEPT I/O REGISTER)
(TO MEMORY UNIT
(TO MICRO PROCESSORS)
TO A & B REGISTERS
I/O CLOCK
(FROM
CENTRAL PROCESSING UNIT (CPU) 48

FIG 3A

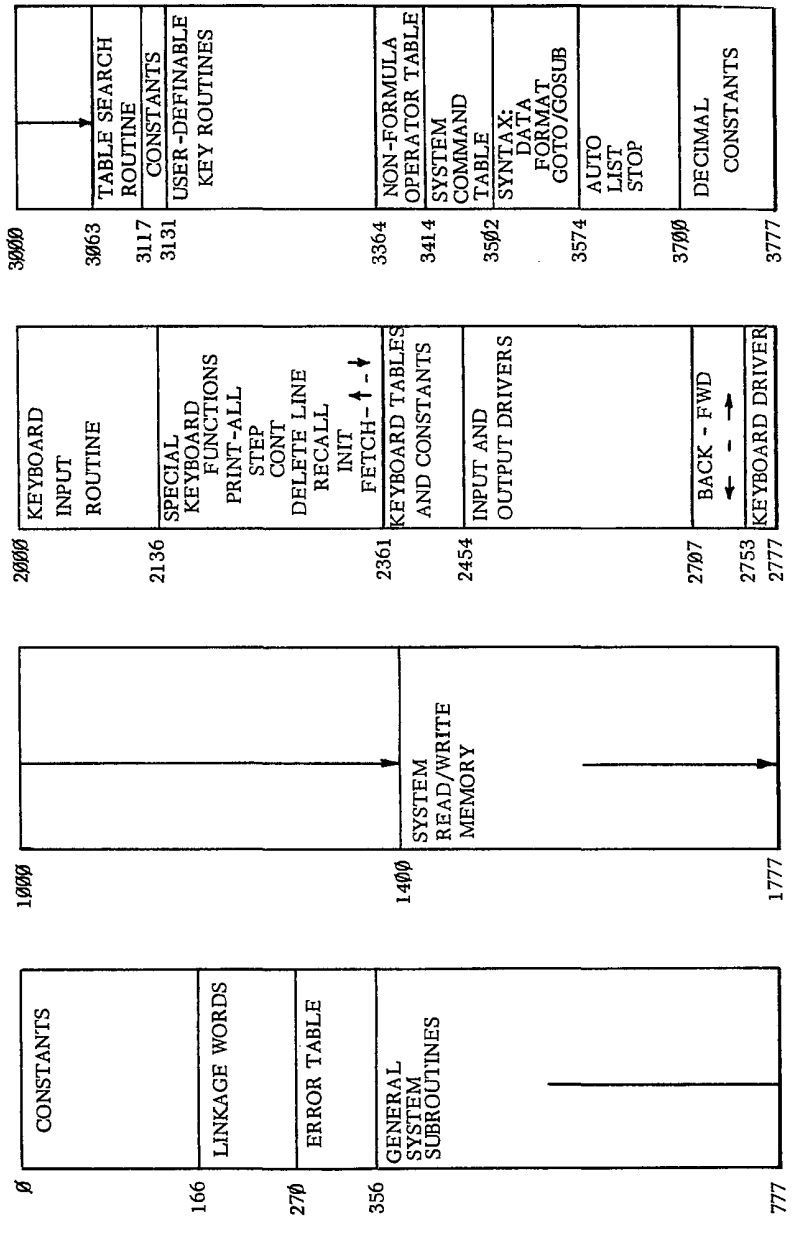

Ø
CONSTANTS
166
LINKAGE WORDS
270
ERROR TABLE
356
GENERAL SYSTEM SUBROUTINES
777
1000
1400
SYSTEM READ/WRITE MEMORY
1777
2000
KEYBOARD INPUT ROUTINE
2136
SPECIAL KEYBOARD FUNCTIONS
PRINT-ALL
STEP
CONT
DELETE LINE
RECALL
INIT
FETCH- ↑ - ↓
2361
KEYBOARD TABLES AND CONSTANTS
2454
INPUT AND OUTPUT DRIVERS
2707
BACK - FWD ← - →
2753
KEYBOARD DRIVER
2777
3000
3063
TABLE SEARCH ROUTINE
3117
CONSTANTS
3131
USER-DEFINABLE KEY ROUTINES
3364
NON-FORMULA OPERATOR TABLE
3414
SYSTEM COMMAND TABLE
3502
SYNTAX: DATA FORMAT GOTO/GOSUB
3574
AUTO
LIST
STOP
3700
DECIMAL CONSTANTS
3777

FIG 4A

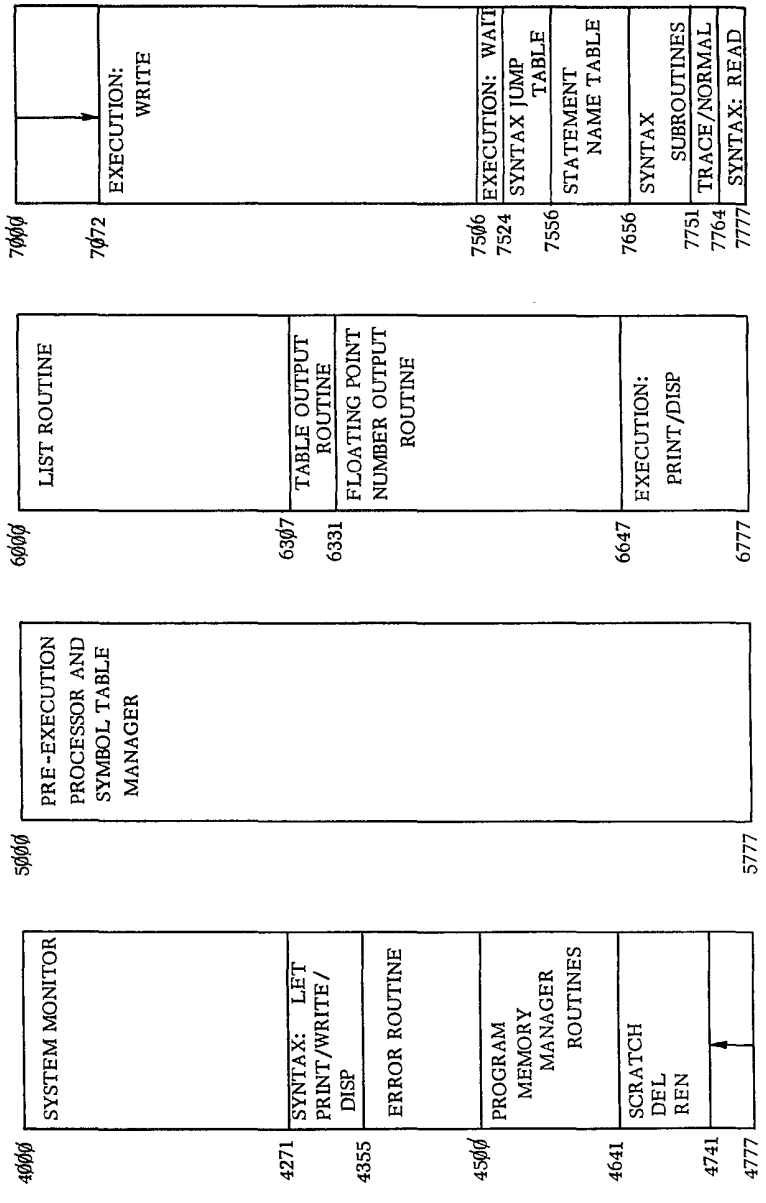

4000
SYSTEM MONITOR
4271
SYNTAX: LET PRINT/WRITE/ DISP
4355
ERROR ROUTINE
4500
PROGRAM MEMORY MANAGER ROUTINES
4641
SCRATCH DEL REN
4741
4777
5000
PRE-EXECUTION PROCESSOR AND SYMBOL TABLE MANAGER
5777
6000
LIST ROUTINE
6307
TABLE OUTPUT ROUTINE
6331
FLOATING POINT NUMBER OUTPUT ROUTINE
6647
EXECUTION: PRINT/DISP
6777
7000
7072
EXECUTION: WRITE
7506
EXECUTION: WAIT
7524
SYNTAX JUMP TABLE
7556
STATEMENT NAME TABLE
7656
SYNTAX SUBROUTINES
7751
TRACE/NORMAL
7764
SYNTAX: READ
7777

FIG 4B

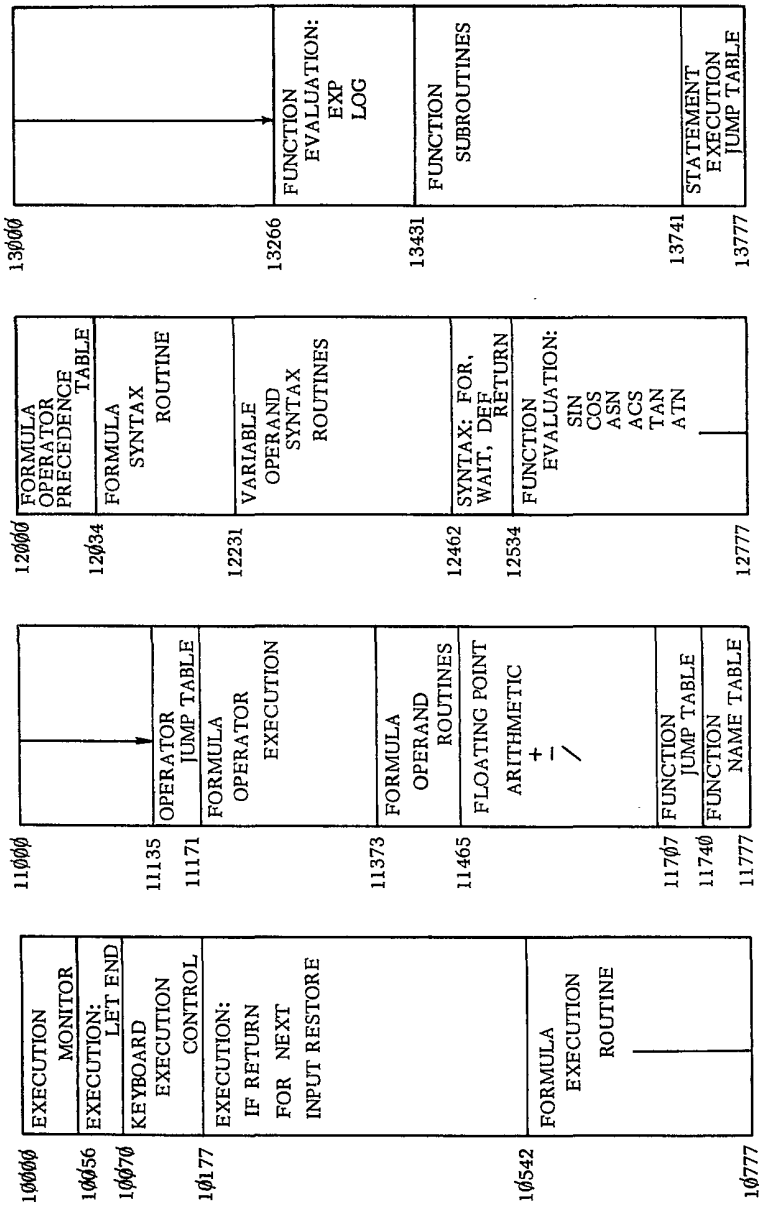

10000
EXECUTION MONITOR
10056
EXECUTION: LET END
10070
KEYBOARD EXECUTION CONTROL
10177
EXECUTION: IF RETURN FOR NEXT INPUT RESTORE
10542
FORMULA EXECUTION ROUTINE
10777
11000
11135
OPERATOR JUMP TABLE
11171
FORMULA OPERATOR EXECUTION
11373
FORMULA OPERAND ROUTINES
11465
FLOATING POINT ARITHMETIC + − / *
11707
FUNCTION JUMP TABLE
11740
FUNCTION NAME TABLE
11777
12000
FORMULA OPERATOR PRECEDENCE TABLE
12034
FORMULA SYNTAX ROUTINE
12231
VARIABLE OPERAND SYNTAX ROUTINES
12462
SYNTAX: FOR, WAIT, DEF RETURN
12534
FUNCTION EVALUATION: SIN COS ASN ACS TAN ATN
12777
13000
13266
FUNCTION EVALUATION: EXP LOG
13431
FUNCTION SUBROUTINES
13741
STATEMENT EXECUTION JUMP TABLE
13777

FIG 4C

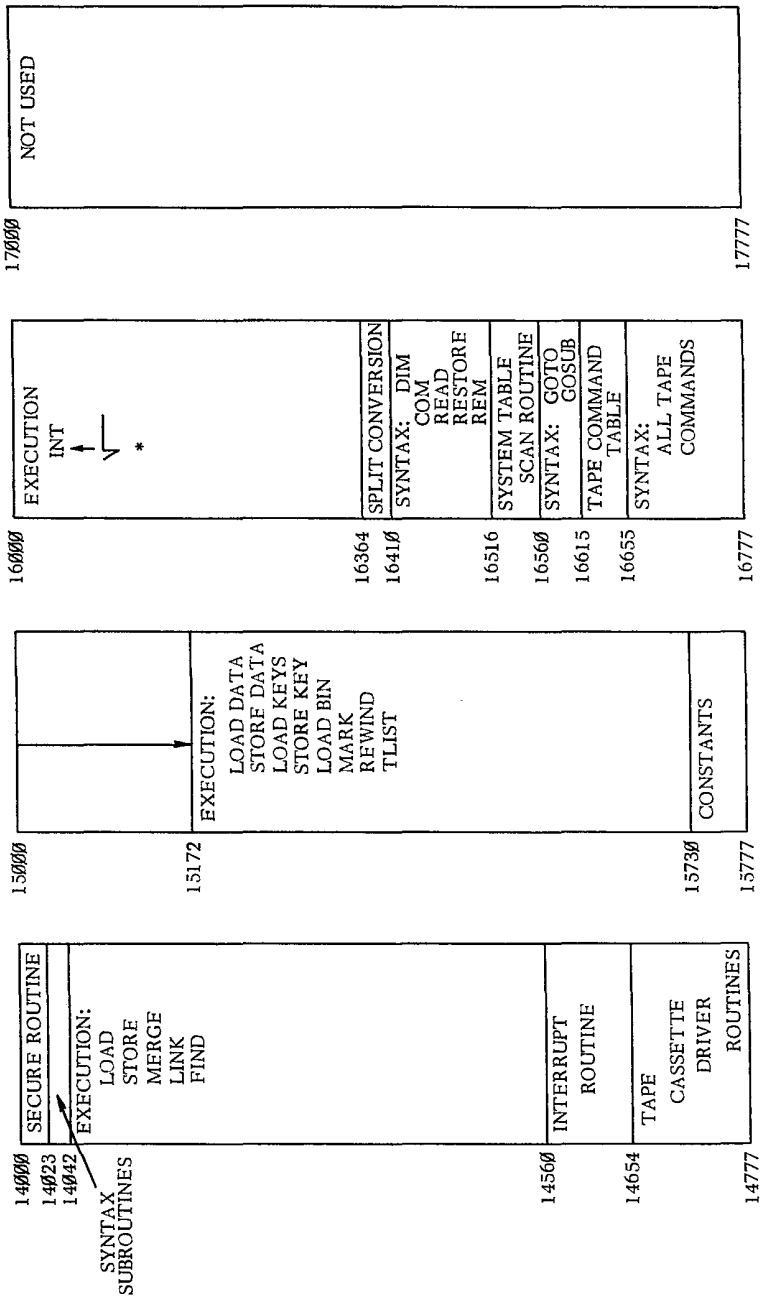

140000
140023
140042
SECURE ROUTINE
EXECUTION:
LOAD
STORE
MERGE
LINK
FIND
SYNTAX SUBROUTINES
14560
INTERRUPT ROUTINE
14654
TAPE CASSETTE DRIVER ROUTINES
14777
150000
151172
EXECUTION:
LOAD DATA
STORE DATA
LOAD KEYS
STORE KEY
LOAD BIN
MARK
REWIND
TLIST
15730
CONSTANTS
15777
160000
EXECUTION
INT
*
16364
SPLIT CONVERSION
16410
SYNTAX: DIM
COM
READ
RESTORE
REM
16516
SYSTEM TABLE SCAN ROUTINE
16560
SYNTAX: GOTO
GOSUB
16615
TAPE COMMAND TABLE
16655
SYNTAX:
ALL TAPE
COMMANDS
16777
170000
NOT USED
17777

FIG 4D

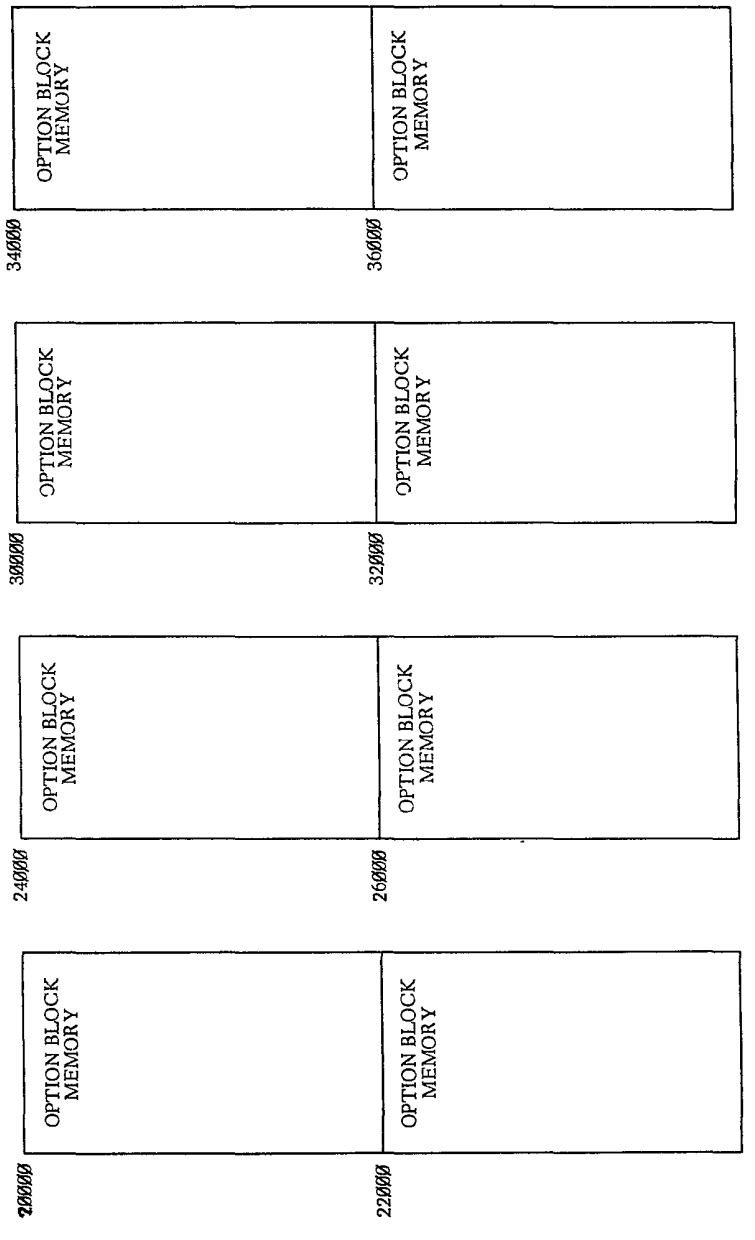

OPTION BLOCK MEMORY
OPTION BLOCK MEMORY
OPTION BLOCK MEMORY
OPTION BLOCK MEMORY
OPTION BLOCK MEMORY
OPTION BLOCK MEMORY
OPTION BLOCK MEMORY
OPTION BLOCK MEMORY

FIG 4E

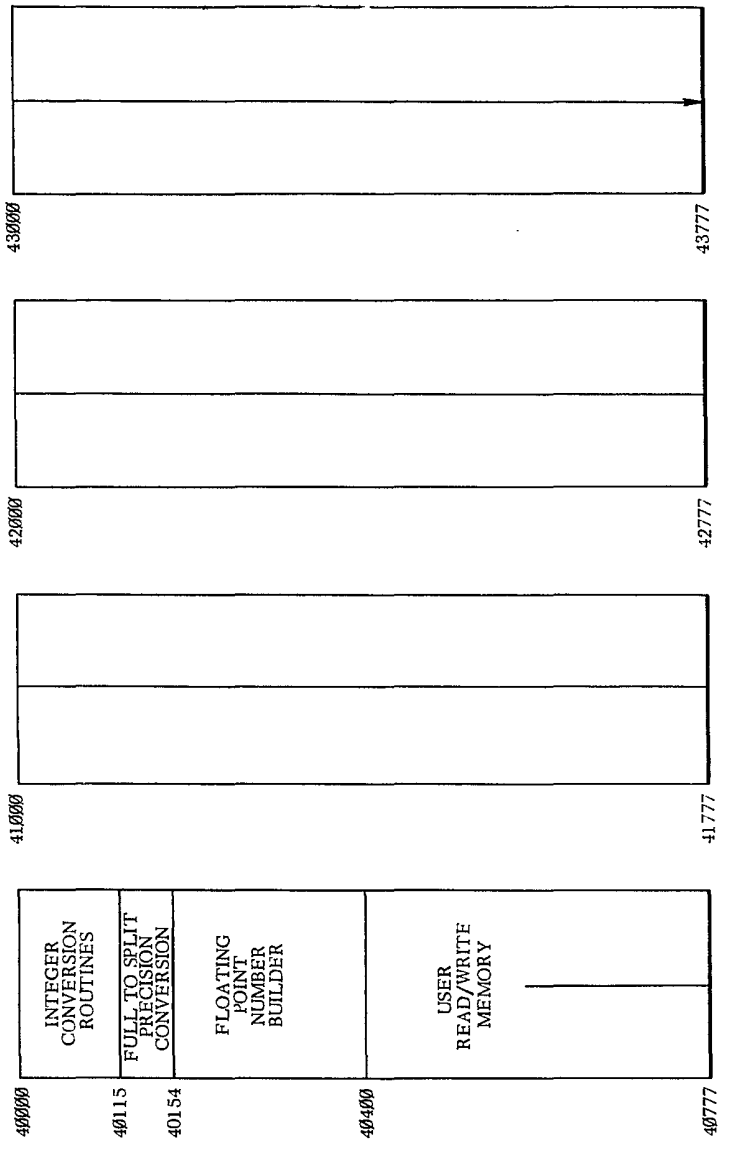

INTEGER CONVERSION ROUTINES
FULL TO SPLIT PRECISION CONVERSION
FLOATING POINT NUMBER BUILDER
USER READ/WRITE MEMORY
400000
40115
40154
40400
40777
410000
41777
420000
42777
430000
43777

FIG 4F

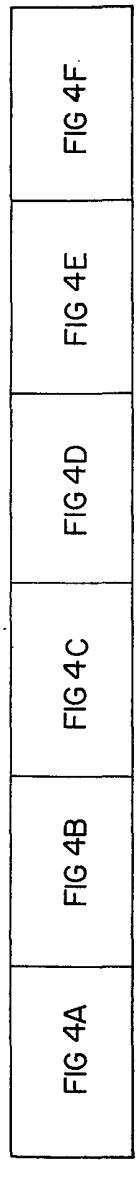


FIG. 4'

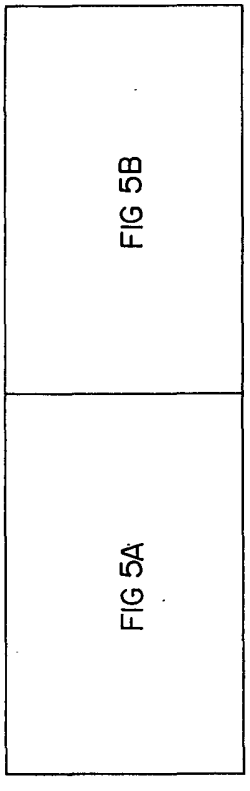


FIG. 5'

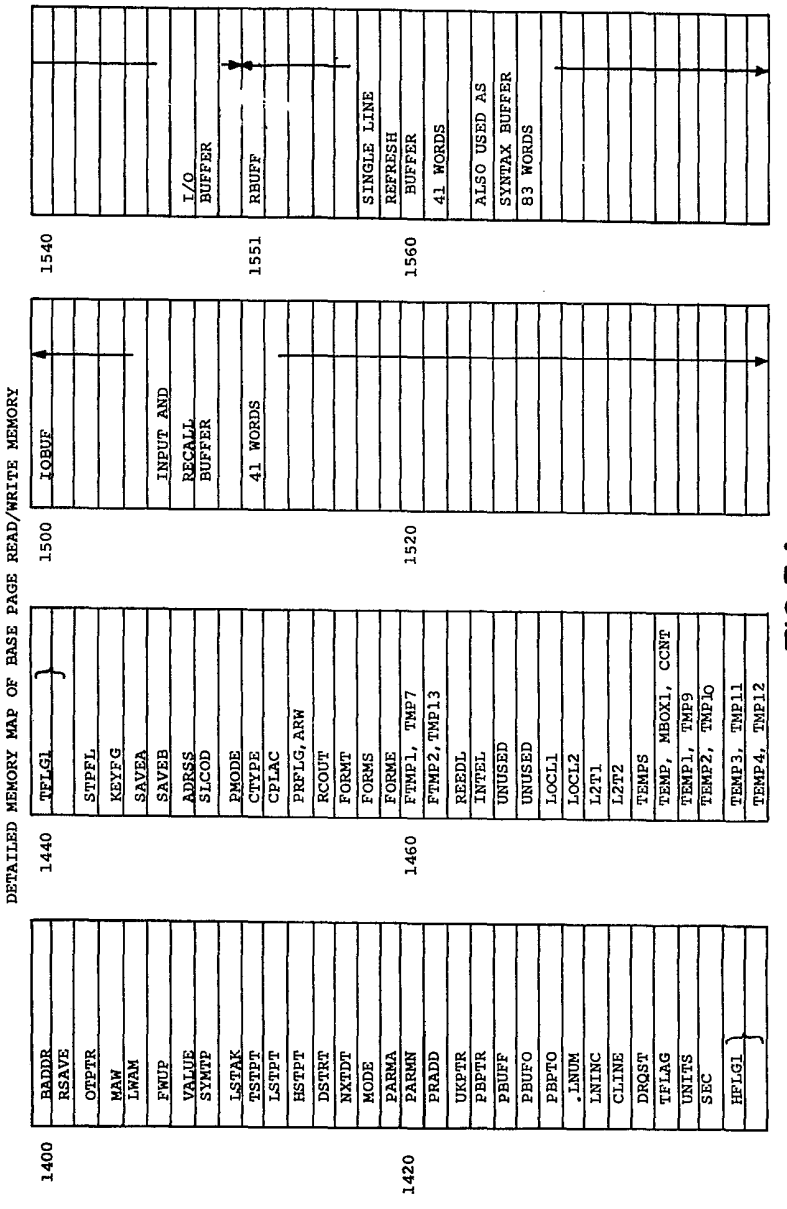

DETAILED MEMORY MAP OF BASE PAGE READ/WRITE MEMORY
1400
BADDR
RSAVE
OTPTR
MAW
LWAM
FWUP
VALUE
SYMTP
LSTAK
TSTPT
LSTPT
HSTPT
DSTRT
NXTDT
MODE
PARMA
PARMN
PRADD
UKPTR
PBPTR
PBUFF
PBUFO
PBPTO
.LNUM
LNINC
CLINE
DRQST
TFLAG
UNITS
SEC
HFLG1
1420
1440
TFLG1
STPFL
KEYFG
SAVEA
SAVEB
ADRSS
SLCOD
PMODE
CTYPE
CPLAC
PRFLG, ARW
RCOUT
FORMT
FORMS
FORME
FTMP1, TMP7
FTMP2, TMP13
REEDL
INTEL
UNUSED
UNUSED
LOCL1
LOCL2
L2T1
L2T2
TEMPS
TEMP, MBOX1, CCNT
TEMP1, TMP9
TEMP2, TMP10
TEMP3, TMP11
TEMP4, TMP12
1460
1500
IOBUF
INPUT AND
RECALL
BUFFER
41 WORDS
1520
1540
I/O
BUFFER
1551
RBUFF
SINGLE LINE
REFRESH
BUFFER
1560
41 WORDS
ALSO USED AS
SYNTAX BUFFER
83 WORDS

FIG.5A

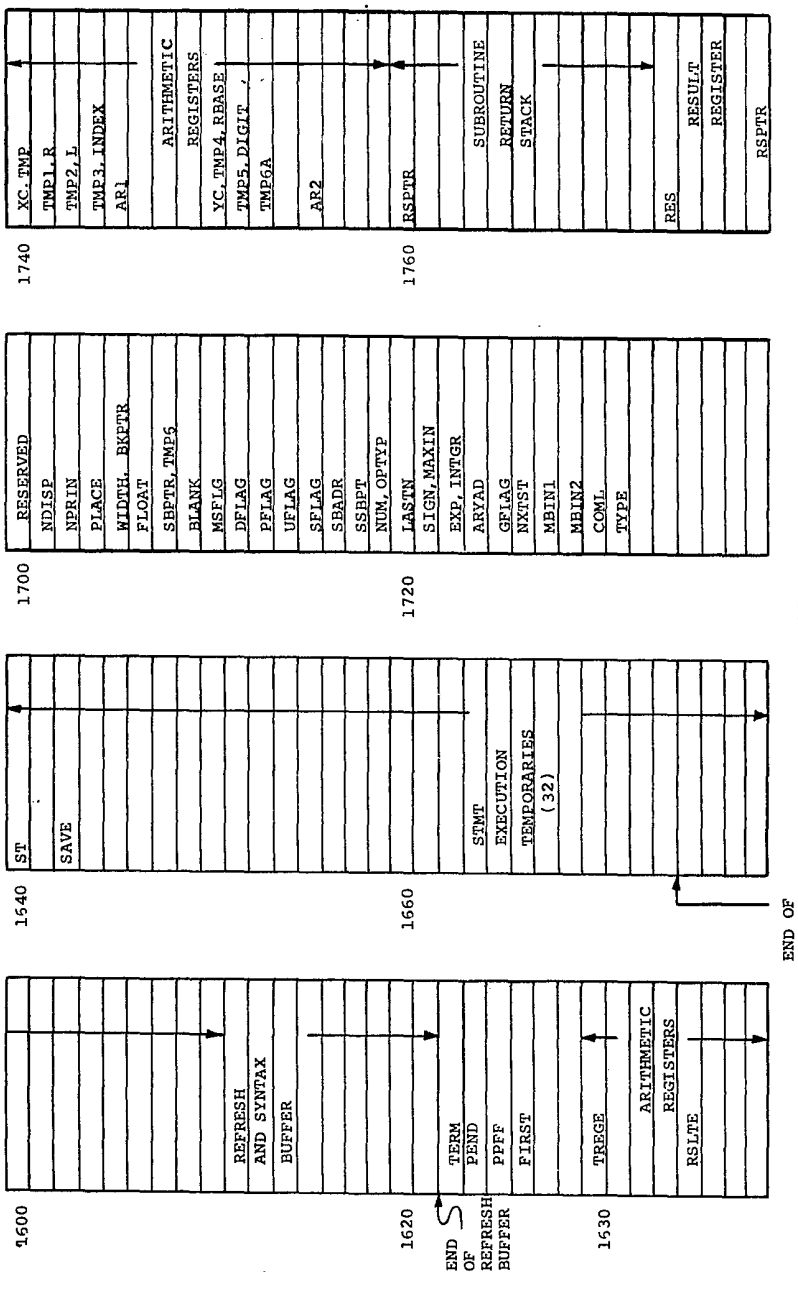

1600
REFRESH AND SYNTAX BUFFER
1620
TERM
PEND
PPFF
FIRST
END OF REFRESH BUFFER
1630
TRSGE
ARITHMETIC REGISTERS
RSLTE
1640
ST
SAVE
1660
STMT
EXECUTION TEMPORARIES (32)
END OF SYNTAX BUFFER
1700
RESERVED
NDISP
NPRIN
PLACE
WIDTH, BKPTR
FLOAT
SBPTR, TMP5
BLANK
MSFLG
DFLAG
PFLAG
UFLAG
SFLAG
SBADR
SSBPT
NUM, OPTYP
1720
LASTN
SIGN, MAXIN
EXP, INTGR
ARYAD
GFLAG
NXTST
MBIN1
MBIN2
COML
TYPE
1740
XC, TMP
TMP1, R
TMP2, L
TMP3, INDEX
AR1
ARITHMETIC REGISTERS
XC, TMP4, RBASE
TMP5, DIGIT
TMP6A
AR2
1760
RSPTR
SUBROUTINE RETURN STACK
RES
RESULT REGISTER
RSPTR

FIG 5B

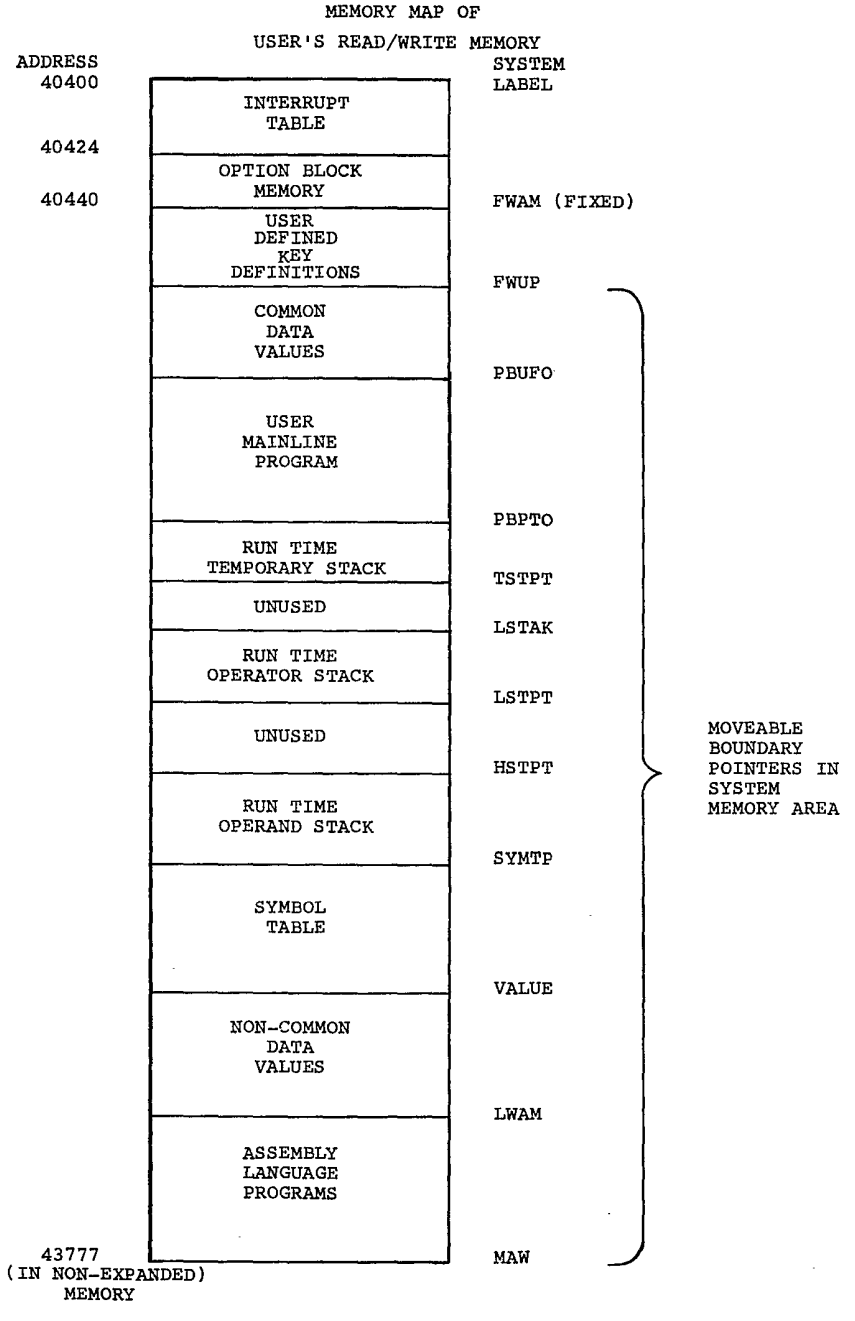

MEMORY MAP OF
USER'S READ/WRITE MEMORY
ADDRESS
40400
SYSTEM
LABEL
INTERRUPT TABLE
40424
OPTION BLOCK MEMORY
40440
FWAM (FIXED)
USER DEFINED KEY DEFINITIONS
FWUP
COMMON DATA VALUES
PBUFO
USER MAINLINE PROGRAM
PBPTO
RUN TIME TEMPORARY STACK
TSTPT
UNUSED
LSTAK
RUN TIME OPERATOR STACK
LSTPT
UNUSED
HSTPT
RUN TIME OPERAND STACK
SYMTP
SYMBOL TABLE
VALUE
NON-COMMON DATA VALUES
LWAM
ASSEMBLY LANGUAGE PROGRAMS
MAW
43777
(IN NON-EXPANDED)
MEMORY
MOVEABLE BOUNDARY POINTERS IN SYSTEM MEMORY AREA

FIG.6

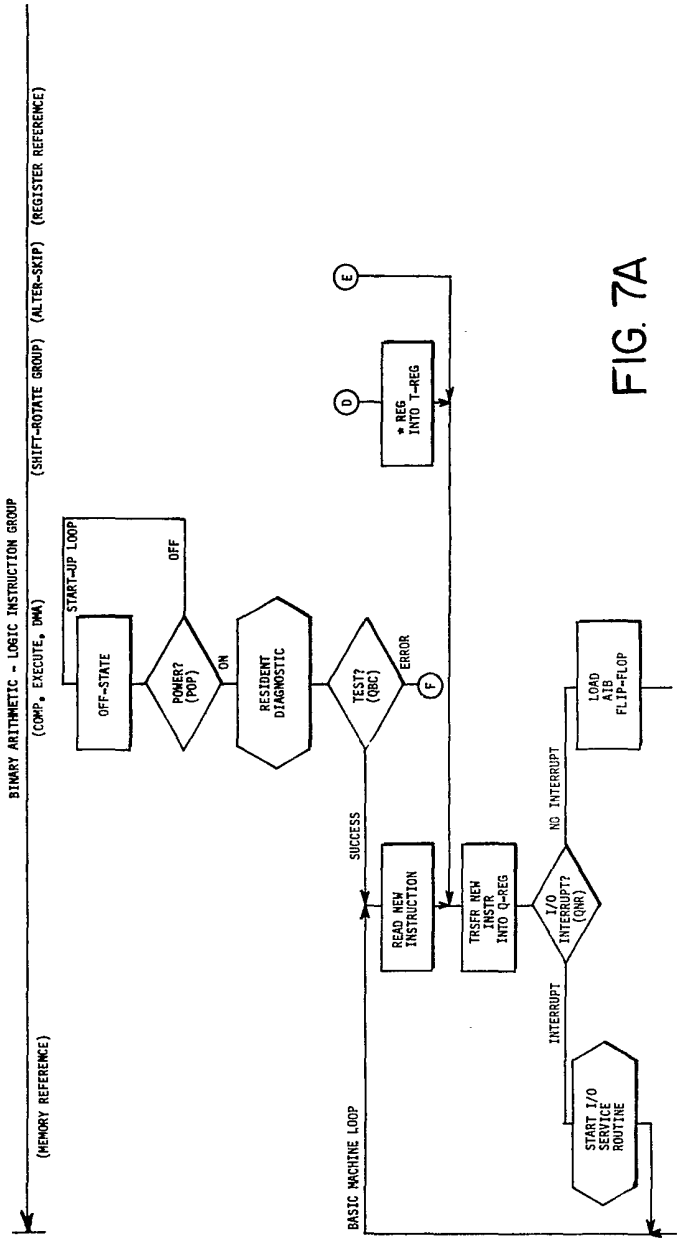

BINARY ARITHMETIC - LOGIC INSTRUCTION GROUP
(COMP, EXECUTE, DMA)
(SHIFT-ROTATE GROUP)
(ALTER-SKIP)
(REGISTER REFERENCE)
(MEMORY REFERENCE)
START-UP LOOP
OFF-STATE
POWER? (POP)
OFF
ON
RESIDENT DIAGNOSTIC
TEST? (QBC)
ERROR
F
E
D
* REG INTO T-REG
SUCCESS
READ NEW INSTRUCTION
TRSFR NEW INSTR INTO Q-REG
I/O INTERRUPT? (QNR)
NO INTERRUPT
INTERRUPT
LOAD AIB FLIP-FLOP
START I/O SERVICE ROUTINE
BASIC MACHINE LOOP

FIG. 7A

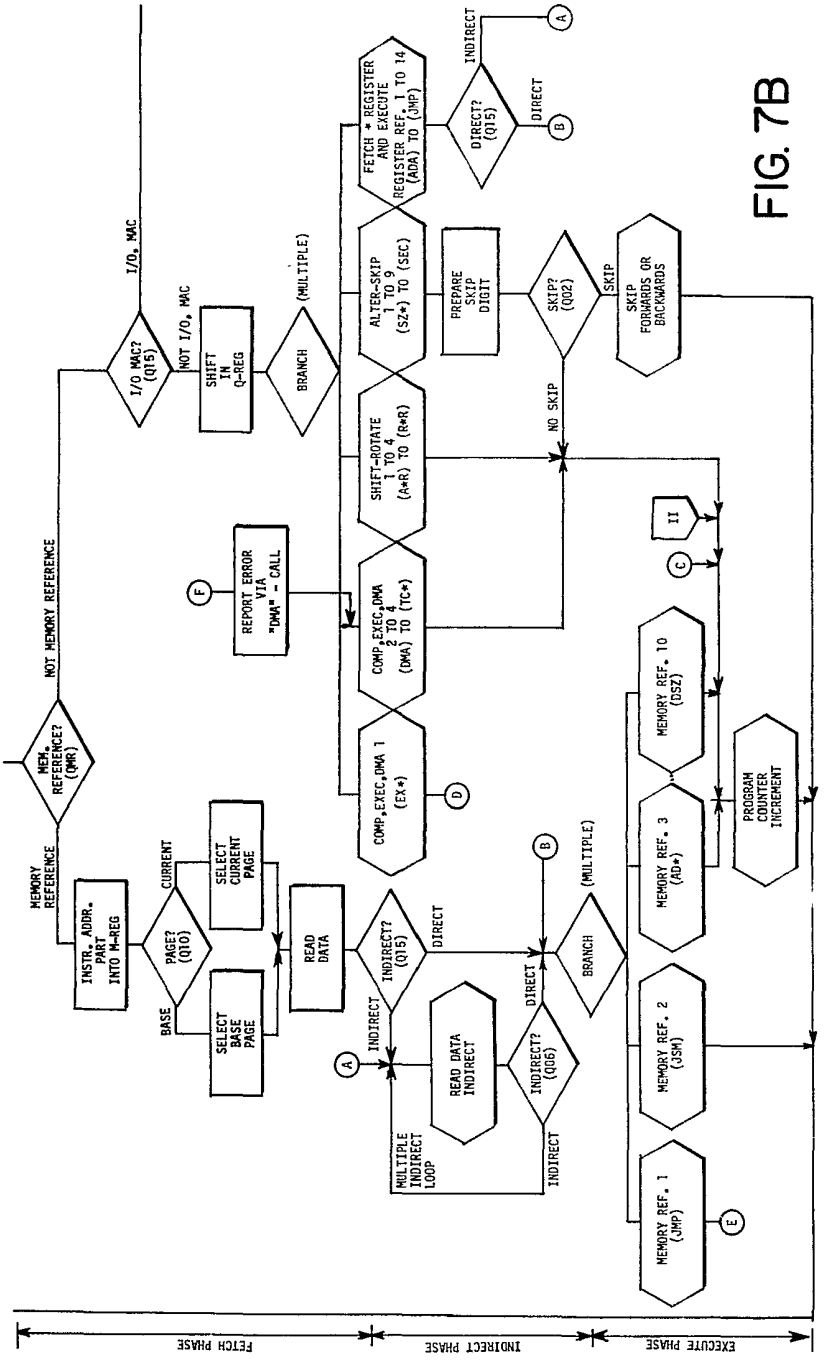
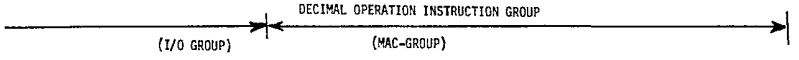

MEM. REFERENCE? (QMR)
NOT MEMORY REFERENCE
I/O MAC
I/O MAC? (Q15)
NOT I/O MAC
SHIFT IN Q-REG
BRANCH
(MULTIPLE)
FETCH * REGISTER AND EXECUTE REGISTER REF. 1 TO 14 (ADA) TO (JMP)
DIRECT? (Q15)
INDIRECT
DIRECT
ALTER-SKIP 1 TO 9 (SZ*) TO (SEC)
PREPARE SKIP DIGIT
SKIP? (Q02)
SKIP
SKIP FORWARDS OR BACKWARDS
NO SKIP
SHIFT-ROTATE 1 TO 4 (A*R) TO (R*R)
REPORT ERROR VIA "DMA" - CALL
COMP.EXEC.DMA 2 TO 4 (DMA) TO (TC*)
COMP.EXEC.DMA 1 (EX*)
MEMORY REFERENCE
INSTR. ADDR. PART INTO M-REG
PAGE? (Q10)
CURRENT
BASE
SELECT CURRENT PAGE
SELECT BASE PAGE
READ DATA
INDIRECT? (Q15)
DIRECT
INDIRECT
READ DATA INDIRECT
INDIRECT? (Q06)
DIRECT
INDIRECT
MULTIPLE INDIRECT LOOP
BRANCH
(MULTIPLE)
MEMORY REF. 10 (DSZ)
MEMORY REF. 3 (AD*)
MEMORY REF. 2 (JSM)
MEMORY REF. 1 (JMP)
PROGRAM COUNTER INCREMENT
FETCH PHASE
INDIRECT PHASE
EXECUTE PHASE

FIG. 7B



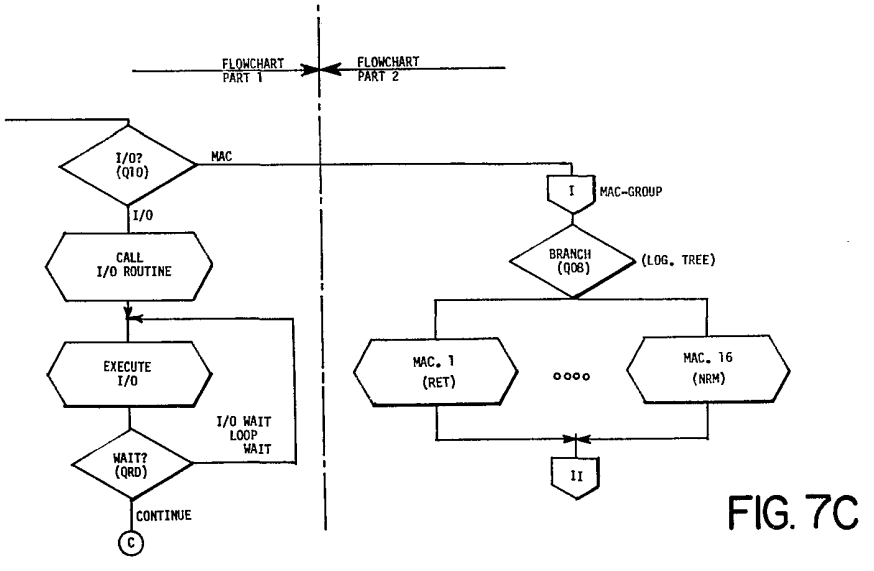


FIG. 7C

NOTE: SUBROUTINES FOR INDIVIDUAL INSTRUCTION EXECUTION USE COMMON PATHS, COMMON LOOPS, COMMON BRANCHES, ETC. IN THE DETAIL FLOWCHART

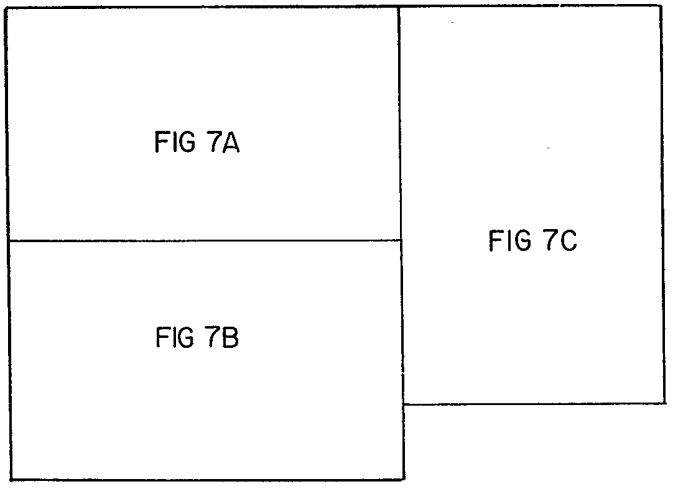


FIG. 7'

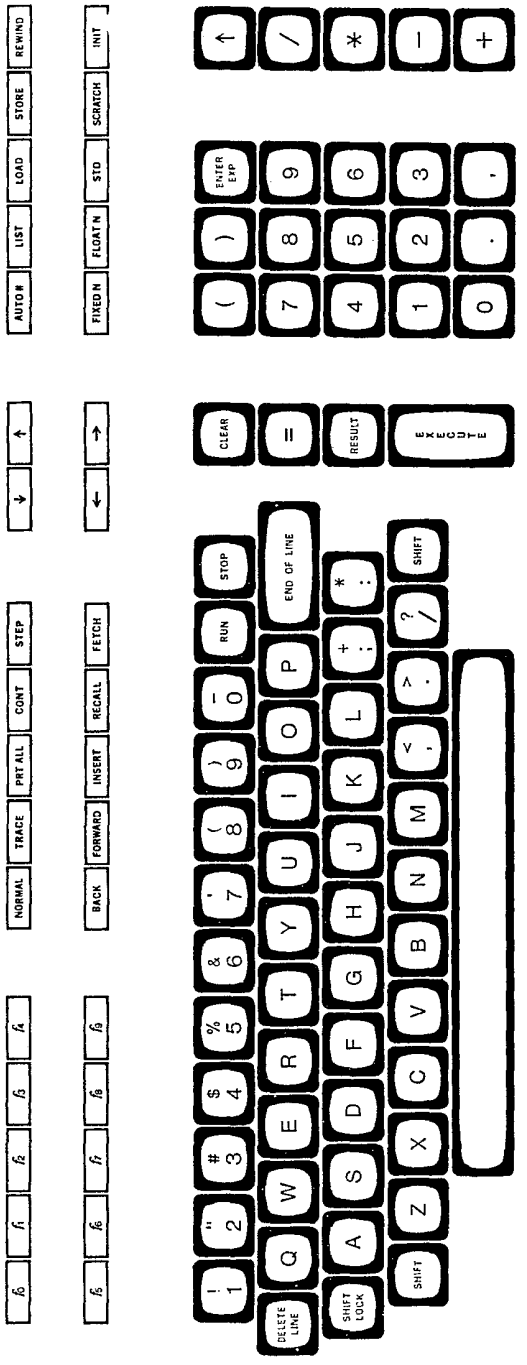

f6 f1 f2 f3 f4 f5
f5 f6 f7 f8 f9
NORMAL TRACE PRT ALL CONT STEP
BACK FORWARD INSERT RECALL FETCH
AUTO # LIST LOAD STORE REWIND
FIXED N FLOAT N STO SCRATCH INIT
CLEAR = RESULT EXECUTE
DELETE LINE
SHIFT LOCK
SHIFT
END OF LINE
STOP
RUN
ENTER EXP

FIG 8

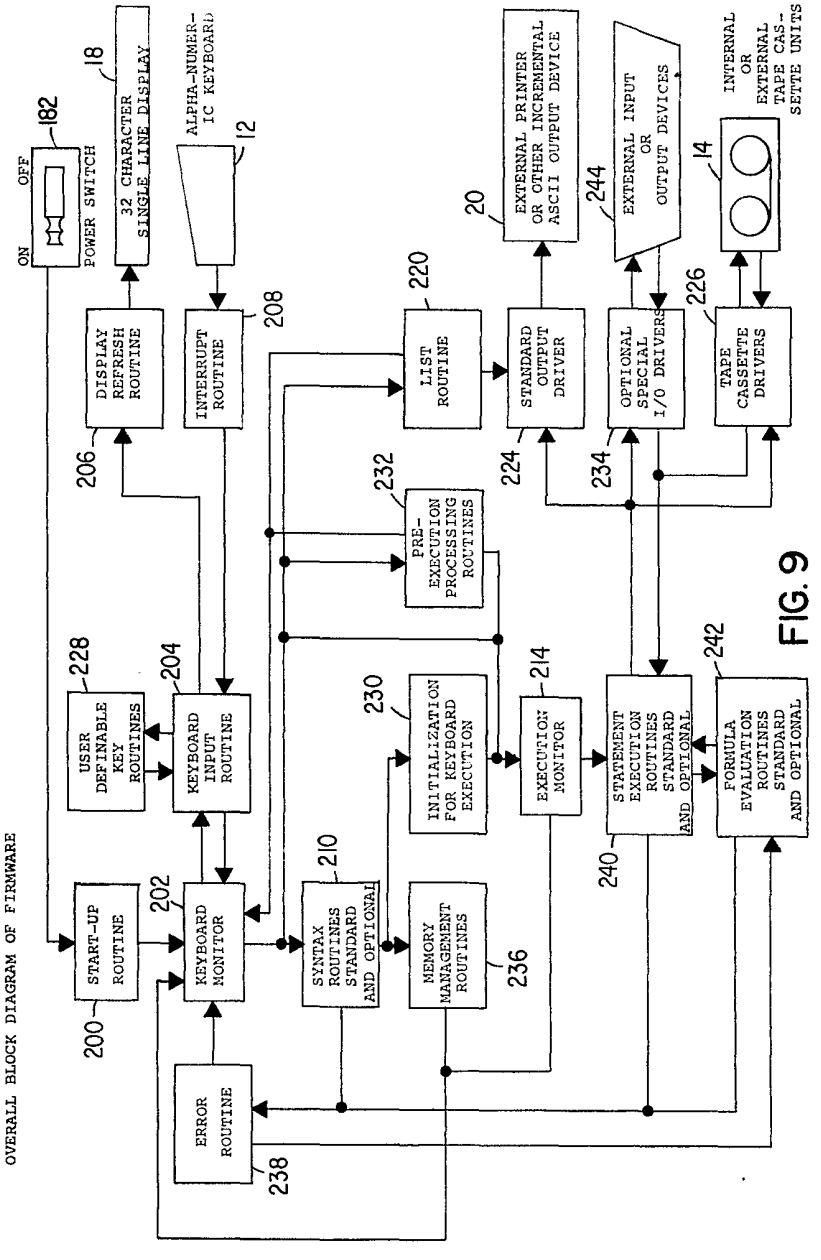

OVERALL BLOCK DIAGRAM OF FIRMWARE
ON
OFF
POWER SWITCH
182
32 CHARACTER SINGLE LINE DISPLAY
18
ALPHA-NUMERIC KEYBOARD
12
EXTERNAL PRINTER OR OTHER INCREMENTAL ASCII OUTPUT DEVICE
20
EXTERNAL INPUT OR OUTPUT DEVICES
244
INTERNAL OR EXTERNAL TAPE CASSETTE UNITS
14
DISPLAY REFRESH ROUTINE
206
INTERRUPT ROUTINE
208
LIST ROUTINE
220
STANDARD OUTPUT DRIVER
224
OPTIONAL SPECIAL I/O DRIVERS
234
TAPE CASSETTE DRIVERS
226
PRE-EXECUTION PROCESSING ROUTINES
232
USER DEFINABLE KEY ROUTINES
228
KEYBOARD INPUT ROUTINE
204
INITIALIZATION FOR KEYBOARD EXECUTION
230
EXECUTION MONITOR
214
STATEMENT EXECUTION ROUTINES STANDARD AND OPTIONAL
240
FORMULA EVALUATION ROUTINES STANDARD AND OPTIONAL
242
START-UP ROUTINE
200
KEYBOARD MONITOR
202
SYNTAX ROUTINES STANDARD AND OPTIONAL
210
MEMORY MANAGEMENT ROUTINES
236
ERROR ROUTINE
238

FIG. 9

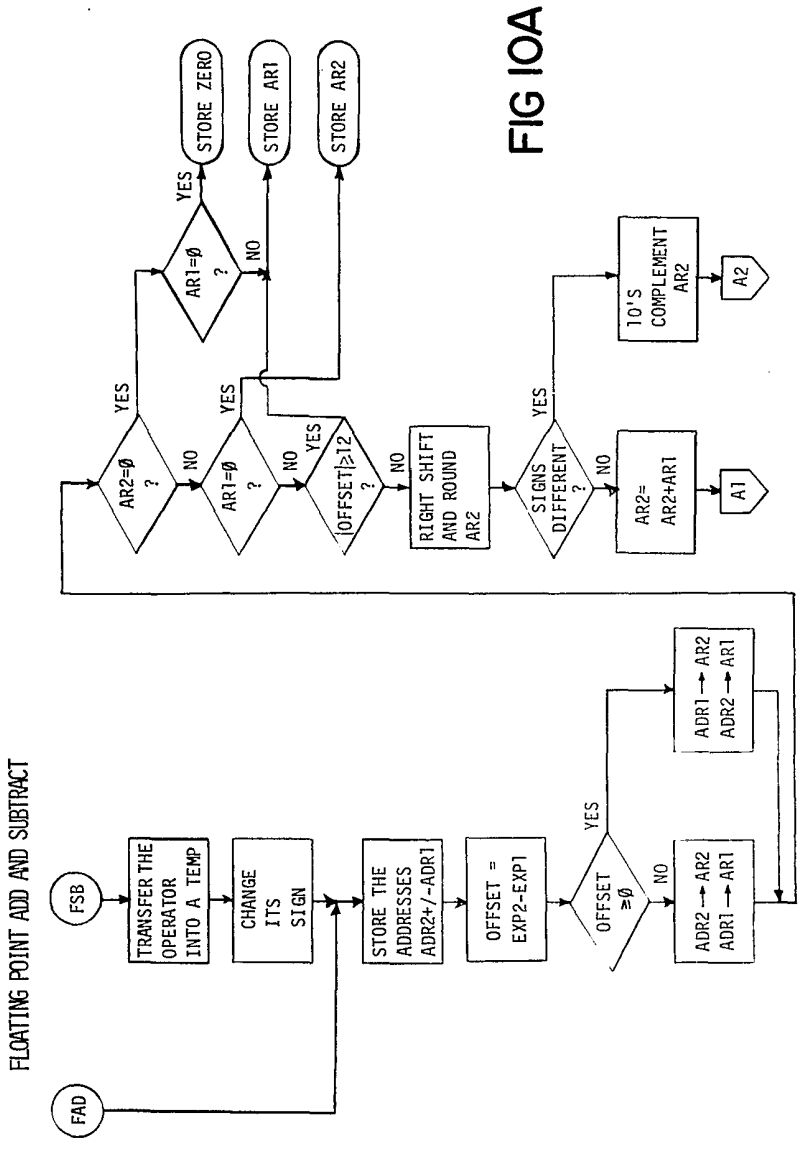

FLOATING POINT ADD AND SUBTRACT
FSB
FAD
TRANSFER THE OPERATOR INTO A TEMP
CHANGE ITS SIGN
STORE THE ADDRESSES ADR2+/-ADR1
OFFSET = EXP2-EXP1
OFFSET ≥ø
YES
NO
ADR1 → AR2
ADR2 → AR1
ADR2 → AR2
ADR1 → AR1
AR2=ø ?
AR1=ø ?
|OFFSET|≥12 ?
RIGHT SHIFT AND ROUND AR2
SIGNS DIFFERENT ?
AR2= AR2+AR1
A1
10'S COMPLEMENT AR2
A2
AR1=ø ?
STORE ZERO
STORE AR1
STORE AR2

FIG 10A

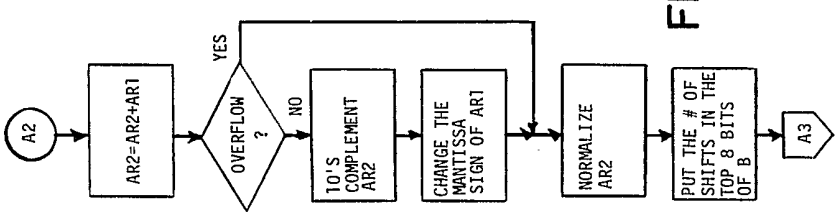


FIG 10C

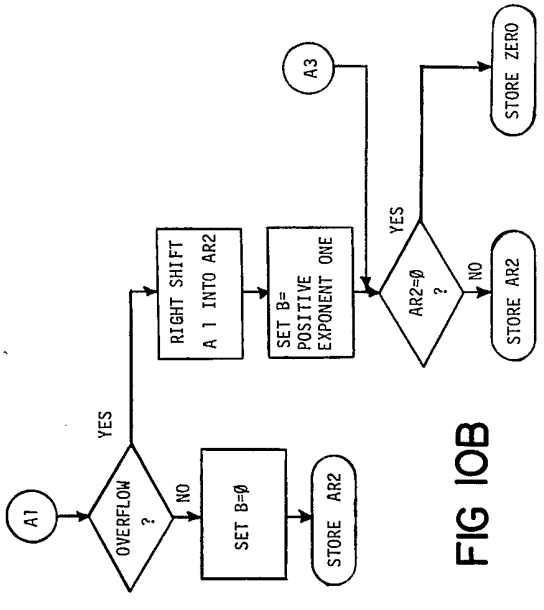
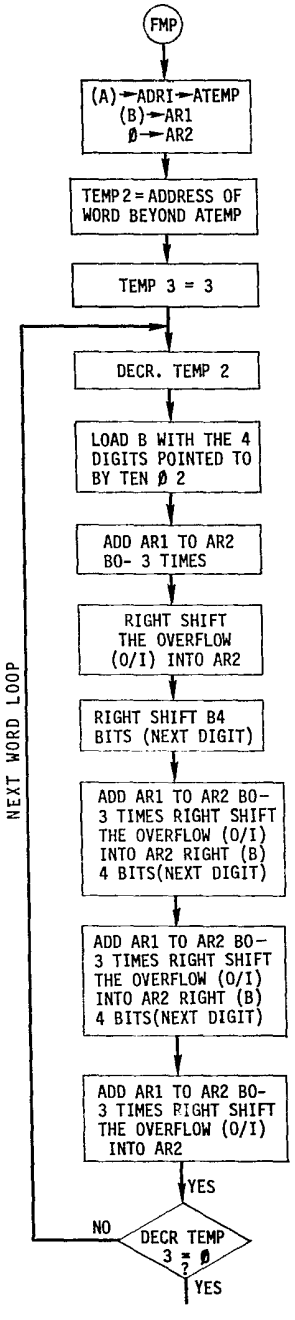


FIG 10B


FMP
(A)→ADRI→ATEMP
(B)→AR1
Ø→AR2
TEMP 2 = ADDRESS OF WORD BEYOND ATEMP
TEMP 3 = 3
DECR. TEMP 2
LOAD B WITH THE 4 DIGITS POINTED TO BY TEN Ø 2
ADD AR1 TO AR2 BO- 3 TIMES
RIGHT SHIFT THE OVERFLOW (O/I) INTO AR2
RIGHT SHIFT B4 BITS (NEXT DIGIT)
ADD AR1 TO AR2 BO- 3 TIMES RIGHT SHIFT THE OVERFLOW (O/I) INTO AR2 RIGHT (B) 4 BITS(NEXT DIGIT)
ADD AR1 TO AR2 BO- 3 TIMES RIGHT SHIFT THE OVERFLOW (O/I) INTO AR2 RIGHT (B) 4 BITS(NEXT DIGIT)
ADD AR1 TO AR2 BO- 3 TIMES RIGHT SHIFT THE OVERFLOW (O/I) INTO AR2
YES
NO
DECR TEMP 3 = Ø ?
YES
NEXT WORD LOOP

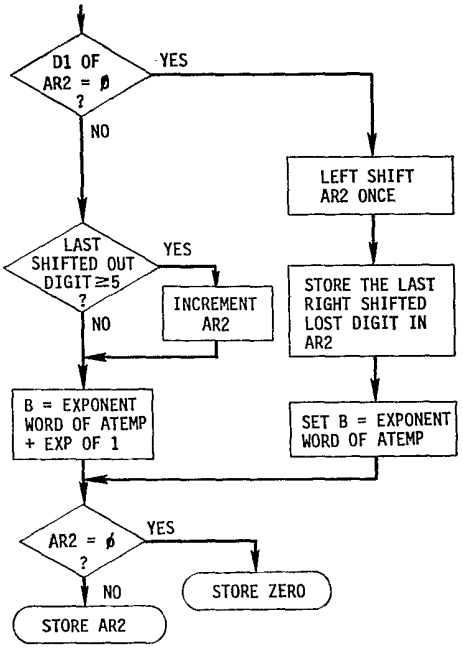
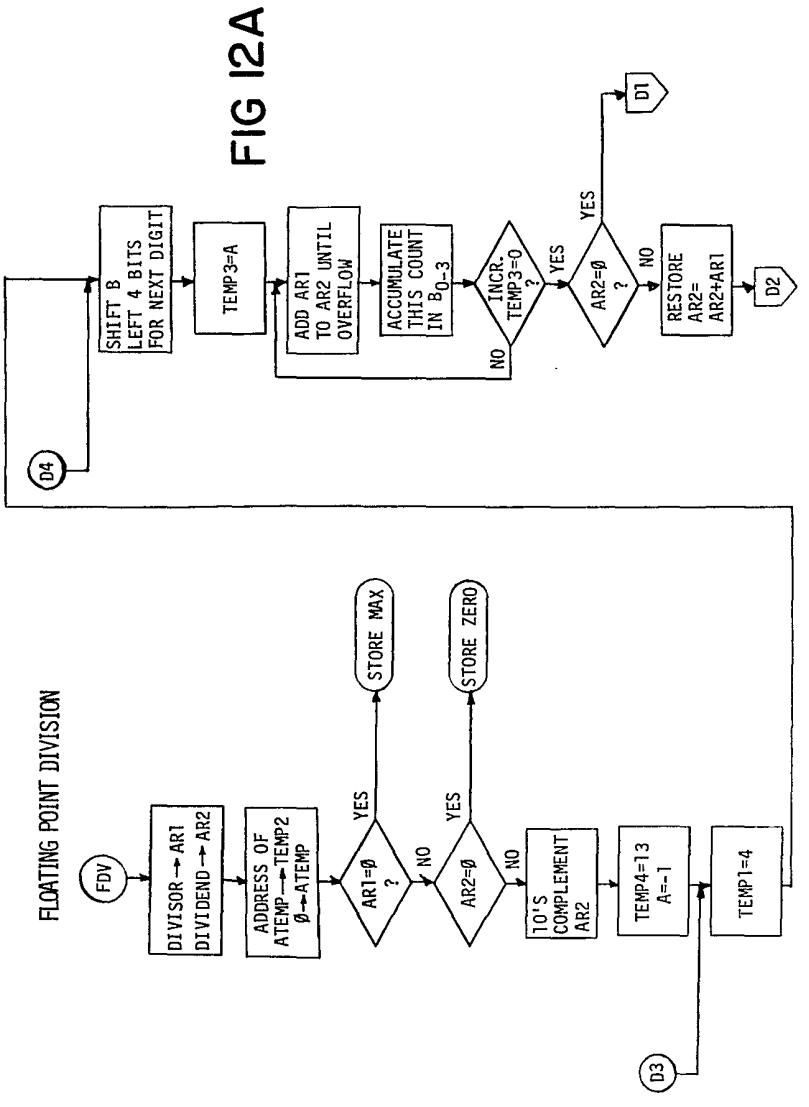

D1 OF AR2 = Ø ?
YES
NO
LEFT SHIFT AR2 ONCE
LAST SHIFTED OUT DIGIT ≥ 5 ?
YES
NO
INCREMENT AR2
STORE THE LAST RIGHT SHIFTED LOST DIGIT IN AR2
B = EXPONENT WORD OF ATEMP + EXP OF 1
SET B = EXPONENT WORD OF ATEMP
AR2 = Ø ?
YES
NO
STORE ZERO
STORE AR2

FIG. 11

FIG 12A


FLOATING POINT DIVISION
FDV
DIVISOR→AR1
DIVIDEND→AR2
ADDRESS OF ATEMP→TEMP2
Ø→ATEMP
AR1=Ø ?
YES
STORE MAX
NO
AR2=Ø
YES
STORE ZERO
NO
10'S COMPLEMENT AR2
TEMP4=13
A=-1
TEMP1=4
D3
D4
SHIFT B LEFT 4 BITS FOR NEXT DIGIT
TEMP3=A
ADD AR1 TO AR2 UNTIL OVERFLOW
ACCUMULATE THIS COUNT IN B_{0-3}
INCR. TEMP3=0 ?
NO
YES
AR2=Ø ?
YES
D1
NO
RESTORE AR2= AR2+AR1
D2

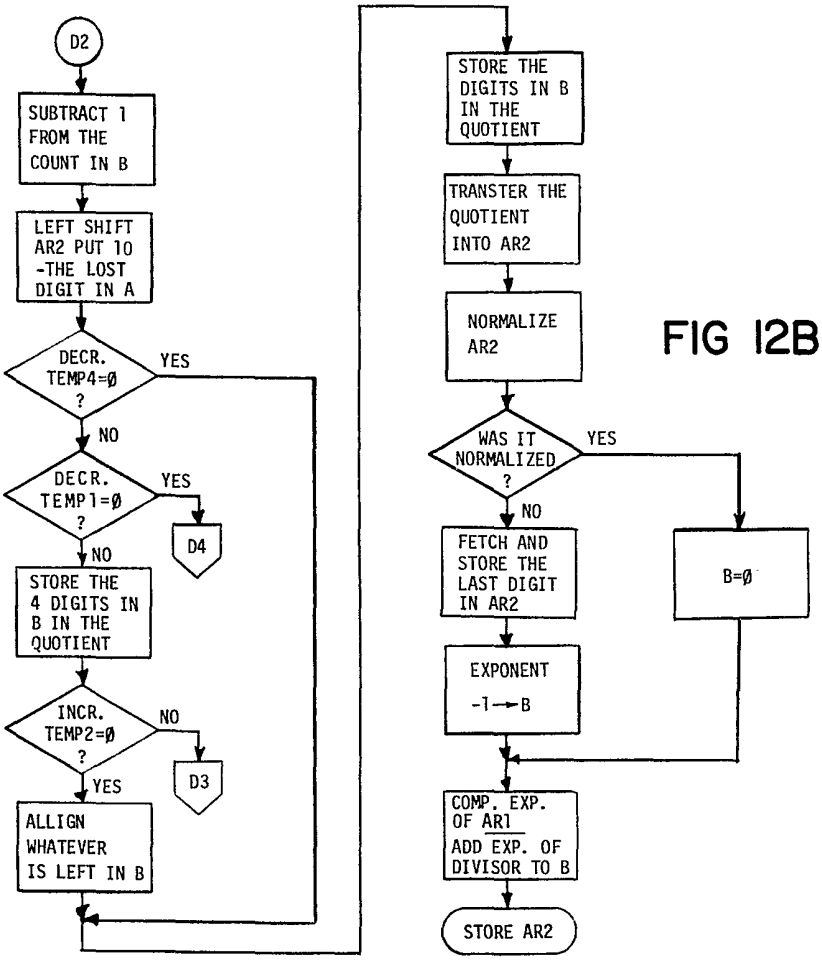

D2
SUBTRACT 1 FROM THE COUNT IN B
LEFT SHIFT AR2 PUT 10 -THE LOST DIGIT IN A
DECR. TEMP4=Ø ?
YES
NO
DECR. TEMP1=Ø ?
YES
D4
NO
STORE THE 4 DIGITS IN B IN THE QUOTIENT
INCR. TEMP2=Ø ?
NO
D3
YES
ALLIGN WHATEVER IS LEFT IN B
STORE THE DIGITS IN B IN THE QUOTIENT
TRANSTER THE QUOTIENT INTO AR2
NORMALIZE AR2
WAS IT NORMALIZED ?
YES
NO
FETCH AND STORE THE LAST DIGIT IN AR2
B=Ø
EXPONENT -1→B
COMP. EXP. OF AR1
ADD EXP. OF DIVISOR TO B
STORE AR2

FIG 12B

FLOATING POINT SQUARE ROOT

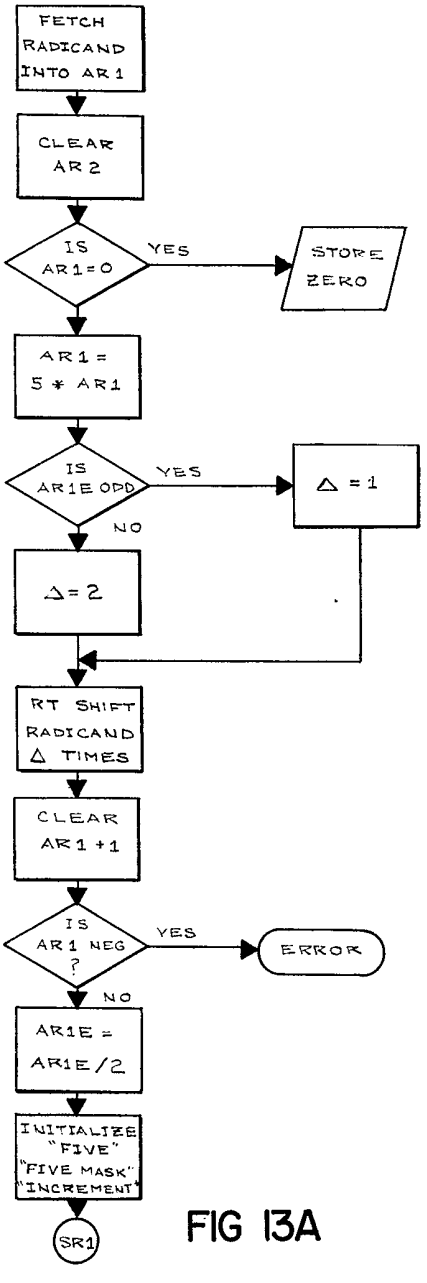


FIG 13A

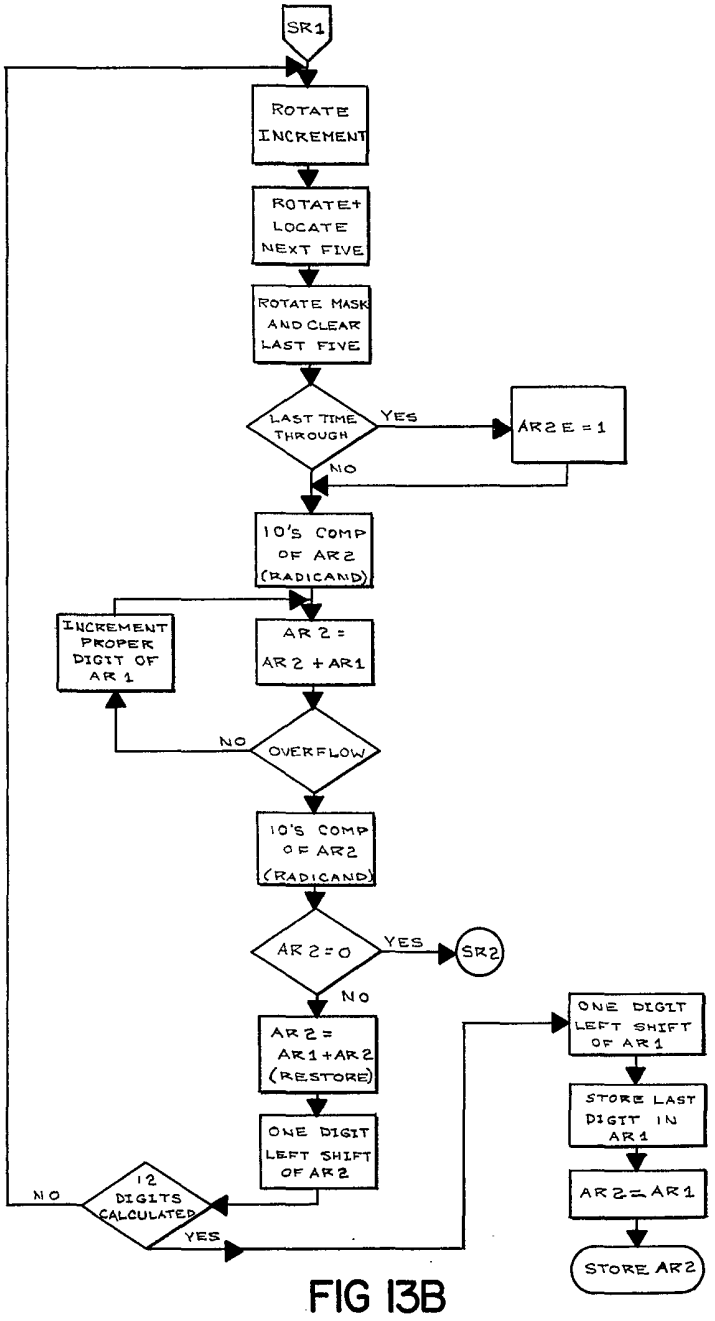

SR1
ROTATE INCREMENT
ROTATE+ LOCATE NEXT FIVE
ROTATE MASK AND CLEAR LAST FIVE
LAST TIME THROUGH
YES
AR2 E = 1
NO
10'S COMP OF AR2 (RADICAND)
INCREMENT PROPER DIGIT OF AR 1
AR 2 = AR 2 + AR1
NO
OVERFLOW
10'S COMP OF AR2 (RADICAND)
AR 2 = 0
YES
SR2
NO
AR 2 = AR1 + AR2 (RESTORE)
ONE DIGIT LEFT SHIFT OF AR2
NO
12 DIGITS CALCULATED
YES
ONE DIGIT LEFT SHIFT OF AR1
STORE LAST DIGIT IN AR1
AR2 = AR1
STORE AR2

FIG 13B

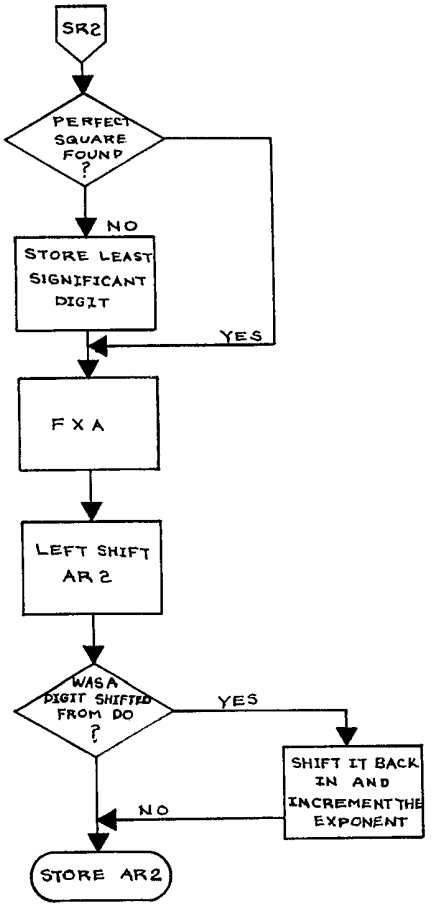

SR2
PERFECT SQUARE FOUND ?
NO
STORE LEAST SIGNIFICANT DIGIT
YES
F X A
LEFT SHIFT AR 2
WAS A DIGIT SHIFTED FROM D0 ?
YES
SHIFT IT BACK IN AND INCREMENT THE EXPONENT
NO
STORE AR2

FIG. 13C

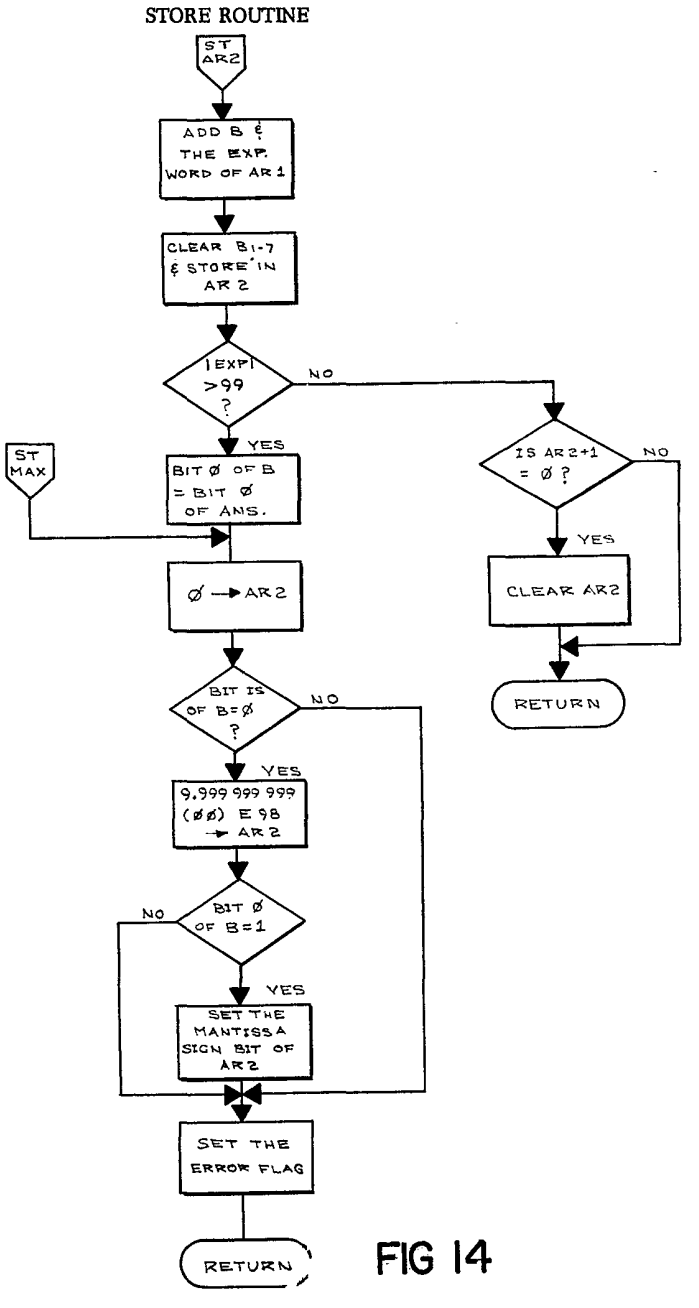

STORE ROUTINE
ST AR2
ADD B & THE EXP. WORD OF AR 1
CLEAR B1-7 & STORE IN AR 2
|EXP| >99 ?
NO
YES
IS AR 2+1 = Ø ?
NO
YES
CLEAR AR2
RETURN
ST MAX
BIT Ø OF B = BIT Ø OF ANS.
Ø → AR2
BIT IS OF B=Ø ?
NO
YES
9.999 999 999 (ØØ) E 98 → AR 2
BIT Ø OF B=1
NO
YES
SET THE MANTISSA SIGN BIT OF AR2
SET THE ERROR FLAG
RETURN

FIG 14

FIG 15

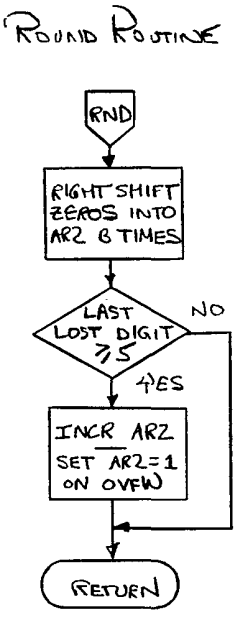
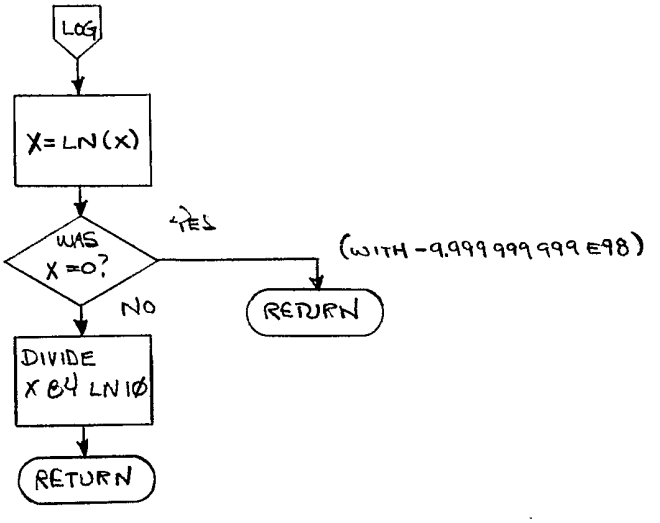

ROUND ROUTINE
RND
RIGHT SHIFT ZEROS INTO AR2 8 TIMES
LAST LOST DIGIT ≥ 5
NO
YES
INCR AR2
SET AR2=1 ON OVFW
RETURN

FIG 26


LOG
X=LN(X)
WAS X=0?
YES
(WITH -9.999999999E98)
NO
RETURN
DIVIDE X BY LN10
RETURN

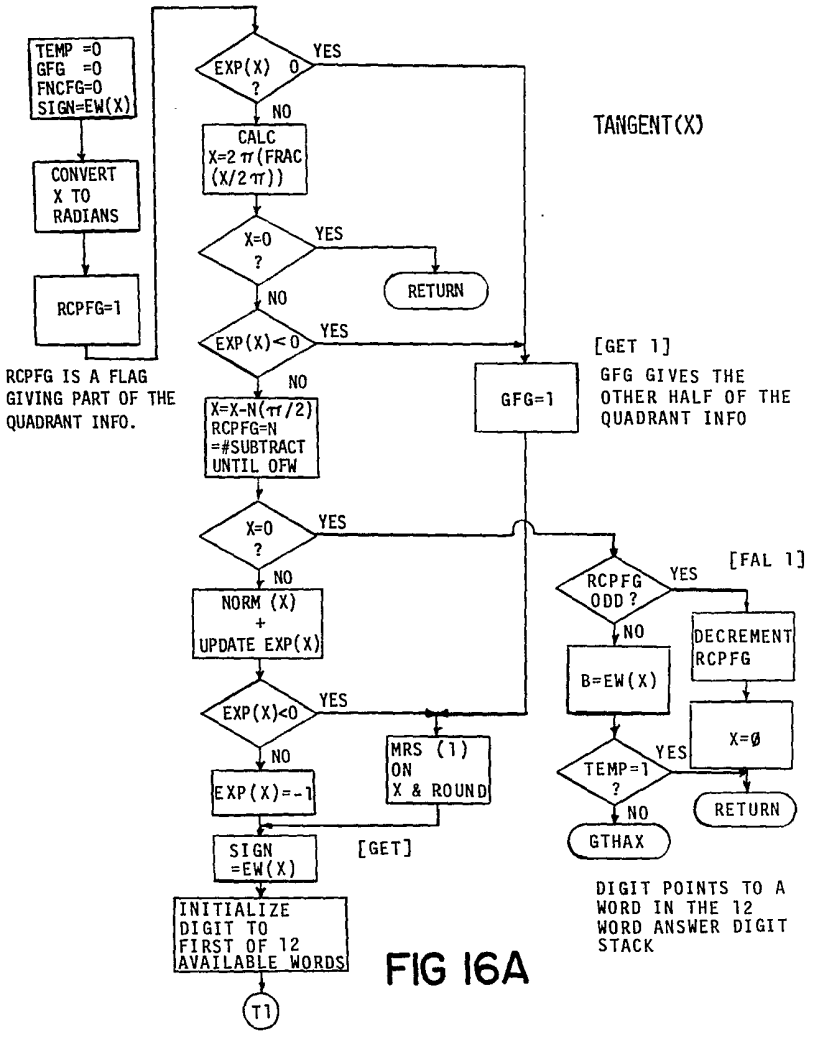

TANGENT(X)
TEMP =0
GFG =0
FNCFG=0
SIGN=EW(X)
CONVERT X TO RADIANS
RCPFG=1
RCPFG IS A FLAG GIVING PART OF THE QUADRANT INFO.
EXP(X) 0 ?
YES
NO
CALC X=2π(FRAC (X/2π))
X=0 ?
YES
RETURN
NO
EXP(X)<0
YES
NO
X=X-N(π/2) RCPFG=N =#SUBTRACT UNTIL OFW
X=0 ?
YES
NO
NORM (X) + UPDATE EXP(X)
EXP(X)<0
YES
NO
EXP(X)=-1
SIGN =EW(X)
[GET]
MRS (1) ON X & ROUND
INITIALIZE DIGIT TO FIRST OF 12 AVAILABLE WORDS
T1
[GET 1]
GFG=1
GFG GIVES THE OTHER HALF OF THE QUADRANT INFO
[FAL 1]
RCPFG ODD ?
YES
NO
DECREMENT RCPFG
B=EW(X)
X=Ø
TEMP=1 ?
YES
NO
RETURN
GTHAX
DIGIT POINTS TO A WORD IN THE 12 WORD ANSWER DIGIT STACK

FIG 16A

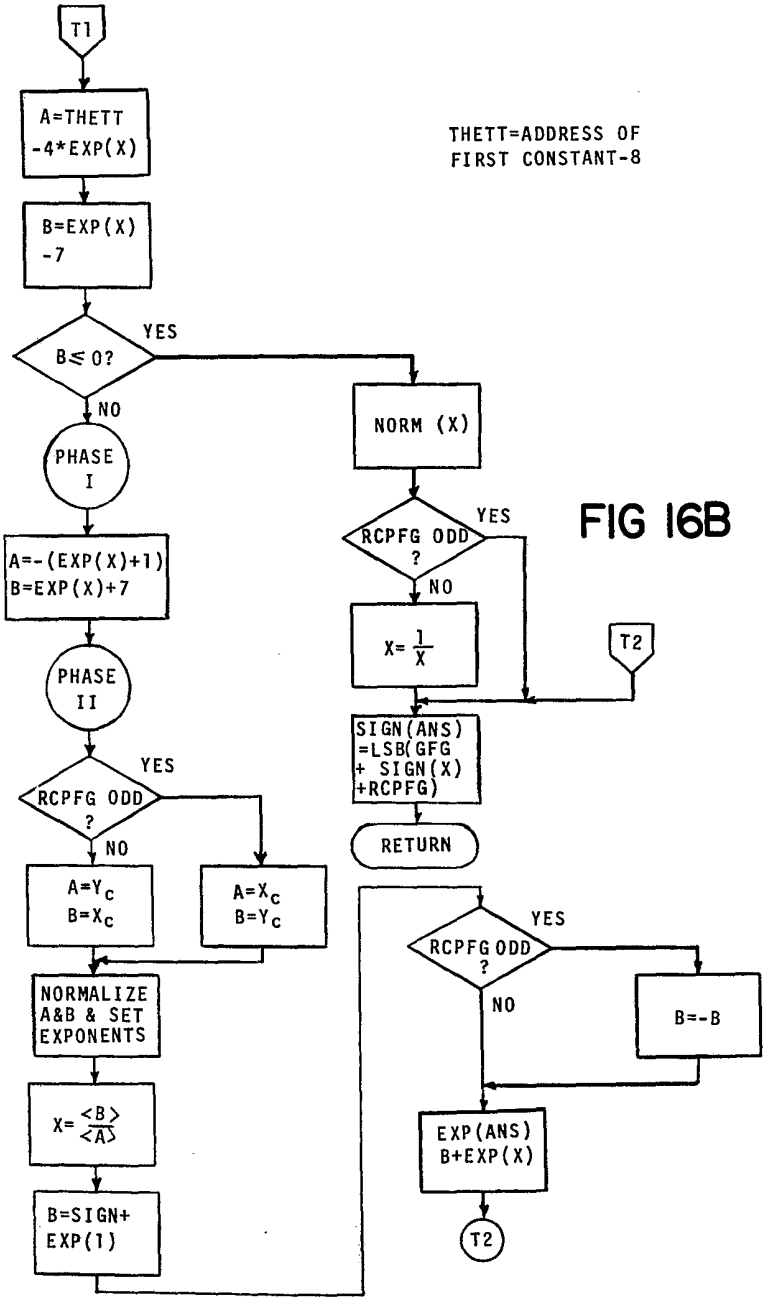
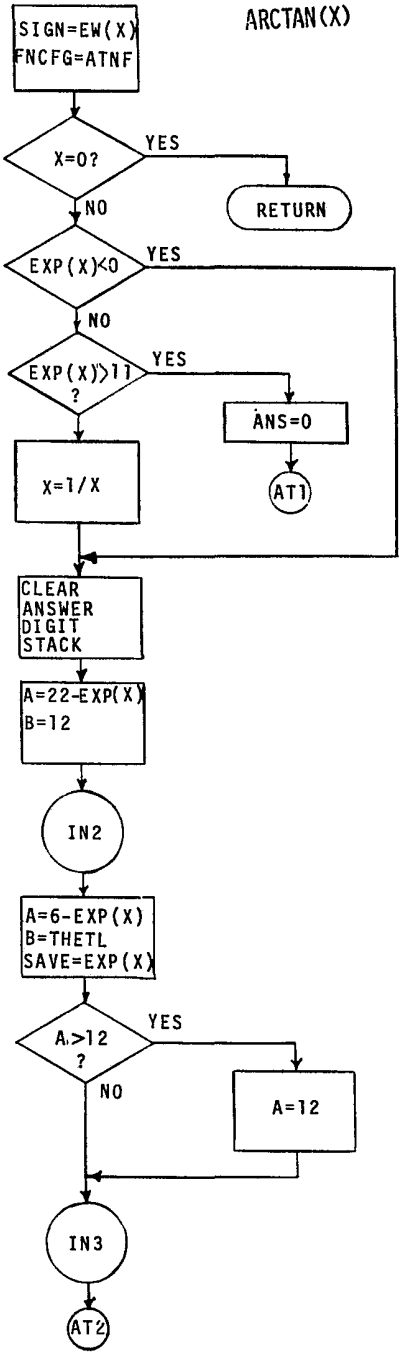

T1
A=THETT -4*EXP(X)
B=EXP(X) -7
B≤0?
YES
NO
PHASE I
A=-(EXP(X)+1) B=EXP(X)+7
PHASE II
RCPFG ODD ?
YES
NO
A=Y_C B=X_C
A=X_C B=Y_C
NORMALIZE A&B & SET EXPONENTS
X=<B>/<A>
B=SIGN+ EXP(1)
NORM (X)
RCPFG ODD ?
YES
NO
X=1/X
T2
SIGN(ANS) =LSB(GFG + SIGN(X) +RCPFG)
RETURN
RCPFG ODD ?
YES
NO
B=-B
EXP(ANS) B+EXP(X)
T2
THETT=ADDRESS OF FIRST CONSTANT-8

FIG 16B



ATNF IS THE ARCTAN FLAG

FIG 17A

THETL=ADDRESS OF LAST CORDIC CONSTANT -4

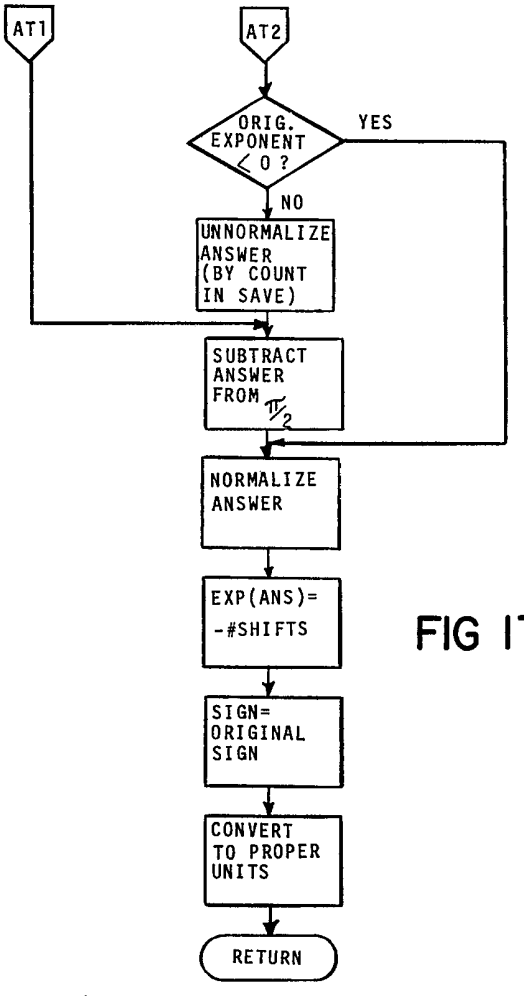

AT1
AT2
ORIG. EXPONENT < 0 ?
YES
NO
UNNORMALIZE ANSWER (BY COUNT IN SAVE)
SUBTRACT ANSWER FROM π/2
NORMALIZE ANSWER
EXP(ANS)= -#SHIFTS
SIGN= ORIGINAL SIGN
CONVERT TO PROPER UNITS
RETURN

FIG 17B

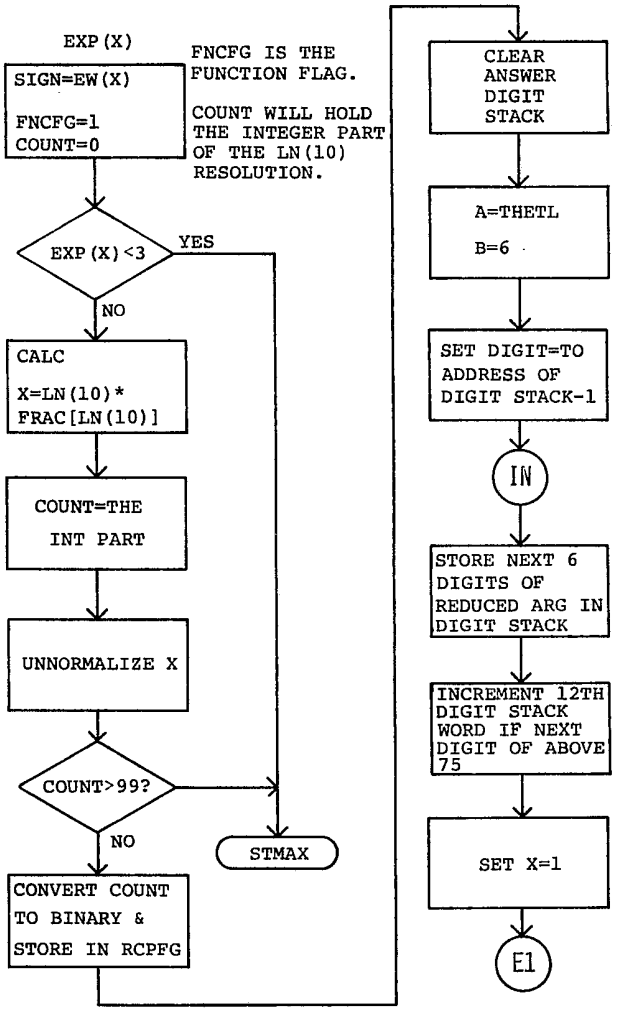

EXP(X)
SIGN=EW(X)
FNCFG=1
COUNT=0
FNCFG IS THE FUNCTION FLAG.
COUNT WILL HOLD THE INTEGER PART OF THE LN(10) RESOLUTION.
EXP(X)<3
YES
NO
CALC
X=LN(10)*
FRAC[LN(10)]
COUNT=THE
INT PART
UNNORMALIZE X
COUNT>99?
NO
STMAX
CONVERT COUNT
TO BINARY &
STORE IN RCPFG
CLEAR
ANSWER
DIGIT
STACK
A=THETL
B=6
SET DIGIT=TO
ADDRESS OF
DIGIT STACK-1
IN
STORE NEXT 6
DIGITS OF
REDUCED ARG IN
DIGIT STACK
INCREMENT 12TH
DIGIT STACK
WORD IF NEXT
DIGIT OF ABOVE
75
SET X=1
E1

FIG. 18A

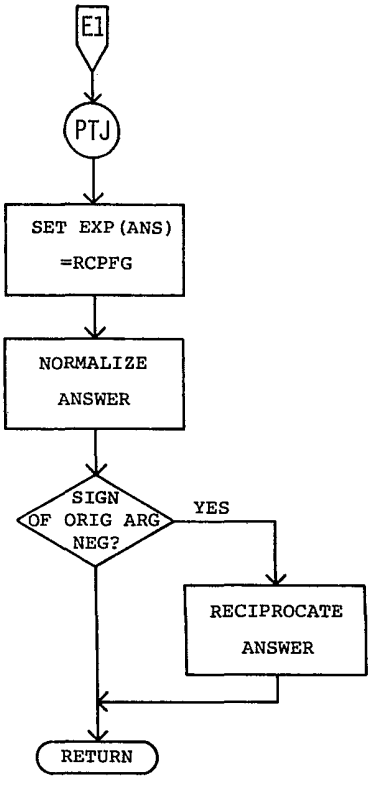

E1
PTJ
SET EXP(ANS) =RCPFG
NORMALIZE ANSWER
SIGN OF ORIG ARG NEG?
YES
RECIPROCATE ANSWER
RETURN

FIG. 18B

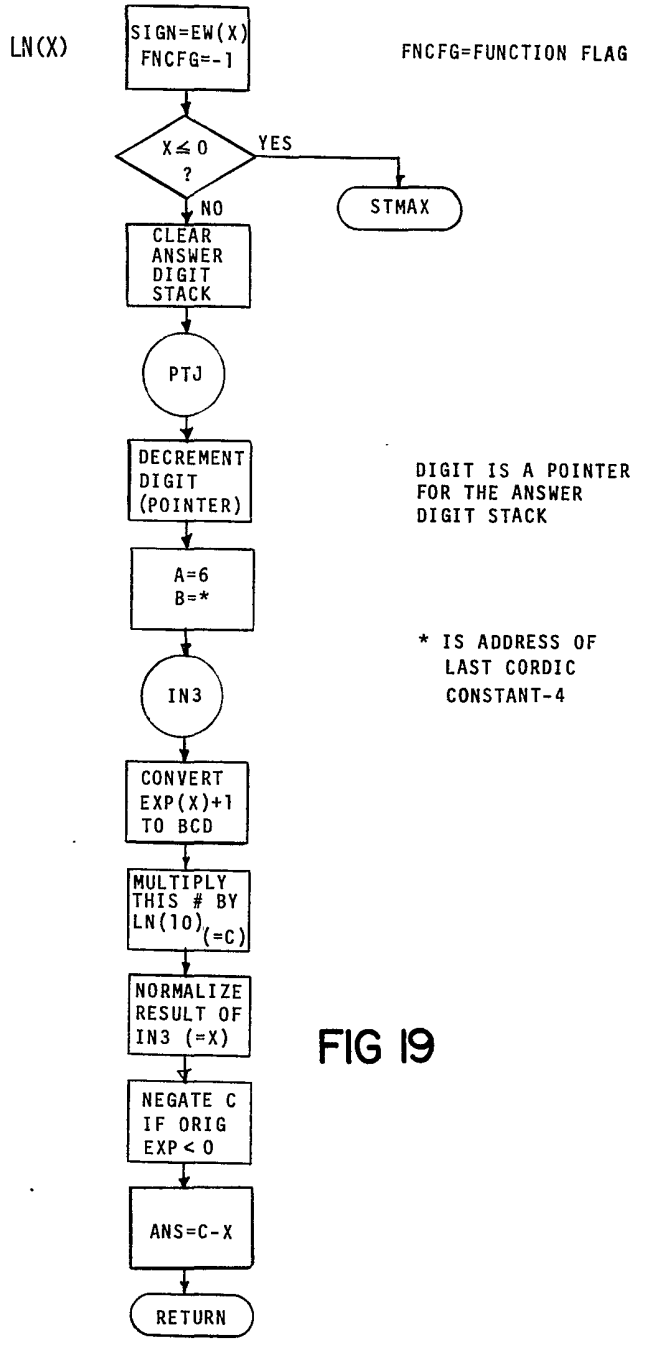

LN(X)
SIGN=EW(X)
FNCFG=-1
X≤0 ?
YES
NO
STMAX
CLEAR ANSWER DIGIT STACK
PTJ
DECREMENT DIGIT (POINTER)
A=6
B=*
IN3
CONVERT EXP(X)+1 TO BCD
MULTIPLY THIS # BY LN(10)(=C)
NORMALIZE RESULT OF IN3 (=X)
NEGATE C IF ORIG EXP < 0
ANS=C-X
RETURN
FNCFG=FUNCTION FLAG
DIGIT IS A POINTER FOR THE ANSWER DIGIT STACK
* IS ADDRESS OF LAST CORDIC CONSTANT-4

FIG 19

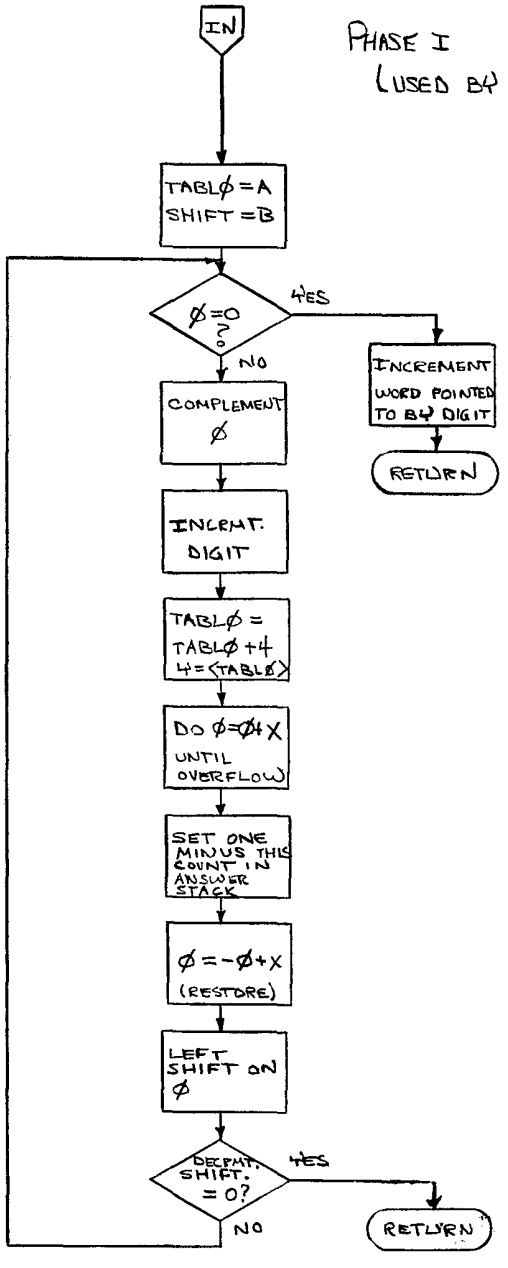
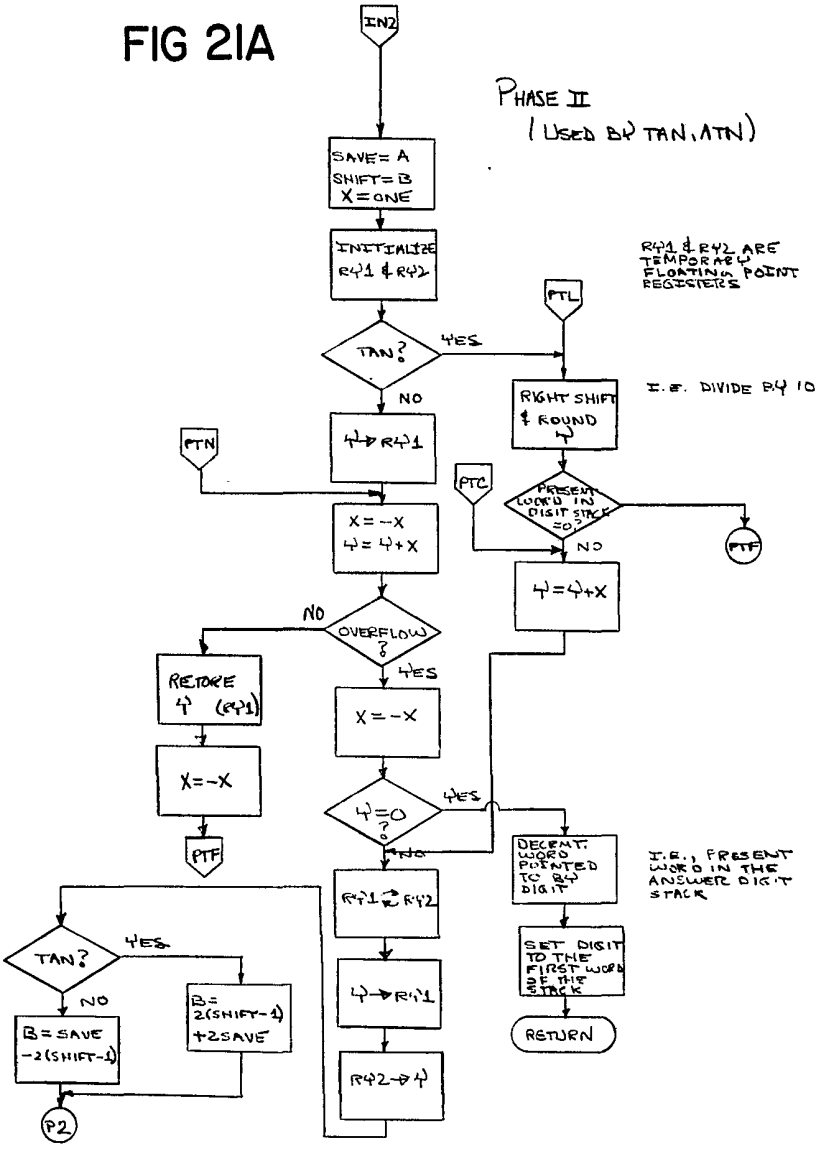

IN
PHASE I
(USED BY TAN, EXP)
TABLØ = A
SHIFT = B
TABLØ HOLDS THE ADDRESS OF A CORDIC CONSTANT
SHIFT = # TIMES TO GO THRU THE MAIN LOOP
Ø = 0 ?
YES
NO
INCREMENT WORD POINTED TO BY DIGIT
RETURN
COMPLEMENT Ø
INCRMT. DIGIT
TABLØ = TABLØ + 4
4 = <TABLØ>
SET X = TO NEXT CORDIC CONSTANT
DO Ø = Ø + X UNTIL OVERFLOW
SET ONE MINUS THIS COUNT IN ANSWER STACK
THE COUNT IS LOCATED IN THE STACK VIA DIGIT
Ø = -Ø + X (RESTORE)
LEFT SHIFT ON Ø
I.E., MULTIPLY Ø BY 10
DECRMT. SHIFT. = 0?
YES
NO
RETURN

FIG 20

FIG 21A


IN2
PHASE II
(USED BY TAN, ATN)
SAVE = A
SHIFT = B
X = ONE
INITIALIZE R41 & R42
R41 & R42 ARE TEMPORARY FLOATING POINT REGISTERS
TAN?
YES
NO
PTL
RIGHT SHIFT & ROUND 4
I.E. DIVIDE BY 10
4 → R41
PTN
PTC
PRESENT LOCATED IN DIGIT STACK = 0?
PTF
X = -X
4 = 4+X
NO
4=4+X
OVERFLOW?
NO
YES
RESTORE 4 (R41)
X = -X
X = -X
4 = 0?
YES
NO
PTF
DECENT. WORD POINTED TO BY DIGIT
I.E., PRESENT WORD IN THE ANSWER DIGIT STACK
R41 ⇄ R42
SET DIGIT TO THE FIRST WORD OF THE STACK
TAN?
YES
NO
B = 2(SHIFT-1) + 2SAVE
4 → R41
RETURN
B = SAVE - 2(SHIFT-1)
R42 → 4
P2

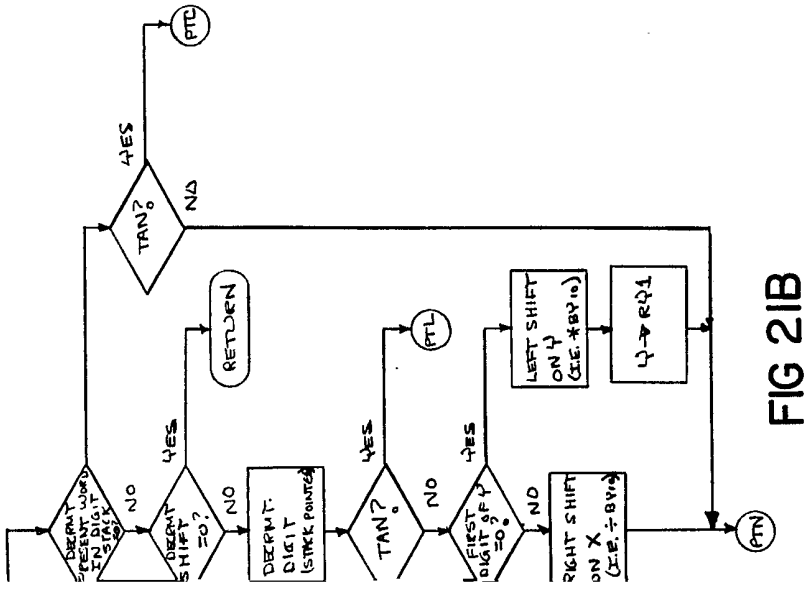

PTC
YES
TAN?
NO
RETURN
YES
DECMT SHIFT =0?
NO
DECMT DIGIT (STACK POINTER)
YES
TAN?
NO
PTL
YES
FIRST DIGIT OF Y =0?
NO
LEFT SHIFT ON Y (I.E. *BY 10)
Y ← RQ1
RIGHT SHIFT ON X (I.E. ÷ BY 10)
PTN

FIG 21B

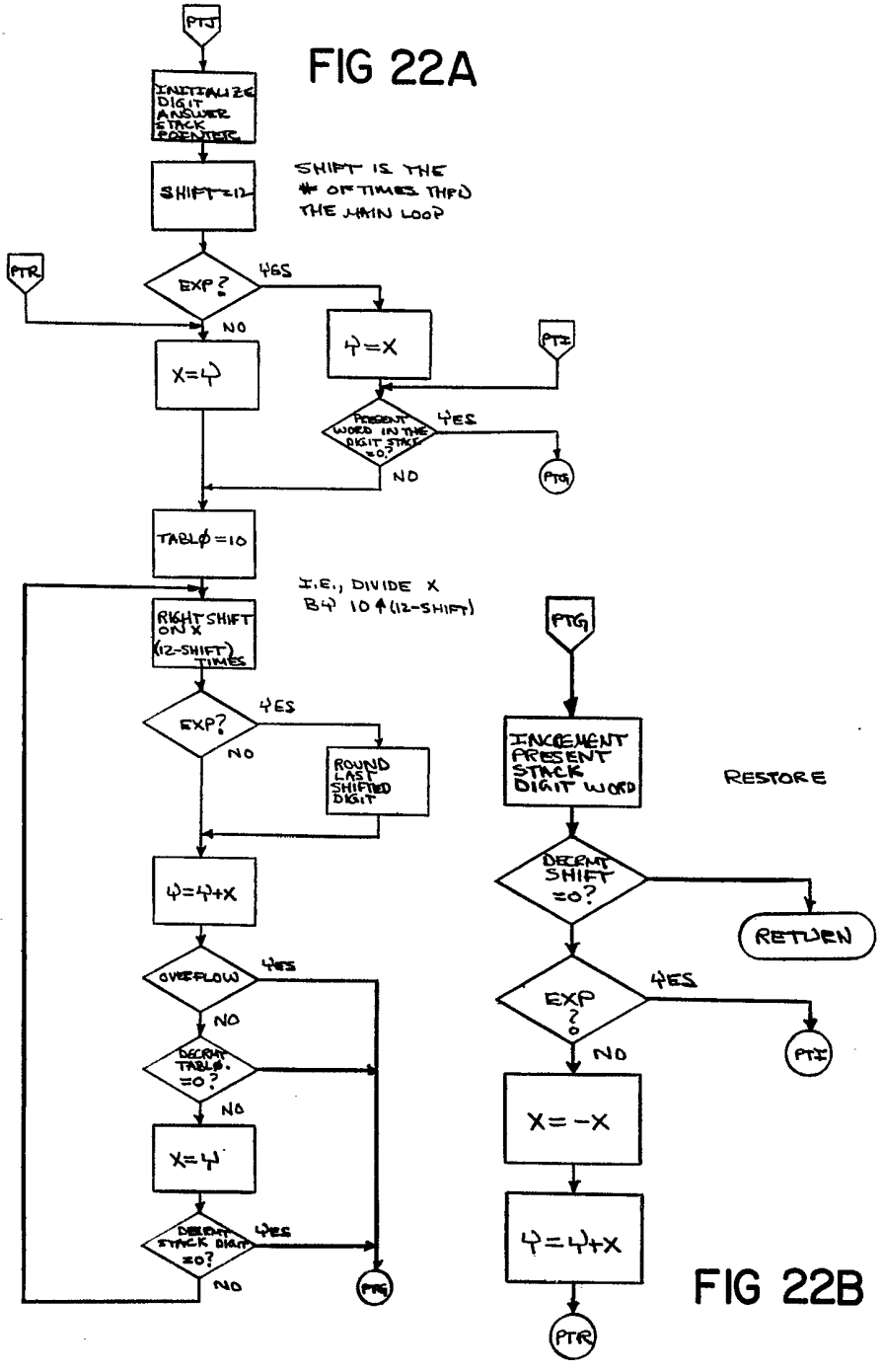


FIG 22A

FIG 22B

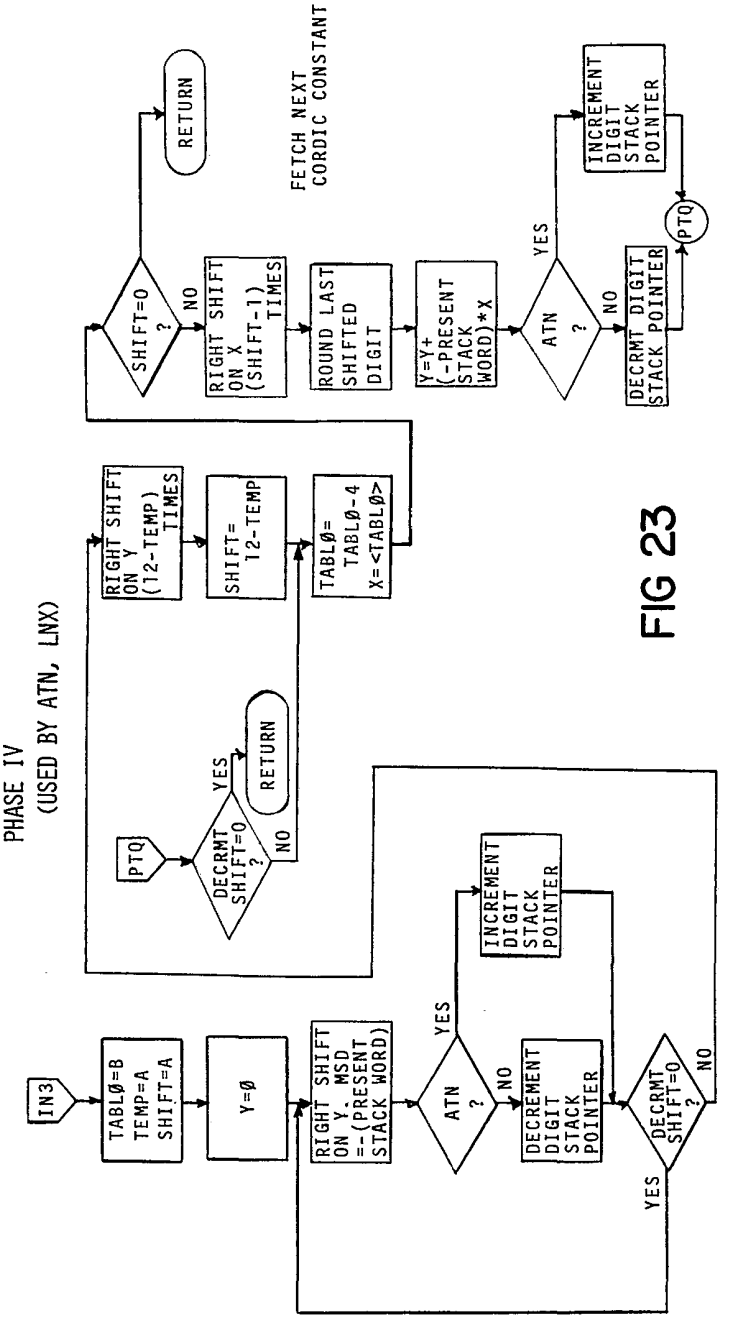
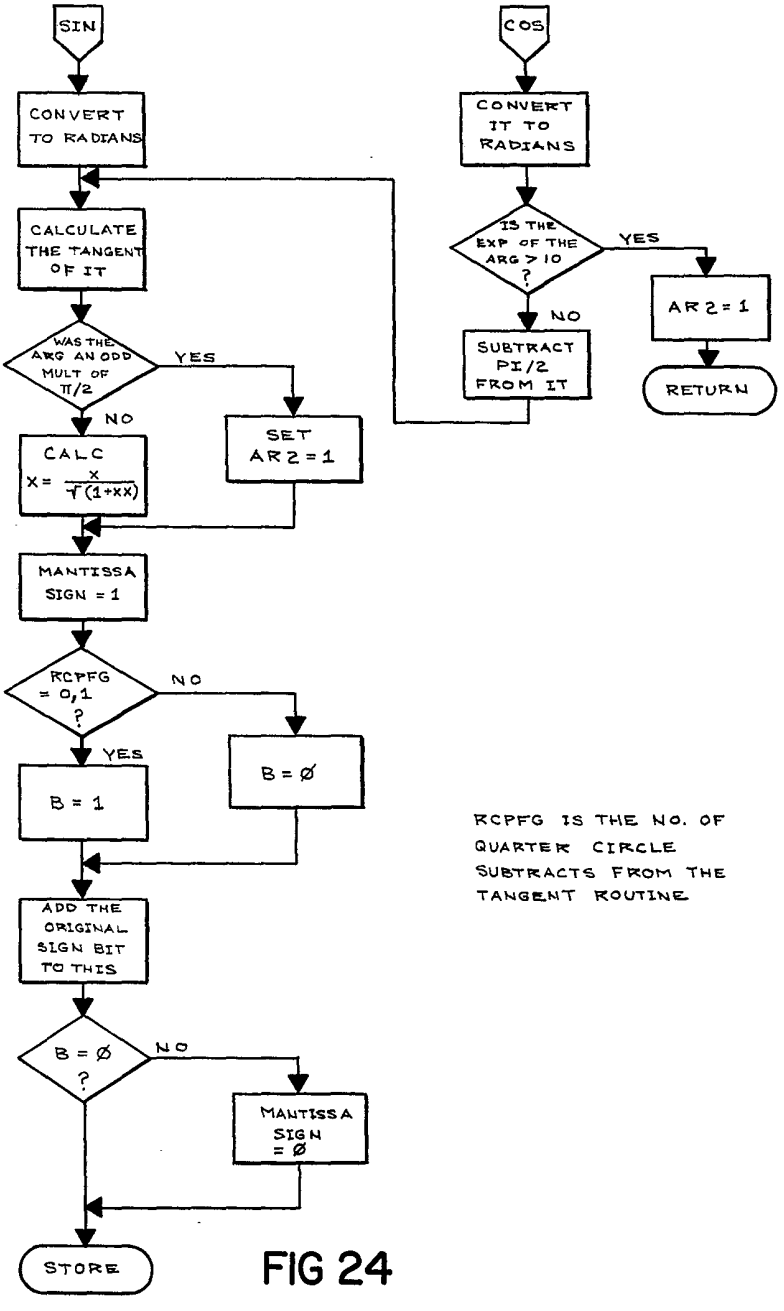

PHASE IV
(USED BY ATN, LNX)
IN3
TABLØ=B
TEMP=A
SHIFT=A
Y=Ø
RIGHT SHIFT
ON Y, MSD
=-(PRESENT
STACK WORD)
ATN
?
YES
NO
INCREMENT
DIGIT
STACK
POINTER
DECREMENT
DIGIT
STACK
POINTER
DECRMT
SHIFT=0
?
YES
NO
PTQ
DECRMT
SHIFT=0
?
YES
NO
RETURN
RIGHT SHIFT
ON Y
(12-TEMP)
TIMES
SHIFT=
12-TEMP
TABLØ=
TABLØ-4
X=<TABLØ>
FETCH NEXT
CORDIC CONSTANT
SHIFT=0
?
NO
YES
RETURN
RIGHT SHIFT
ON X
(SHIFT-1)
TIMES
ROUND LAST
SHIFTED
DIGIT
Y=Y+
(-PRESENT
STACK
WORD)*X
ATN
?
YES
NO
INCREMENT
DIGIT
STACK
POINTER
DECRMT DIGIT
STACK POINTER
PTQ

FIG 23



RCPFG IS THE NO. OF QUARTER CIRCLE SUBTRACTS FROM THE TANGENT ROUTINE

FIG 24

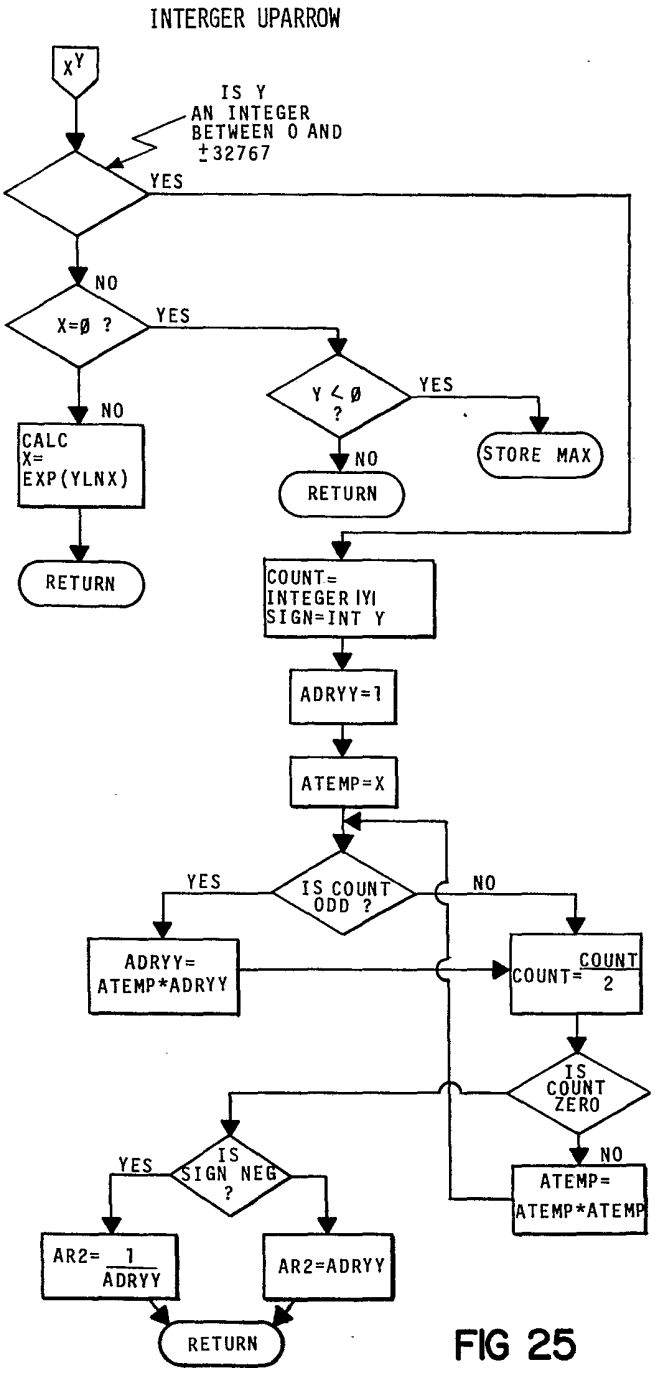

INTERGER UPARROW
X^Y
IS Y AN INTEGER BETWEEN 0 AND ±32767
YES
NO
X=Ø ?
YES
NO
CALC X= EXP(YLNX)
RETURN
Y < Ø ?
YES
STORE MAX
NO
RETURN
COUNT= INTEGER |Y|
SIGN=INT Y
ADRYY=1
ATEMP=X
IS COUNT ODD ?
YES
NO
ADRYY= ATEMP*ADRYY
COUNT= COUNT/2
IS COUNT ZERO
NO
ATEMP= ATEMP*ATEMP
IS SIGN NEG ?
YES
AR2= 1/ADRYY
AR2=ADRYY
RETURN

FIG 25

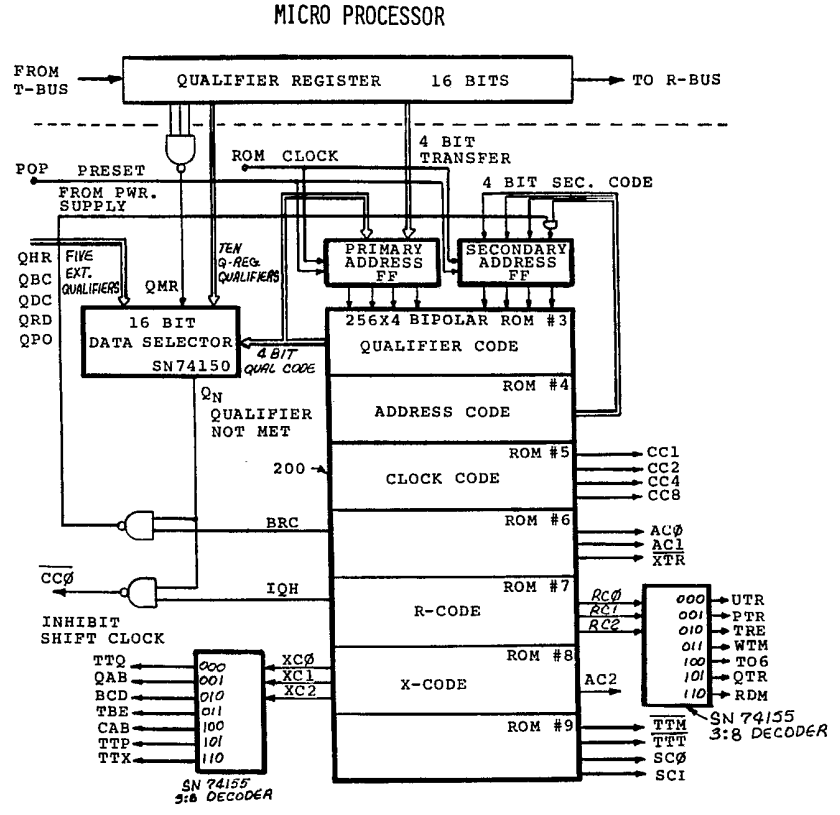

MICRO PROCESSOR
FROM T-BUS
QUALIFIER REGISTER 16 BITS
TO R-BUS
4 BIT TRANSFER
POP PRESET
ROM CLOCK
4 BIT SEC. CODE
FROM PWR. SUPPLY
QHR
QBC
QDC
QRD
QPO
FIVE EXT. QUALIFIERS
QMR
TEN Q-REG. QUALIFIERS
PRIMARY ADDRESS FF
SECONDARY ADDRESS FF
16 BIT DATA SELECTOR SN74150
4 BIT QUAL CODE
256X4 BIPOLAR ROM #3
QUALIFIER CODE
ROM #4
ADDRESS CODE
Q_N QUALIFIER NOT MET
ROM #5
CLOCK CODE
200
CC1
CC2
CC4
CC8
BRC
ROM #6
ACØ
AC1
XTR
CCØ
IQH
ROM #7
R-CODE
RCØ
RC1
RC2
000 UTR
001 PTR
010 TRE
011 WTM
100 TO6
101 QTR
110 RDM
SN 74155 3:8 DECODER
INHIBIT SHIFT CLOCK
ROM #8
X-CODE
AC2
TTQ
QAB
BCD
TBE
CAB
TTP
TTX
XCØ
XC1
XC2
SN 74155 3:8 DECODER
ROM #9
TTM
TTT
SCØ
SCI

FIG 27

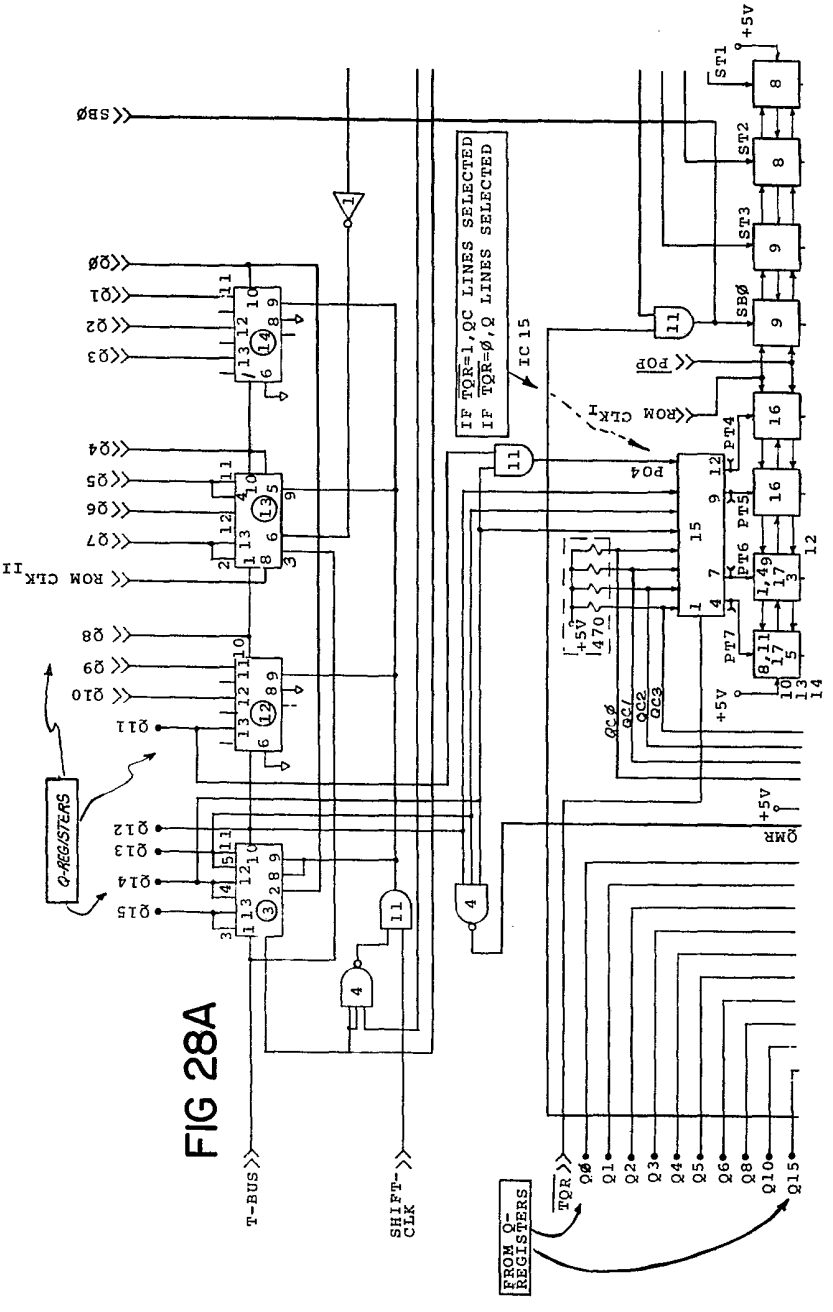

ØBS
ØQ
Q1
Q2
Q3
Q4
Q5
Q6
Q7
ROM CLK II
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Q15
Q-REGISTERS
IF TQR=1, QC LINES SELECTED
IF TQR=Ø, 2 LINES SELECTED
IC 15
ROM CLK I
POP
PO4
PT4
PT5
PT6
PT7
+5V
470
QCØ
QC1
QC2
QC3
QMR
ST1
ST2
ST3
SBØ
T-BUS
SHIFT-CLK
TQR
FROM Q-REGISTERS

FIG 28A

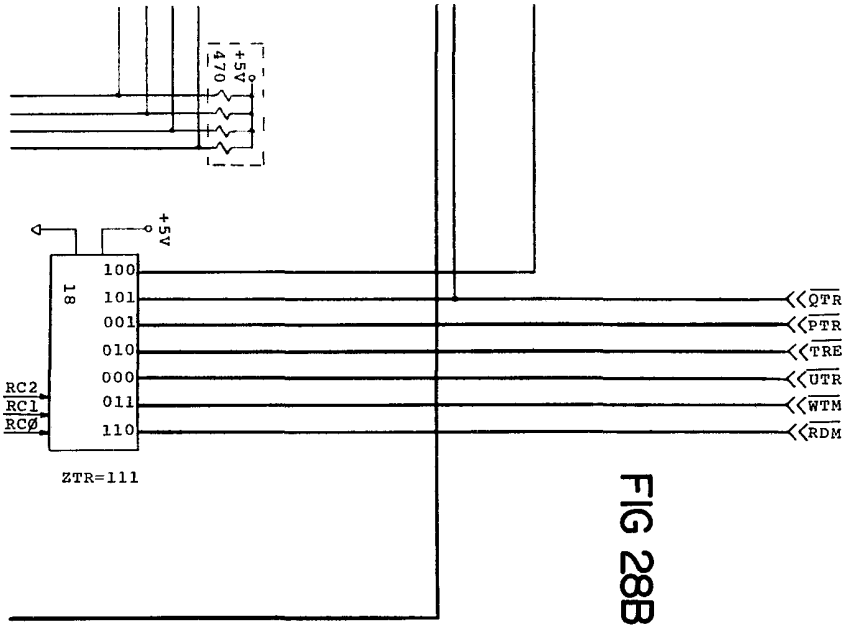

+5V
470
+5V
18
100
101
001
010
000
011
110
RC2
RC1
RCØ
ZTR=111
QTR
PTR
TRE
UTR
WTM
RDM

FIG 28B

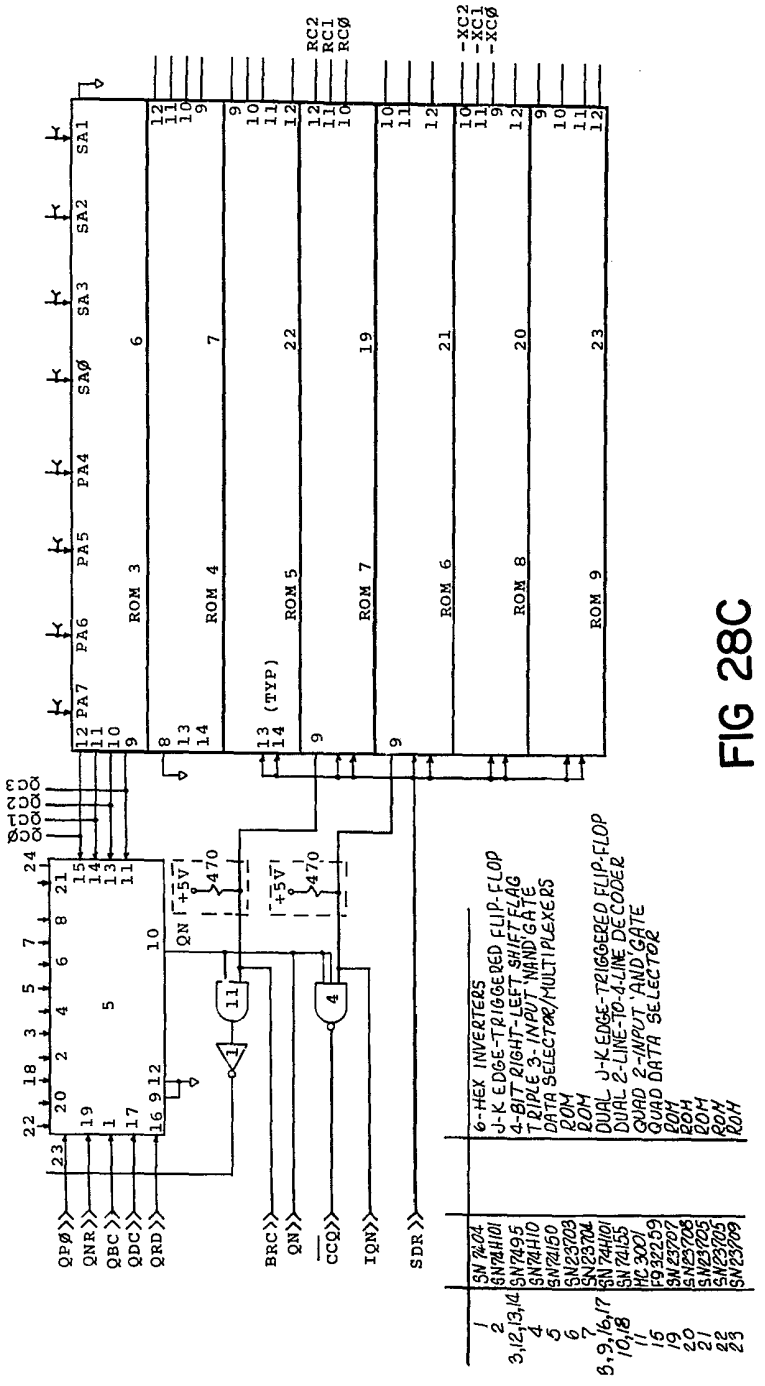

RC2
RC1
RC0
-XC2
-XC1
-XC0
SA1
SA2
SA3
SA0
PA4
PA5
PA6
PA7
ROM 3
ROM 4
ROM 5
ROM 7
ROM 6
ROM 8
ROM 9
(TYP)
+5V
470
QN
QP0
QNR
QBC
QDC
QRD
BRC
QN
CCQ
IQN
SDR
6-HEX INVERTERS
J-K EDGE-TRIGGERED FLIP-FLOP
4-BIT RIGHT-LEFT SHIFT FLAG
TRIPLE 3-INPUT NAND GATE
DATA SELECTOR/MULTIPLEXERS
20H
20H
DUAL J-K EDGE-TRIGGERED FLIP-FLOP
DUAL 2-LINE-TO-4-LINE DECODER
QUAD 2-INPUT AND GATE
QUAD DATA SELECTOR
20H
20H
20H
20H
20H
SN 74L04
SN74H101
SN7495
SN74H10
SN74150
SN23703
SN23704
SN74H101
SN74155
HC3001
F932259
SN23707
SN23705
SN23705
SN23705
SN23709
1
2
3,12,13,14
4
5
6
7
8,9,16,17
10,18
11
15
19
20
21
22
23

FIG 28C

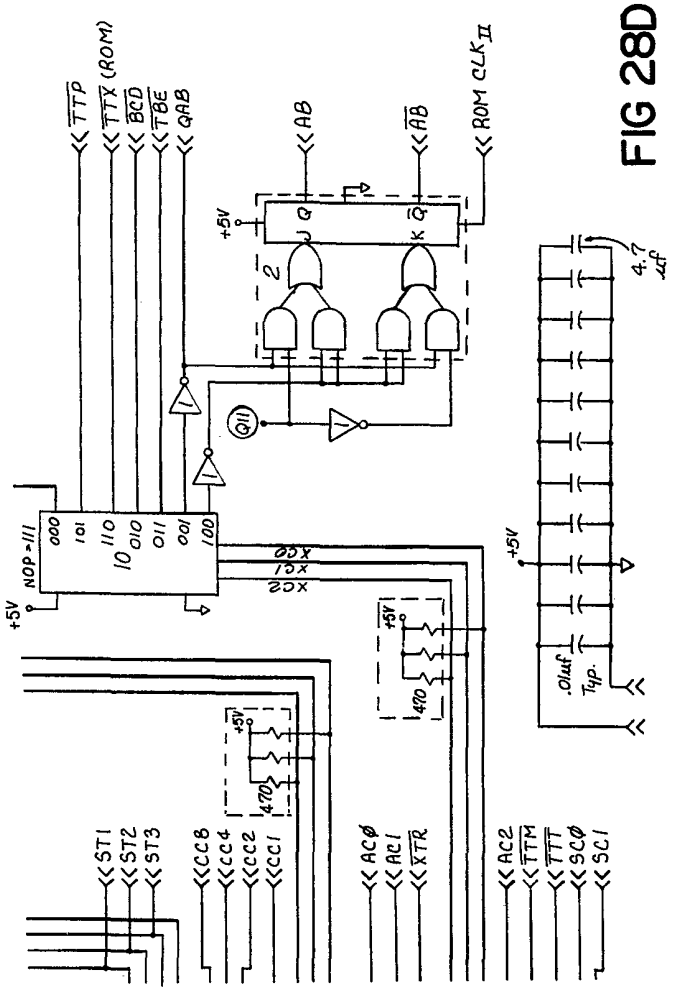

TTP
TTX (ROM)
BCD
TBE
QAB
AB
AB
ROM CLK II
+5V
Q
Q
J
K
2
1
Q11
NOP=111
000
101
110
010
011
001
100
10
X20
X10
X00
+5V
4.7 uF
.01uf Typ.
+5V
470
+5V
470
ST1
ST2
ST3
CC8
CC4
CC2
CC1
AC0
AC1
XTR
AC2
TTM
TTT
SC0
SC1

FIG 28D

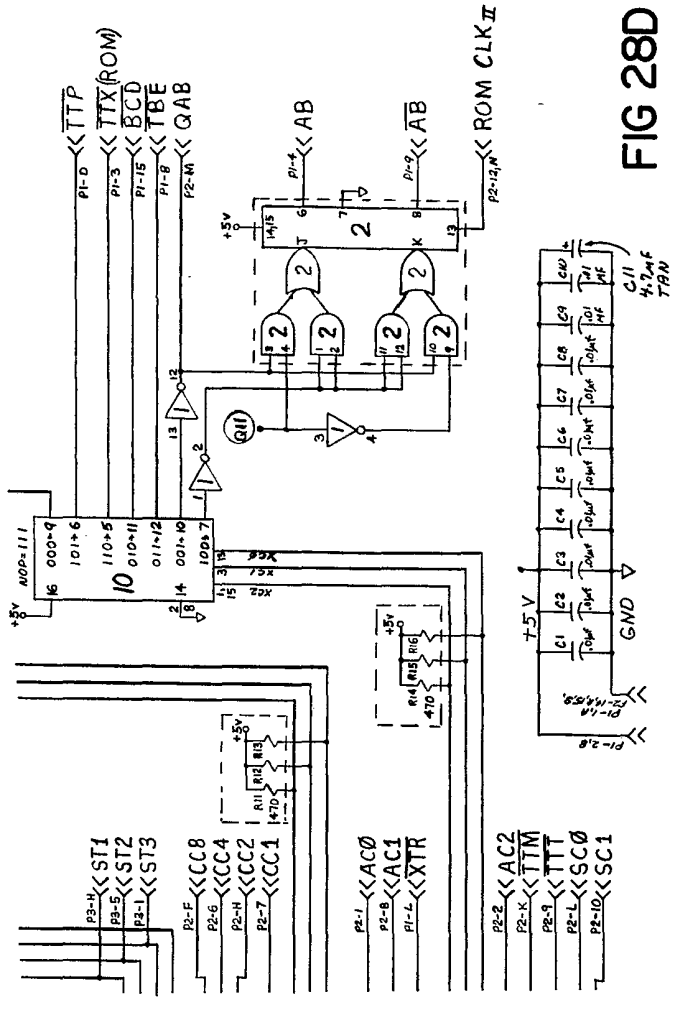

TTP
TTX(ROM)
BCD
TBE
QAB
AB
AB
ROM CLK II
+5V
GND
ST1
ST2
ST3
CC8
CC4
CC2
CC1
AC0
AC1
XTR
AC2
TTM
TTT
SC0
SC1

FIG 28D

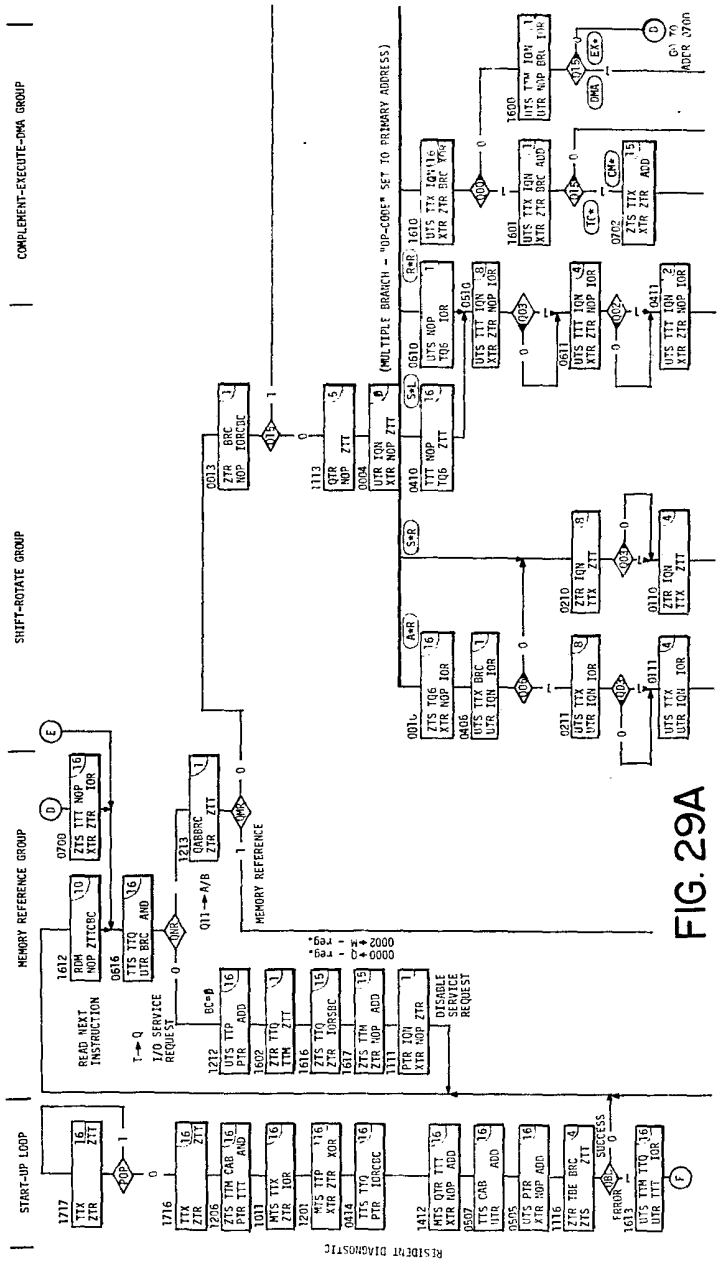

START-UP LOOP
SHIFT-ROTATE GROUP
COMPLEMENT-EXECUTE-DMA GROUP
MEMORY REFERENCE GROUP
READ NEXT INSTRUCTION
I/O SERVICE REQUEST
MEMORY REFERENCE
(MULTIPLE BRANCH - "OP-CODE" SET TO PRIMARY ADDRESS)
DISABLE SERVICE REQUEST
RESIDENT DIAGNOSTIC

FIG. 29A

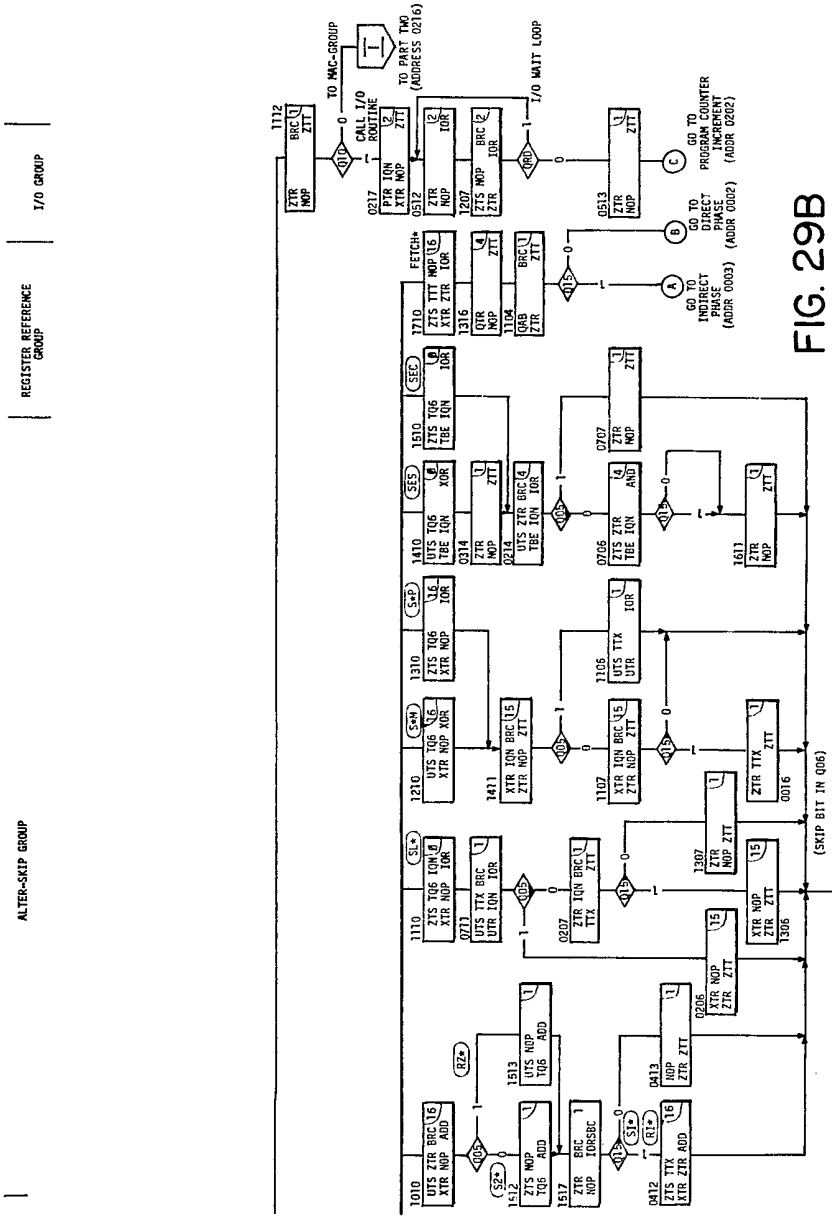

ALTER-SKIP GROUP
REGISTER REFERENCE GROUP
I/O GROUP
TO MAC-GROUP
CALL I/O ROUTINE
TO PART TWO (ADDRESS 0216)
I/O WAIT LOOP
GO TO PROGRAM COUNTER INCREMENT (ADDR 0202)
GO TO DIRECT PHASE (ADDR 0002)
GO TO INDIRECT PHASE (ADDR 0003)
(SKIP BIT IN Q06)

FIG. 29B

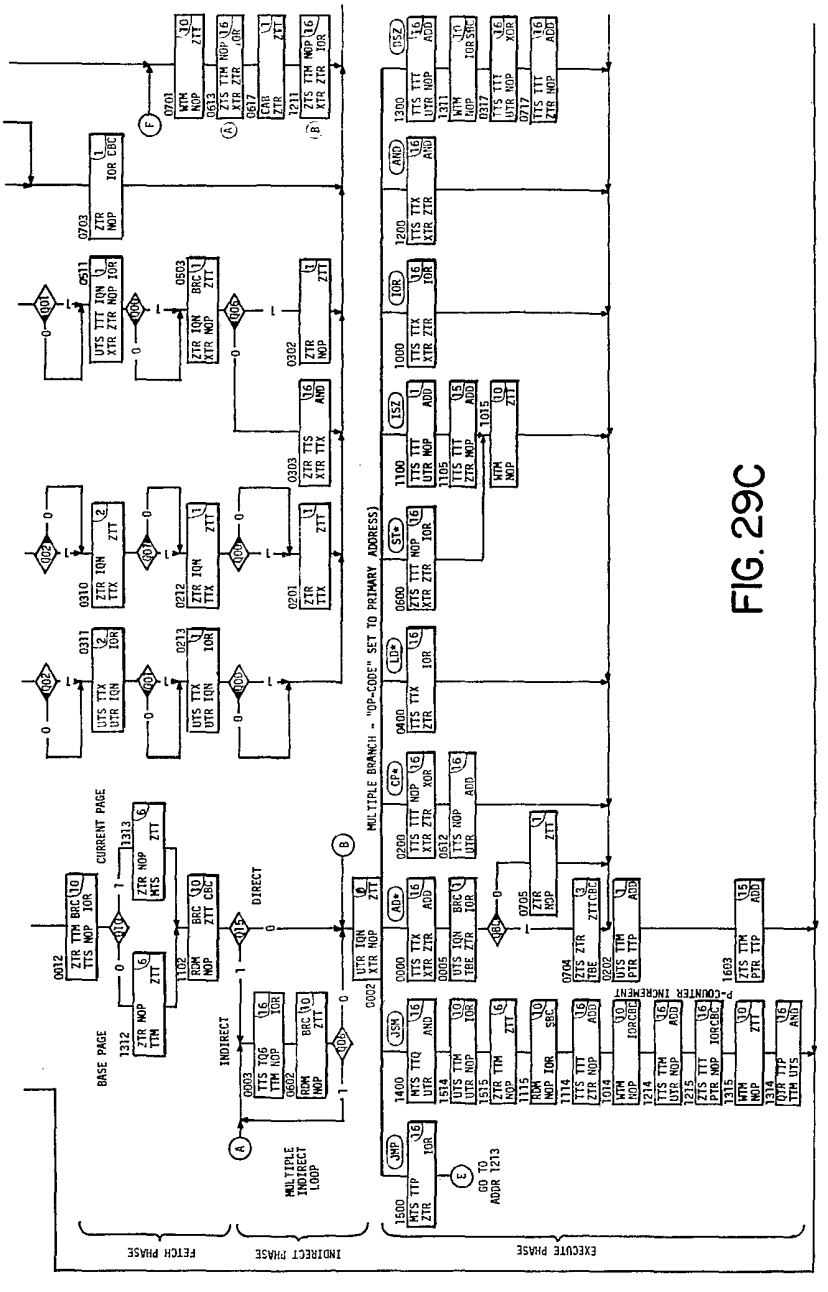

FETCH PHASE
INDIRECT PHASE
EXECUTE PHASE
MULTIPLE BRANCH - "OP-CODE" SET TO PRIMARY ADDRESS)
BASE PAGE
CURRENT PAGE
INDIRECT
DIRECT
MULTIPLE INDIRECT LOOP
GO TO ADDR 1213
P-COUNTER INCREMENT

FIG. 29C

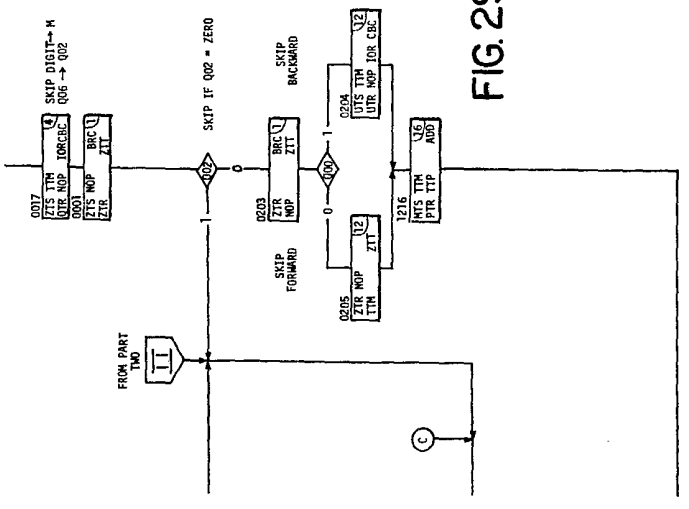

SKIP DIGIT→M
Q06→Q02
SKIP IF Q02 = ZERO
SKIP BACKWARD
SKIP FORWARD
FROM PART TWO
C

FIG. 29D

1444141 COMPLETE SPECIFICATION

233 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 51

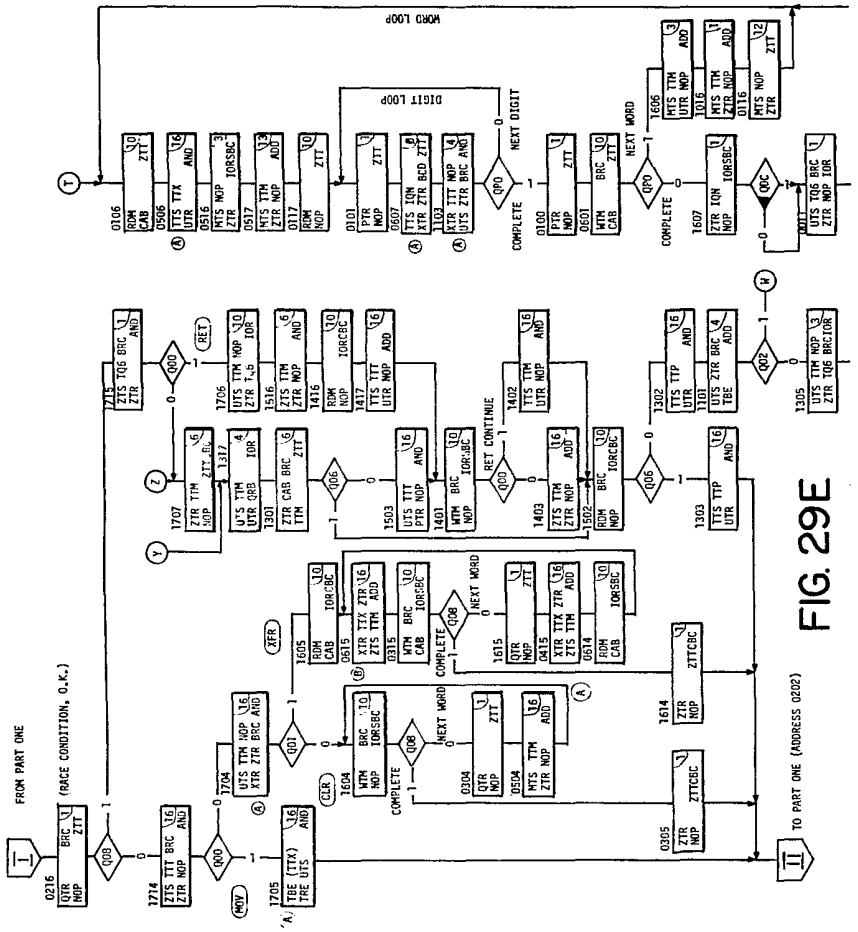


FIG. 29E

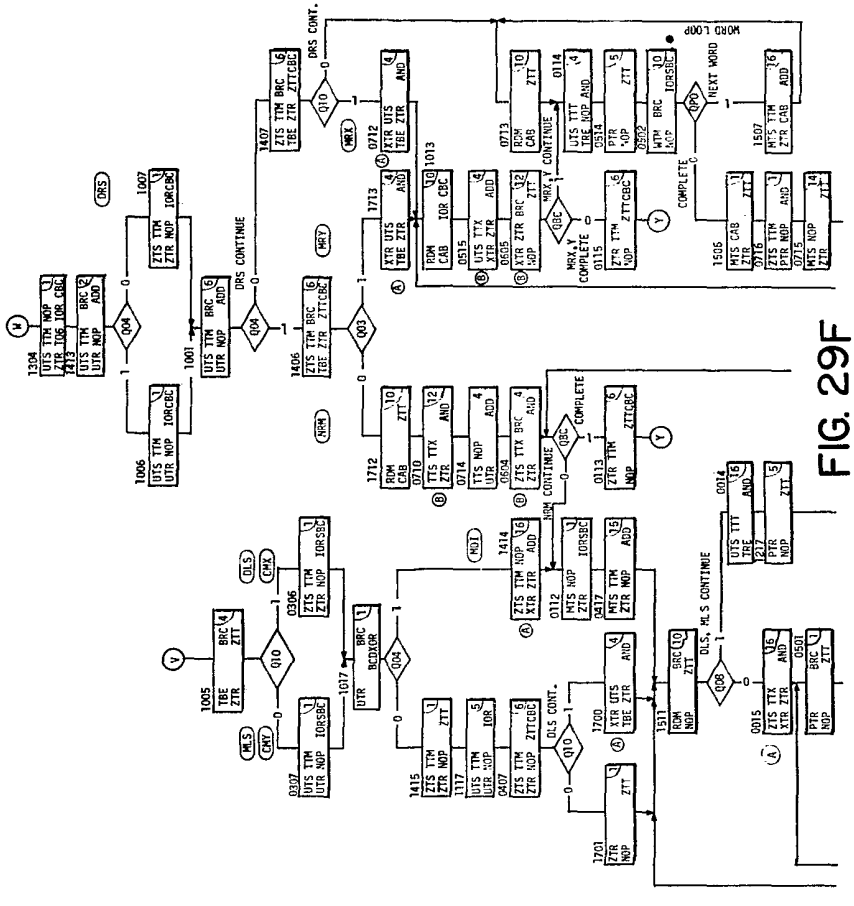


FIG. 29F

1444141 COMPLETE SPECIFICATION
233 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 53

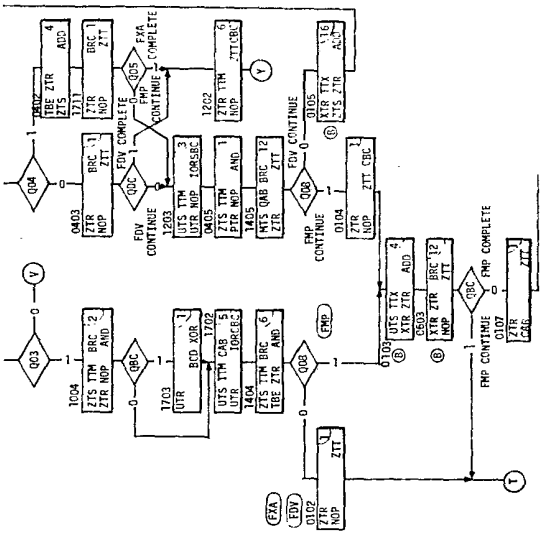
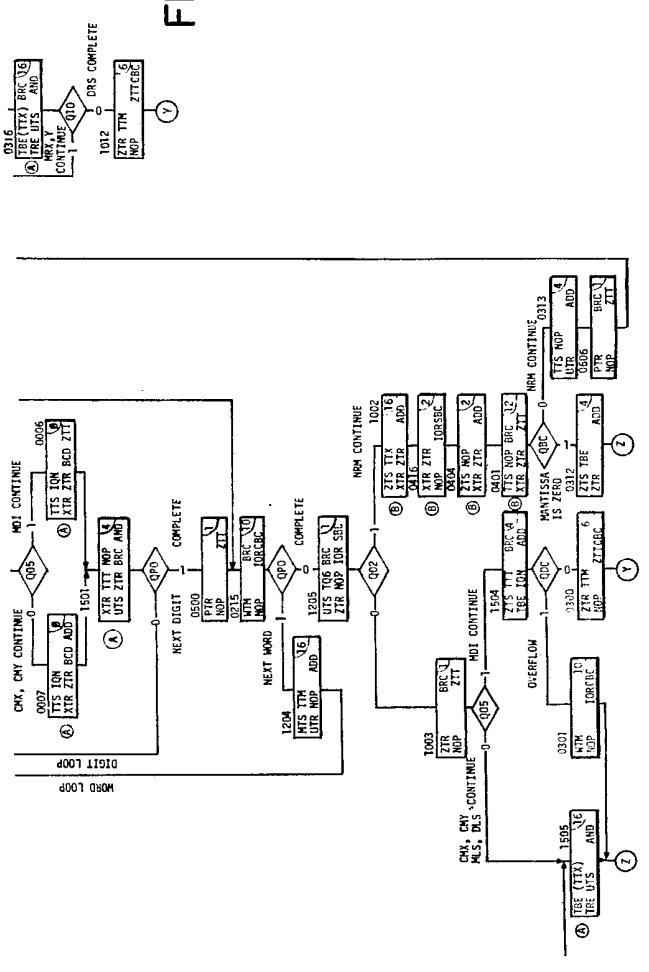


FIG. 29G

FIG. 29H


WORD LOOP
DIGIT LOOP
CHK, CHY CONTINUE
MDI CONTINUE
NEXT DIGIT
COMPLETE
NEXT WORD
NRM CONTINUE
OVERFLOW
MANTISSA IS ZERO
CHK, CHY CHLS, DLS CONTINUE
DRS COMPLETE

1 MAC-INSTRUCTION CODING TABLE:

MNEMONIX	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	OCTAL
RET	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	170402
MOV	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	170002
CLR	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	170000
XFR	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	170004
MRY	1	1	1	1	1	0	0	1	0	0	1	1	1	0	0	0	174470
MLS	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	171400
DRS	1	1	1	1	0	0	0	1	0	0	0	0	1	0	0	0	170410
DLS	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	175400
FXA	1	1	1	1	0	0	0	1	0	1	1	1	0	0	0	0	170560
FMP	1	1	1	1	0	0	1	1	0	0	1	1	0	0	0	0	171460
FDV	1	1	1	1	0	0	0	1	0	0	0	1	0	0	0	0	170420
CMX	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	174400
CMY	1	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	170400
MDI	1	1	1	1	0	0	0	1	0	1	1	0	0	0	0	0	170540
NRM	1	1	1	1	0	0	1	1	0	0	1	0	1	0	0	0	171450
MRX	1	1	1	1	1	0	0	1	0	0	0	1	1	0	0	0	174430

2 USED DATA FORMAT:

ADDRESS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
M	se	exponent														sm
M+1	D_1				D_2				D_3				D_4			
M+2	D_5				D_6				D_7				D_8			
M+3	D_9				D_{10}				D_{11}				D_{12}			

D_1 ... MOST SIGNIFICANT DIGIT

D_{12} .. LEAST SIGNIFICANT DIGIT

se ... SIGN OF EXPONENT

sm ... SIGN OF MANTISSA

DECIMAL POINT IS LOCATED BETWEEN D_1 AND D_2

FIG. 291

3 USED ADDRESS AND CONSTANTS (OCTAL)

0001 COUNTER CONSTANT ADDRESS

1700 P-REGISTER CONTENTS STORAGE

1777 STACK-POINTER ADDRESS

1744-47 AR1
1754-57 AR2 } ARITHMETIC PSEUDOREGISTERS

043060 COUNTER CONSTANT

INSTRUCTIONS

ADD - BINARY ADD = CARRY FLIP-FLOP + R_{BUS} + S_{BUS} TO T_{BUS} - CARRY OUT TO CARRY FLIP-FLOP.

AND - LOGICAL AND = R·S TO T_{BUS}

BCD - BCD ARITHMETIC MODE OF ALU

BRC - BRANCH INHIBIT SOO IF QNM

CAB - COMPLEMENT AB FLIP-FLOP

IOR - INCLUSIVE OR R+S TO T_{BUS}

IOR·CBC - IOR, CLEAR BINARY CARRY FLIP-FLOP

IOR·SBC - IOR, SET BINARY CARRY FLIP-FLOP

IOS = PTR·XTR - INITIATES TRANSFER OF CONTROL TO I/O

IQN - INHIBIT SHIFT CLOCK IF QNM

MTS - TRANSFER M_{REG} TO S_{BUS}

NOP - NO OPERATION ON XC INSTRUCTIONS

PTR - TRANSFER P_{REG} TO R_{BUS}

QAB - Q_{REG} (BIT 11) TO AB FLIP-FLOP

QTR - TRANSFER Q_{REG} TO R_{BUS}

RDM - READ MEMORY (M) TO T_{REG}

TBE - TRANSFER T_{BUS} TO E_{REG} TO R_{BUS}

TQR = UTR·XTR - TRANSFER Q_{REG} TO PRIMARY ADDRESS

Q14·Q11	→ P04
Q12	→ P05
Q13	→ P06
Q14	→ P07

TRE - TRANSFER T_{REG} TO E_{REG} TO R_{BUS}

TTM - TRANSFER T_{BUS} TO M_{REG}

TTP - TRANSFER T_{BUS} TO P_{REG}

TTQ - TRANSFER T_{BUS} TO Q_{REG}

TTS - TRANSFER T_{REG} TO S_{BUS}

TTT - TRANSFER T_{BUS} TO T_{REG}

TTX - TRANSFER T_{BUS} TO A/B_{REG}

TO6·ZTR - TRANSFER T_{BUS} TO Q_{REG} (BIT 6)

UTR - ONE TO R_{BUS}

UTS - ONE TO S_{BUS}

WTM - STORE T_{REG} IN MEMORY

XOR - EXCLUSIVE OR R+S TO T_{BUS}

XTR - A/B_{REG} TO R_{BUS}

ZTR - ZERO TO R_{BUS}

ZTS - ZERO TO S_{BUS}

ZTT - ZERO TO T_{BUS}

ZTT·CBC - ZERO TO T_{BUS}, CLEAR BINARY CARRY FLIP-FLOP

FIG. 29J

FIG 29"

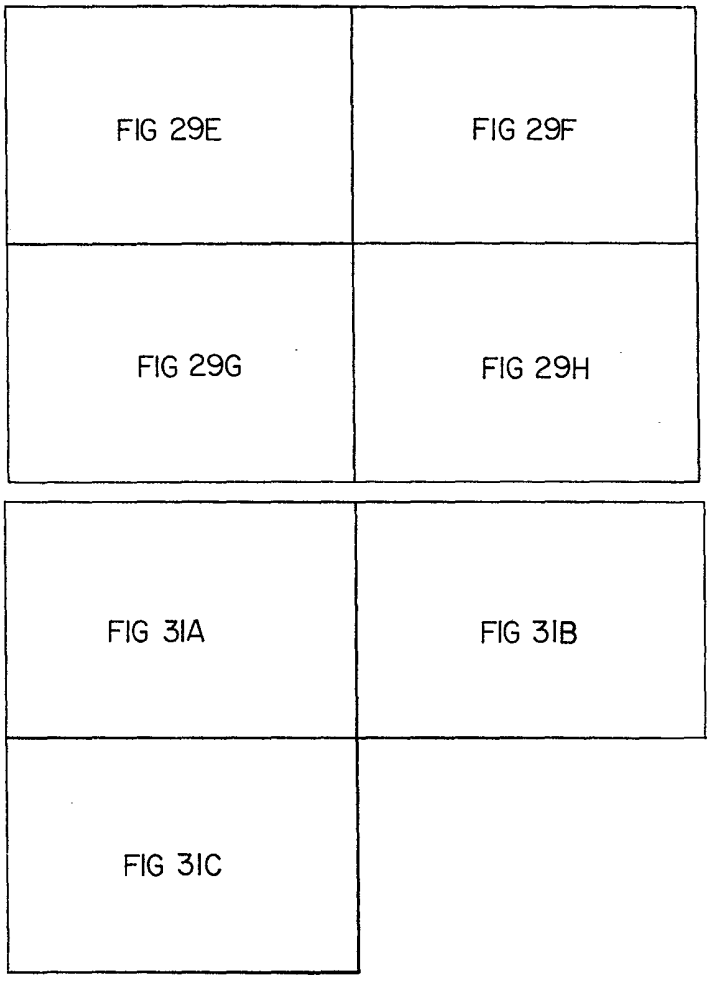


FIG 31'

PROGRAMMABLE CLOCK

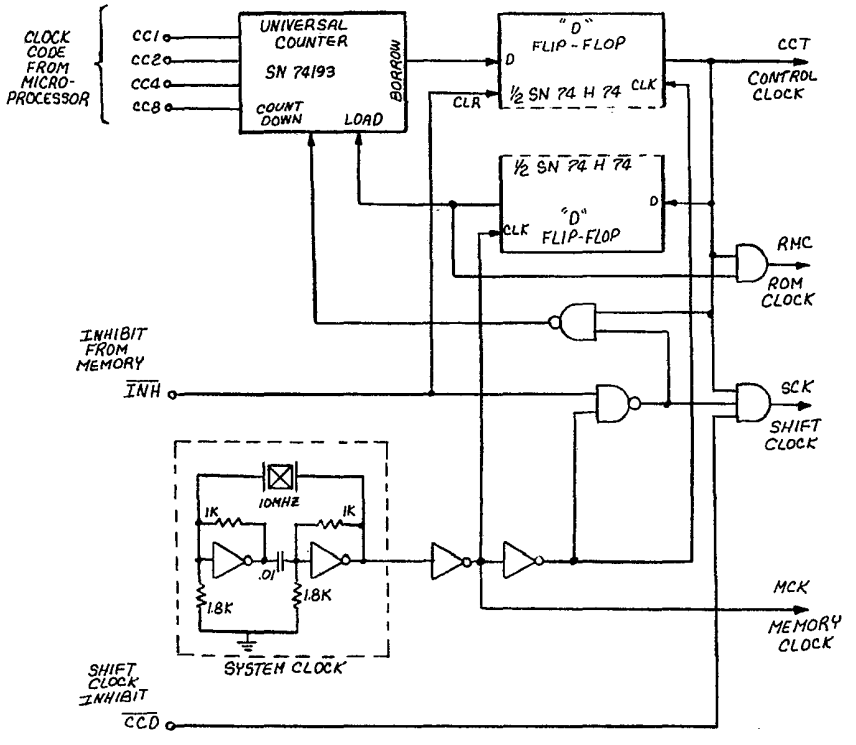
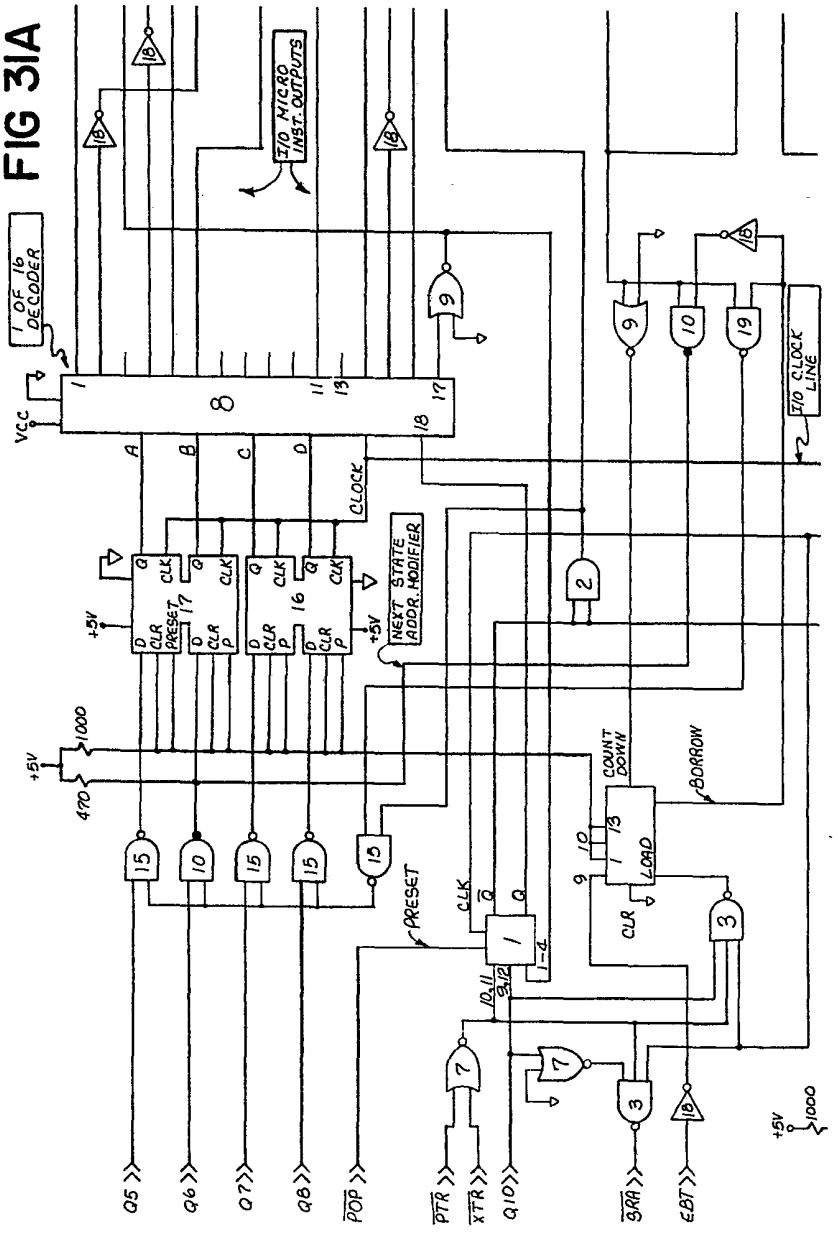


FIG 30

1444141 COMPLETE SPECIFICATION
233 SHEETS

FIG 31A



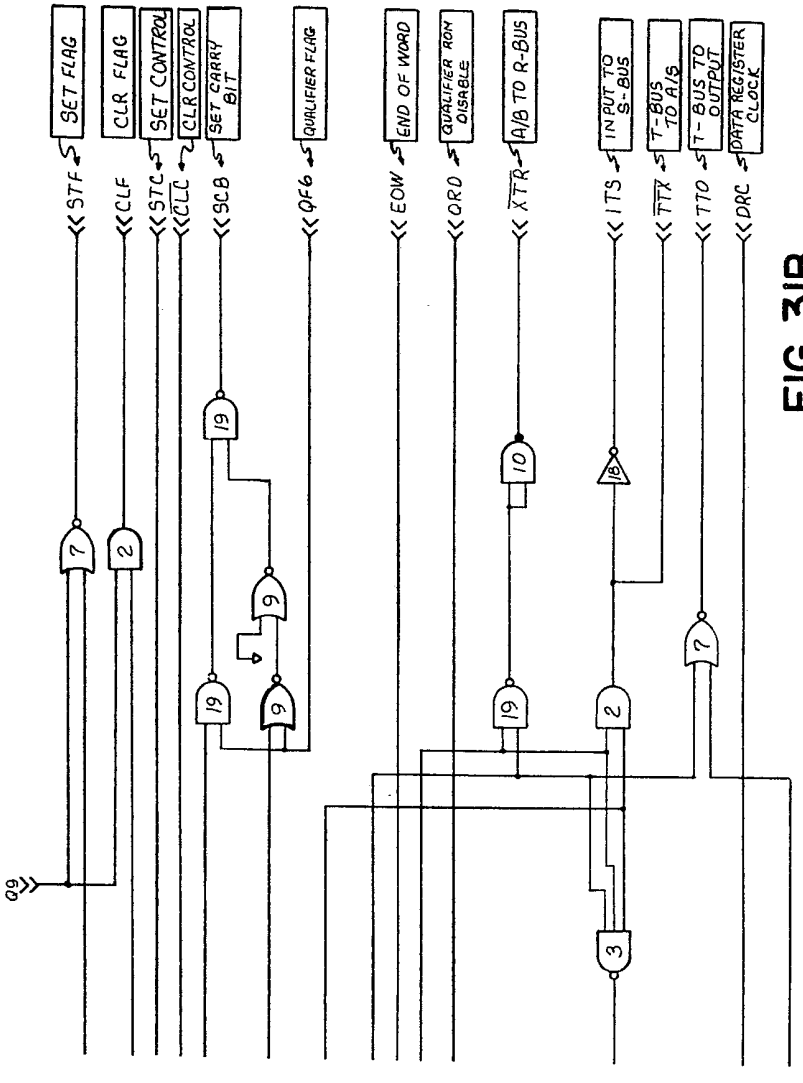

SET FLAG
CLR FLAG
SET CONTROL
CLR CONTROL
SET CARRY BIT
QUALIFIER FLAG
END OF WORD
QUALIFIER RON DISABLE
A/B TO R-BUS
INPUT TO S-BUS
T-BUS TO A/S
T-BUS TO OUTPUT
DATA REGISTER CLOCK
STF
CLF
STC
CLC
SCB
QF6
EOW
ORD
XTR
ITS
TTX
TTO
DRC
Q9
7
2
19
9
10
18
3

FIG 31B

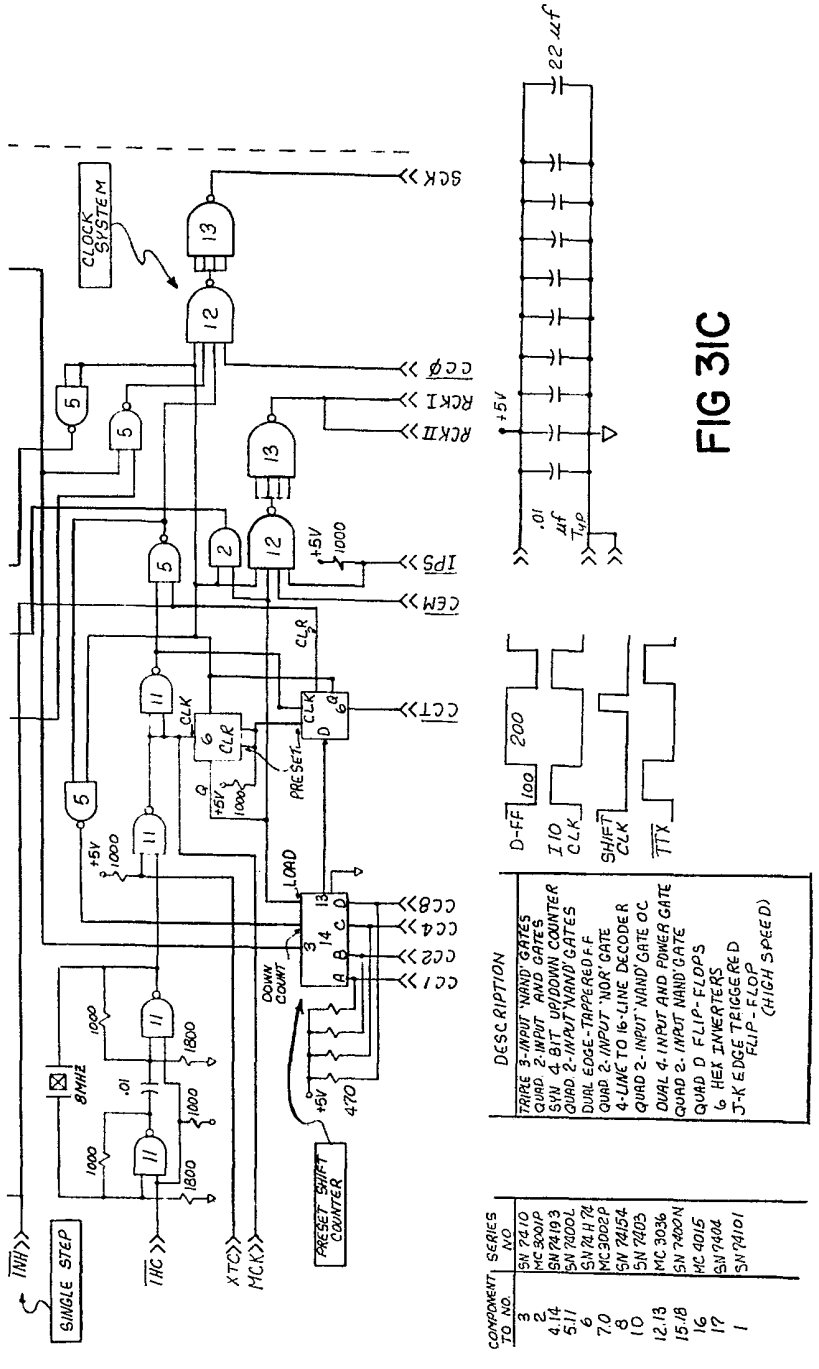
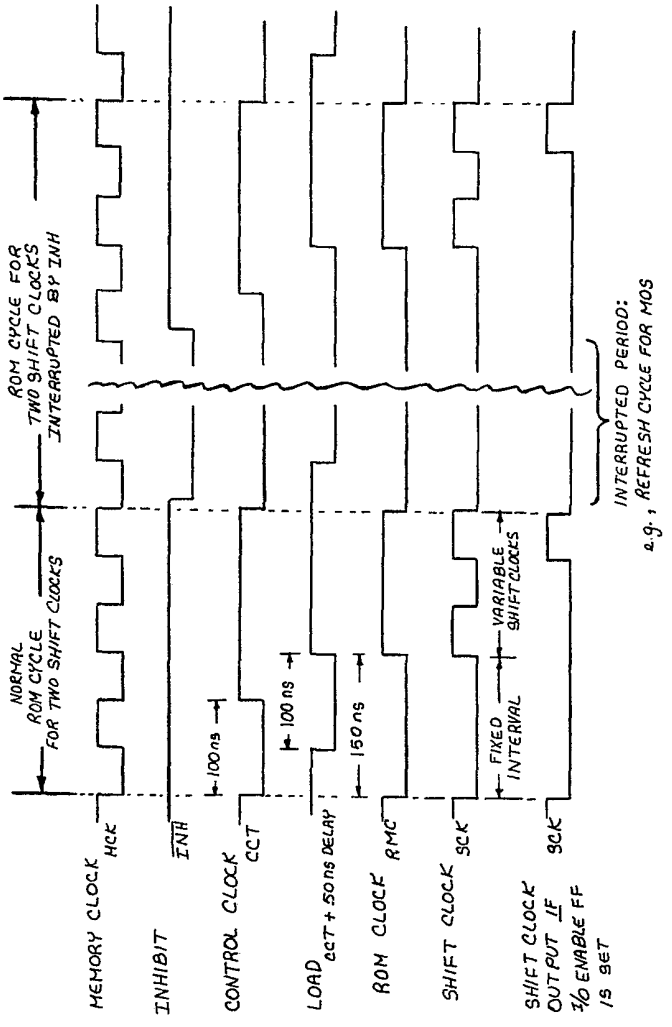


FIG 31C

COMPONENT TO NO.	SERIES NO	DESCRIPTION
3	SN 7410	TRIPLE 3-INPUT 'NAND' GATES
2	MC 3001P	QUAD 2-INPUT AND GATES
4.14	SN 74193	SYN 4 BIT UP/DOWN COUNTER
5.11	SN 7400L	QUAD 2-INPUT 'NAND' GATES
6	SN 74H72	DUAL EDGE-TRIPPERED D-F
7.0	MC 3002P	QUAD 2-INPUT 'NOR' GATE
8	SN 74154	4-LINE TO 16-LINE DECODER
10	SN 7403	QUAD 2-INPUT 'NAND' GATE OC
12.13	MC 3036	DUAL 4-INPUT AND POWER GATE
15.18	SN 7400N	QUAD 2-INPUT NAND GATE
16	MC 4015	QUAD D FLIP-FLOPS
17	SN 7404	6 HEX INVERTERS
1	SN 74101	J-K EDGE TRIGGERED FLIP-FLOP (HIGH SPEED)

FIG 32

TIMING WAVEFORMS-CENTRAL PROCESSOR



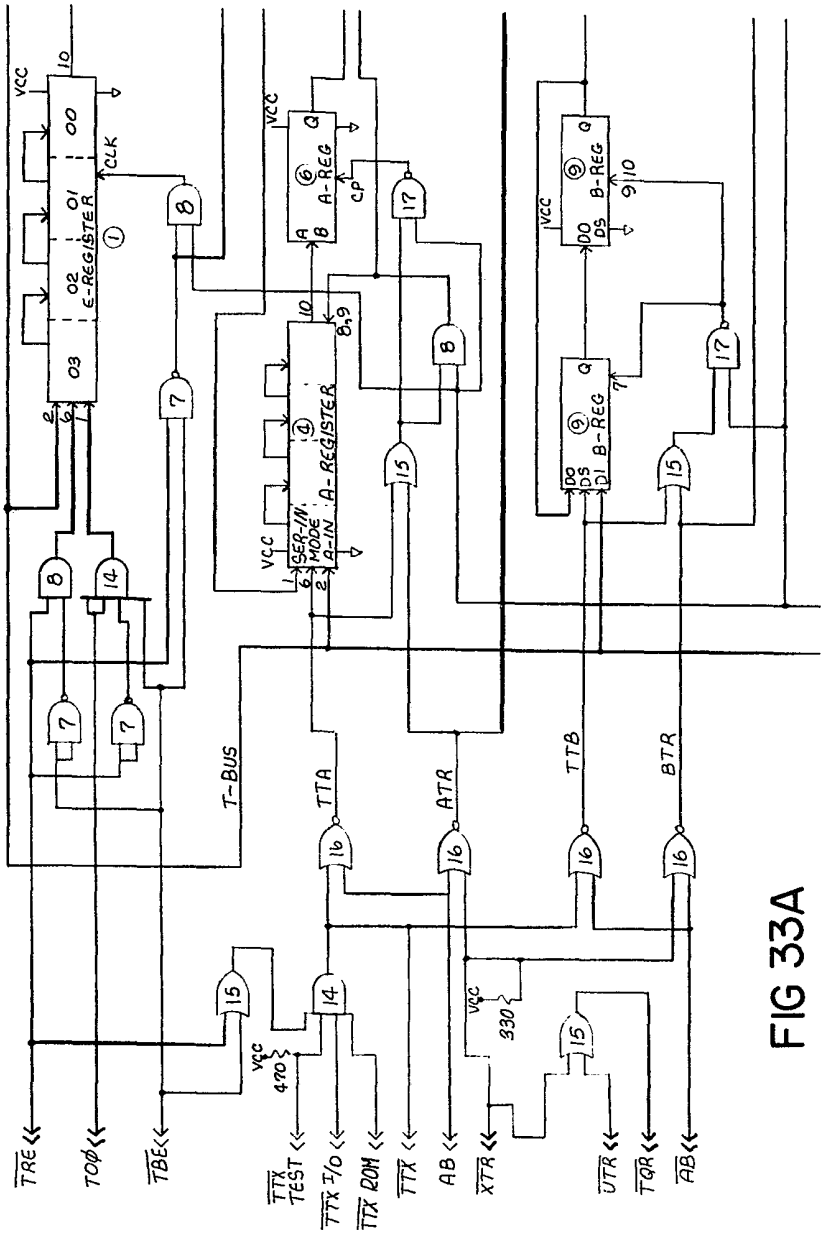
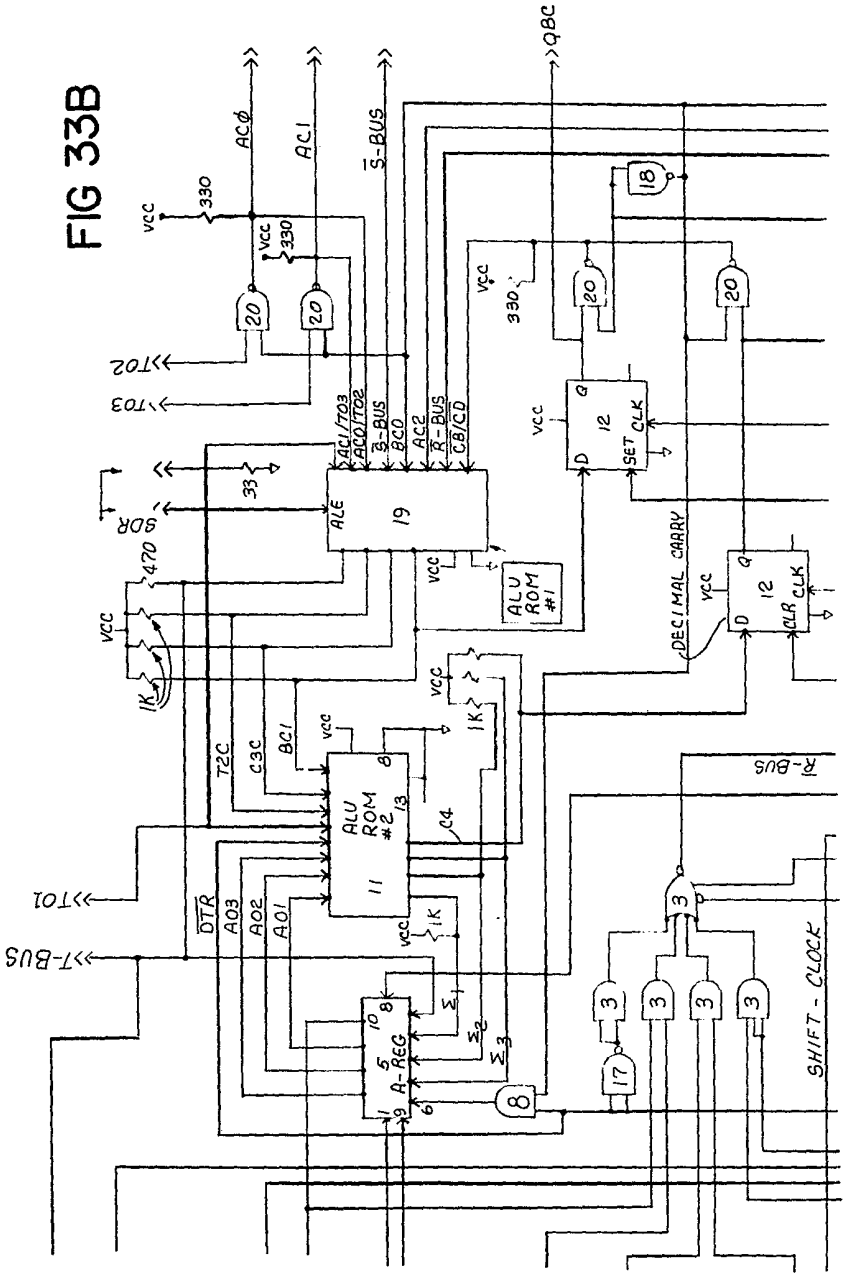

VCC
E-REGISTER
CLK
A-REGISTER
SER-IN
MODE
A-IN
A-REG
B-REG
T-BUS
TTA
ATR
TTB
BTR
TRE
TOΦ
TBE
TTX TEST
TTX I/O
TTX ROM
TTX
AB
XTR
UTR
TQR
AB
470
330

FIG 33A

1444141 COMPLETE SPECIFICATION
233 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 62

FIG 33B



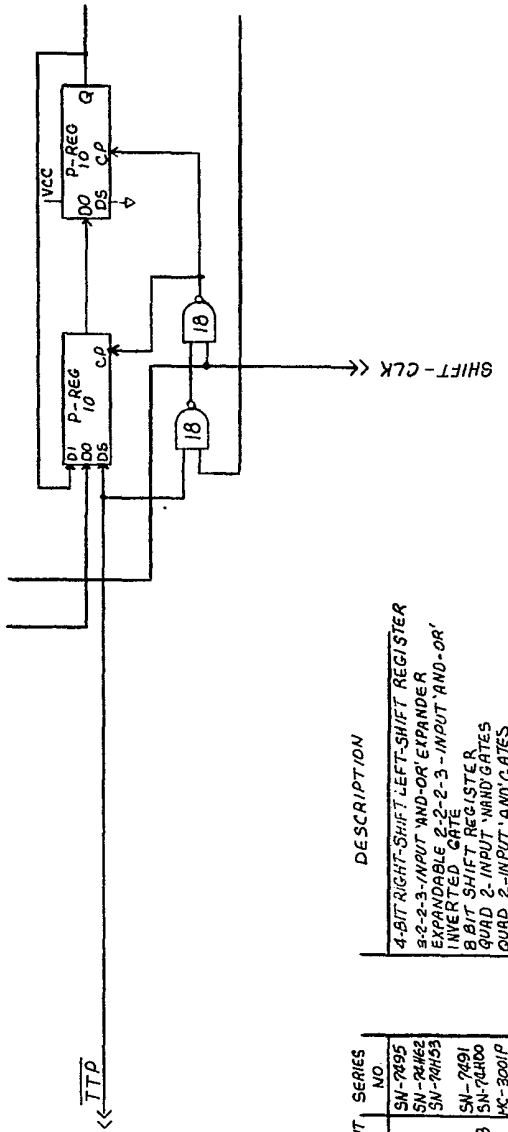


FIG 33C

COMPONENT IC NO.	SERIES NO.	DESCRIPTION
1, 4, 5	SN-7495	4-BIT RIGHT-SHIFT-LEFT-SHIFT REGISTER
2	SN-74H62	3-2-2-3-INPUT 'AND-OR' EXPANDER
3	SN-74H53	EXPANDABLE 2-2-2-3-INPUT 'AND-OR' INVERTED GATE
6	SN-7491	8 BIT SHIFT REGISTER
7, 13, 17, 18	SN-74H00	QUAD 2-INPUT 'NAND' GATES
8	MC-3001P	QUAD 2-INPUT 'AND' GATES
9, 10	F93B59	8 BIT SHIFT REGISTER, DUAL
11		BI-POLAR 'ROM'
12	SN-7474	DUAL, EDGE-TRIGGERED FLIP-FLOPS
14	SN-74H21	DUAL 4-INPUT 'AND' GATES
15	MC-3003P	QUAD, 2-INPUT 'OR' GATES
16	MC-3002P	QUAD, 2-INPUT 'NOR' GATES
19		BI-POLAR 'ROM'
20	SN-74H01	QUAD 2-INPUT 'NAND' GATE (OPEN COLLECTOR OUTPUT)

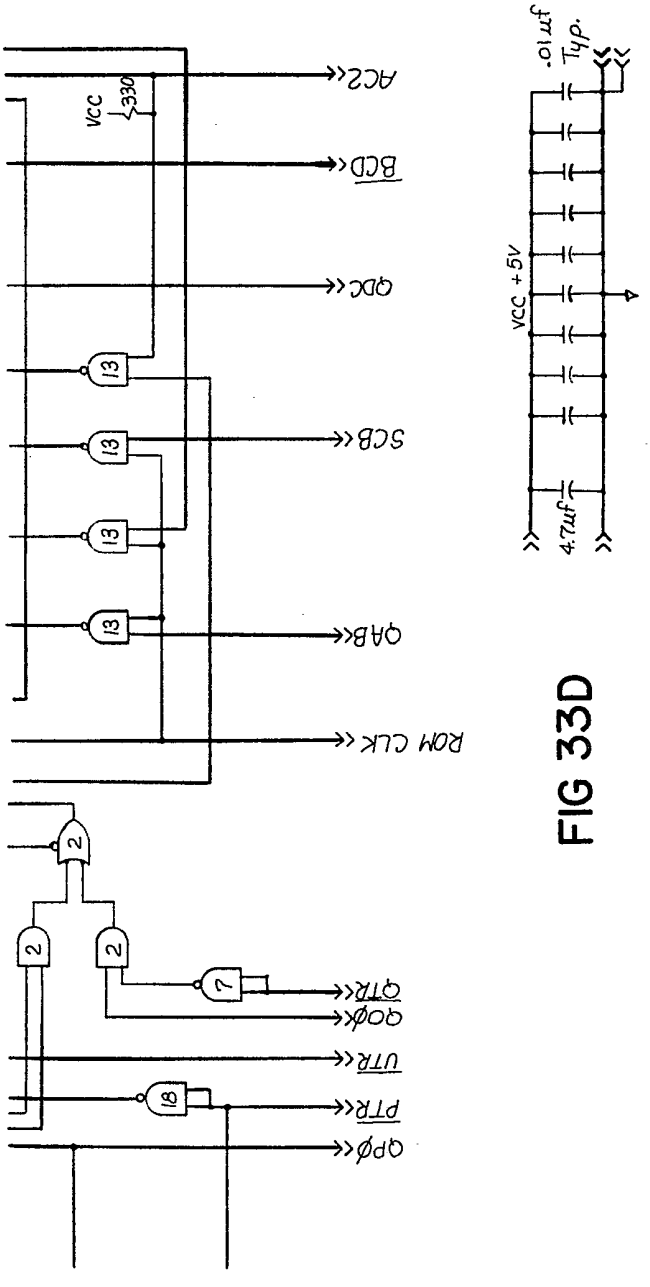

ACZ
VCC
330
BCD
QDC
13
SCB
QAB
ROM CLK
2
2
2
7
QTR
QØ
UTR
18
PTR
QPØ
.01μf
Typ.
VCC +5V
4.7μf

FIG 33D

FIG 33'

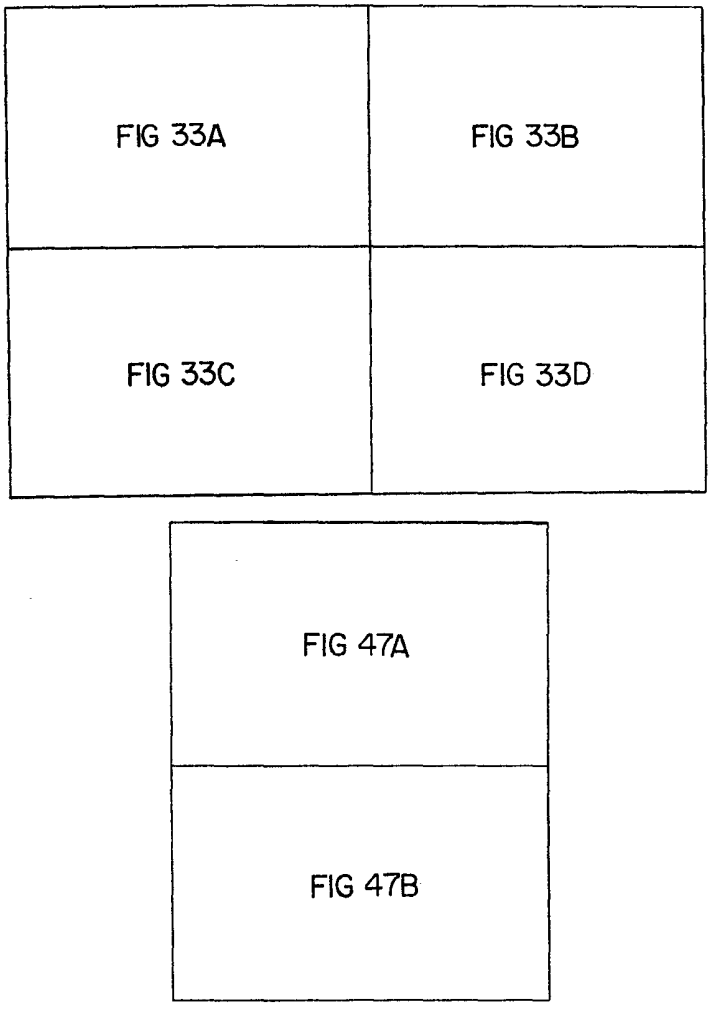


FIG 47'

BINARY/BCD ARITH LOGIC UNIT

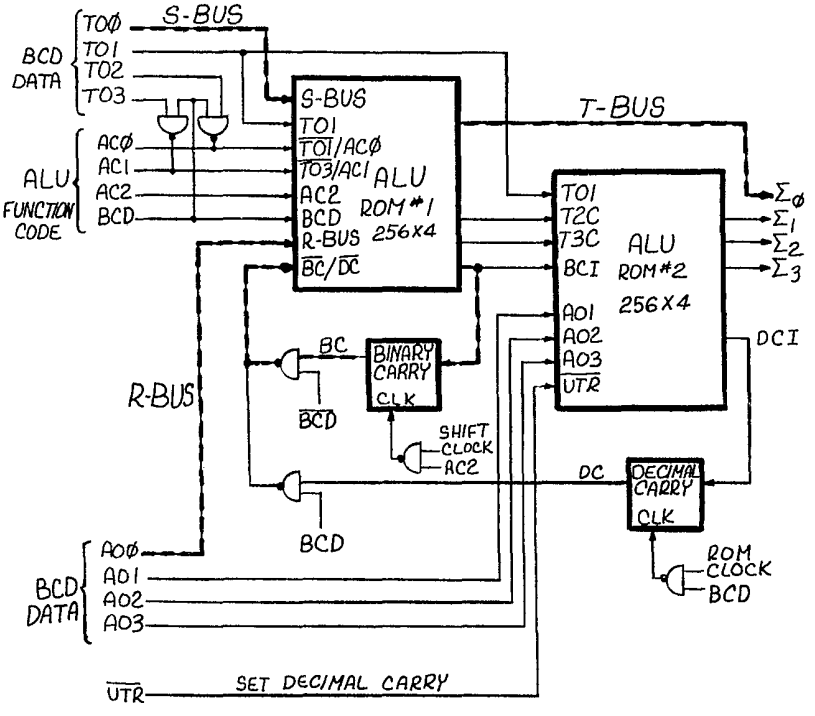


FIG 34

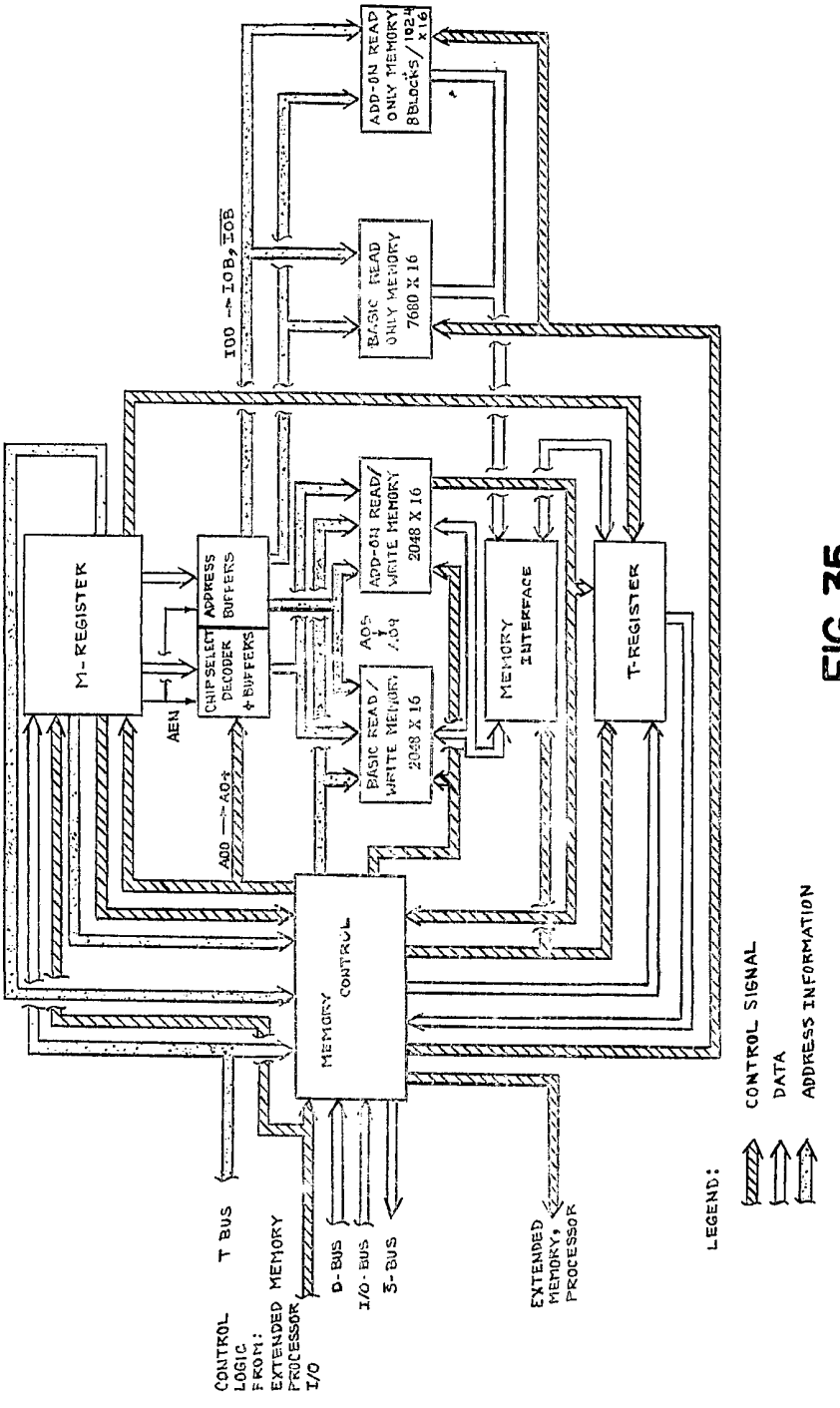
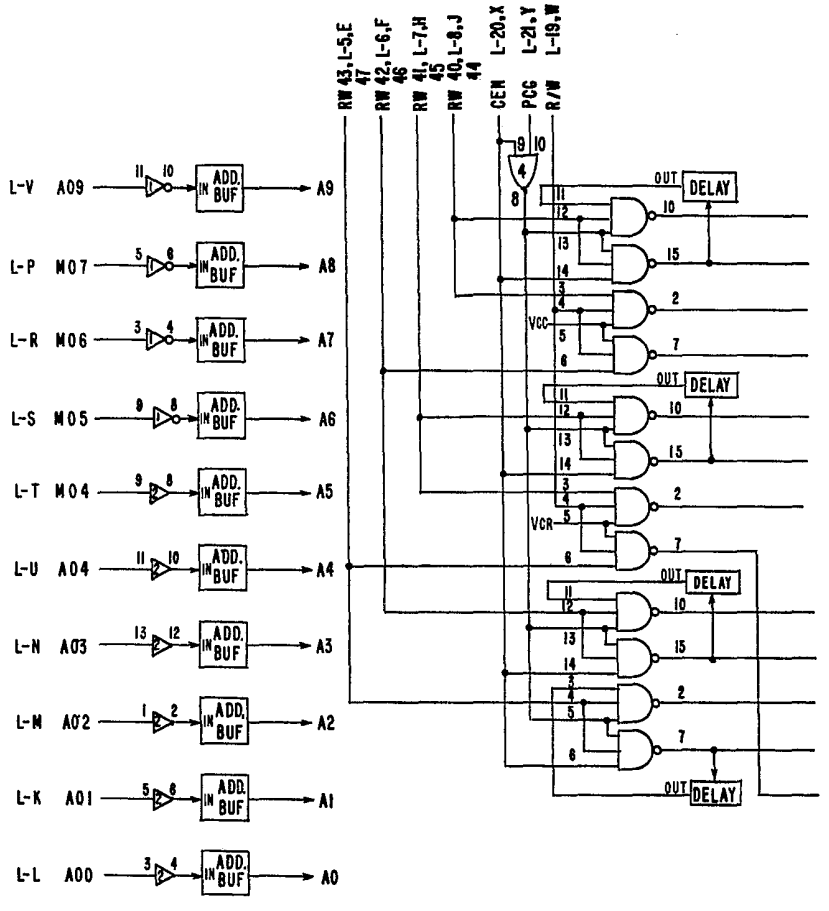

ADD-ON READ ONLY MEMORY 8BLOCKS/1024 X16
BASIC READ ONLY MEMORY 7680 X 16
IOD → IOB, IOB
ADD-ON READ/ WRITE MEMORY 2048 X 16
BASIC READ/ WRITE MEMORY 2048 X 16
M-REGISTER
ADDRESS BUFFERS
CHIPSELECT DECODER + BUFFERS
AEN
A00 → A04
A05 → A19
MEMORY INTERFACE
T-REGISTER
MEMORY CONTROL
CONTROL LOGIC FROM: EXTENDED PROCESSOR I/O
T BUS
EXTENDED MEMORY
D-BUS
I/O-BUS
S-BUS
EXTENDED MEMORY, PROCESSOR
LEGEND:
CONTROL SIGNAL
DATA
ADDRESS INFORMATION

FIG 35


RW 43,L-5,E 47
RW 42,L-6,F 46
RW 41,L-7,H 45
RW 40,L-8,J 44
CEN
L-20,X
L-21,Y
L-19,W
R/W
L-V A09
L-P M07
L-R M06
L-S M05
L-T M04
L-U A04
L-N A03
L-M A02
L-K A01
L-L A00
ADD. BUF
A9
A8
A7
A6
A5
A4
A3
A2
A1
A0
OUT
DELAY
VCC
VCR

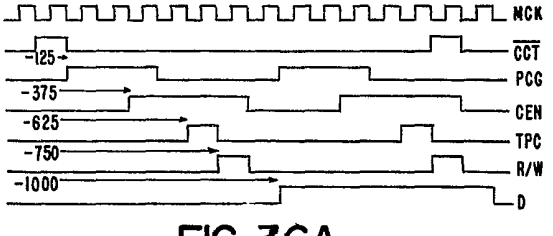
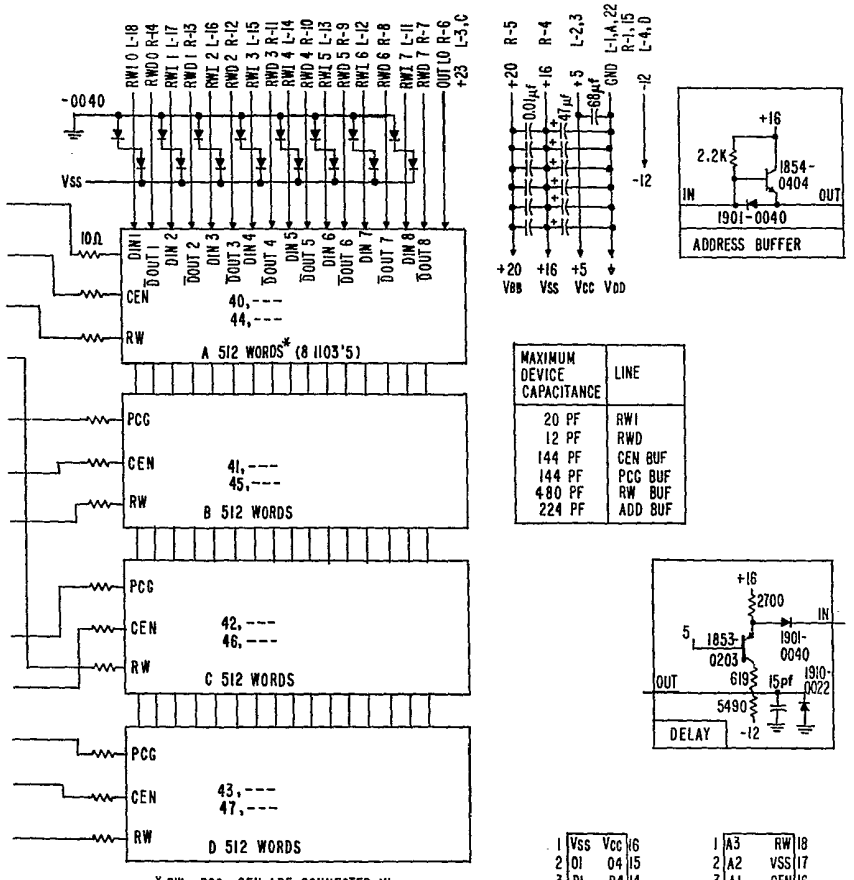

MCK
-125
CCT
PCG
-375
CEN
-625
TPC
-750
R/W
-1000
D

FIG 36A



*RW, PCG, CEN ARE CONNECTED IN COMMON TO ALL 8 PACKAGES. DIN 1 IS CONNECTED TO DIN OF PACKAGE 1 IN BLOCKS A, B, C, & D.

MAXIMUM DEVICE CAPACITANCE	LINE
20 PF	RWI
12 PF	RWD
144 PF	CEN BUF
144 PF	PCG BUF
480 PF	RW BUF
224 PF	ADD BUF

1	Vss	Vcc	16
2	O1	O4	15
3	D1	D4	14
4	E1	E4	13
5	E2	E3	12
6	D2	D3	11
7	O2	O3	10
8	GND	VBB	9

I3207

1	A3	RW	18
2	A2	VSS	17
3	A1	CEN	16
4	A0	A4	15
5	PCG	$\overline{DOUT}$	14
6	A9	A8	13
7	A6	DIN	12
8	A5	VDD	11
9	A7	VBB	10

INTEL 1103

FIG 36B

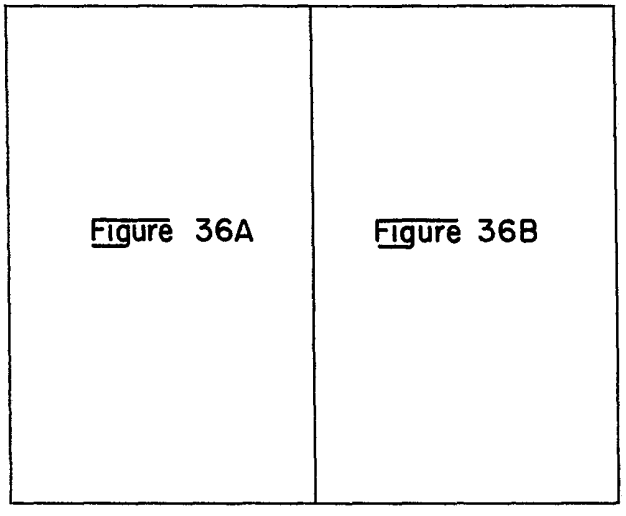
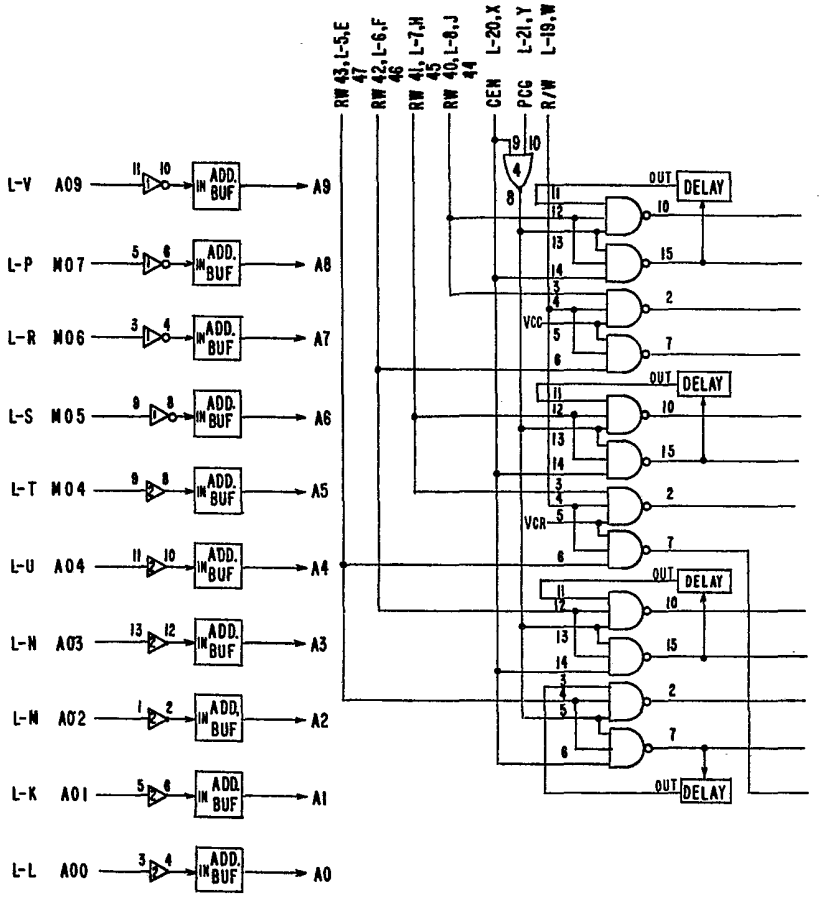


Figure 36'


RW 43, L-5, E
RW 42, L-6, F
RW 41, L-7, H
RW 40, L-8, J
CEN
PCG
R/W
L-20, X
L-21, Y
L-19, W
L-V A09
L-P M07
L-R M06
L-S M05
L-T M04
L-U A04
L-N A03
L-M A02
L-K A01
L-L A00
ADD. BUF
A9
A8
A7
A6
A5
A4
A3
A2
A1
A0
VCC
VCR
DELAY
OUT

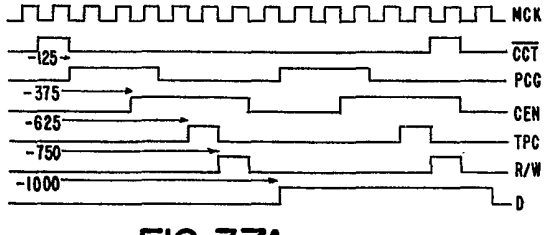
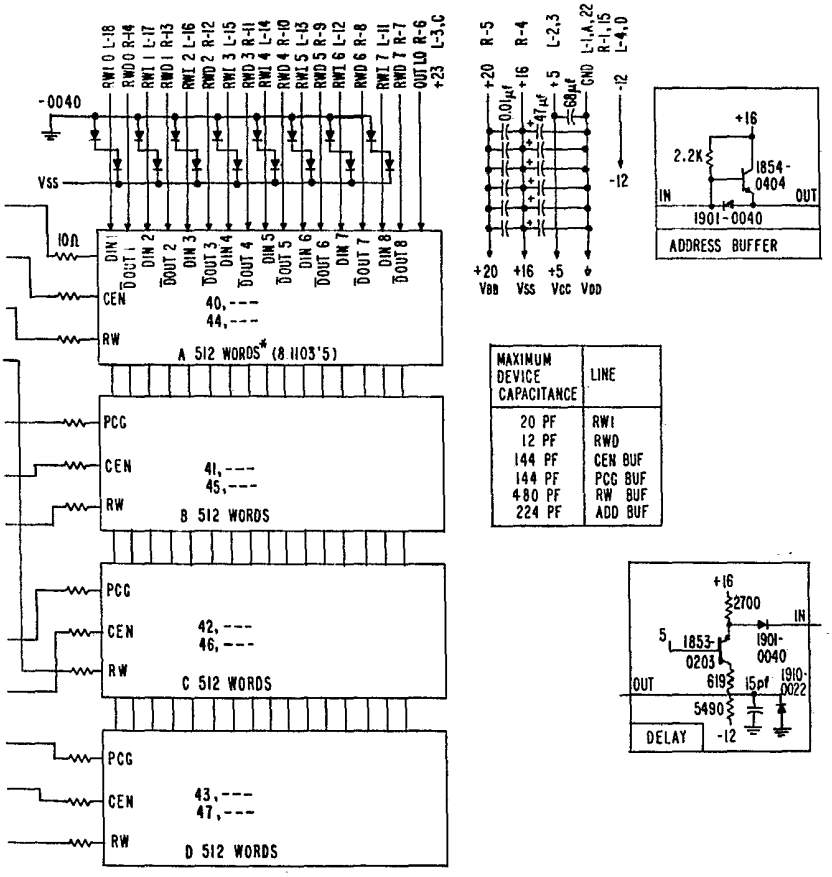

MCK
-125
CCT
-375
PCG
-625
CEN
-750
TPC
-1000
R/W
D

FIG 37A



* RW, PCG, CEN ARE CONNECTED IN COMMON TO ALL 8 PACKAGES. DIN 1 IS CONNECTED TO DIN OF PACKAGE 1 IN BLOCKS A, B, C, & D.

MAXIMUM DEVICE CAPACITANCE	LINE
20 PF	RWI
12 PF	RWD
144 PF	CEN BUF
144 PF	PCG BUF
480 PF	RW BUF
224 PF	ADD BUF

FIG 37B

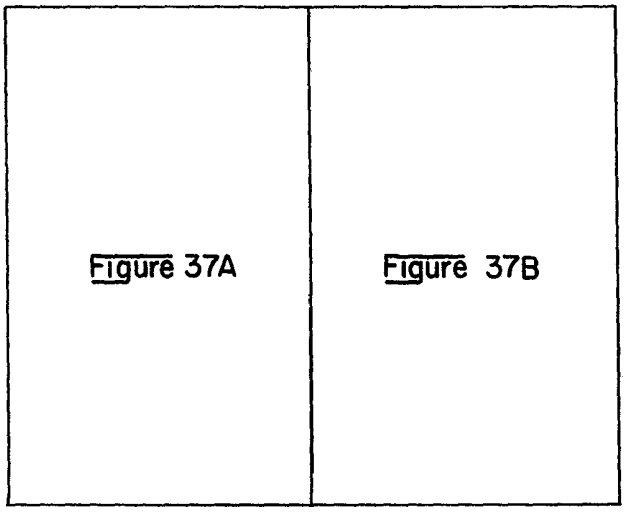


Figure 37'

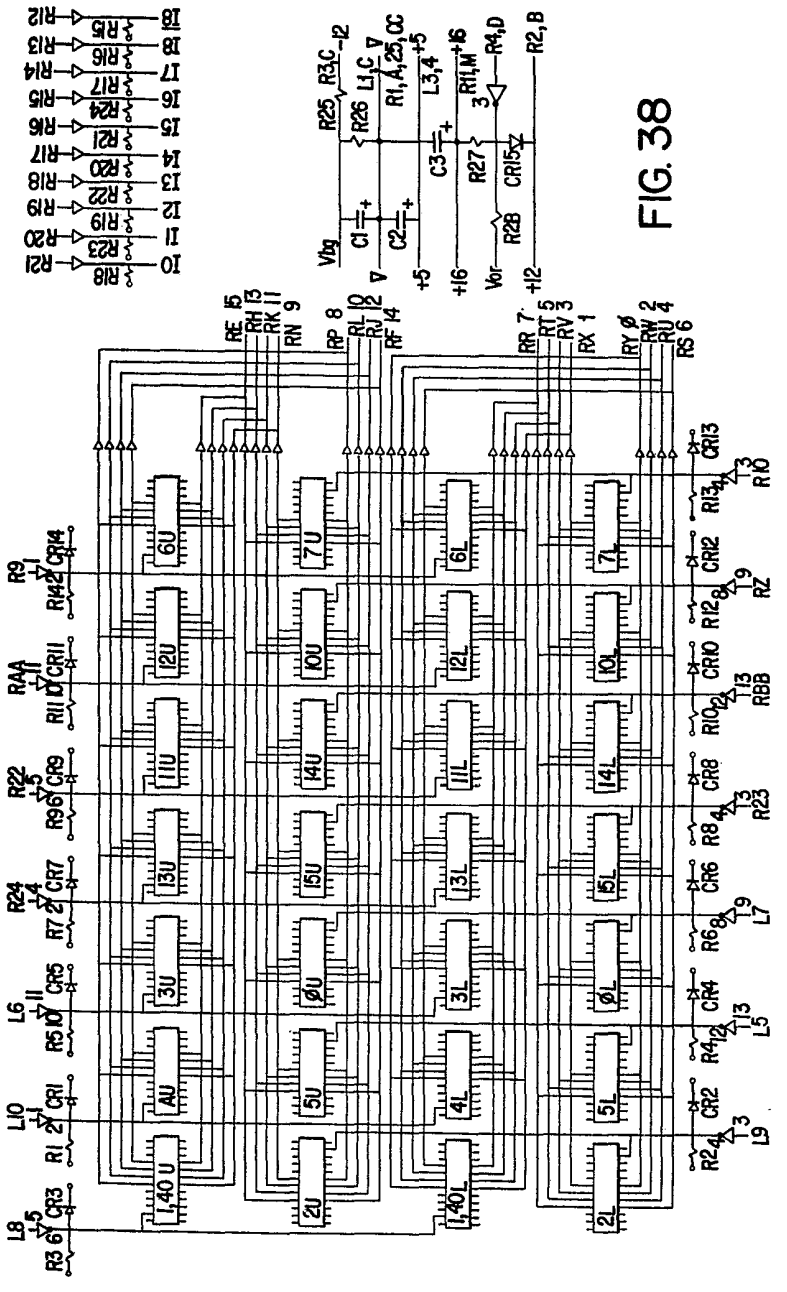


FIG. 38

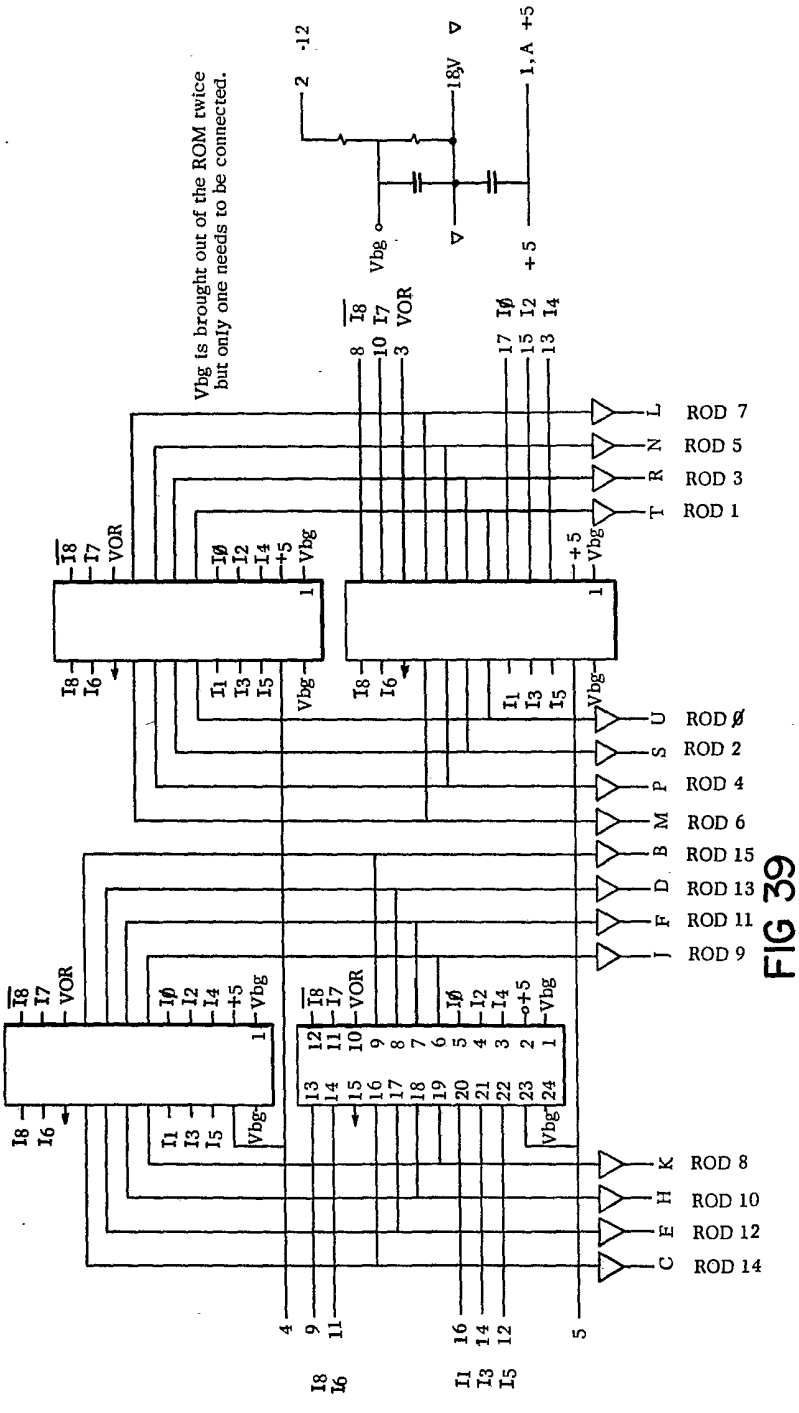

Vbg is brought out of the ROM twice but only one needs to be connected.
-12
18V
+5
Vbg
ROD 7
ROD 5
ROD 3
ROD 1
ROD Ø
ROD 2
ROD 4
ROD 6
ROD 15
ROD 13
ROD 11
ROD 9
ROD 8
ROD 10
ROD 12
ROD 14

FIG 39

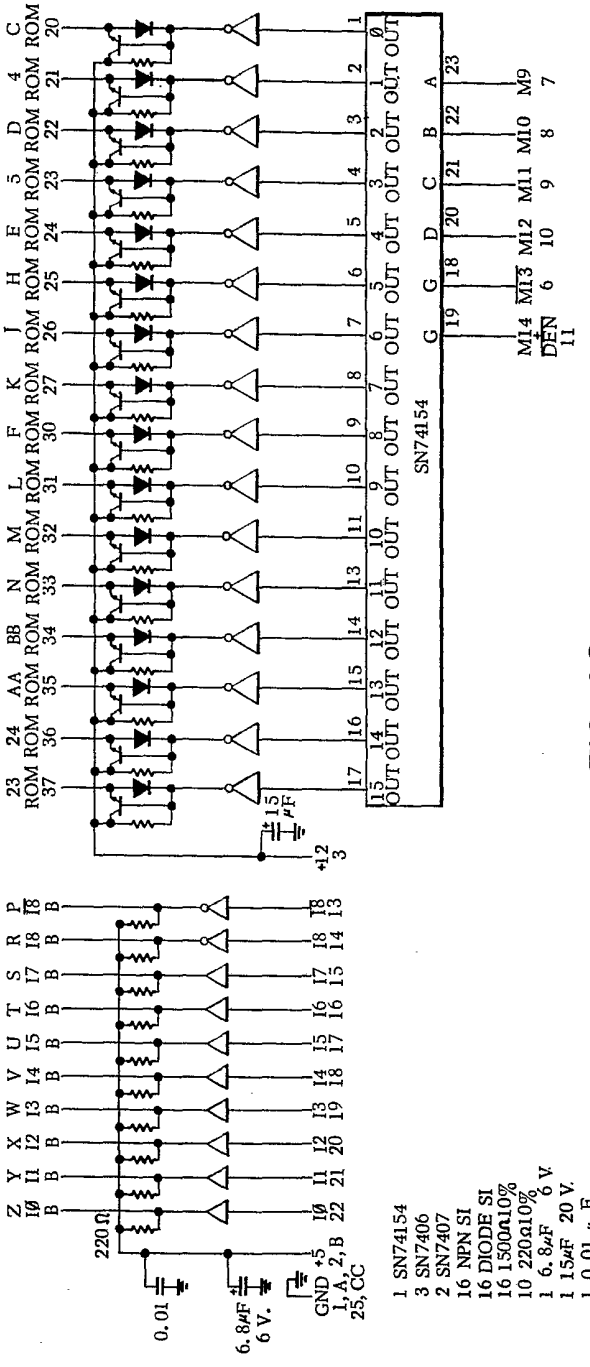

SN74154
1 SN74154
3 SN7406
2 SN7407
16 NPN SI
16 DIODE SI
16 1500Ω10%
10 220Ω10%
1 6.8μF 6 V.
1 15μF 20 V.
1 0.01 μF
220Ω
0.01
6.8μF 6 V.
GND +5
1, A, 2, B 25, CC
+12 3
15 μF

FIG 40

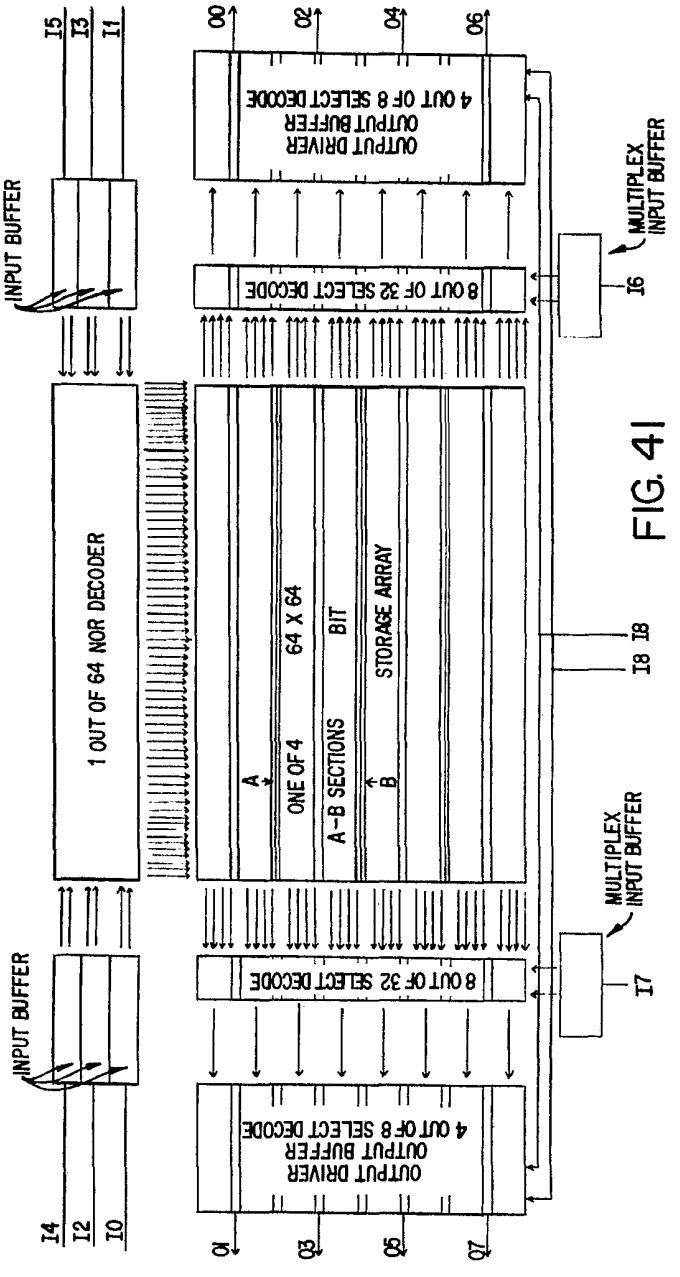

I5
I3
I1
INPUT BUFFER
I4
I2
I0
1 OUT OF 64 NOR DECODER
A
ONE OF 4
64 X 64
A-B SECTIONS
BIT
B
STORAGE ARRAY
4 OUT OF 8 SELECT DECODE
OUTPUT BUFFER
OUTPUT DRIVER
8 OUT OF 32 SELECT DECODE
MULTIPLEX INPUT BUFFER
I6
I7
I8
I9
Q0
Q2
Q4
Q6
Q1
Q3
Q5
Q7

FIG. 41

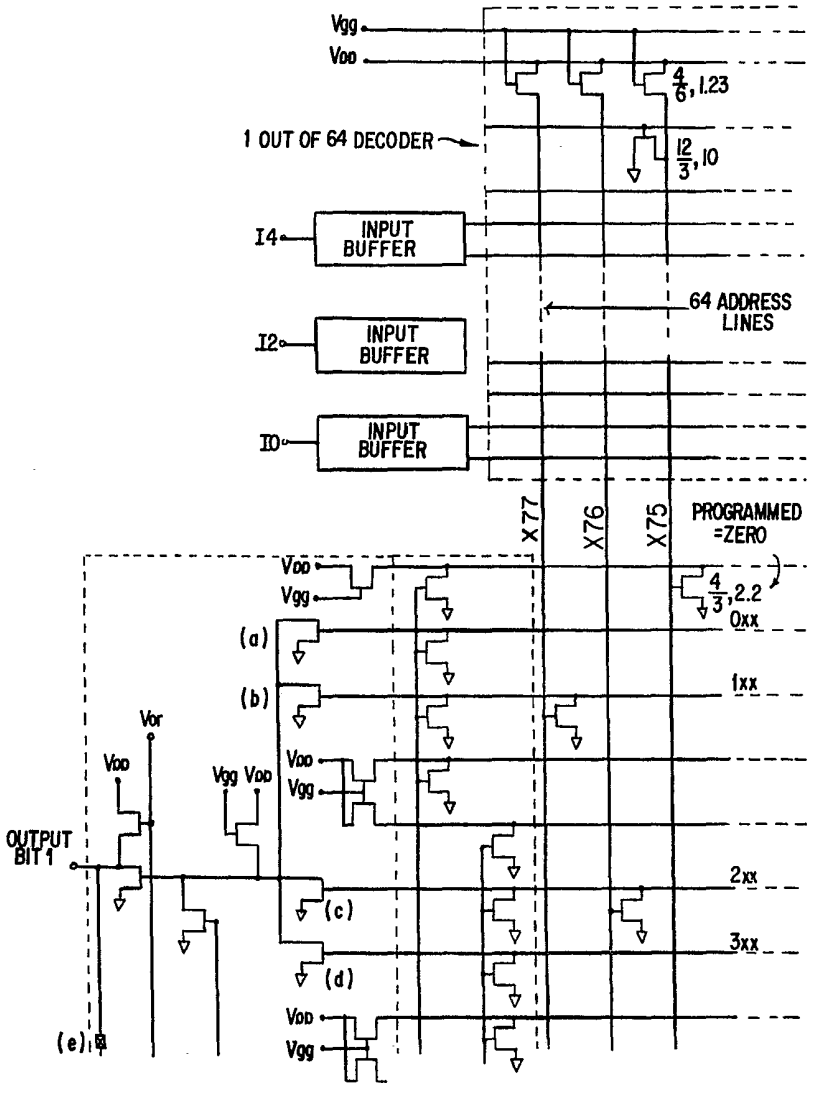

Vgg
Voo
4/6, 1.23
1 OUT OF 64 DECODER
12/3, 10
I4
INPUT BUFFER
64 ADDRESS LINES
I2
INPUT BUFFER
I0
INPUT BUFFER
X77
X76
X75
PROGRAMMED =ZERO
Voo
Vgg
4/3, 2.2
0xx
(a)
1xx
(b)
Vor
Voo
Vgg Voo
Voo
Vgg
OUTPUT BIT 1
2xx
(c)
3xx
(d)
Voo
Vgg
(e)

FIG. 42A

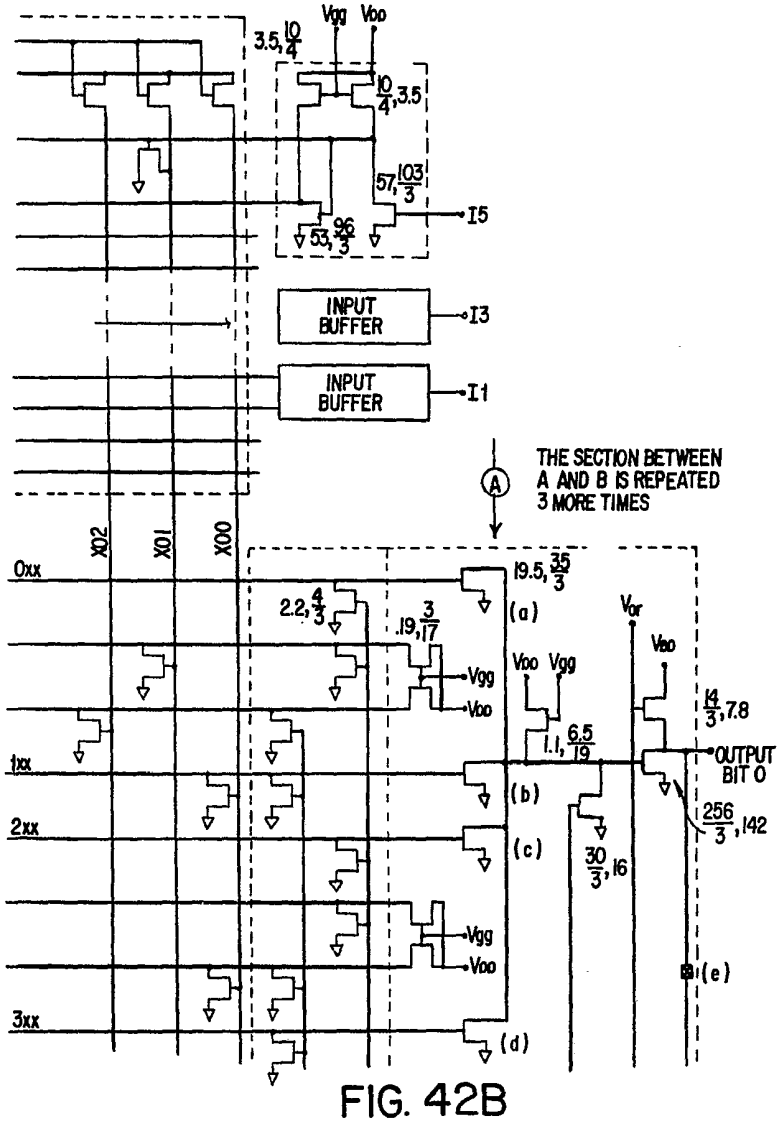
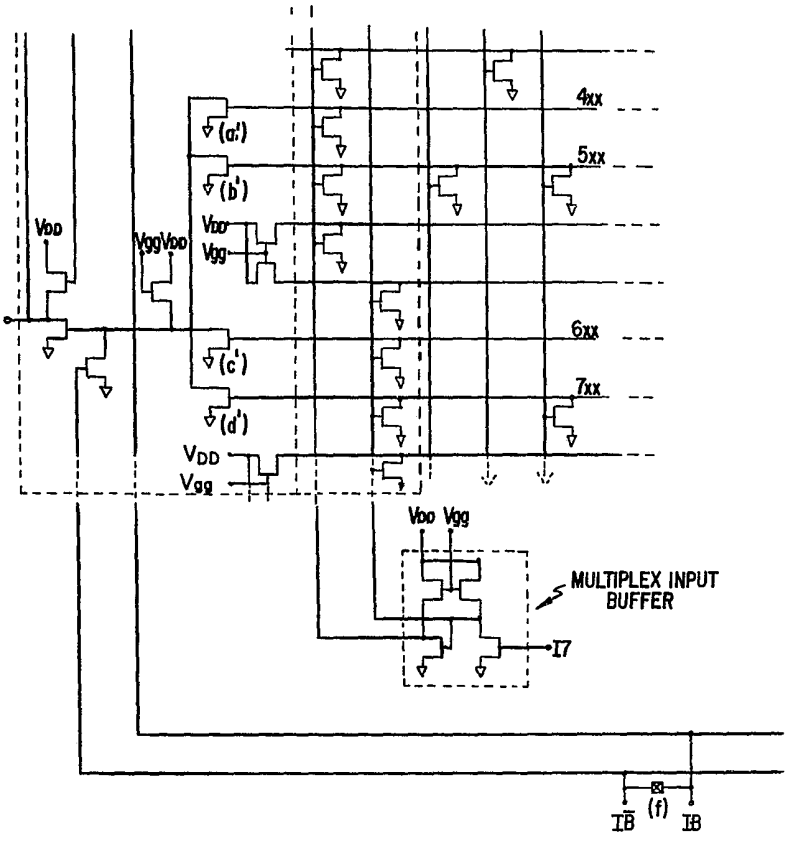

Vgg Vdd
3.5, 10/4
10/4, 3.5
57, 103/3
53, 96/3
I5
INPUT BUFFER
I3
INPUT BUFFER
I1
A
THE SECTION BETWEEN A AND B IS REPEATED 3 MORE TIMES
X02
X01
X00
0xx
1xx
2xx
3xx
19.5, 35/3
(a)
2.2, 4/3
.19, 3/17
Vgg
Vdd
Vdd Vgg
Vor
Vdd
14/3, 7.8
1.1, 6.5/19
OUTPUT BIT 0
(b)
(c)
30/3, 16
256/3, 142
(e)
(d)

FIG. 42B



NOTES

THIS SYMBOL INDICATES CONNECTIONS WHICH CAN BE PROGRAMMED OPEN OR SHORT —⊠—

① FOR A 512 X 8 :
- ⓐ TIE OUTPUT PAIRS TOGETHER
- ⓑ DO NOT TIE IB AND $\overline{IB}$ TOGETHER

② FOR A 256 X 16:
- ⓐ DO NOT TIE OUTPUT PAIRS TOGETHER
- ⓑ TIE IB AND $\overline{IB}$ TOGETHER

③ V_{DD} =+5V V_{gg} =+12V(SWITCHED) (POSITIVE TRUE LOGIC)

⑤ RESISTANCES ASSUME 10Ω □
ALL $^{W}/_{L}$'s ASSUME A 3μ TOTAL SIDE DIFFUSION
ALL CONTACTS SHOWN AS (⊠) ARE PROGRAMABLE WITH GATE MASK

FIG. 42C

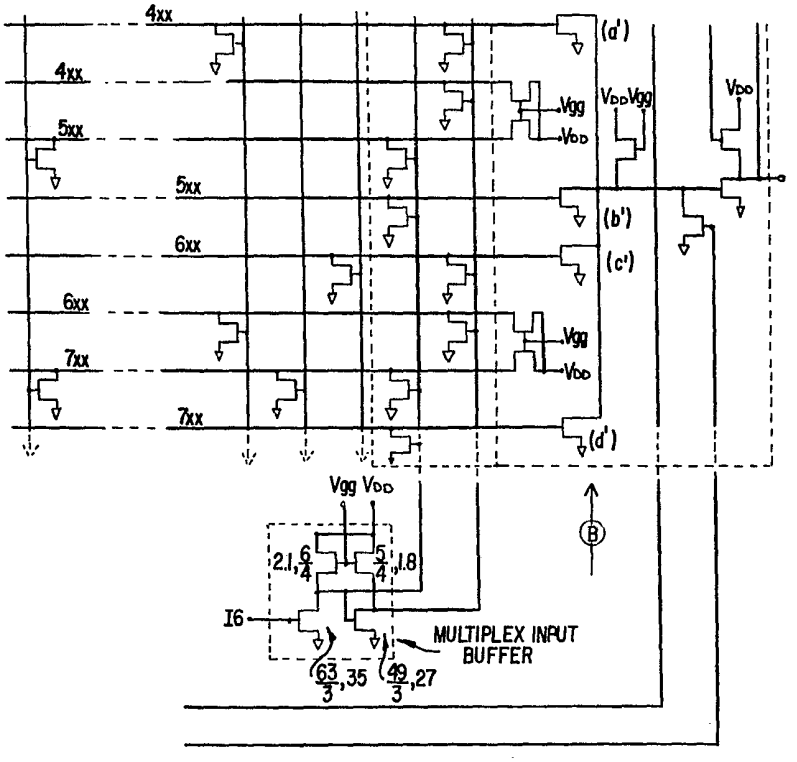

4xx
4xx
5xx
5xx
6xx
6xx
7xx
7xx
(a')
(b')
(c')
(d')
Vgg
VDD
VDDVgg
VDD
Vgg
VDD
Vgg VDD
B
I6
MULTIPLEX INPUT BUFFER

FIG. 42D

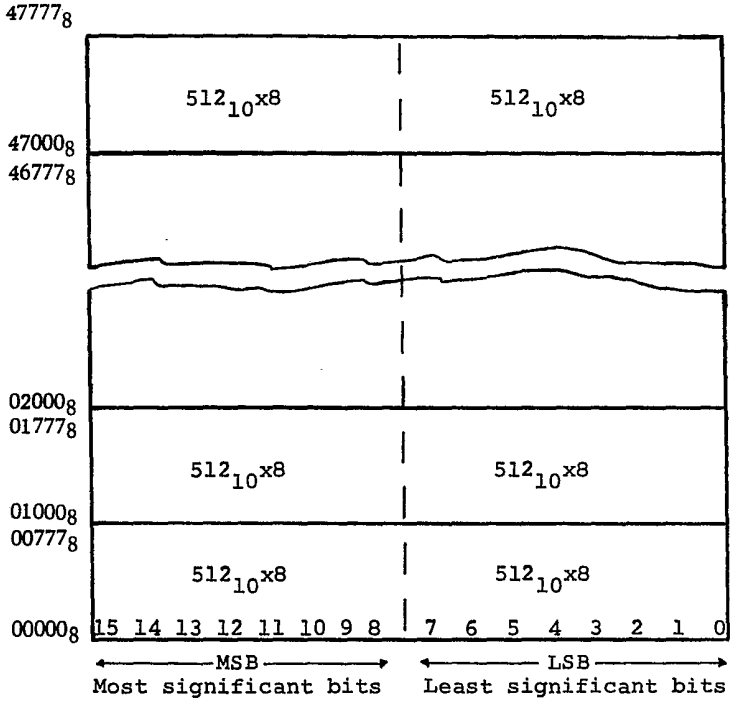

47777_8
512_{10}x8
512_{10}x8
47000_8
46777_8
02000_8
01777_8
512_{10}x8
512_{10}x8
01000_8
00777_8
512_{10}x8
512_{10}x8
00000_8
15 14 13 12 11 10 9 8
7 6 5 4 3 2 1 0
MSB
LSB
Most significant bits
Least significant bits

FIG 43

BIT NUMBERS	ACTUAL BIT
1	15 or 7
2	14 or 6
3	13 or 5
4	12 or 4
5	11 or 3
6	10 or 2
7	9 or 1
8	8 or 0

FIG 45

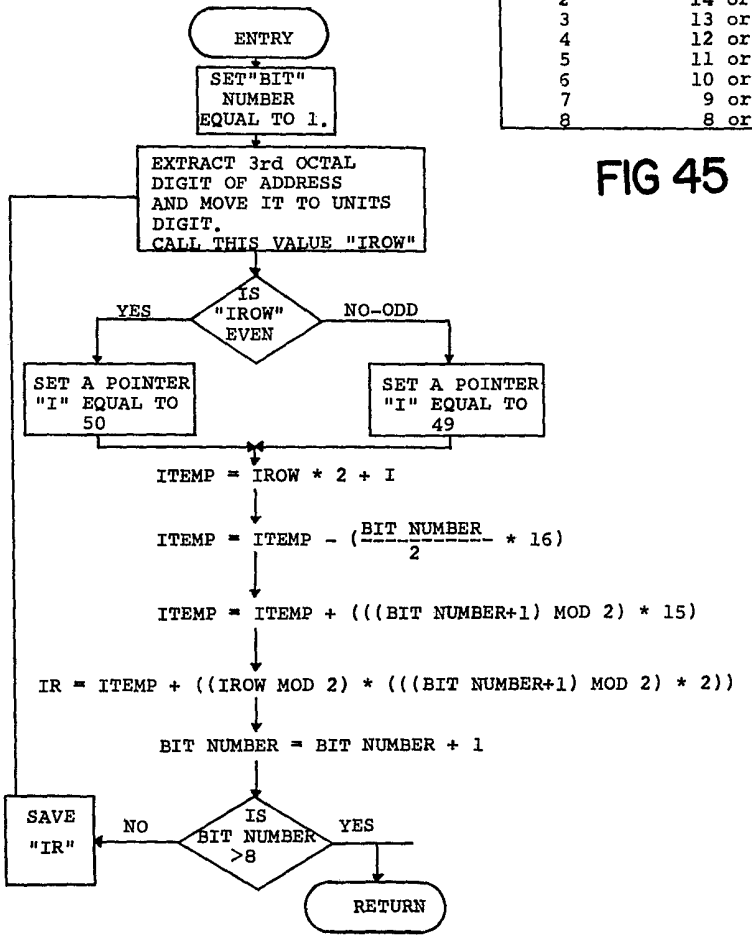


FIG 44

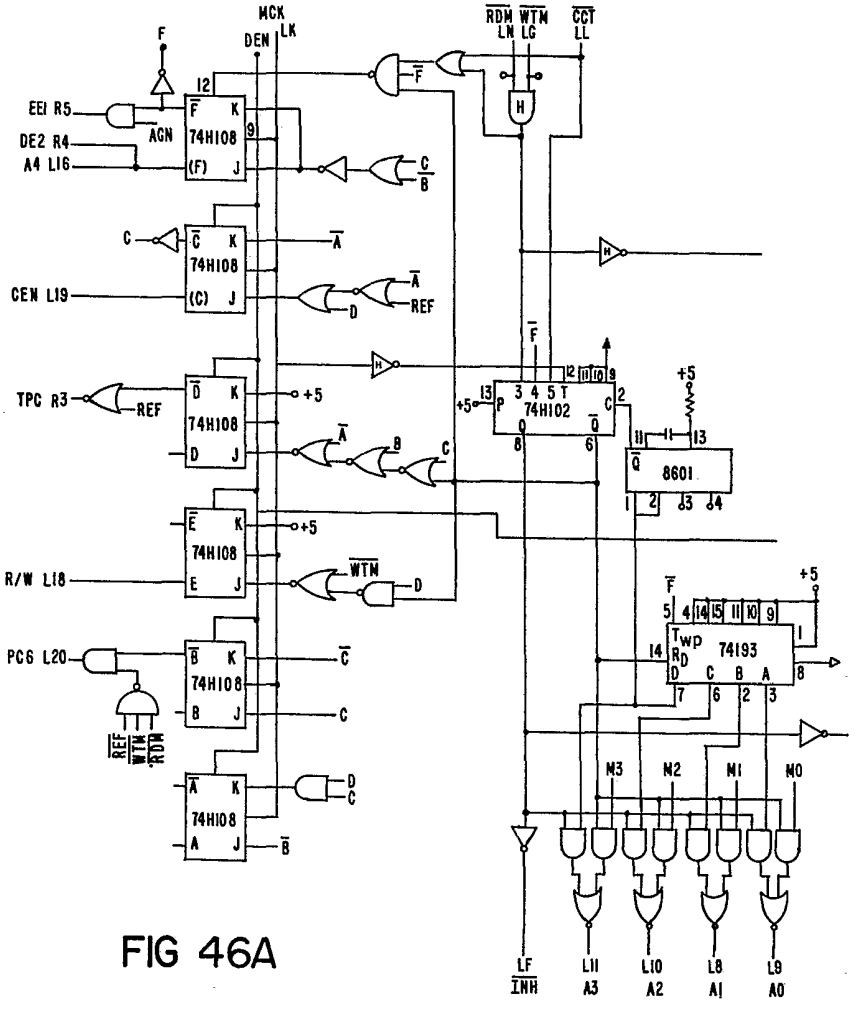
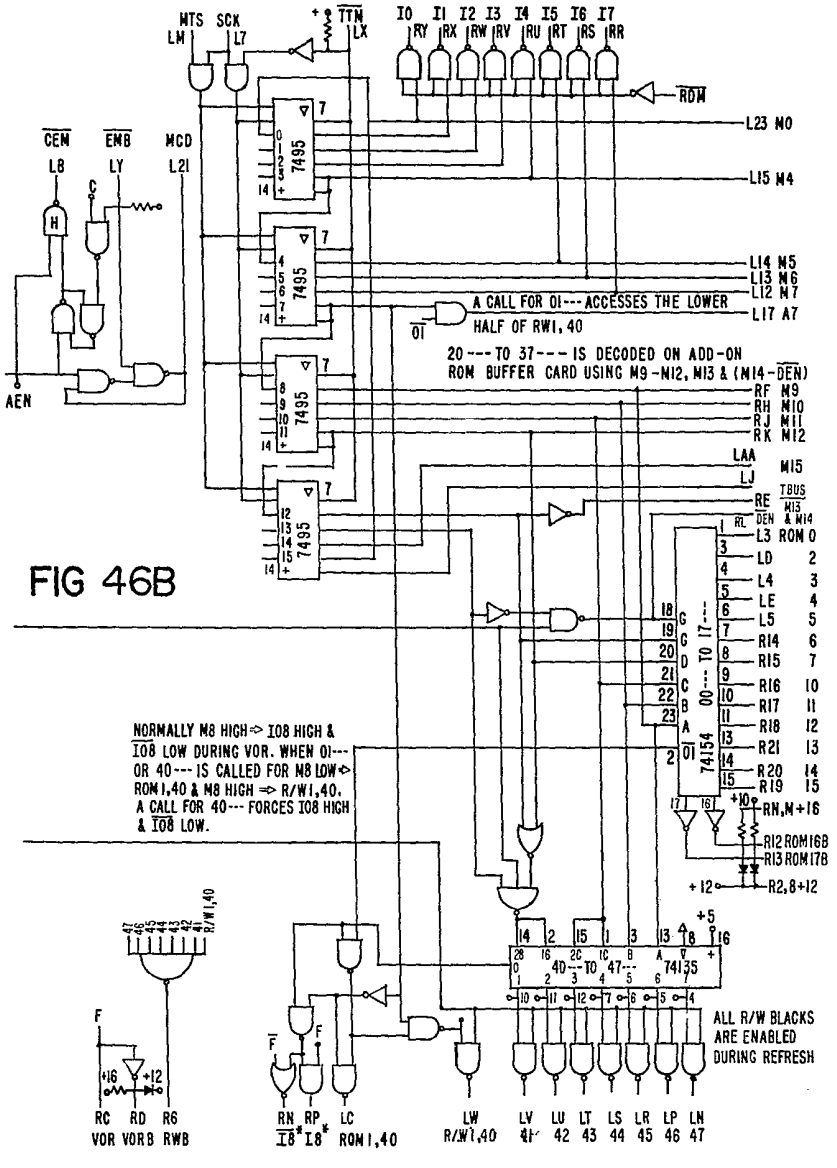

MCK
DEN
LK
F
EEI R5
DE2 R4
A4 L16
AGN
74H108
C
CEN L19
REF
TPC R3
+5
R/W L18
WTM
PC6 L20
RDM LN
WTM LG
CCT LL
74H102
8601
74193
M3
M2
M1
M0
LF INH
L11 A3
L10 A2
L8 A1
L9 A0

FIG 46A


MTS SCK
LM L7
TTM LX
I0 I1 I2 I3 I4 I5 I6 I7
RY RX RW RV RU RT RS RR
RDW
CEM EMB MCD
L8 LY L21
L23 M0
L15 M4
L14 M5
L13 M6
L12 M7
L17 A7
A CALL FOR 01---ACCESSES THE LOWER HALF OF RW1,40
01
20---TO 37---IS DECODED ON ADD-ON ROM BUFFER CARD USING M9-M12, M13 & (M14-DEN)
RF M9
RH M10
RJ M11
RK M12
LAA
LJ M15
RE TBUS M13 & M14
DEN
RL
L3 ROM 0
LD 2
L4 3
LE 4
L5 5
R14 6
R15 7
R16 10
R17 11
R18 12
R21 13
R20 14
R19 15
00---TO 17---
74154
RN,M+16
R12 ROM16B
R13 ROM17B
R2,8+12
AEN
FIG 46B
NORMALLY M8 HIGH⇒ I08 HIGH & I08 LOW DURING VOR. WHEN 01--- OR 40--- IS CALLED FOR M8 LOW⇒ ROM1,40 & M8 HIGH ⇒ R/W1,40. A CALL FOR 40--- FORCES I08 HIGH & I08 LOW.
40---TO 47---
74135
ALL R/W BLACKS ARE ENABLED DURING REFRESH
RC VOR
RD VORB
R6 RWB
RN I8*
RP I8*
LC ROM1,40
LW R/W1,40
LV 41
LU 42
LT 43
LS 44
LR 45
LP 46
LN 47

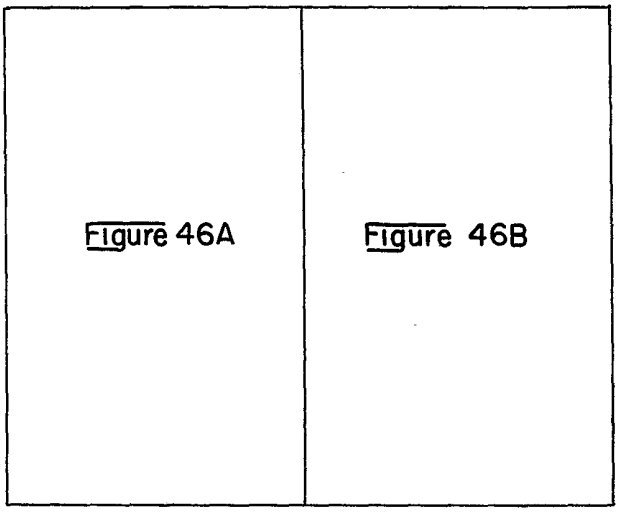


Figure 46'

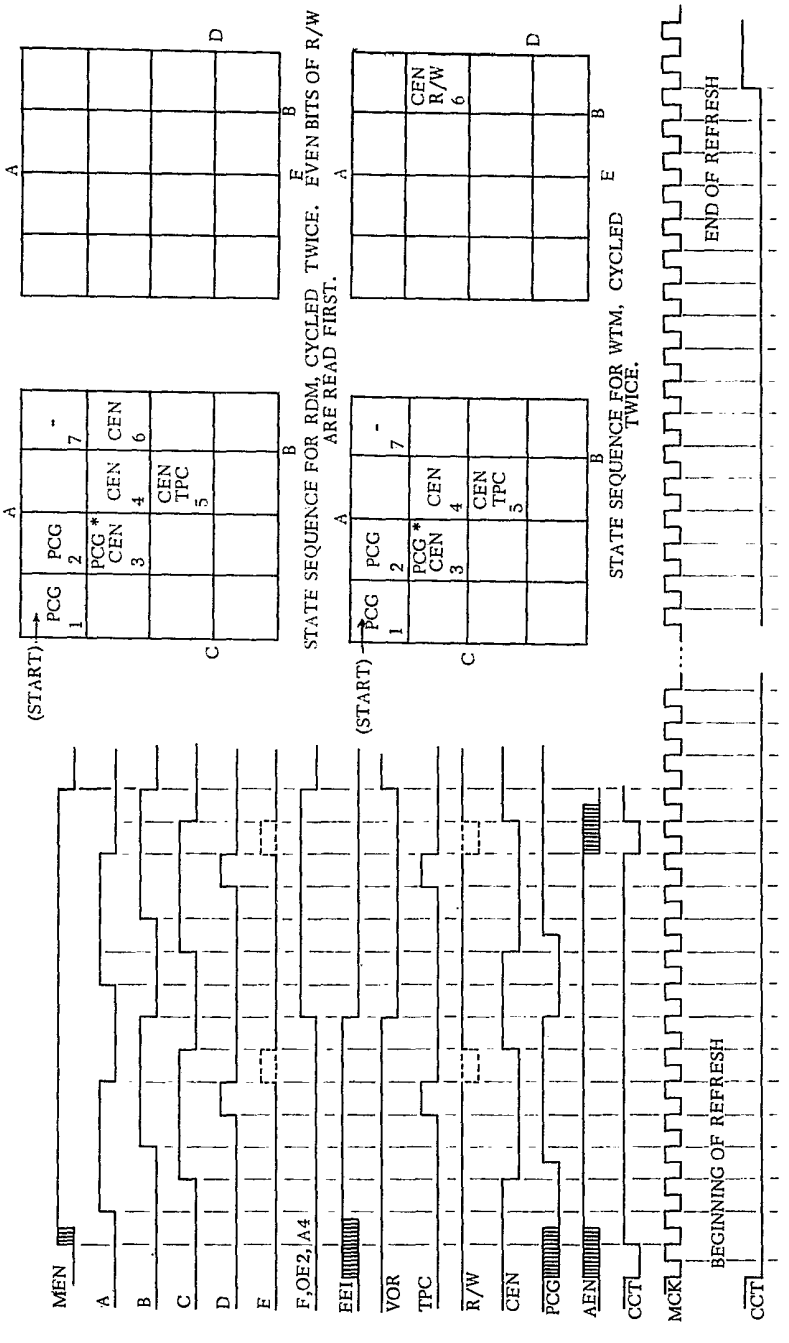
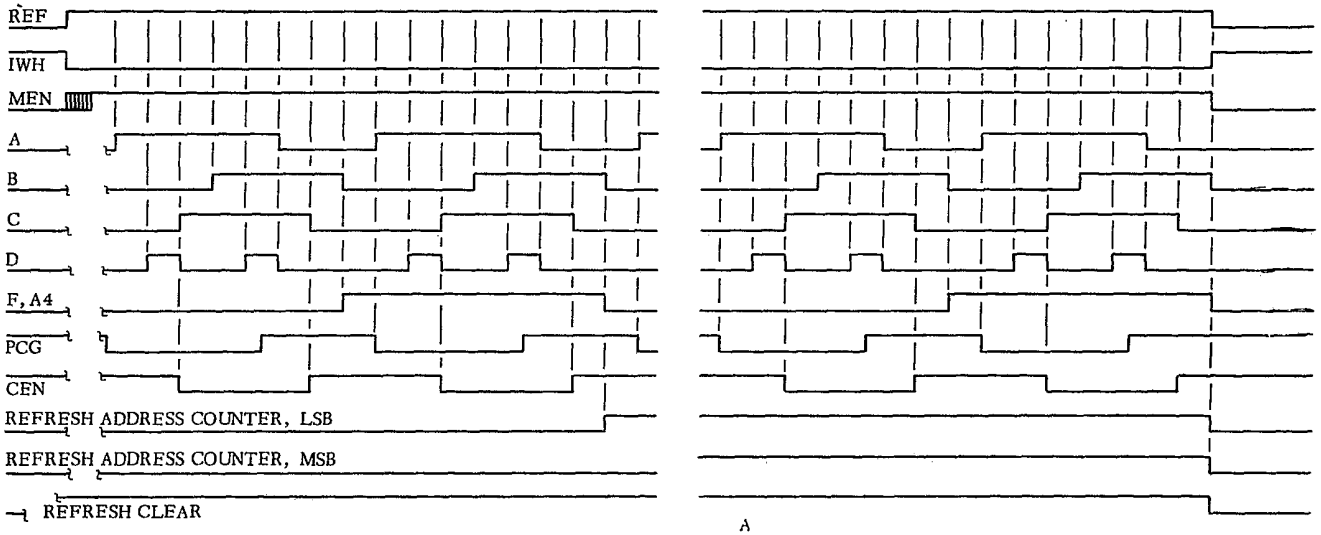

(START)
PCG 1
PCG 2
PCG * CEN 3
CEN 4
CEN TPC 5
CEN 6
- 7
A
B
C
D
E
STATE SEQUENCE FOR RDM, CYCLED TWICE. EVEN BITS OF R/W ARE READ FIRST.
CEN R/W 6
STATE SEQUENCE FOR WTM, CYCLED TWICE.
MEN
A
B
C
D
E
F,OE2,A4
EEI
VOR
TPC
R/W
CEN
PCG
AEN
CCT
MCR
BEGINNING OF REFRESH
END OF REFRESH
CCT

FIG 47A



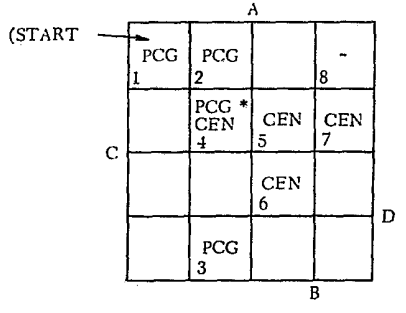
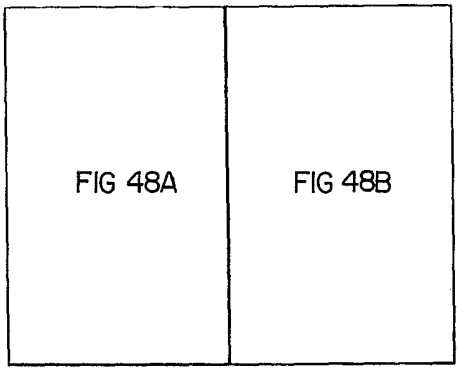


FIG 47B

STATE SEQUENCE FOR REFRESH, CYCLED 32 TIMES

FIG 48'



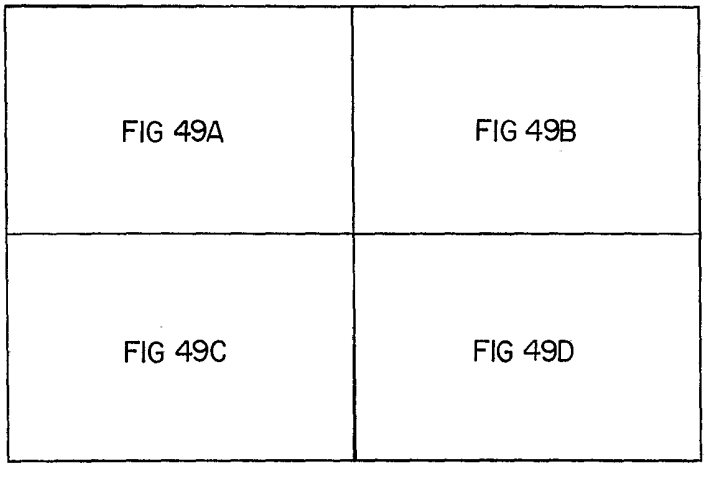


FIG 49'

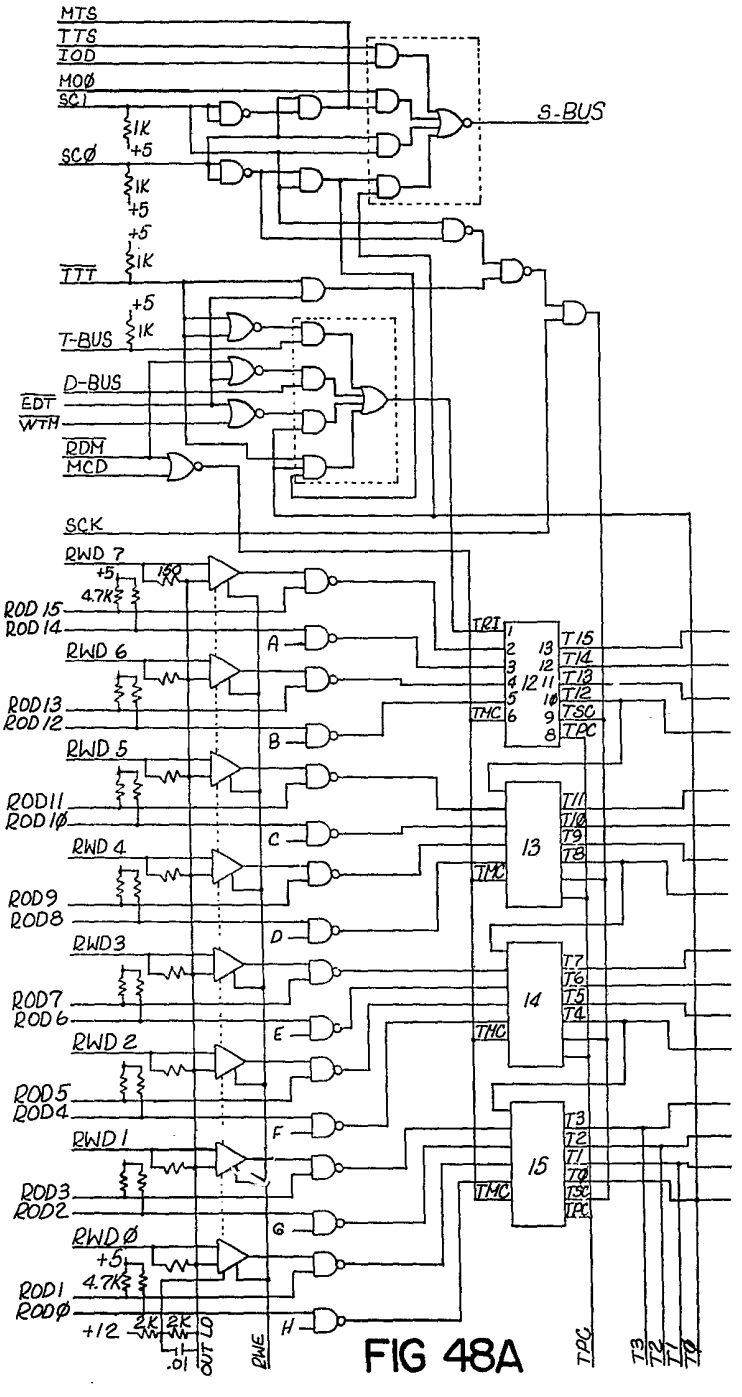
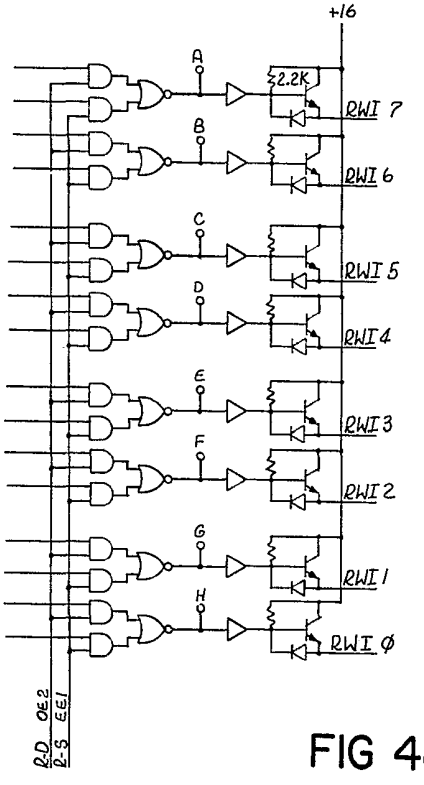
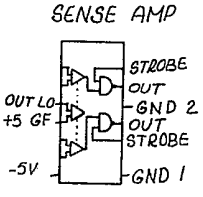

MTS
TTS
IOD
MOØ
SCI
SCØ
1K
+5
S-BUS
TTT
T-BUS
D-BUS
EDT
WTH
RDM
MCD
SCK
RWD 7
4.7K
150
ROD 15
ROD 14
RWD 6
ROD 13
ROD 12
RWD 5
ROD 11
ROD 10
RWD 4
ROD 9
ROD 8
RWD 3
ROD 7
ROD 6
RWD 2
ROD 5
ROD 4
RWD 1
ROD 3
ROD 2
RWDØ
ROD 1
RODØ
+12
2K
.01
OUT LO
RWE
A
B
C
D
E
F
G
H
TRI
THC
13
14
15
T15
T14
T13
T12
TSC
TPC
T11
T10
T9
T8
T7
T6
T5
T4
T3
T2
T1
TØ

FIG 48A


+16
A
B
C
D
E
F
G
H
2.2K
RWI 7
RWI 6
RWI 5
RWI 4
RWI 3
RWI 2
RWI 1
RWI Ø
R.D
D-S
OE2
EE1


SENSE AMP
STROBE
OUT
GND 2
OUT
STROBE
GND 1
OUT LO
+5 GF
-5V

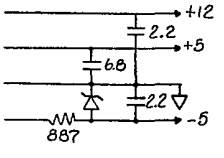

+12
2.2
+5
6.8
2.2
-5
887

FIG 48B

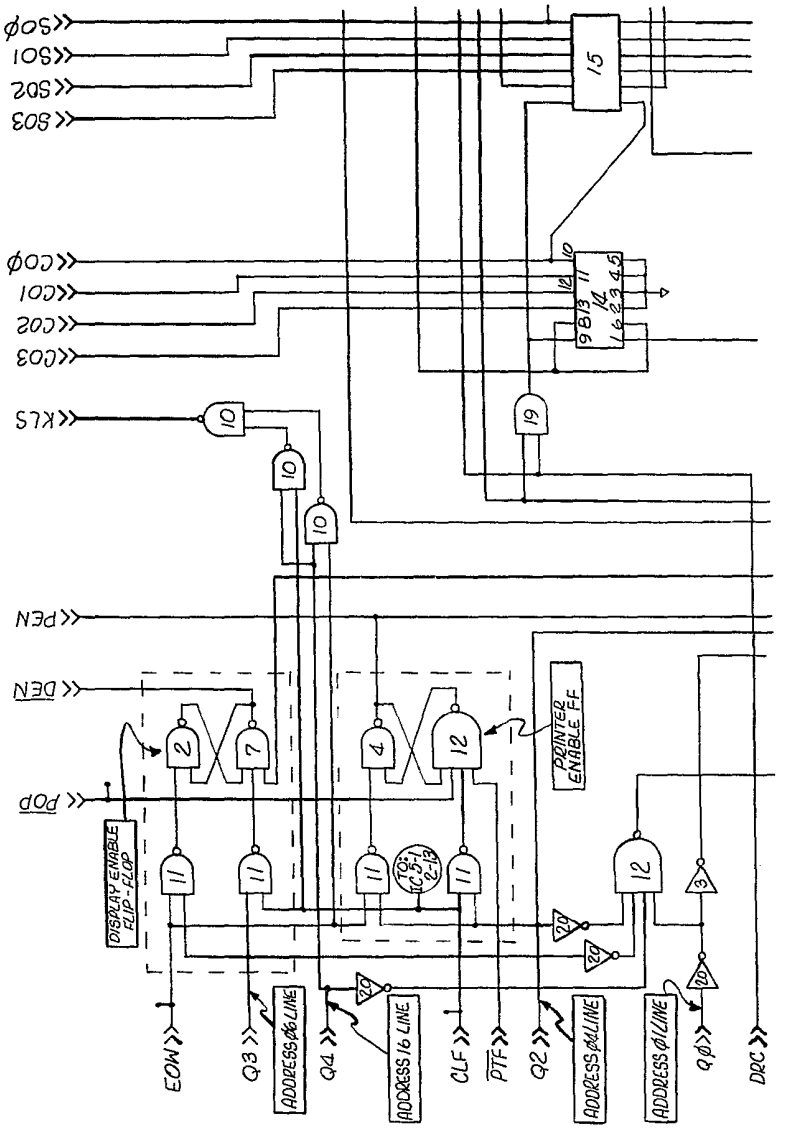
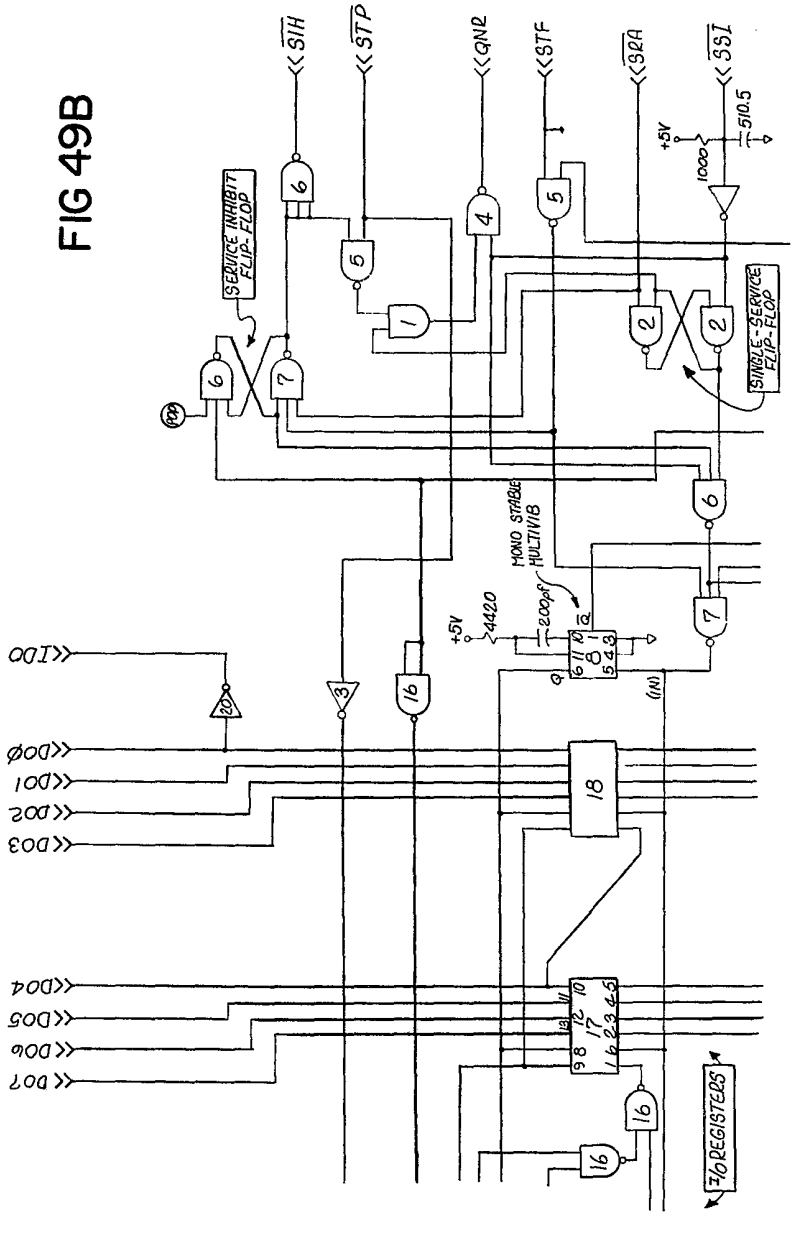

S0φ
S01
S02
S03
C0φ
C01
C02
C03
KLS
PEN
DEN
POP
EOW
Q3
Q4
Q2
CLF
PTF
Qφ
DRC
DISPLAY ENABLE FLIP-FLOP
POINTER ENABLE FF
ADDRESS φ6 LINE
ADDRESS 16 LINE
ADDRESS φ4 LINE
ADDRESS φ1 LINE
TO IIC 35-1 2-13
9813 14 L623 45

FIG 49A

FIG 49B


SIH
STP
QNR
STF
S2A
SSI
+5V
1000
510.5
SERVICE INHIBIT FLIP-FLOP
SINGLE-SERVICE FLIP-FLOP
MONO STABLE MULTIVIB
200pf
4420
+5V
IDO
ØDO
1DO
2DO
3DO
4DO
5DO
6DO
7DO
I/O REGISTERS

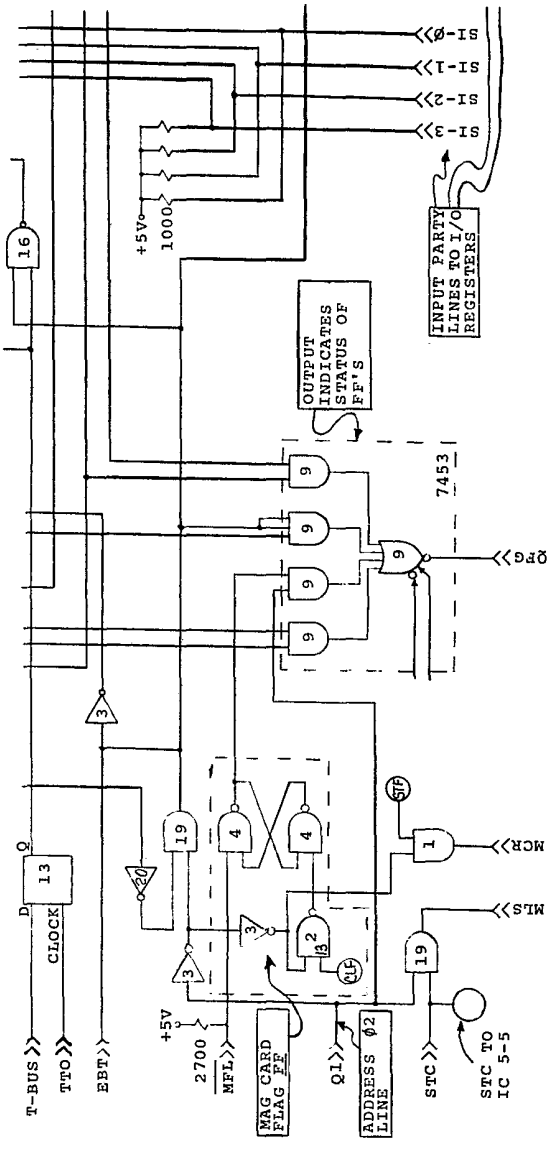


FIG 49C

COMPONENT I.C. NO.	SERIES NO.	DESCRIPTION
1, 19	MC-3001P	QUAD 2-INPUT 'AND' GATES
2,4,5,10,11,16	SN-7400	QUAD 2-INPUT 'NAND' GATES
3,20	-7404	6 PK HEX INVERTERS
6,7	-7410	TRIPLE 3-INPUT 'NAND' GATES
8	-74121	MONOSTABLE MULTIVIBRATOR
9	-7452	EXPANDABLE 4-WIDE 2-INPUT AND-OR-INVERTED GATES
12	-7420	DUAL 4-INPUT 'NAND' GATES
13	-7474	DUAL EDGE-TRIGGERED FLIP-FLOPS
14,15,17,18	-7495	4-BIT RIGHT SHIFT, LEFT SHIFT REGISTER

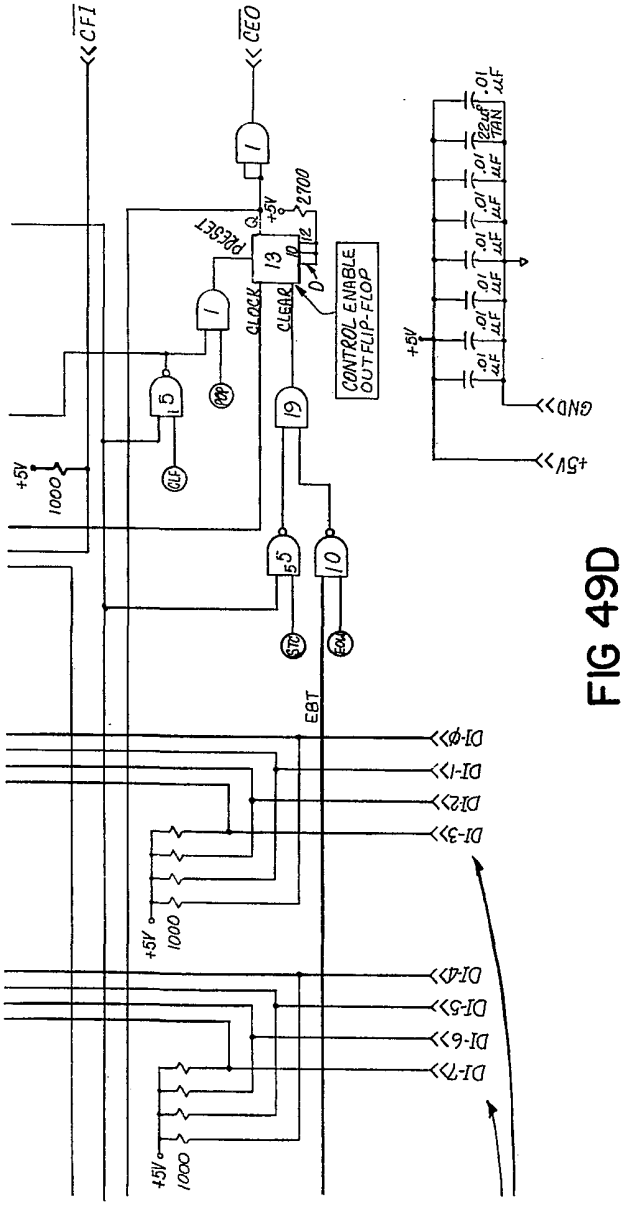

CFI
CEO
+5V
2700
PULSE
CLOCK
CLEAR
CONTROL ENABLE OUTFLIP-FLOP
1000
EBT
DI-Ø
DI-1
DI-2
DI-3
DI-4
DI-5
DI-6
DI-7
GND
+5V
.01 μF
22μF TAN

FIG 49D

Relationship of the I/0 Lines.

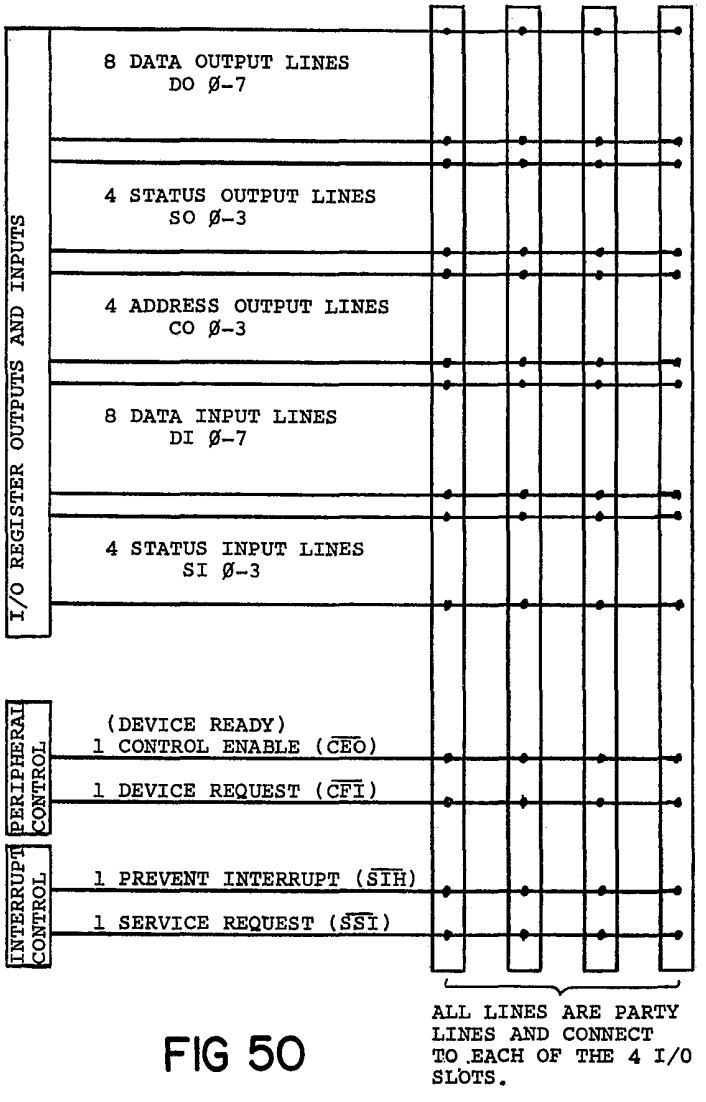


FIG 50

I/O Control Board Timing Diagrams Showing Execution of STC

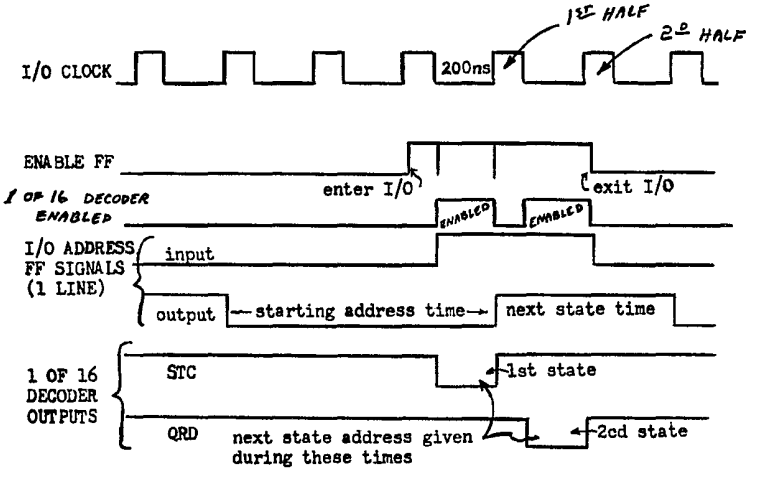


FIG 51

FIG 52

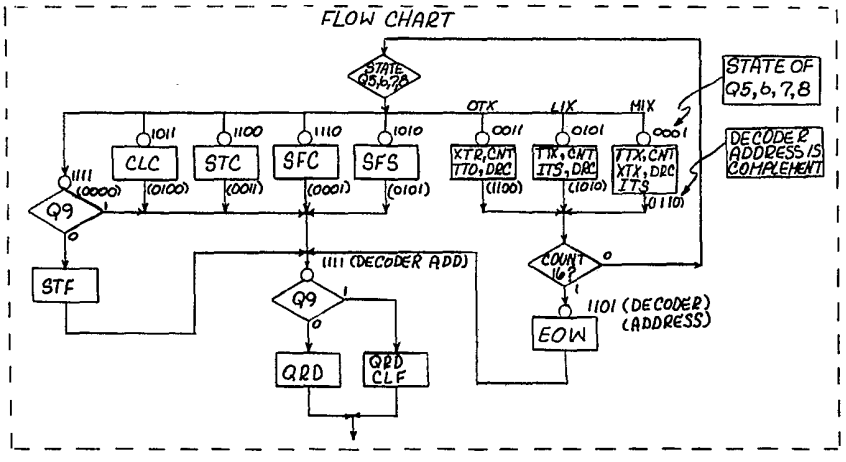
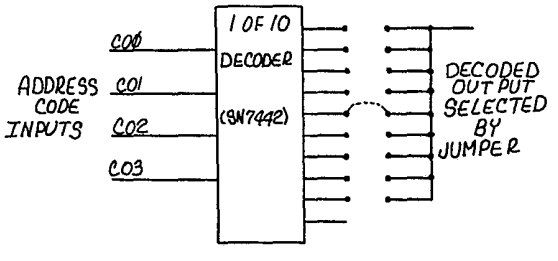

FLOW CHART
STATE Q5,6,7,8
OTX
LIX
MIX
STATE OF Q5,6,7,8
1011
1100
1110
1010
0011
0101
0001
CLC
STC
SFC
SFS
XTR,CNT TTD,DRC
TTX,CNT ITS,DRC
TTX,CNT XTX,DRC ITS
DECODER ADDRESS IS COMPLEMENT
1111 (0000)
(0100)
(0011)
(0001)
(0101)
(1100)
(1010)
(0110)
Q9
STF
1111 (DECODER ADD)
COUNT 16?
1101 (DECODER) (ADDRESS)
EOW
QRD
QRD CLF

FIG 53


1 OF 10
DECODER
(SN7442)
ADDRESS CODE INPUTS
C00
C01
C02
C03
DECODED OUTPUT SELECTED BY JUMPER

GENERAL MODE INPUT WAVEFORMS.

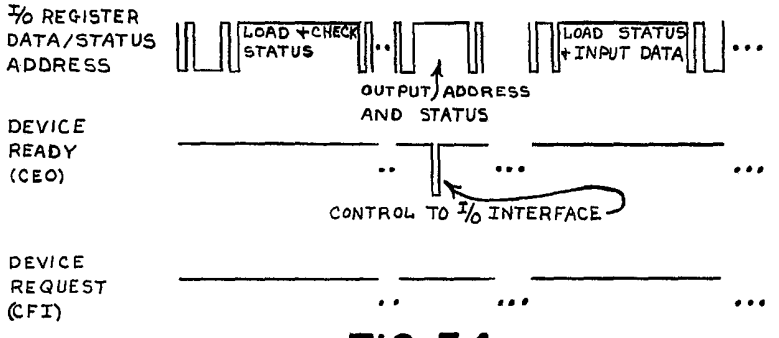


FIG 54

GENERAL MODE OUTPUT WAVEFORMS

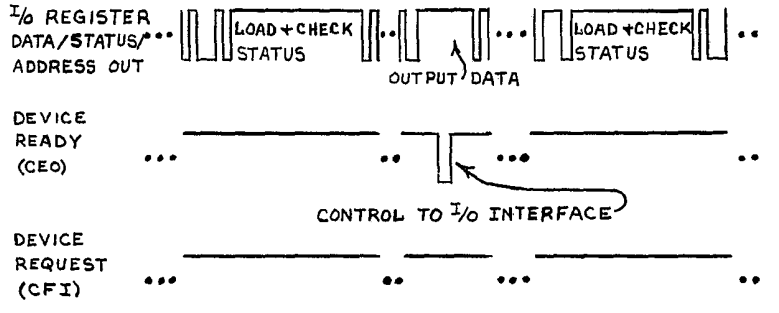


FIG 55

HIGH SPEED INPUT WAVEFORMS

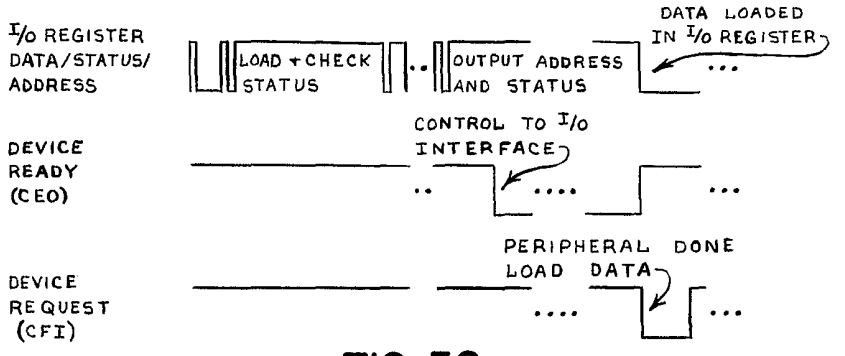


FIG 56

HIGH SPEED OUTPUT WAVE FORM

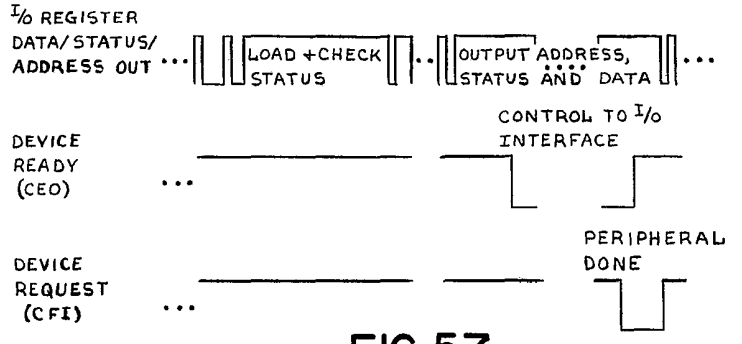


FIG 57

INTERRUPT WAVEFORMS

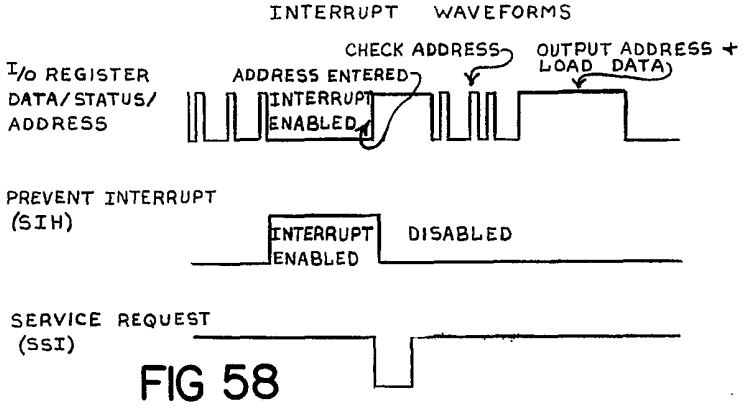


FIG 58

1444141 COMPLETE SPECIFICATION
233 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 101

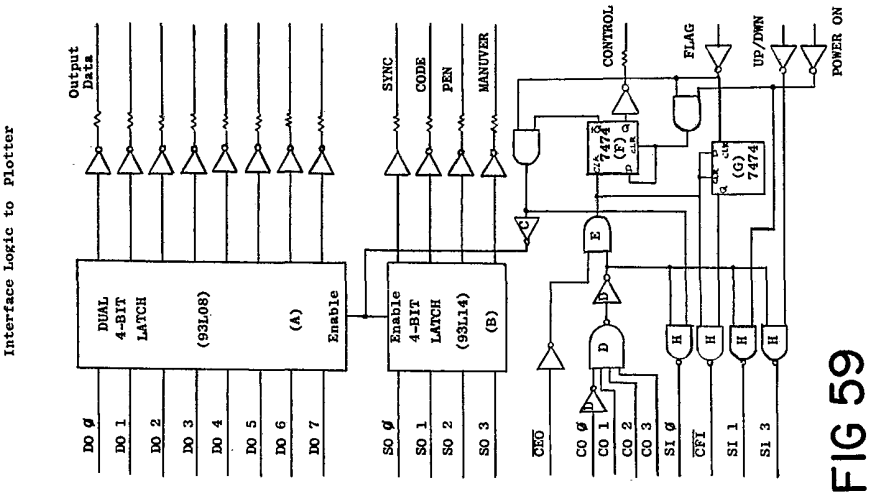


FIG 59

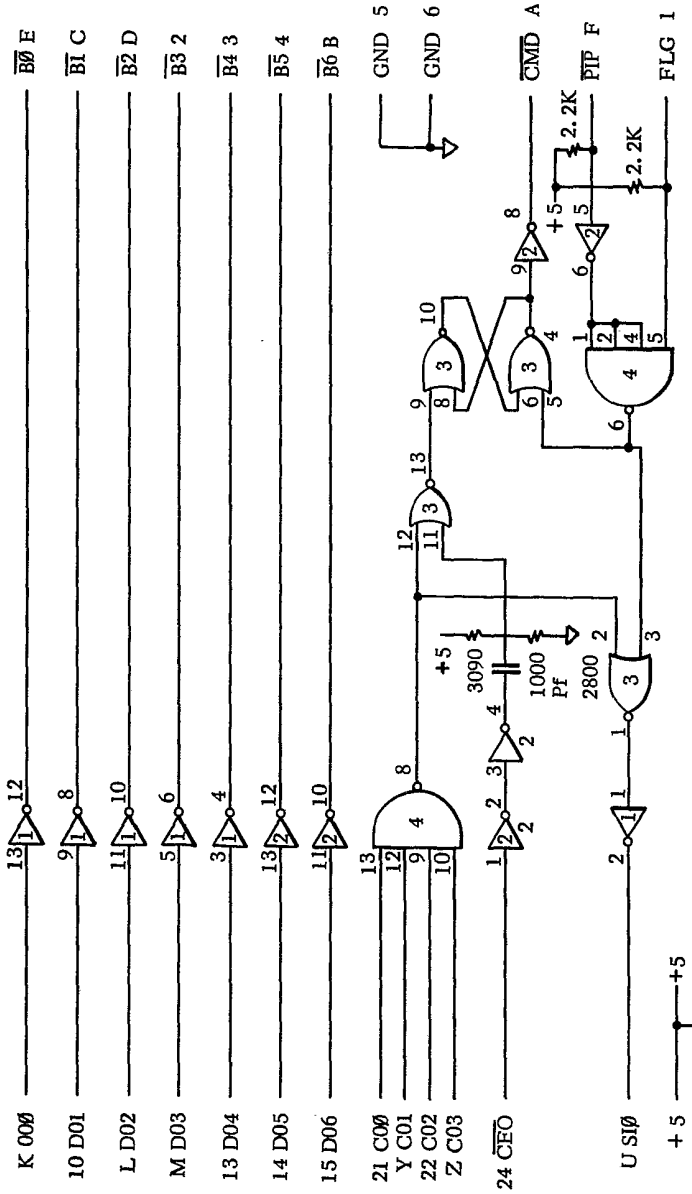

K 00
10 D01
L D02
M D03
13 D04
14 D05
15 D06
21 C00
Y C01
22 C02
Z C03
24 CEO
U SIO
+5
GND
0.01
3090
1000 Pf
2800
2.2K
2.2K
GND 5
GND 6
CMD A
PIP F
FLG 1

FIG 60

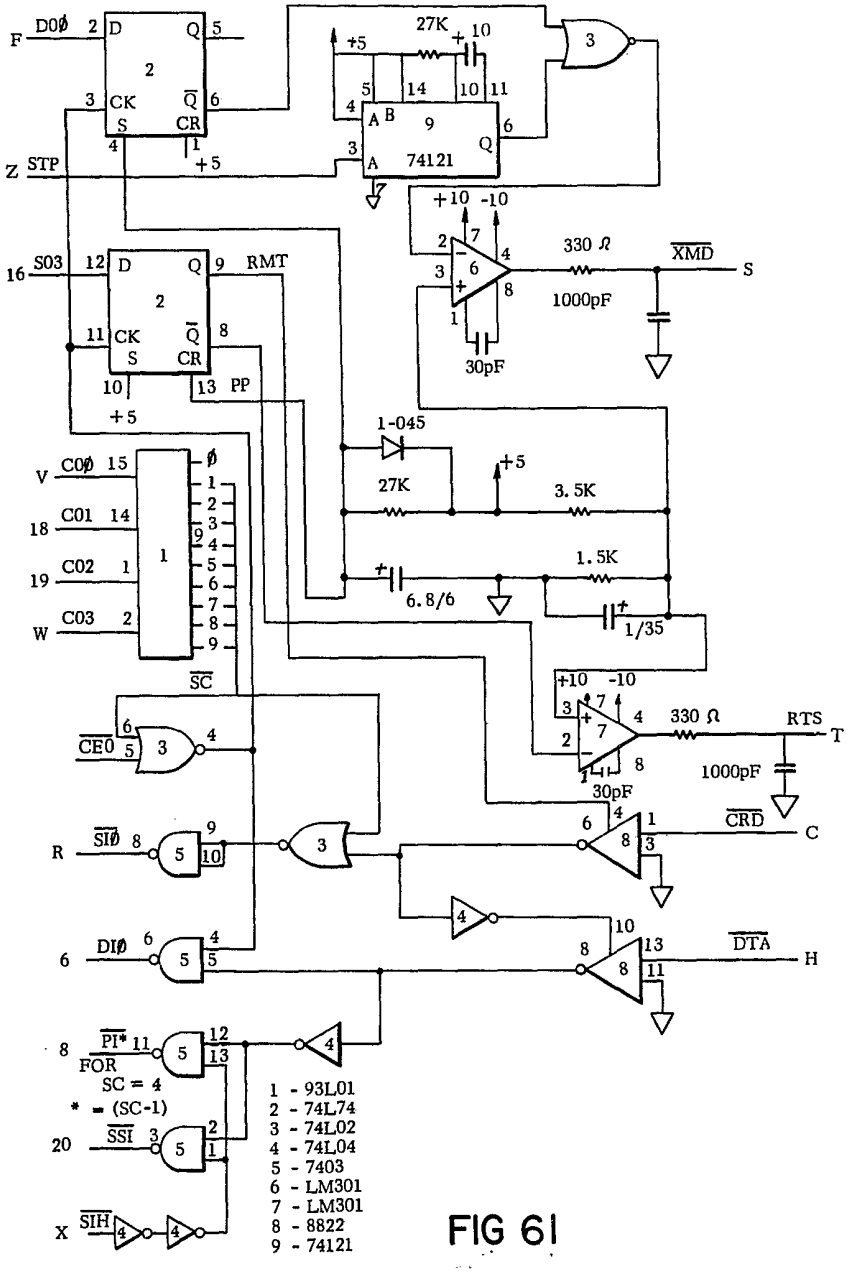

F
DØ
Z STP
16 S03
V C0Ø 15
18 C01 14
19 C02 1
W C03 2
R SIØ 8
6 DIØ
8 PI* FOR SC = 4 * = (SC-1)
20 SSI
X SIH
27K
+5
+10 -10
330 Ω
1000pF
30pF
XMD
S
RMT
PP
1-045
3.5K
1.5K
6.8/6
1/35
SC
CE0
RTS
T
CRD
C
DTA
H
1 - 93L01
2 - 74L74
3 - 74L02
4 - 74L04
5 - 7403
6 - LM301
7 - LM301
8 - 8822
9 - 74121

FIG 61

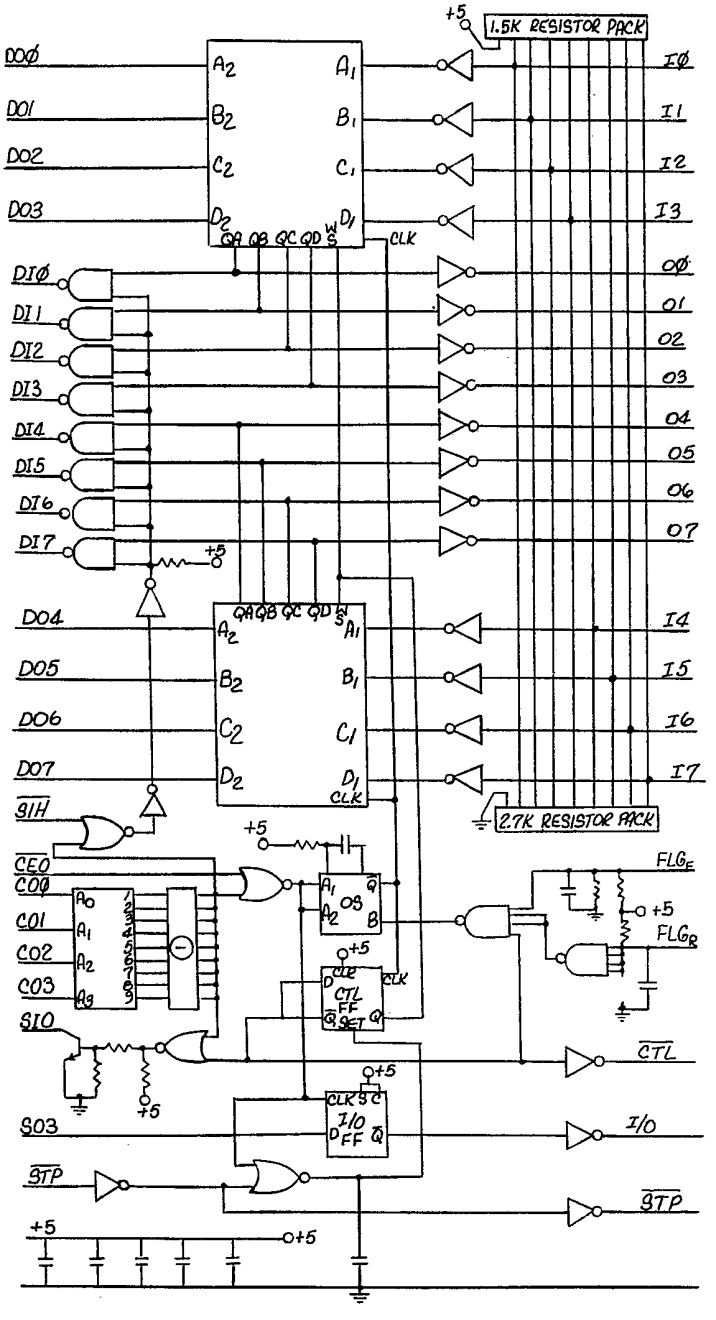

+5
1.5K RESISTOR PACK
DOØ
DO1
DO2
DO3
A2
B2
C2
D2
A1
B1
C1
D1
QA QB QC QD
W
S
CLK
IØ
I1
I2
I3
DIØ
DI1
DI2
DI3
DI4
DI5
DI6
DI7
ØØ
Ø1
Ø2
Ø3
Ø4
Ø5
Ø6
Ø7
DO4
DO5
DO6
DO7
I4
I5
I6
I7
2.7K RESISTOR PACK
GIH
CEO
COØ
CO1
CO2
CO3
SIO
SO3
GTP
FLGF
FLGR
CTL
I/O
CLR
CTL FF
SET
CLK
S C
I/O FF

FIG 62

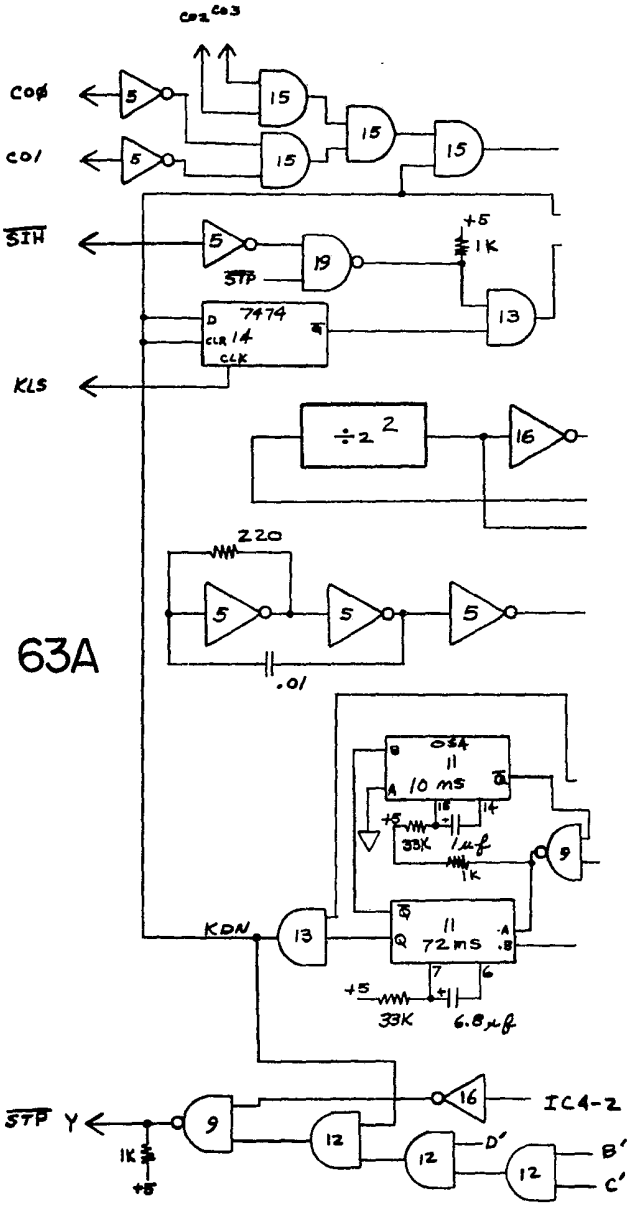

CO2 CO3
CO0
CO1
SIH
STP
KLS
7474
D
CLR 14
CLK
Q
+5
1K
÷2 2
220
.01
0S4
A 10 ms
33K
1μf
1K
KDN
Q 72ms
6.8μf
STP Y
IC4-2
D'
B'
C'

FIG. 63A

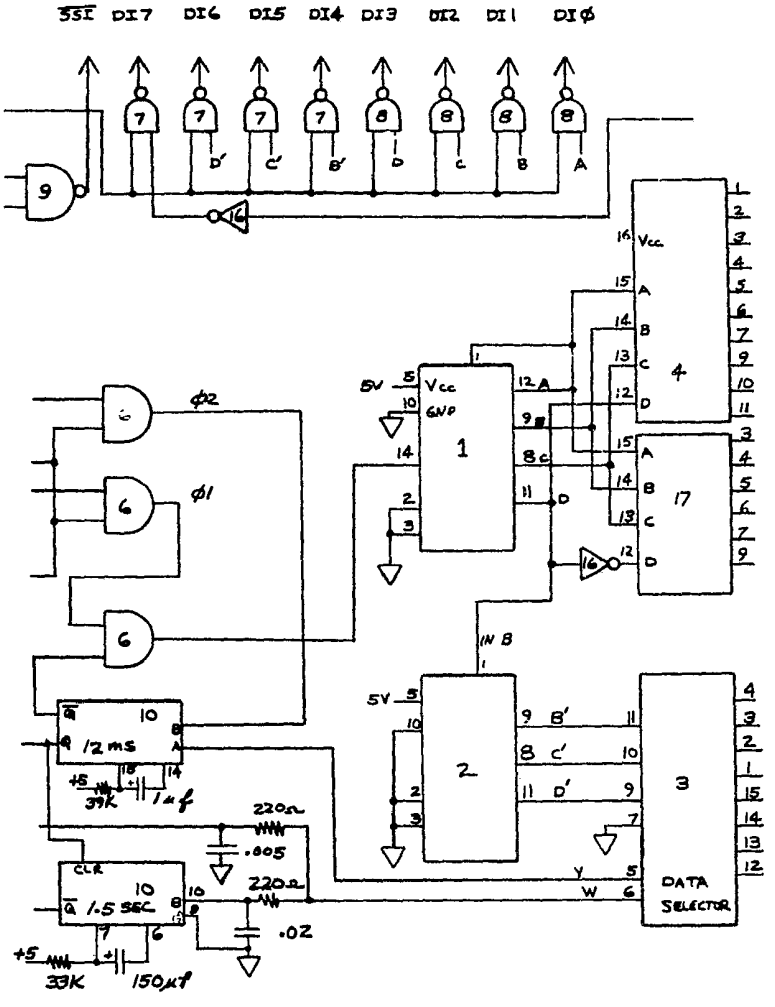

SSI DI7 DI6 DI5 DI4 DI3 DI2 DI1 DIØ
7
8
9
16
D' C' B' D C B A
Vcc
GND
5V
1
2
3
4
17
DATA SELECTOR
IN B
ØI
Ø2
12 ms
39K
1 µf
220Ω
.005
.02
1.5 SEC
33K
150µf
+5

FIG. 63B

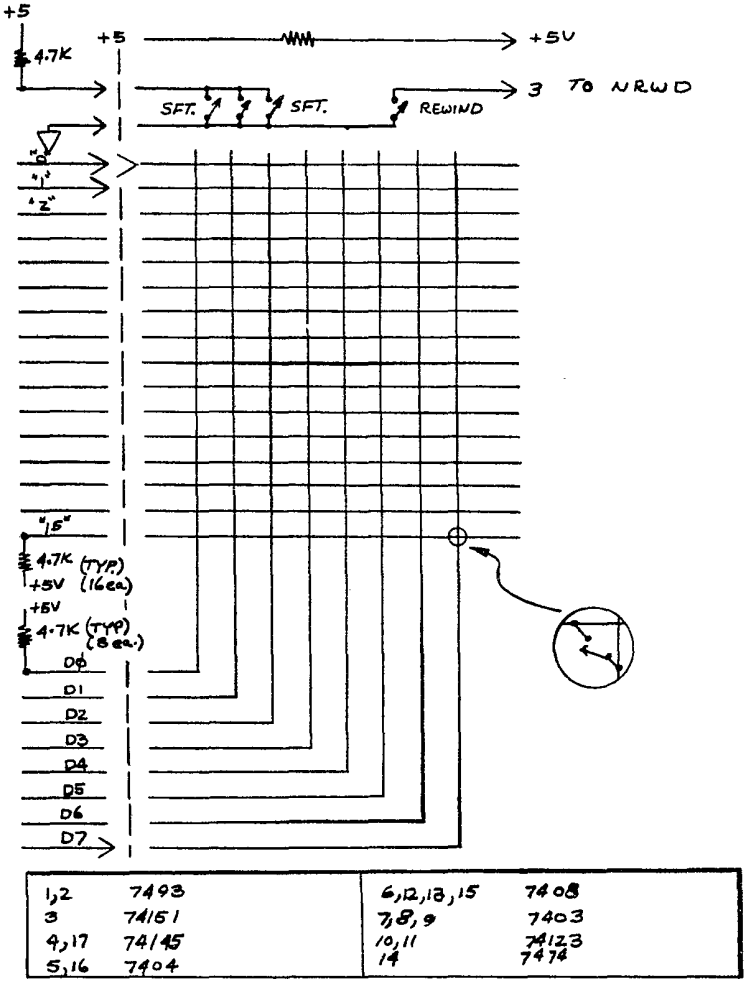

+5
+5
4.7K
+5V
SFT.
SFT.
REWIND
3 TO NRWD
"0"
"1"
"2"
"15"
4.7K (TYP) (16ea)
+5V
+5V
4.7K (TYP) (8ea.)
D0
D1
D2
D3
D4
D5
D6
D7
1,2 7493
3 74151
4,17 74145
5,16 7404
6,12,18,15 7408
7,8,9 7403
10,11 74123
14 7474

FIG. 63C

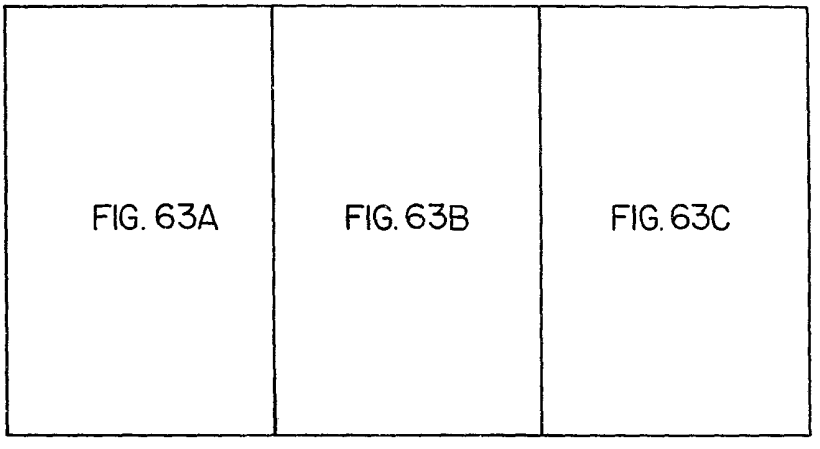


FIG. 63'

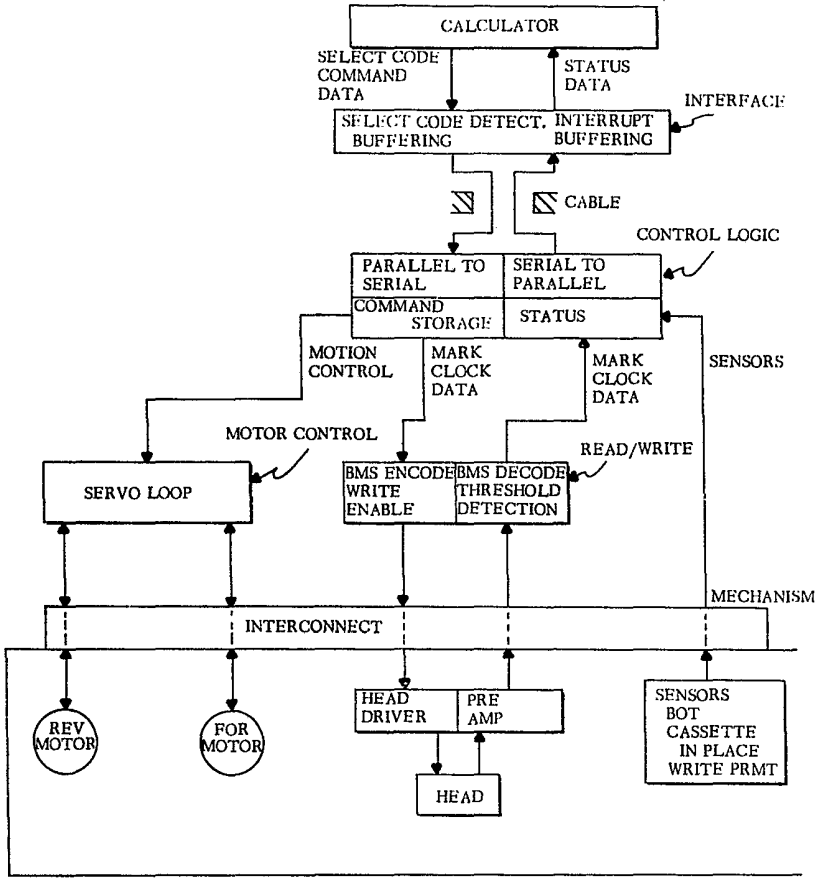

CALCULATOR
SELECT CODE COMMAND DATA
STATUS DATA
INTERFACE
SELECT CODE DETECT, BUFFERING
INTERRUPT BUFFERING
CABLE
CONTROL LOGIC
PARALLEL TO SERIAL
SERIAL TO PARALLEL
COMMAND STORAGE
STATUS
MOTION CONTROL
MARK CLOCK DATA
MARK CLOCK DATA
SENSORS
MOTOR CONTROL
READ/WRITE
SERVO LOOP
BMS ENCODE WRITE ENABLE
BMS DECODE THRESHOLD DETECTION
MECHANISM
INTERCONNECT
REV MOTOR
FOR MOTOR
HEAD DRIVER
PRE AMP
HEAD
SENSORS BOT CASSETTE IN PLACE WRITE PRMT

FIG 64

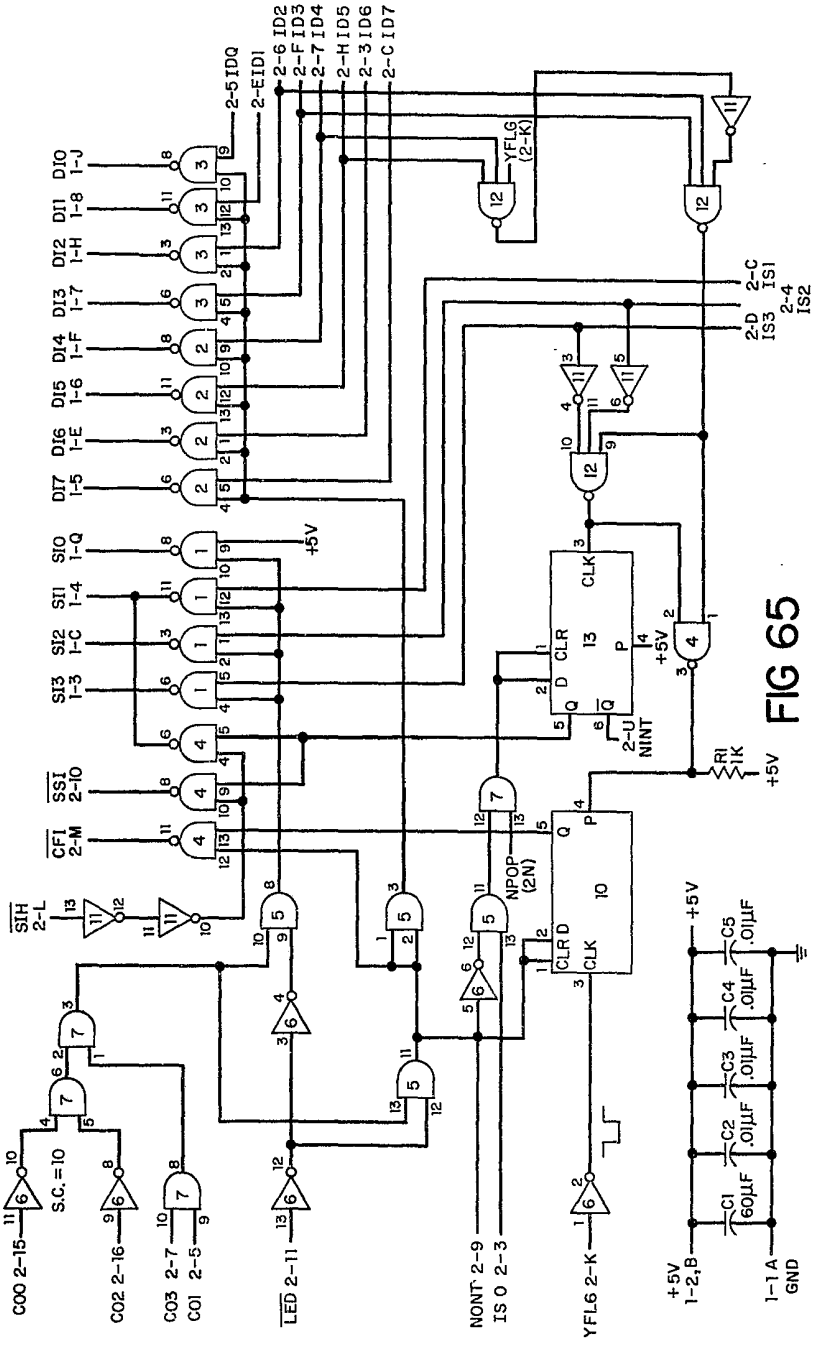

DI0 1-J
DI1 1-8
DI2 1-H
DI3 1-7
DI4 1-F
DI5 1-6
DI6 1-E
DI7 1-5
SI0 1-Q
SI1 1-4
SI2 1-C
SI3 1-3
SSI 2-10
CFI 2-M
SIH 2-L
2-5 IDQ
2-E ID1
2-6 ID2
2-F ID3
2-7 ID4
2-H ID5
2-3 ID6
2-C ID7
YFLG (2-K)
+5V
2-C IS1
2-D IS3
2-4 IS2
CLK
CLR
D
Q
P
2-U NINT
RI 1K
NPOP (2N)
CLR D
CLK
S.C.=10
CO0 2-15
CO2 2-16
CO3 2-7
CO1 2-5
LED 2-11
NONT 2-9
IS 0 2-3
YFL6 2-K
C1 60µF
C2 .01µF
C3 .01µF
C4 .01µF
C5 .01µF
+5V 1-2,B
1-1 A GND

FIG 65

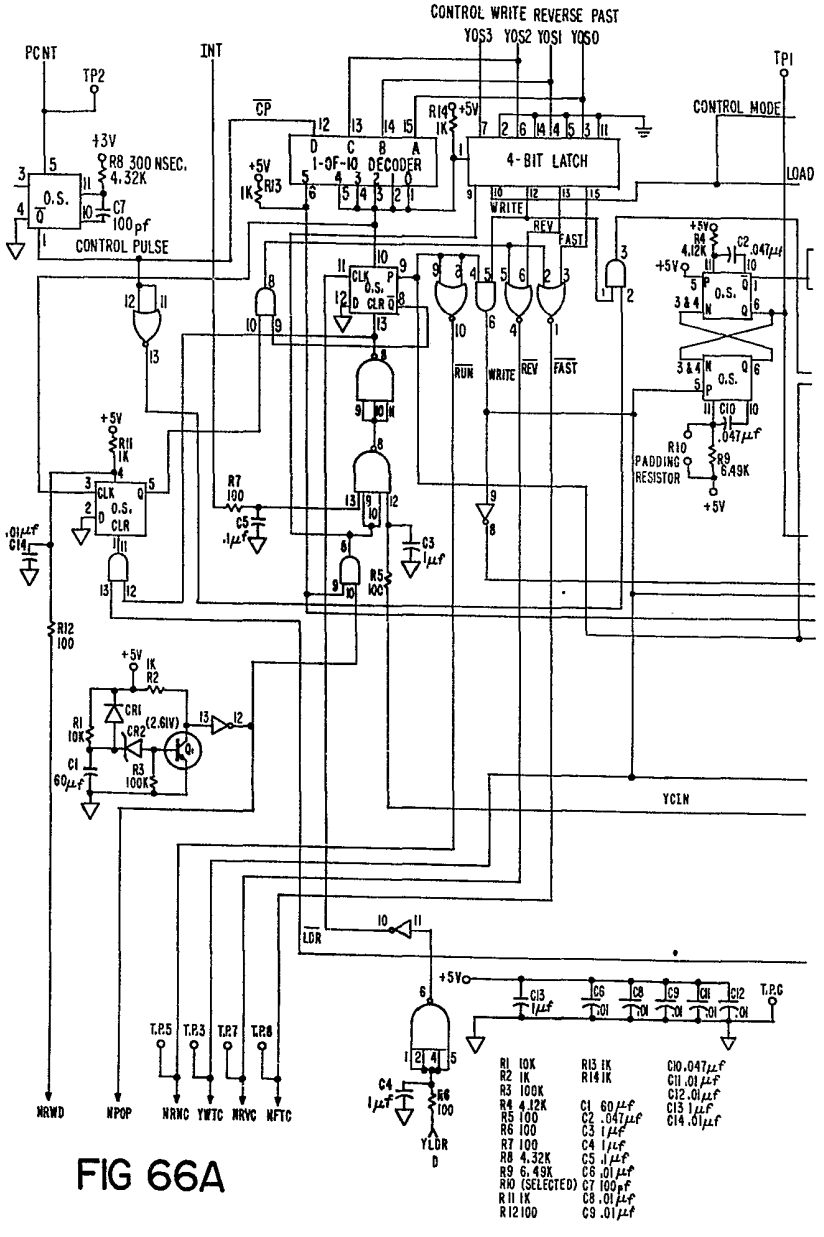

CONTROL WRITE REVERSE PAST
YOS3 YOS2 YOS1 YOS0
PCNT
TP2
INT
TP1
CONTROL MODE
LOAD
4-BIT LATCH
1-OF-10 DECODER
CONTROL PULSE
WRITE
REV
FAST
RUN
PADDING RESISTOR
YCIN
LDR
NRWD
NPOP
NRNC
YWTC
NRYC
NFTC
YLDR
T.P.5
T.P.3
T.P.7
T.P.8
T.P.C

FIG 66A

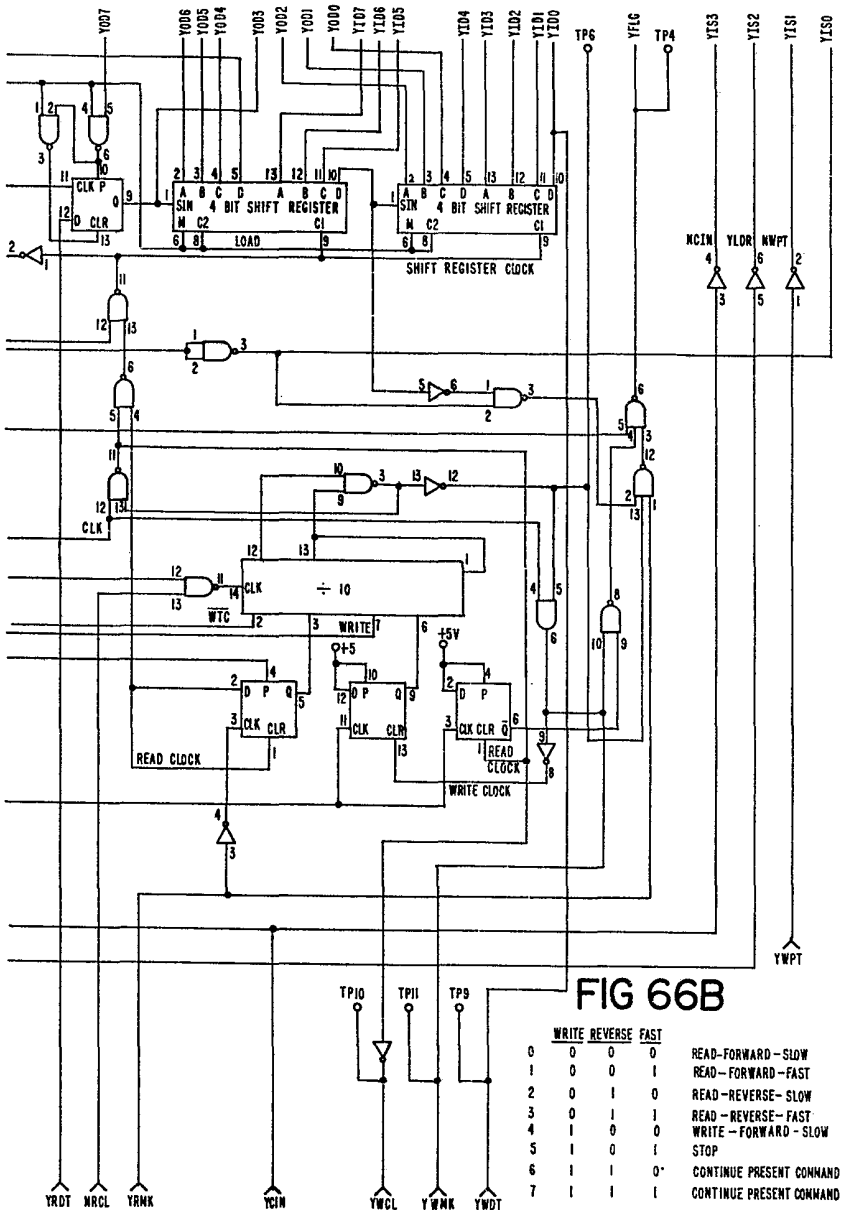


FIG 66B

	WRITE	REVERSE	FAST	
0	0	0	0	READ-FORWARD-SLOW
1	0	0	1	READ-FORWARD-FAST
2	0	1	0	READ-REVERSE-SLOW
3	0	1	1	READ-REVERSE-FAST
4	1	0	0	WRITE-FORWARD-SLOW
5	1	0	1	STOP
6	1	1	0	CONTINUE PRESENT COMMAND
7	1	1	1	CONTINUE PRESENT COMMAND

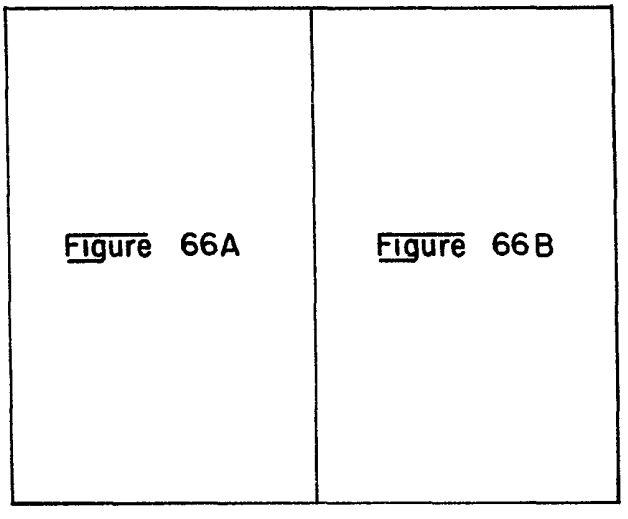


Figure 66'

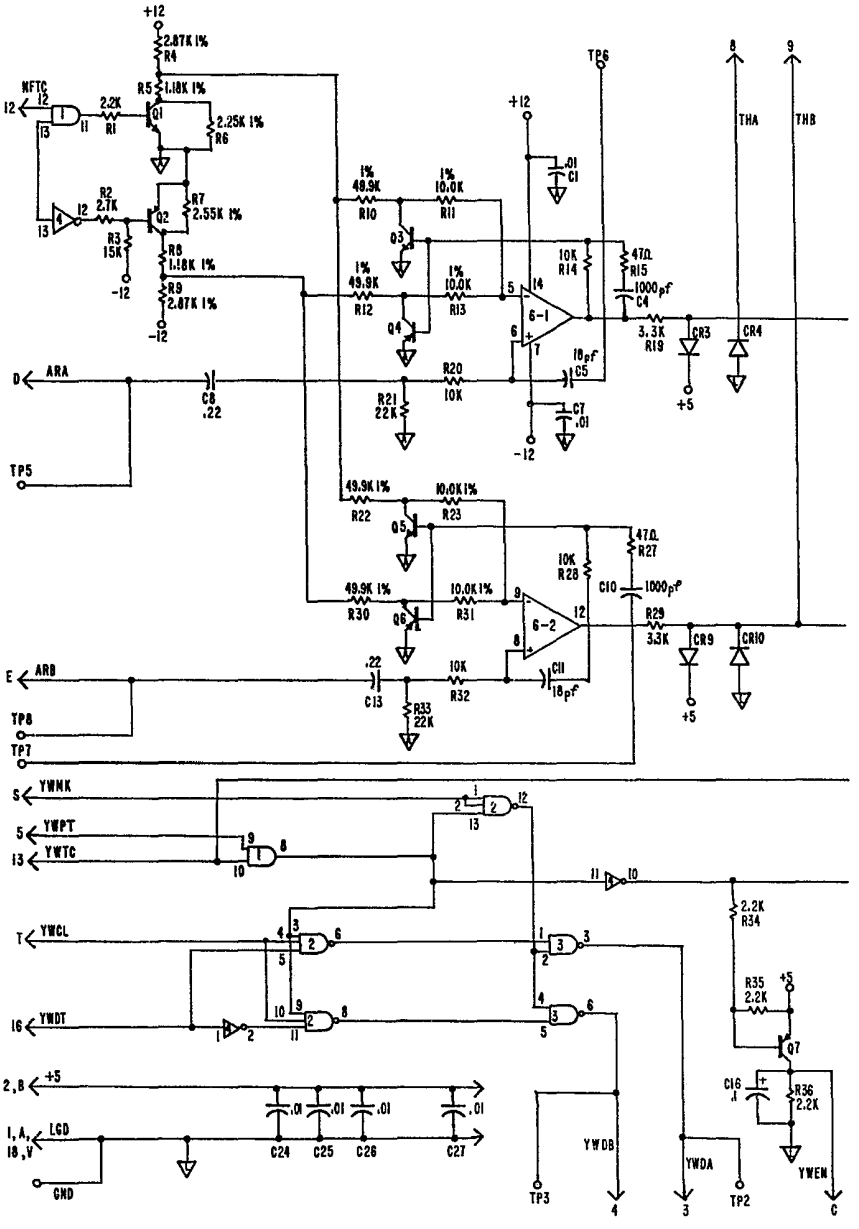

+12
2.87K 1%
R4
R5 1.18K 1%
NFTC
2.2K
R1
Q1
2.25K 1%
R6
R2 2.7K
Q2
R7 2.55K 1%
R3 15K
-12
R8 1.18K 1%
R9 2.87K 1%
1% 49.9K R10
1% 10.0K R11
Q3
1% 49.9K R12
1% 10.0K R13
Q4
.01 C1
10K R14
47Ω R15
1000pf C4
6-1
3.3K R19
CR3
CR4
+5
18pf C5
R20 10K
R21 22K
C7 .01
ARA
C6 .22
TP5
49.9K 1% R22
10.0K 1% R23
Q5
47Ω R27
10K R28
C10 1000pf
49.9K 1% R30
10.0K 1% R31
Q6
6-2
R29 3.3K
CR9
CR10
ARB
.22 C13
10K R32
C11 18pf
R33 22K
TP8
TP7
TP6
THA
THB
YWMK
YWPT
YWTC
YWCL
YWDT
2.2K R34
R35 2.2K
Q7
C16 .1
R36 2.2K
2,B
1,A,18,V
LGD
GND
C24 .01
C25 .01
C26 .01
C27 .01
YWDB
YWDA
YWEN
TP3
TP2

FIG 67A

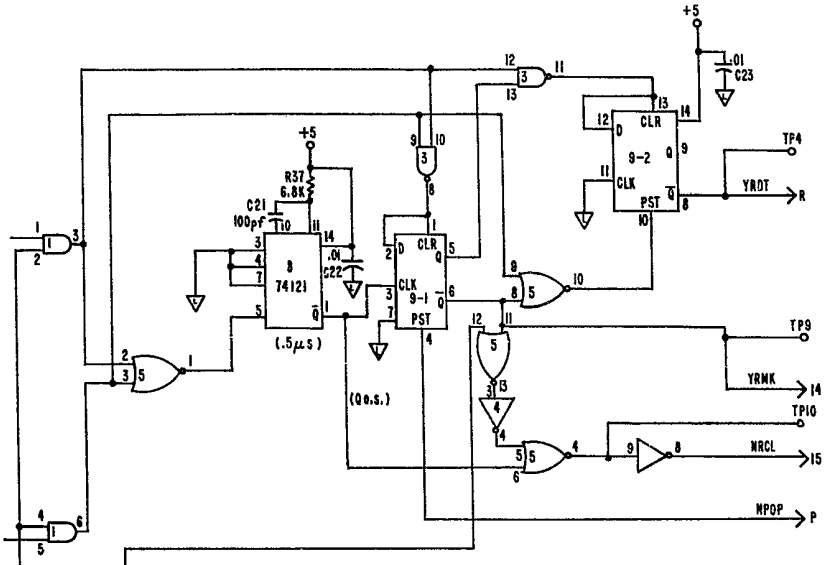
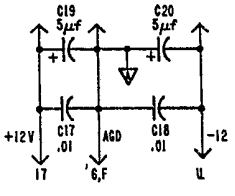


FIG 67B

DESIGNATORS USED: R1-R37, EXC. R16-18, R24-26
Q1-Q7
C1-C27, EXC. C6, 12, 14, 15, 2, 3, 9
CR3, 4, 9, 10

RESISTORS 1/4 WATT 10% UNLESS NOTED
DIODES 1901-0040
NPN: 1854-0071
PNP: 1853-0020



9	1	SN7474N
8	1	SN74121
6	1	MC1437
5	1	SN7402
4	1	SN7404N
3	1	SN7400N
2	1	SN7410N
1	1	SN7408N

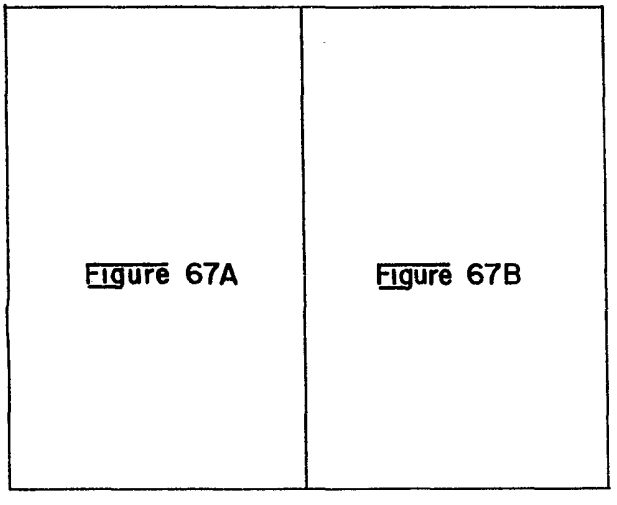


Figure 67'

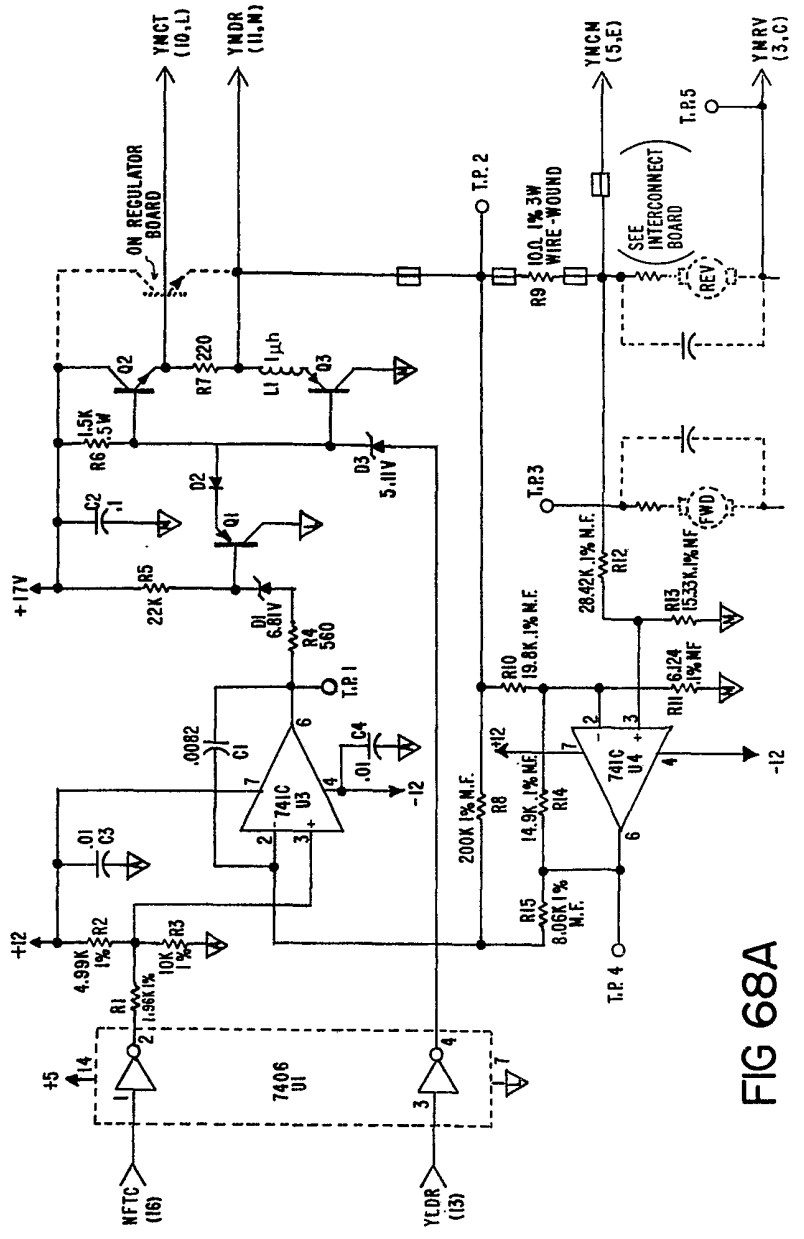

YMCT (10,L)
YMDR (11,M)
YMCM (5,E)
YMRV (3,C)
ON REGULATOR BOARD
T.P.2
T.P.5
SEE INTERCONNECT BOARD
REV
FWD
R9 10.0 1% 3W WIRE-WOUND
Q2
R7 220
L1 1μh
Q3
R6 1.5K 5W
D3 5.1IV
D2
Q1
C2 .1
+17V
R5 22K
D1 6.8IV
R4 560
T.P.1
T.P.3
R12 28.42K 1% M.F.
R13 15.33K 1% MF
R10 19.8K 1% M.F.
R11 6.124 1% MF
C1 .0082
C4 .01
741C U3
741C U4
-12
R8 200K 1% M.F.
R14 14.9K 1% MF
C3 .01
+12
R2 4.99K 1%
R3 10K 1%
R1 1.96K 1%
R15 8.06K 1% M.F.
T.P.4
+5
7406 U1
NFTC (16)
YEDR (13)

FIG 68A

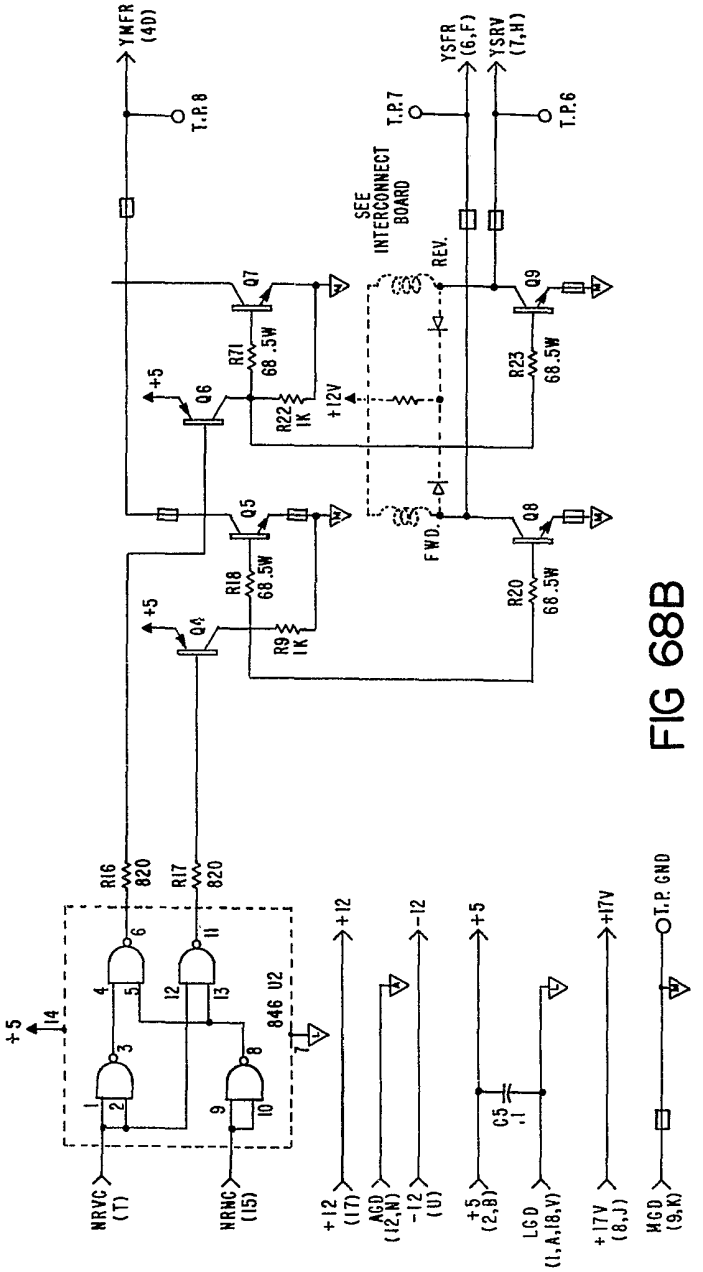

YMFR (4D)
T.P.8
T.P.7
YSFR (6,F)
YSRV (7,H)
T.P.6
SEE INTERCONNECT BOARD
REV.
FWD.
Q7
Q9
Q5
Q8
Q6
Q4
R71 68.5W
R23 68.5W
R18 68.5W
R20 68.5W
R22 1K
R9 1K
+12V
+5
R16 820
R17 820
846 U2
NRVC (T)
NRNC (15)
+12 (17)
AGD (12,N)
-12 (U)
+5 (2,B)
C5 .1
LGD (1,A,18,V)
+17V (8,J)
T.P. GND
MGD (9,K)

FIG 68B

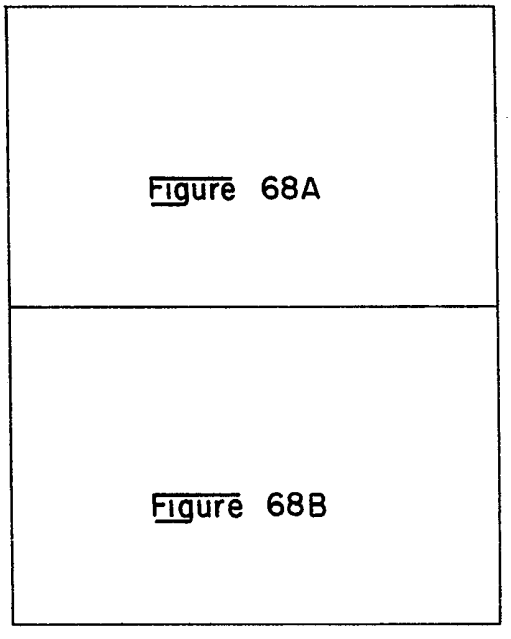


Figure 68'

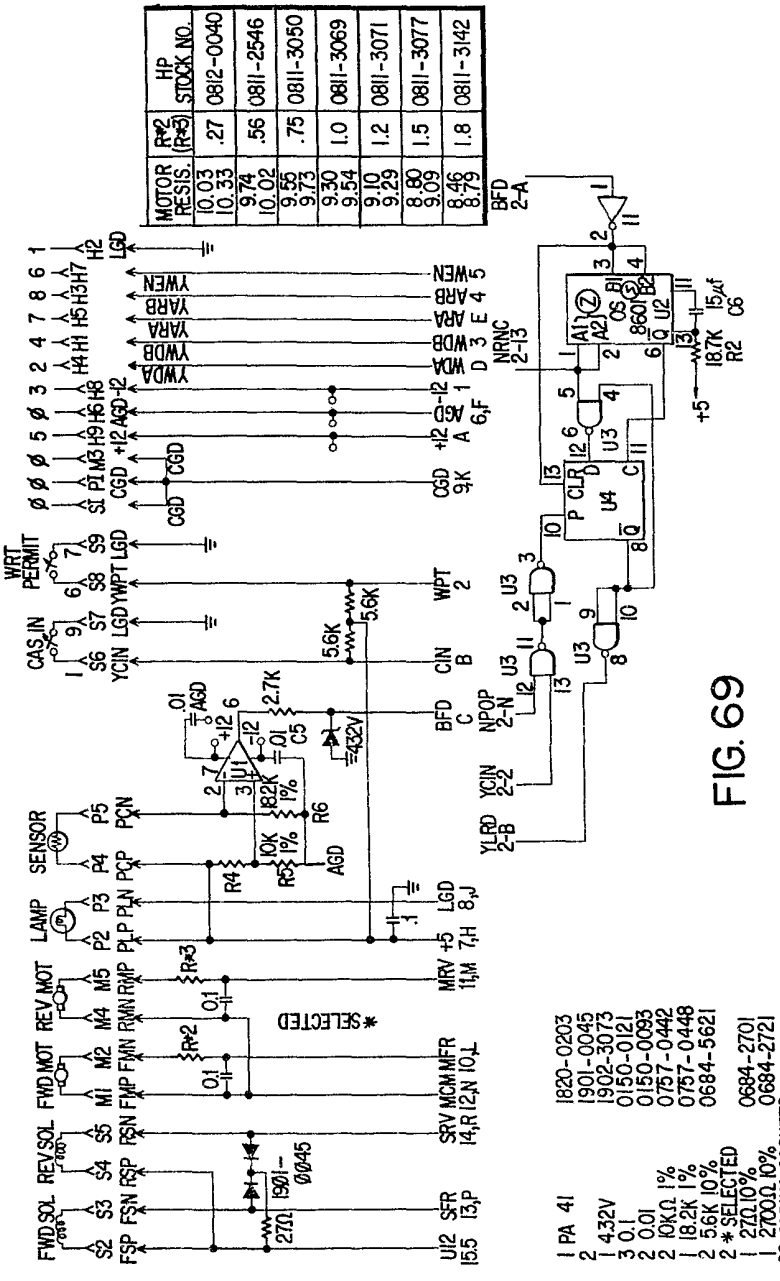

MOTOR RESIS.
R#2 (R#3)
HP STOCK NO.
10.03 10.33 .27 0812-0040
9.74 10.02 .56 0811-2546
9.55 9.73 .75 0811-3050
9.30 9.54 1.0 0811-3069
9.10 9.29 1.2 0811-3071
8.80 9.09 1.5 0811-3077
8.46 8.79 1.8 0811-3142
BFD 2-A
WRT PERMIT
CAS IN
SENSOR
LAMP
REV MOT
FWD MOT
REV SOL
FWD SOL
*SELECTED
1 PA 41
2 1 4.32V
3 0.1
2 0.01
2 10KΩ 1%
1 18.2K 1%
2 5.6K 10%
2 *SELECTED
1 270Ω 10%
1 2700Ω 10%
28 SPRING SOCKETS
1820-0203
1901-0045
1902-3073
0150-0121
0150-0093
0757-0442
0757-0448
0684-5621
0684-2701
0684-2721

FIG. 69

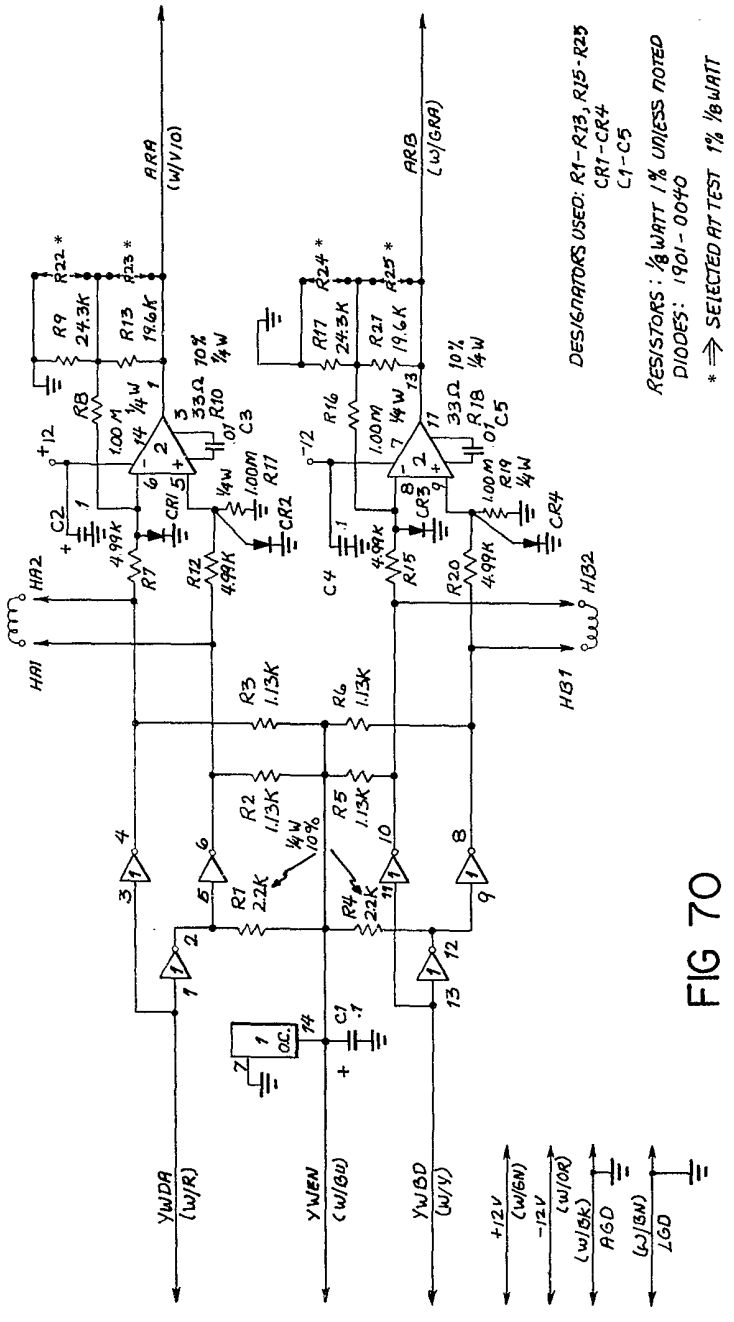

DESIGNATORS USED: R1-R13, R15-R25
CR1-CR4
C1-C5
RESISTORS: ⅛ WATT 1% UNLESS NOTED
DIODES: 1901-0040
* ⇒ SELECTED AT TEST 1% ⅛ WATT
ARA (W/V10)
ARB (W/GRA)
HA1
HA2
HB1
HB2
YWDA (W/R)
YWEN (W/BU)
YWBD (W/Y)
+12V (W/BN)
-12V (W/OR)
AGD (W/BK)
AGD
LGD (W/BN)
LGD

FIG 70

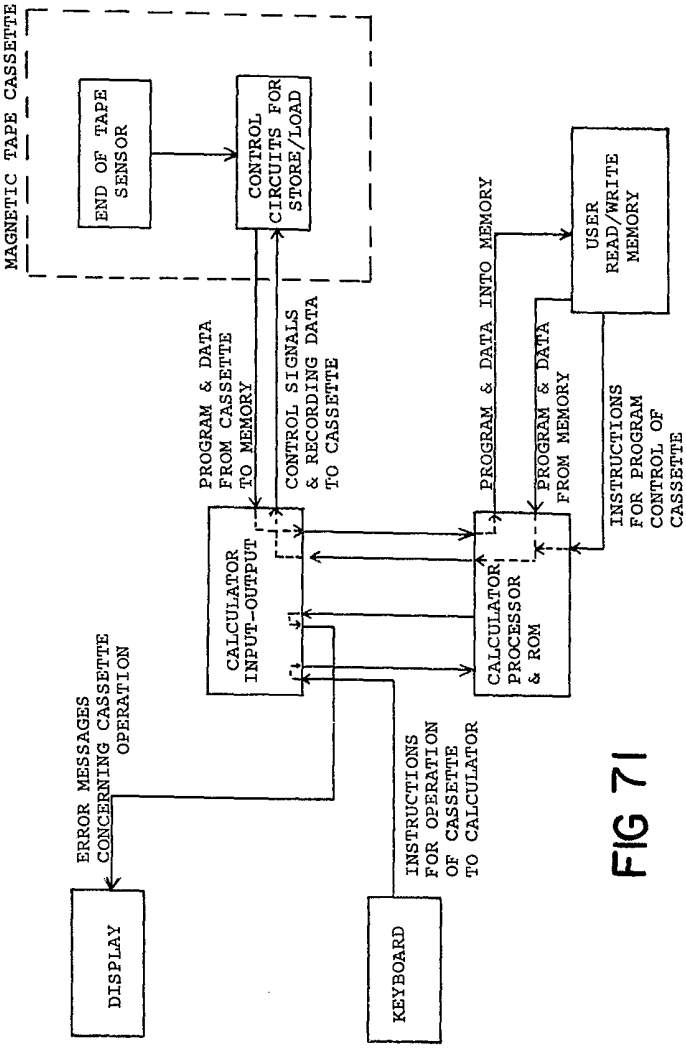

MAGNETIC TAPE CASSETTE
END OF TAPE SENSOR
CONTROL CIRCUITS FOR STORE/LOAD
PROGRAM & DATA FROM CASSETTE TO MEMORY
CONTROL SIGNALS & RECORDING DATA TO CASSETTE
PROGRAM & DATA INTO MEMORY
PROGRAM & DATA FROM MEMORY
USER READ/WRITE MEMORY
INSTRUCTIONS FOR PROGRAM CONTROL OF CASSETTE
CALCULATOR INPUT-OUTPUT
CALCULATOR PROCESSOR & ROM
ERROR MESSAGES CONCERNING CASSETTE OPERATION
INSTRUCTIONS FOR OPERATION OF CASSETTE TO CALCULATOR
DISPLAY
KEYBOARD

FIG 71

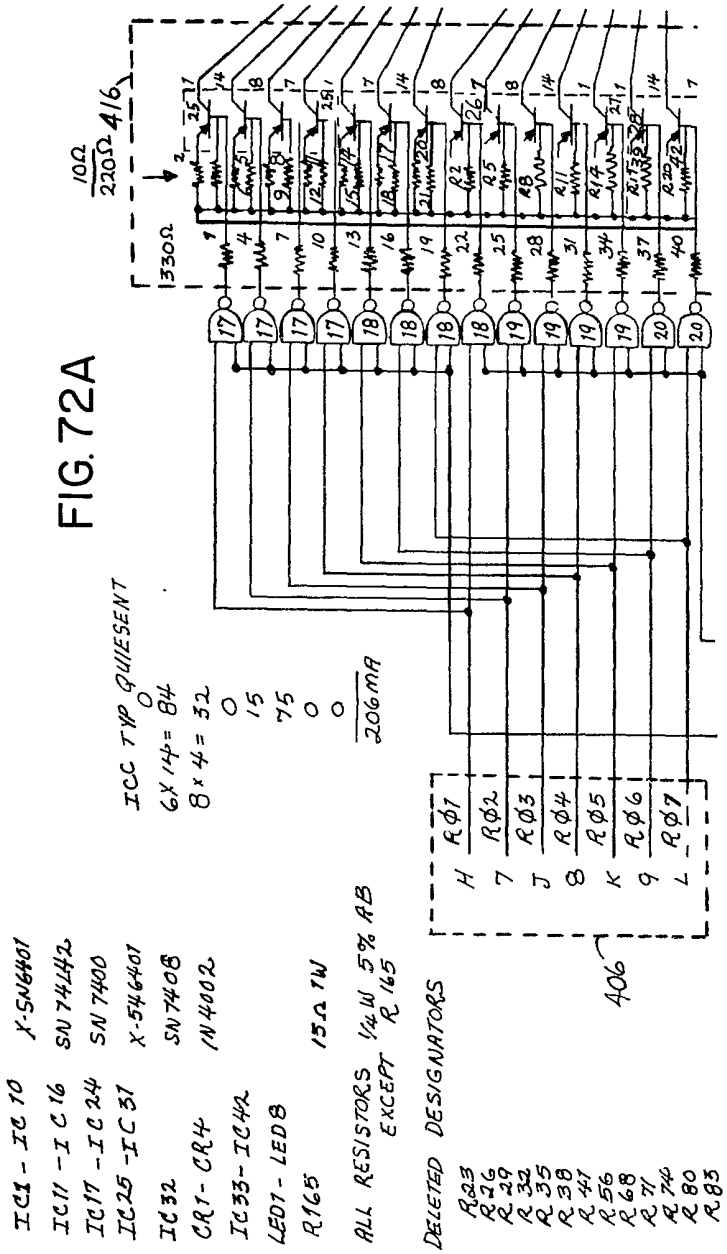
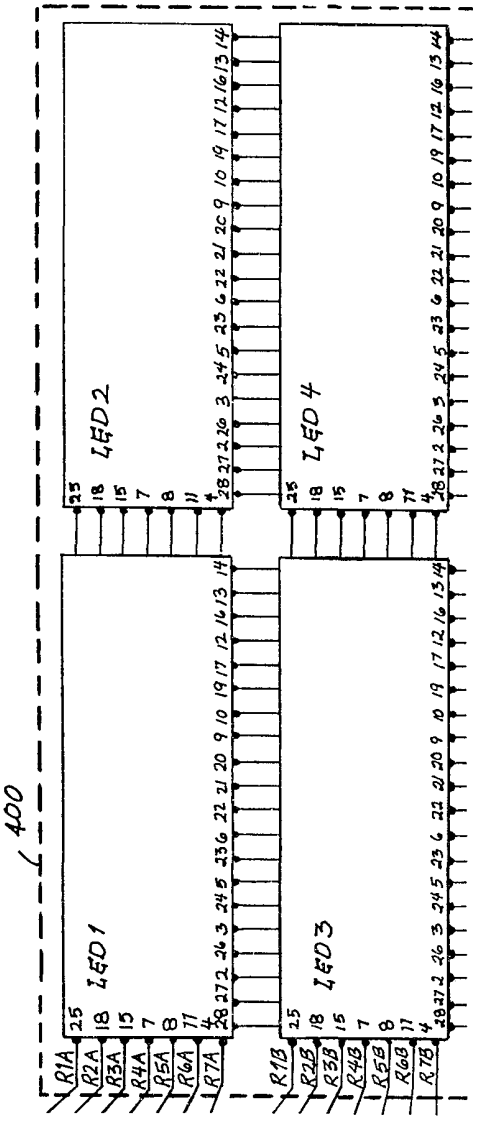

IC1 - IC 10 X-SN6401
IC11 - IC 16 SN 74L42
IC17 - IC 24 SN 7400
IC25 - IC 31 X-546401
IC 32 SN7408
CR1 - CR4 1N4002
IC33 - IC42
LED1 - LED8
R165 150Ω 1W
ALL RESISTORS 1/4W 5% AB EXCEPT R 165
DELETED DESIGNATORS
R23 R26 R29 R32 R35 R38 R41 R56 R68 R71 R74 R80 R85
ICC TYP QUIESENT
0
6X 14= 84
8 x 4 = 32
0
15
75
0
0
206 MA
1330Ω
10Ω / 220Ω 416
406
RØ1 RØ2 RØ3 RØ4 RØ5 RØ6 RØ7
H 7 J 8 K 9 L
FIG. 72A

FIG. 72B


400
LED 1
LED 2
LED 3
LED 4
R1A
R2A
R3A
R4A
R5A
R6A
R7A
R1B
R2B
R3B
R4B
R5B
R6B
R7B

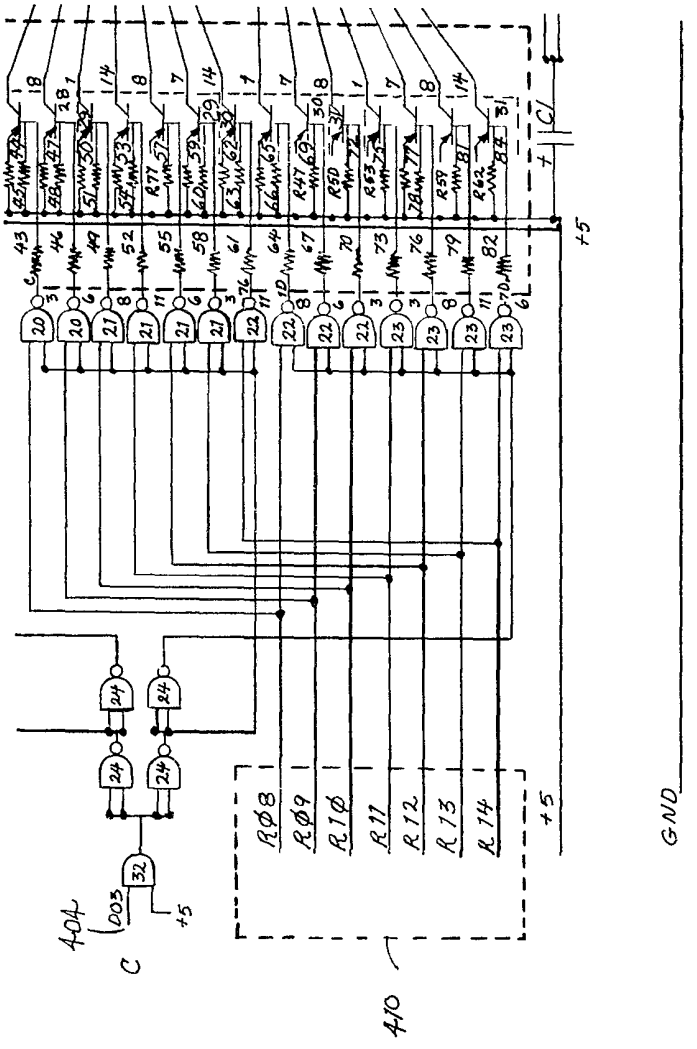
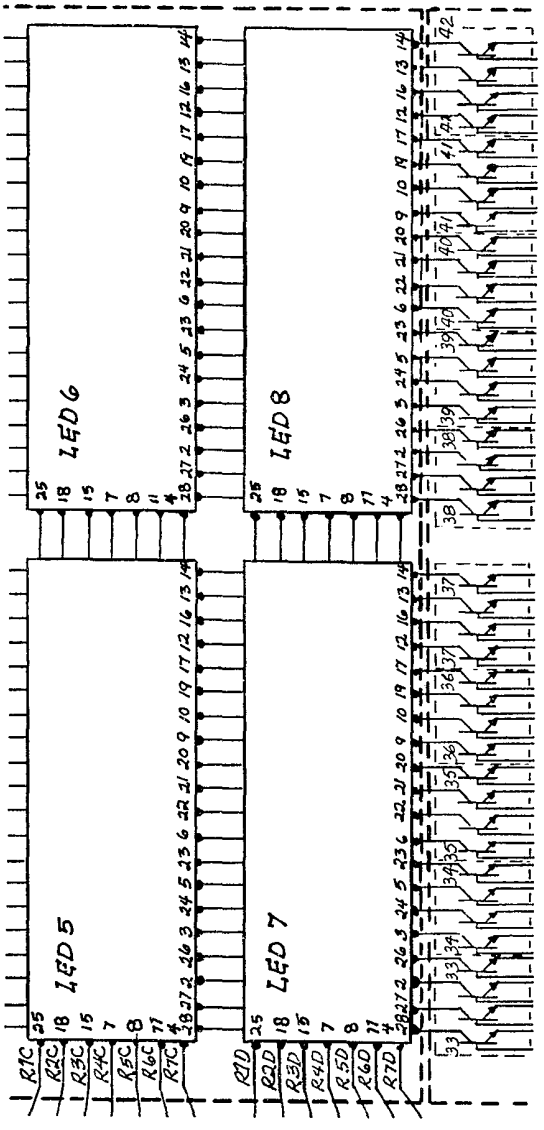


FIG. 72C

FIG. 72D


LED 6
LED 8
LED 5
LED 7
R1C
R2C
R3C
R4C
R5C
R6C
R7C
R1D
R2D
R3D
R4D
R5D
R6D
R7D

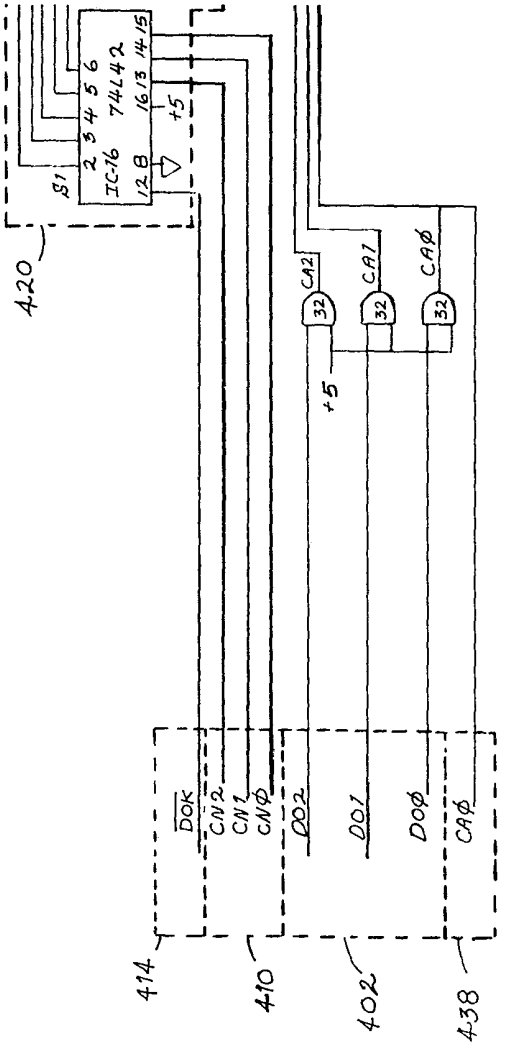

420
S1
IC-16
74L42
+5
CA2
CA1
CA0
32
DOK
CN2
CN1
CN0
DO2
DO1
DO0
CA0
414
410
402
438

FIG. 72E

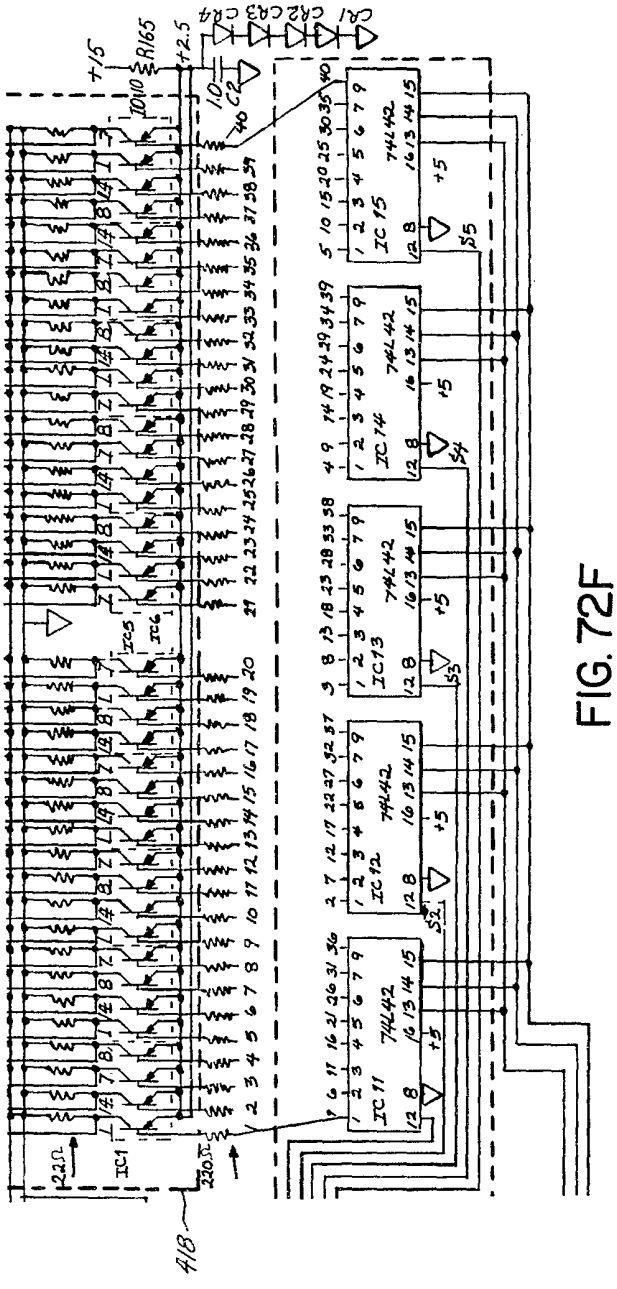


FIG. 72F

FIG. 72A	FIG. 72B
FIG. 72C	FIG. 72D
FIG. 72E	FIG. 72F

FIG. 72'

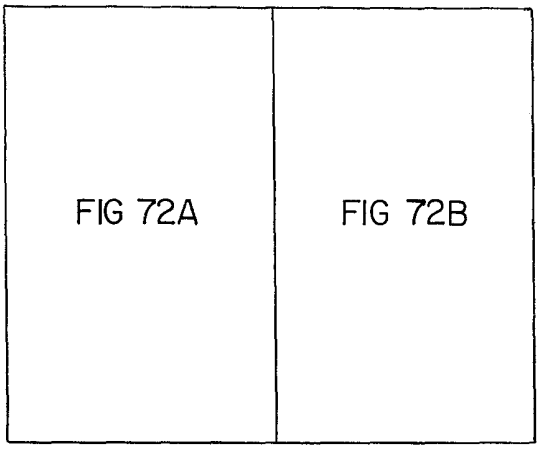


FIG 72'

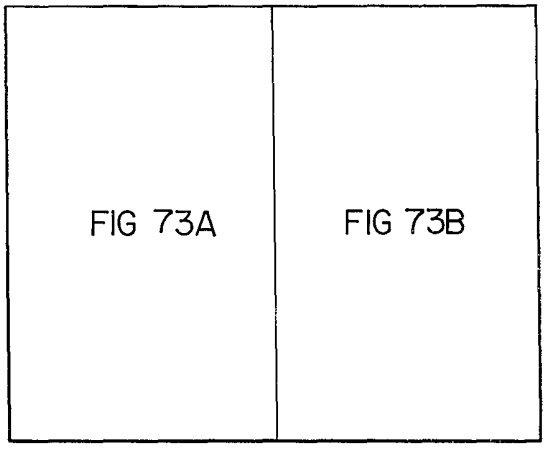


FIG 73'

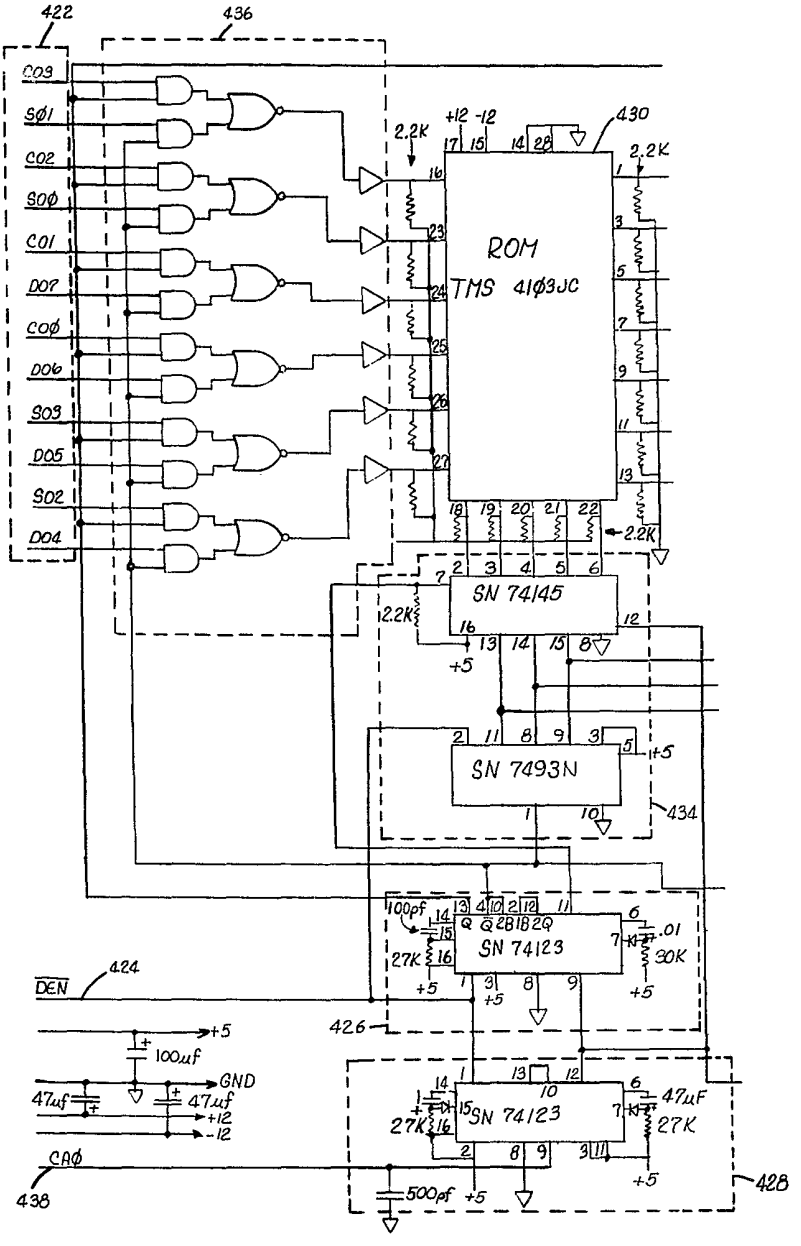
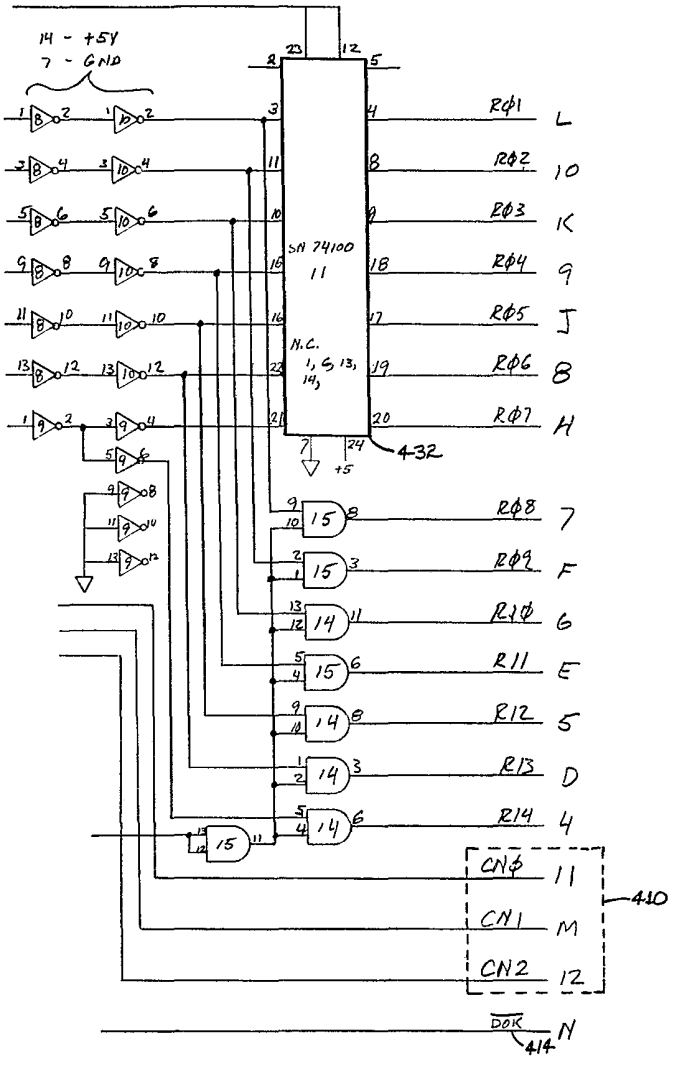

422
436
CO3
SØ1
CO2
SØØ
CO1
DO7
COØ
DO6
SØ3
DO5
SØ2
DO4
2.2K
+12 -12
430
ROM
TMS 41Ø3JC
SN 74145
SN 7493N
434
100pf
SN 74123
.01
30K
27K
DEN
424
+5
100µf
GND
47µf
+12
-12
CAØ
438
426
500pf
47µF
428

FIG 73A



IC1, IC2, IC3 SN7451
IC4 SN7407
IC8, IC9 SN74L04
IC10 1820-0174
IC14, IC15 1820-0511

FIG 73B

CALCULATOR POWER SYSTEM BLOCK DIAGRAM.

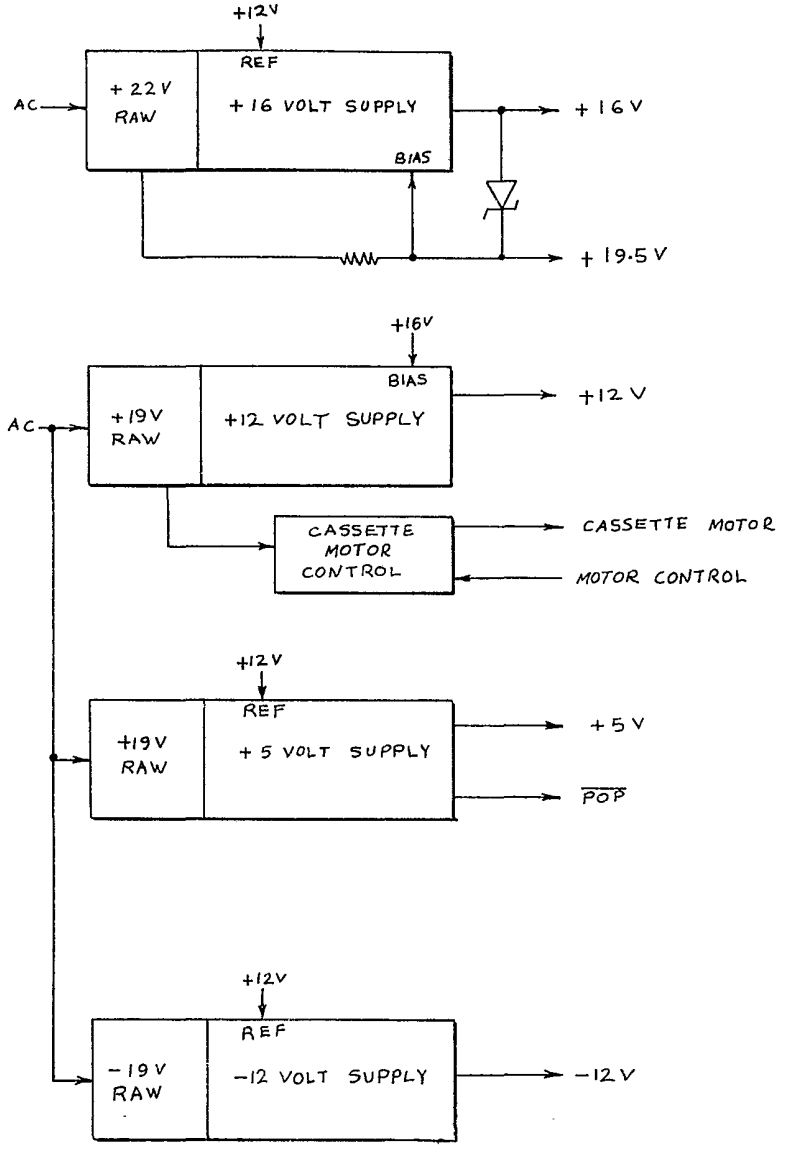


FIG 74

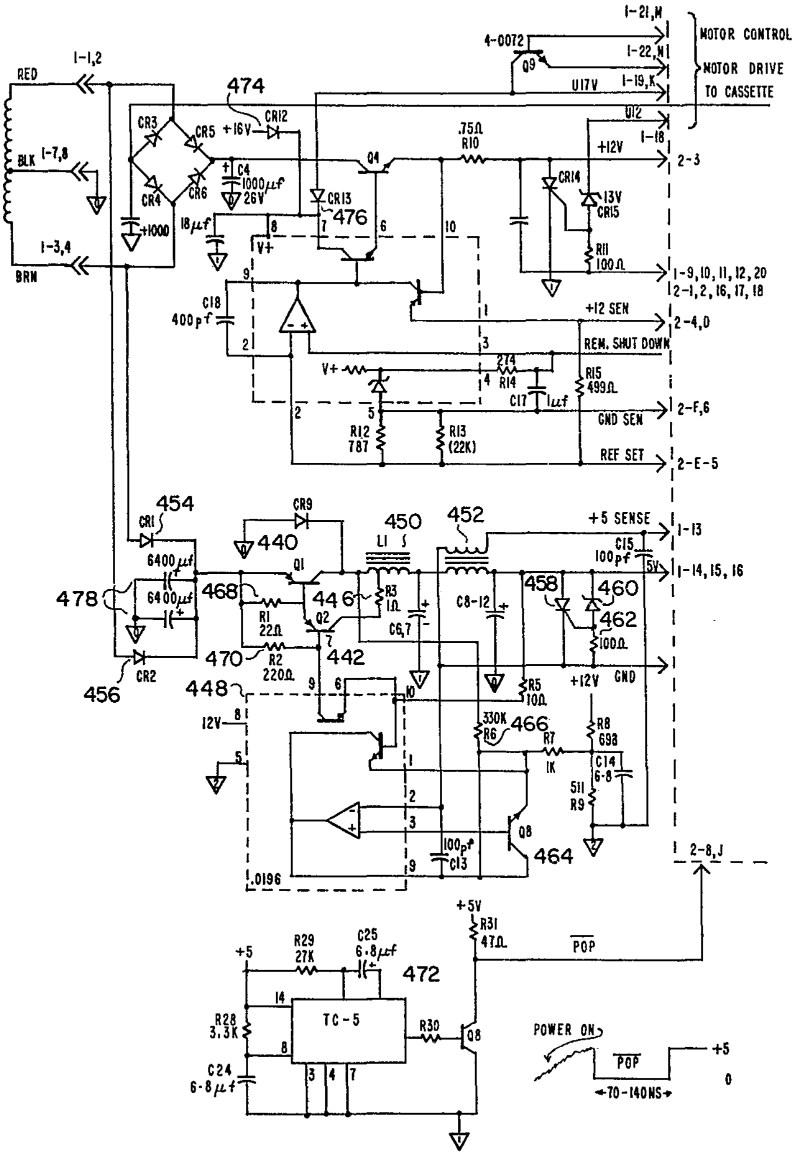

MOTOR CONTROL
MOTOR DRIVE
TO CASSETTE
RED
BLK
BRN
+5 SENSE
+12 SEN
REM. SHUT DOWN
GND SEN
REF SET
POWER ON
POP
TC-5
70-140NS

FIG 75A

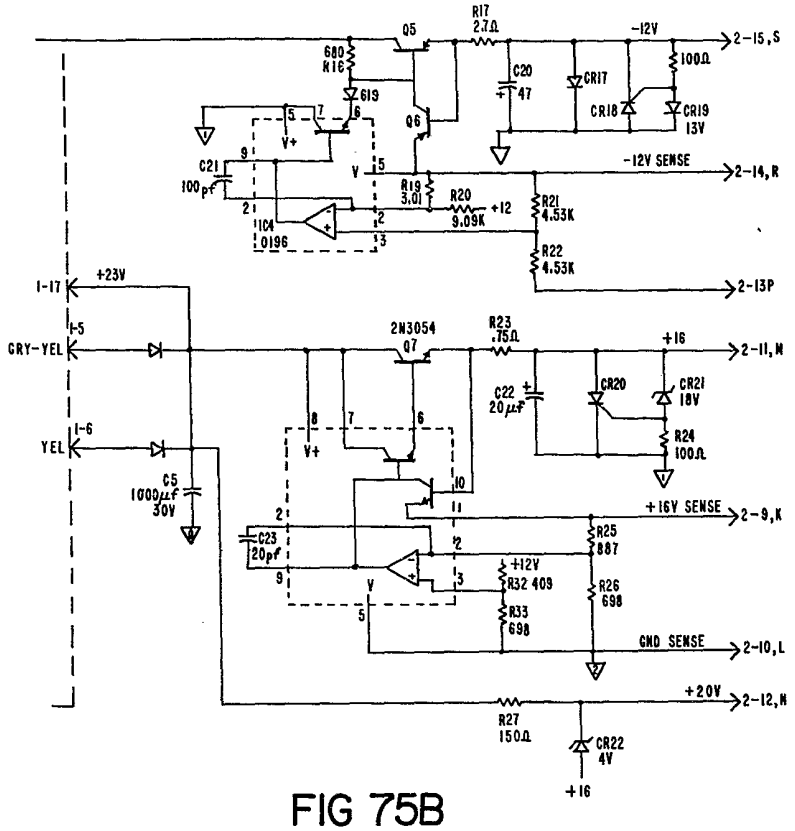

Q5
R17 2.7Ω
-12V
2-15,S
680 R16
C20 47
CR17
100Ω
619
Q6
CR18
CR19 13V
C21 100pf
-12V SENSE
2-14,R
R19 3.01
R20 9.09K
+12
R21 4.53K
IC4 0196
R22 4.53K
2-13P
I-17
+23V
I-5
GRY-YEL
2N3054
Q7
R23 .75Ω
+16
2-11,M
C22 20μF
CR20
CR21 18V
I-6
YEL
R24 100Ω
C5 1000μF 30V
+16V SENSE
2-9,K
C23 20pf
R25 887
+12V
R32 409
R26 698
R33 698
GND SENSE
2-10,L
+20V
2-12,N
R27 150Ω
CR22 4V
+16

FIG 75B

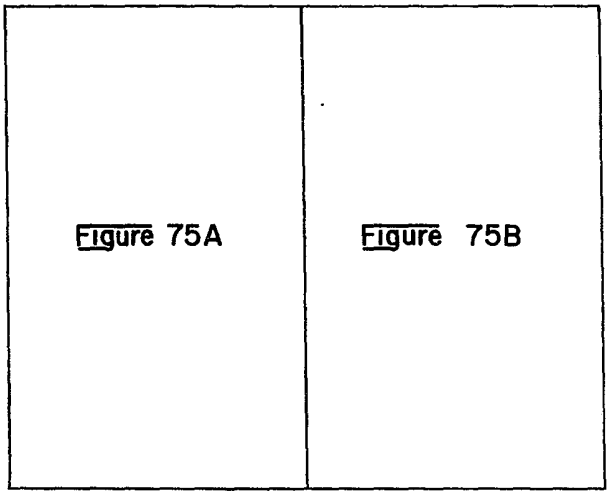


Figure 75'

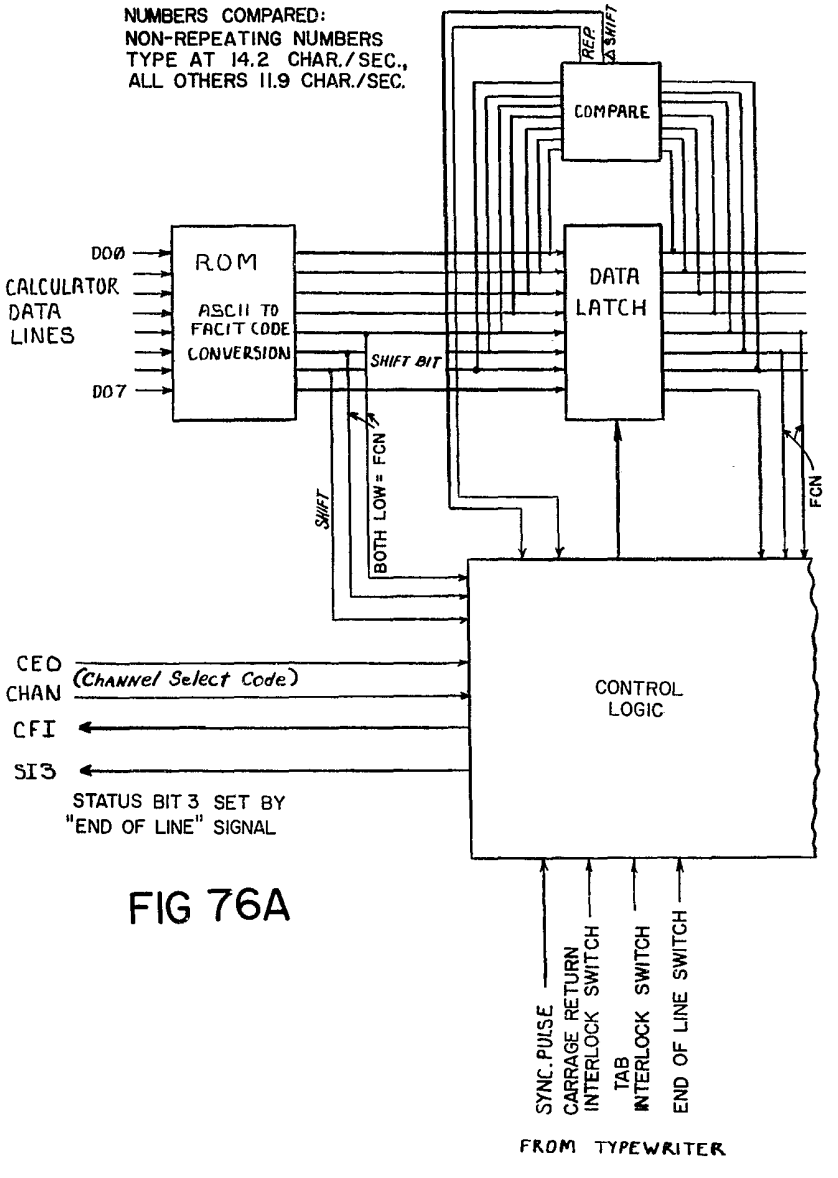
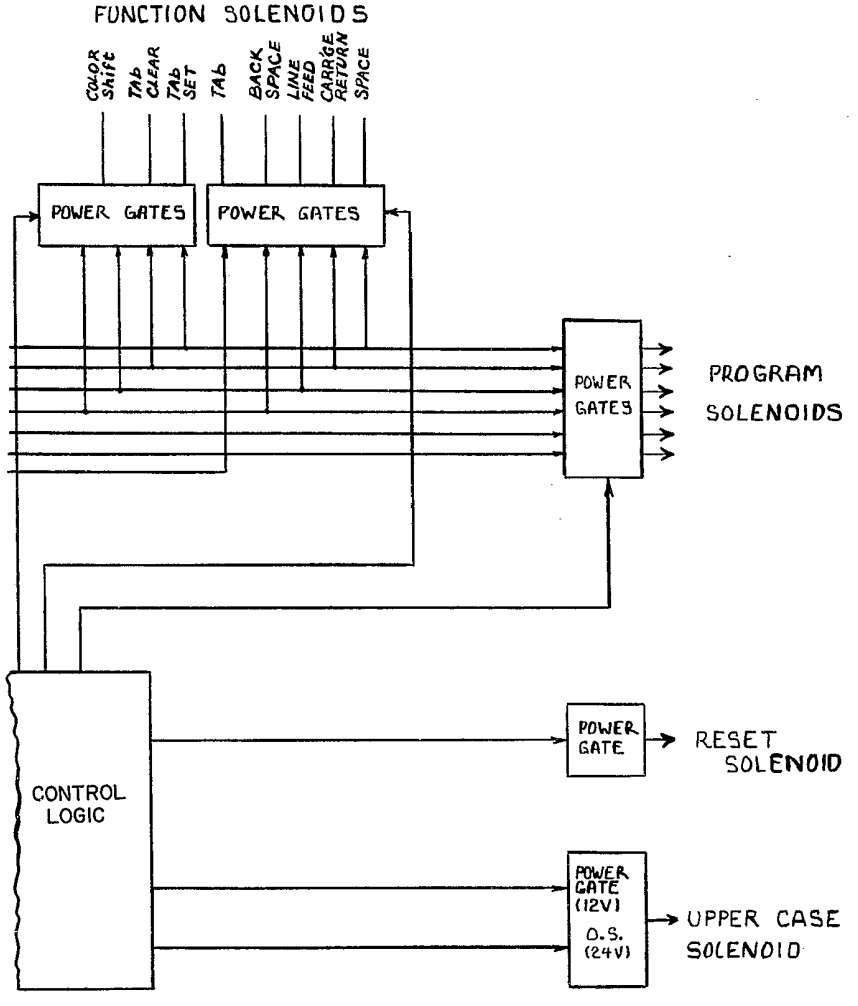

NUMBERS COMPARED:
NON-REPEATING NUMBERS
TYPE AT 14.2 CHAR./SEC.,
ALL OTHERS 11.9 CHAR./SEC.
REP
Δ SHIFT
COMPARE
DATA LATCH
ROM
ASCII TO FACIT CODE CONVERSION
D00
D07
CALCULATOR DATA LINES
SHIFT BIT
SHIFT
BOTH LOW = FCN
FCN
CE0
CHAN
(Channel Select Code)
CFI
SI3
STATUS BIT 3 SET BY "END OF LINE" SIGNAL
CONTROL LOGIC
SYNC. PULSE
CARRAGE RETURN INTERLOCK SWITCH
TAB INTERLOCK SWITCH
END OF LINE SWITCH
FROM TYPEWRITER

FIG 76A



POWER SUPPLIES: 5V, 24V

FIG 76B

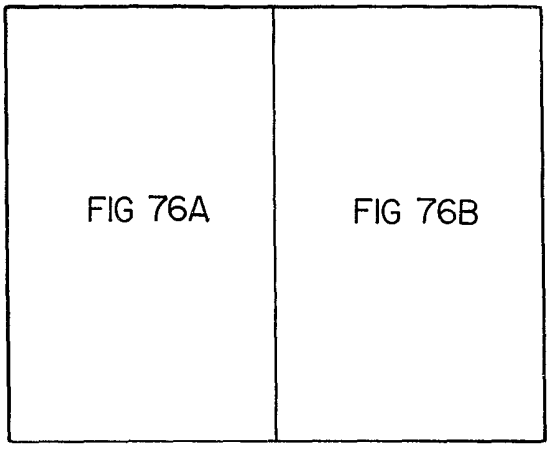


FIG 76'

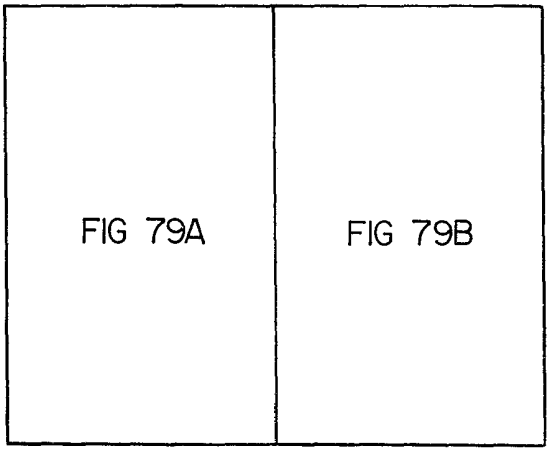


FIG 79'

1444141 COMPLETE SPECIFICATION
233 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 133

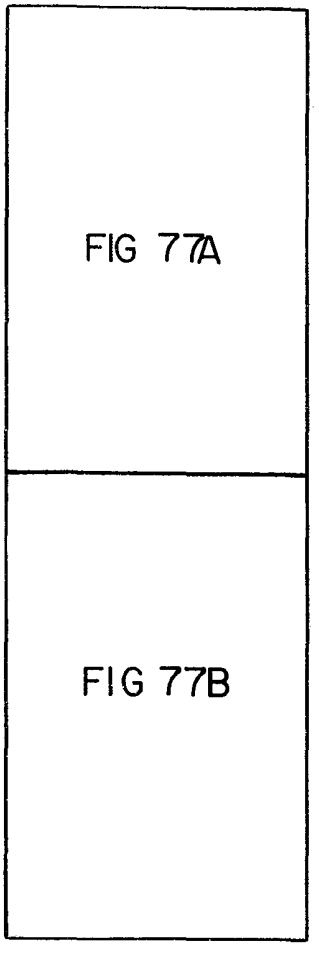


FIG 77'

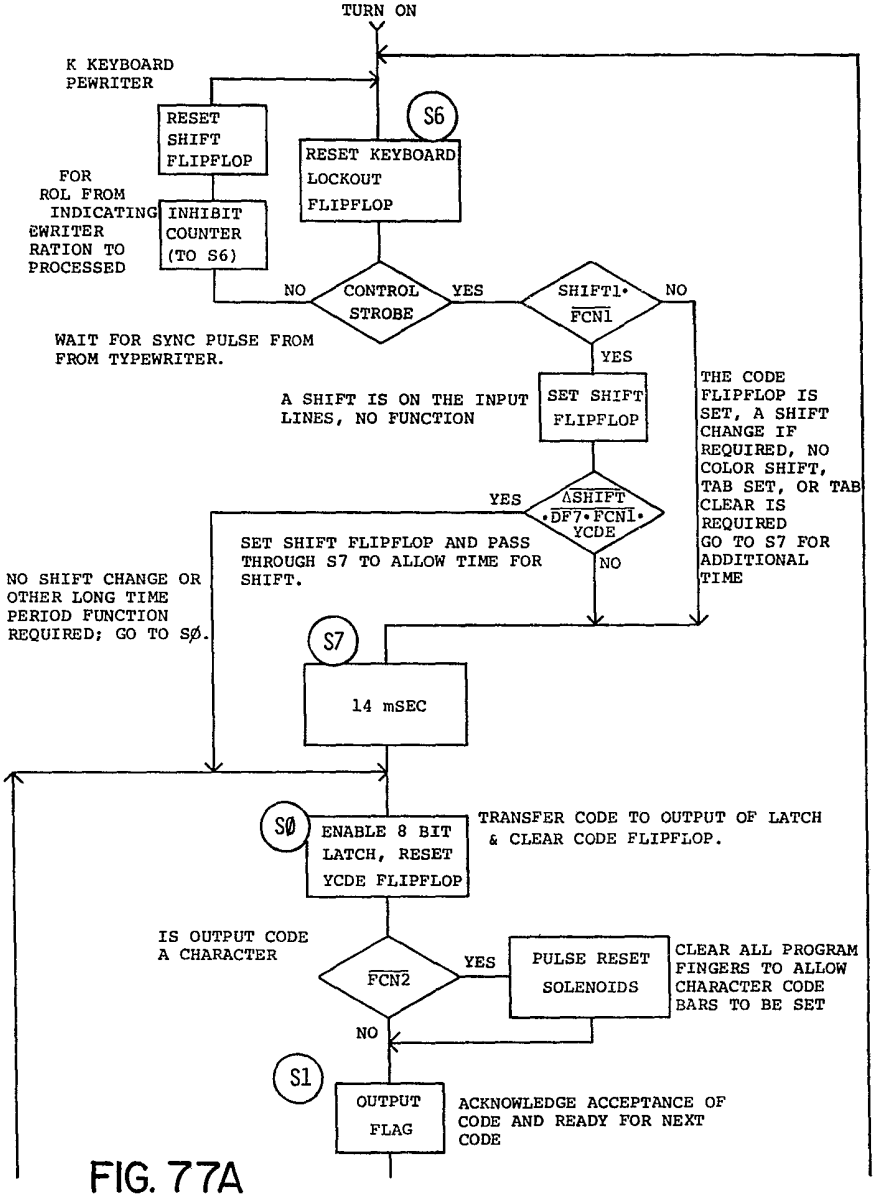

TURN ON
K KEYBOARD
PEWRITER
RESET SHIFT FLIPFLOP
FOR ROL FROM INDICATING EWRITER RATION TO PROCESSED
INHIBIT COUNTER (TO S6)
S6
RESET KEYBOARD LOCKOUT FLIPFLOP
NO
CONTROL STROBE
YES
SHIFT1• $\overline{FCN1}$
NO
YES
WAIT FOR SYNC PULSE FROM FROM TYPEWRITER.
A SHIFT IS ON THE INPUT LINES, NO FUNCTION
SET SHIFT FLIPFLOP
THE CODE FLIPFLOP IS SET, A SHIFT CHANGE IF REQUIRED, NO COLOR SHIFT, TAB SET, OR TAB CLEAR IS REQUIRED GO TO S7 FOR ADDITIONAL TIME
YES
ΔSHIFT •DF7•$\overline{FCN1}$• YCDE
NO
SET SHIFT FLIPFLOP AND PASS THROUGH S7 TO ALLOW TIME FOR SHIFT.
NO SHIFT CHANGE OR OTHER LONG TIME PERIOD FUNCTION REQUIRED; GO TO SØ.
S7
14 mSEC
SØ
ENABLE 8 BIT LATCH, RESET YCDE FLIPFLOP
TRANSFER CODE TO OUTPUT OF LATCH & CLEAR CODE FLIPFLOP.
IS OUTPUT CODE A CHARACTER
$\overline{FCN2}$
YES
PULSE RESET SOLENOIDS
CLEAR ALL PROGRAM FINGERS TO ALLOW CHARACTER CODE BARS TO BE SET
NO
S1
OUTPUT FLAG
ACKNOWLEDGE ACCEPTANCE OF CODE AND READY FOR NEXT CODE

FIG. 77A

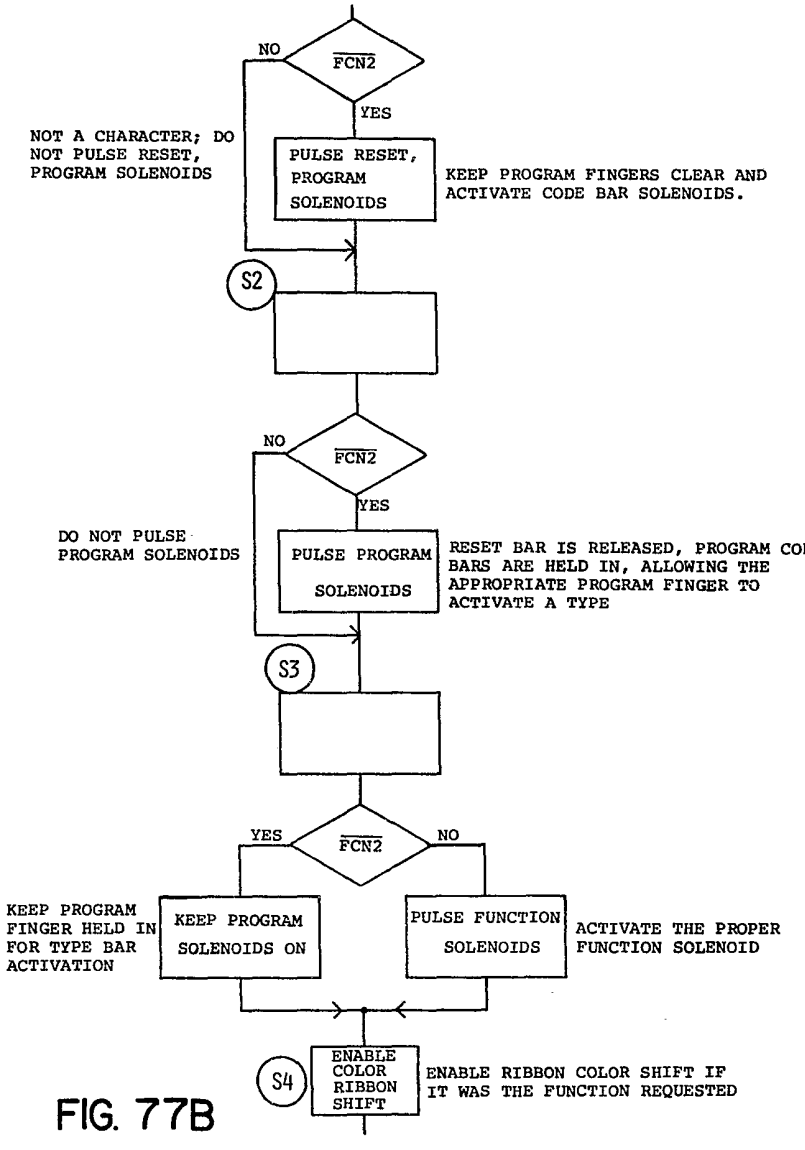

NO
FCN2
YES
NOT A CHARACTER; DO NOT PULSE RESET, PROGRAM SOLENOIDS
PULSE RESET, PROGRAM SOLENOIDS
KEEP PROGRAM FINGERS CLEAR AND ACTIVATE CODE BAR SOLENOIDS.
S2
NO
FCN2
YES
DO NOT PULSE PROGRAM SOLENOIDS
PULSE PROGRAM SOLENOIDS
RESET BAR IS RELEASED, PROGRAM CODE BARS ARE HELD IN, ALLOWING THE APPROPRIATE PROGRAM FINGER TO ACTIVATE A TYPE
S3
YES
FCN2
NO
KEEP PROGRAM FINGER HELD IN FOR TYPE BAR ACTIVATION
KEEP PROGRAM SOLENOIDS ON
PULSE FUNCTION SOLENOIDS
ACTIVATE THE PROPER FUNCTION SOLENOID
S4
ENABLE COLOR RIBBON SHIFT
ENABLE RIBBON COLOR SHIFT IF IT WAS THE FUNCTION REQUESTED

FIG. 77B

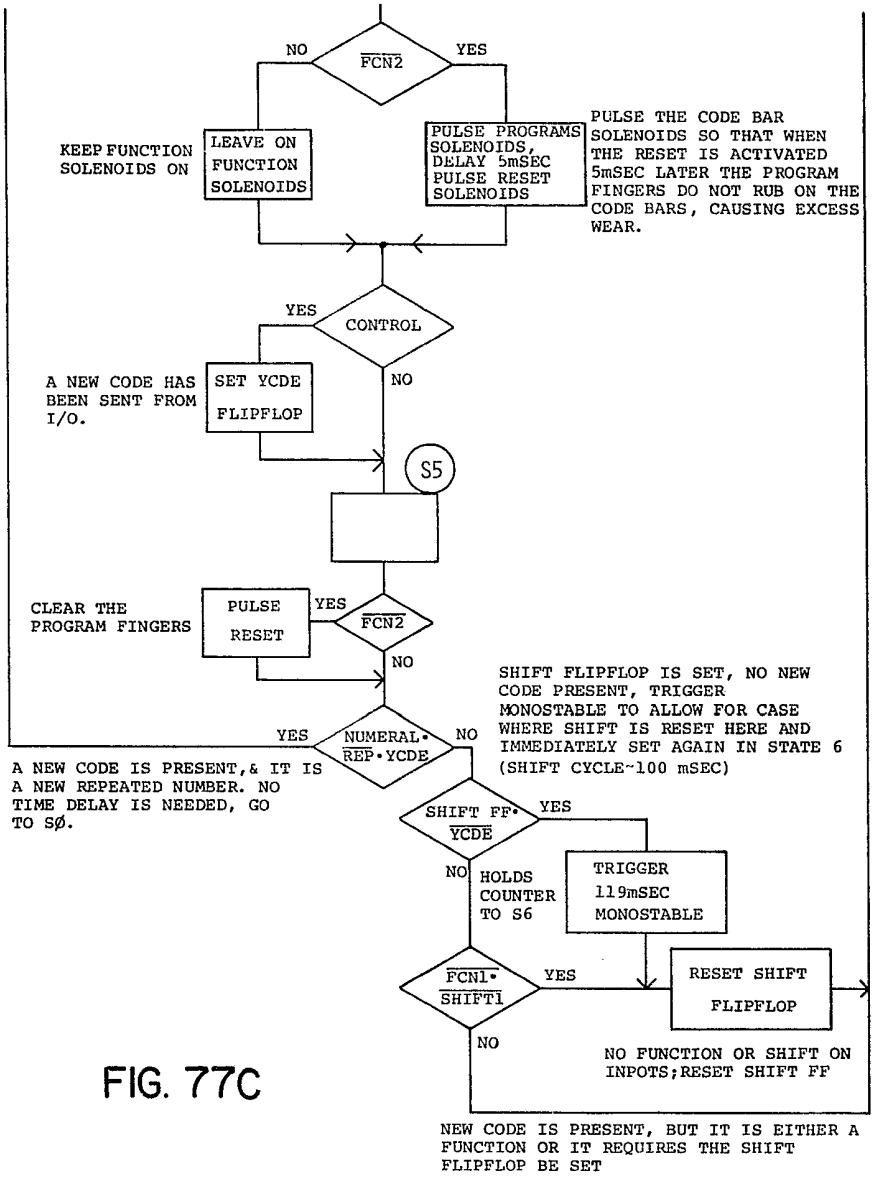

NO
FCN2
YES
KEEP FUNCTION SOLENOIDS ON
LEAVE ON FUNCTION SOLENOIDS
PULSE PROGRAMS SOLENOIDS, DELAY 5mSEC PULSE RESET SOLENOIDS
PULSE THE CODE BAR SOLENOIDS SO THAT WHEN THE RESET IS ACTIVATED 5mSEC LATER THE PROGRAM FINGERS DO NOT RUB ON THE CODE BARS, CAUSING EXCESS WEAR.
YES
CONTROL
A NEW CODE HAS BEEN SENT FROM I/O.
SET YCDE FLIPFLOP
NO
S5
CLEAR THE PROGRAM FINGERS
PULSE RESET
YES
FCN2
NO
SHIFT FLIPFLOP IS SET, NO NEW CODE PRESENT, TRIGGER MONOSTABLE TO ALLOW FOR CASE WHERE SHIFT IS RESET HERE AND IMMEDIATELY SET AGAIN IN STATE 6 (SHIFT CYCLE~100 mSEC)
YES
NUMERAL• REP•YCDE
NO
A NEW CODE IS PRESENT,& IT IS A NEW REPEATED NUMBER. NO TIME DELAY IS NEEDED, GO TO SØ.
SHIFT FF• YCDE
YES
NO
HOLDS COUNTER TO S6
TRIGGER 119mSEC MONOSTABLE
FCN1• SHIFT1
YES
RESET SHIFT FLIPFLOP
NO
NO FUNCTION OR SHIFT ON INPOTS;RESET SHIFT FF
NEW CODE IS PRESENT, BUT IT IS EITHER A FUNCTION OR IT REQUIRES THE SHIFT FLIPFLOP BE SET

FIG. 77C

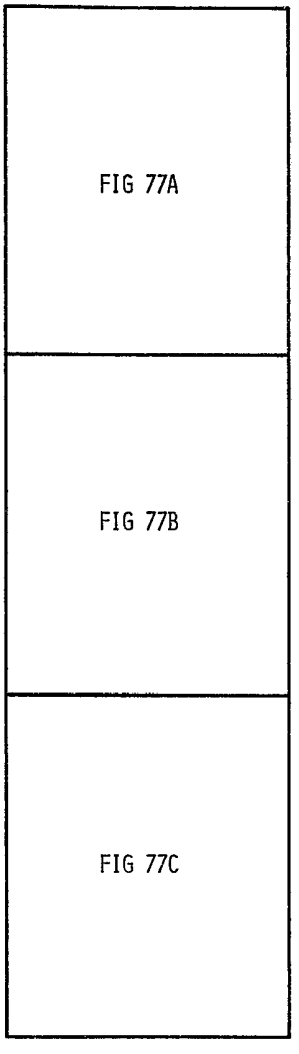


FIG. 77′

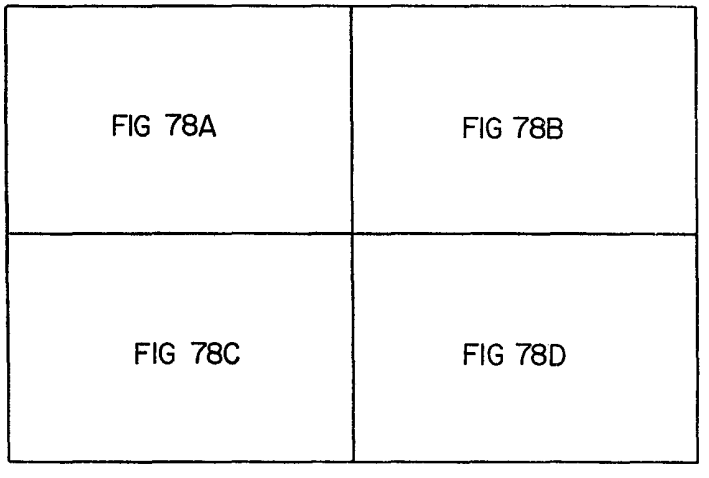


FIG 78'

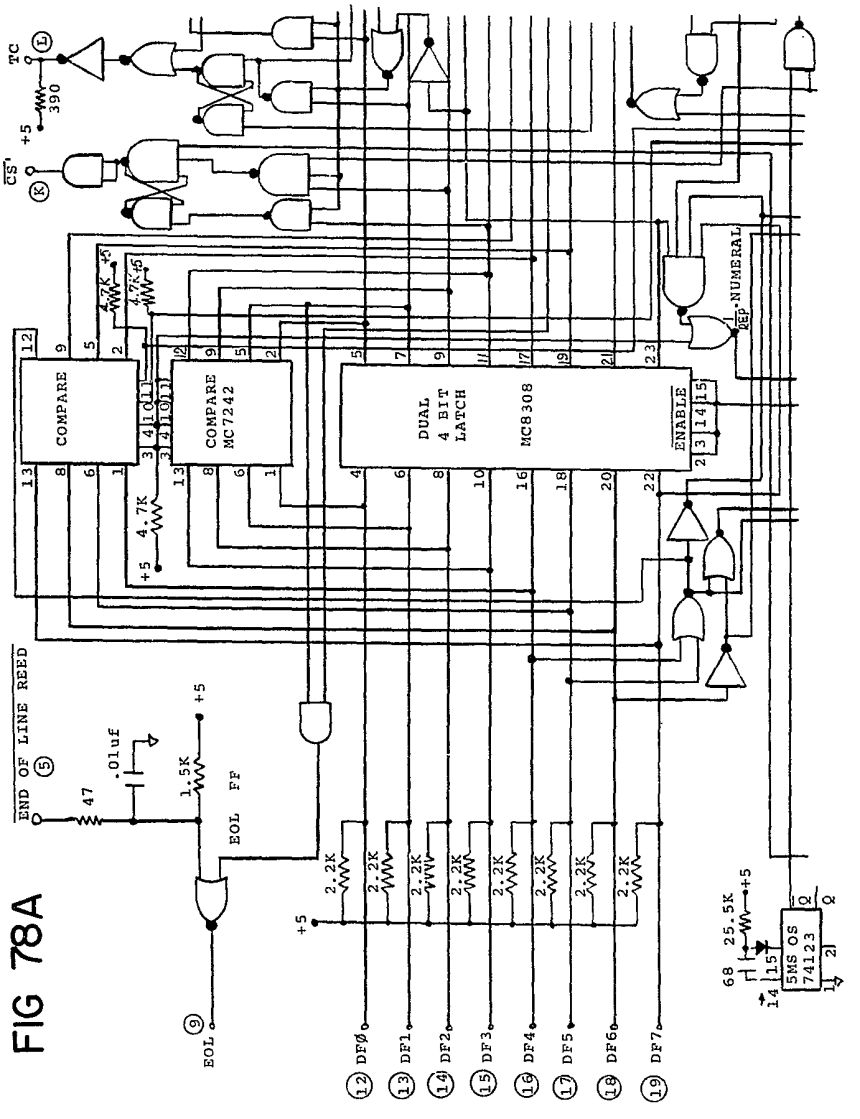
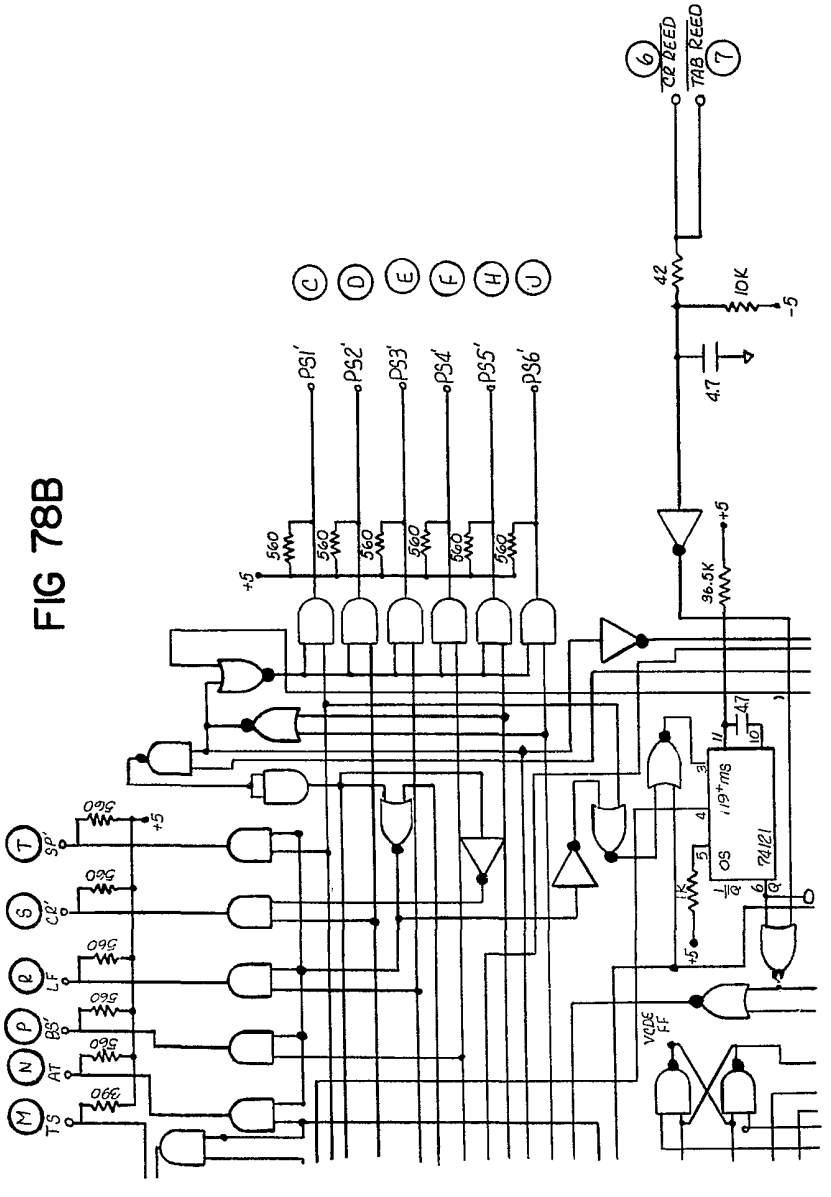

TC
CS'
+5
390
4.7K
COMPARE
COMPARE MC7242
DUAL 4 BIT LATCH MC8308
ENABLE
NUMERAL
REP
END OF LINE REED
47
.01uf
1.5K
EOL FF
EOL
2.2K
DF0
DF1
DF2
DF3
DF4
DF5
DF6
DF7
68
25.5K
5MS OS
74123

FIG 78A

FIG 78B


CR REED
TAB REED
PS1'
PS2'
PS3'
PS4'
PS5'
PS6'
560
42
10K
4.7
36.5K
74121
VCOE F.F
SP'
CR'
LF
BS'
AT
TS

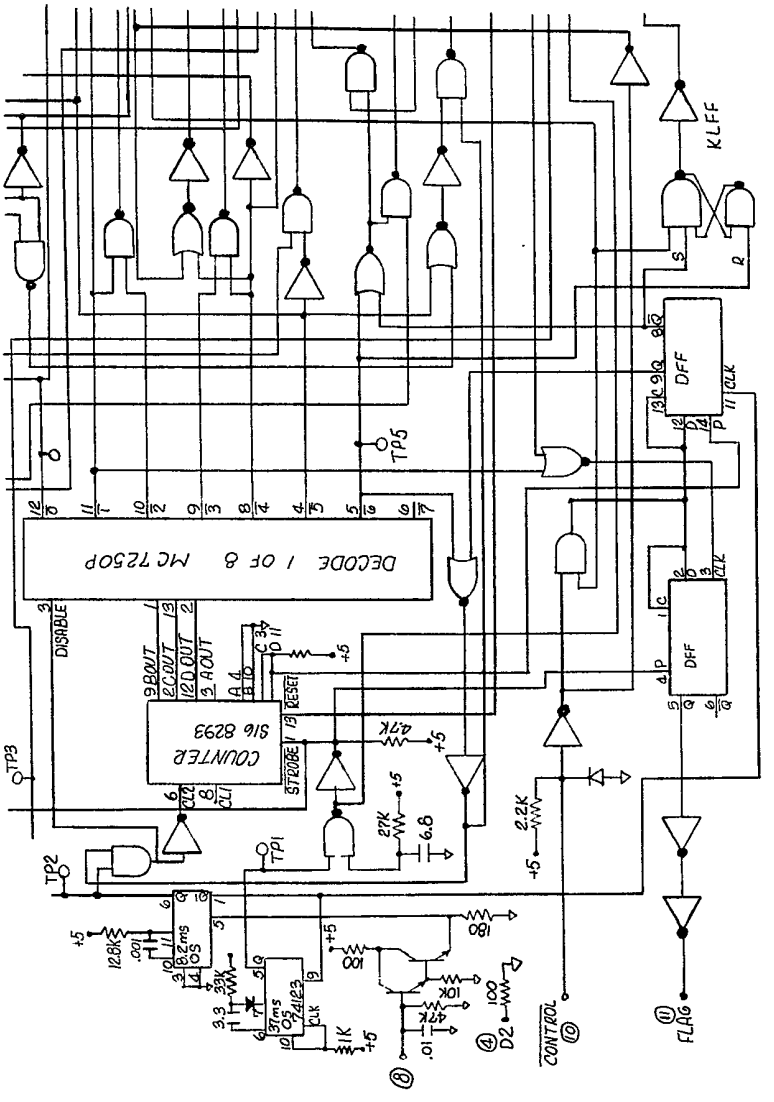

DECODE 1 OF 8 MC 7250P
DISABLE
COUNTER
8116 8293
DFF
KLFF
CONTROL
FLAG
TP1
TP2
TP3
TP5
+5
4.7K
27K
6.8
2.2K
12.8K
33K
1K
100
10K
.001
.01

FIG 78C

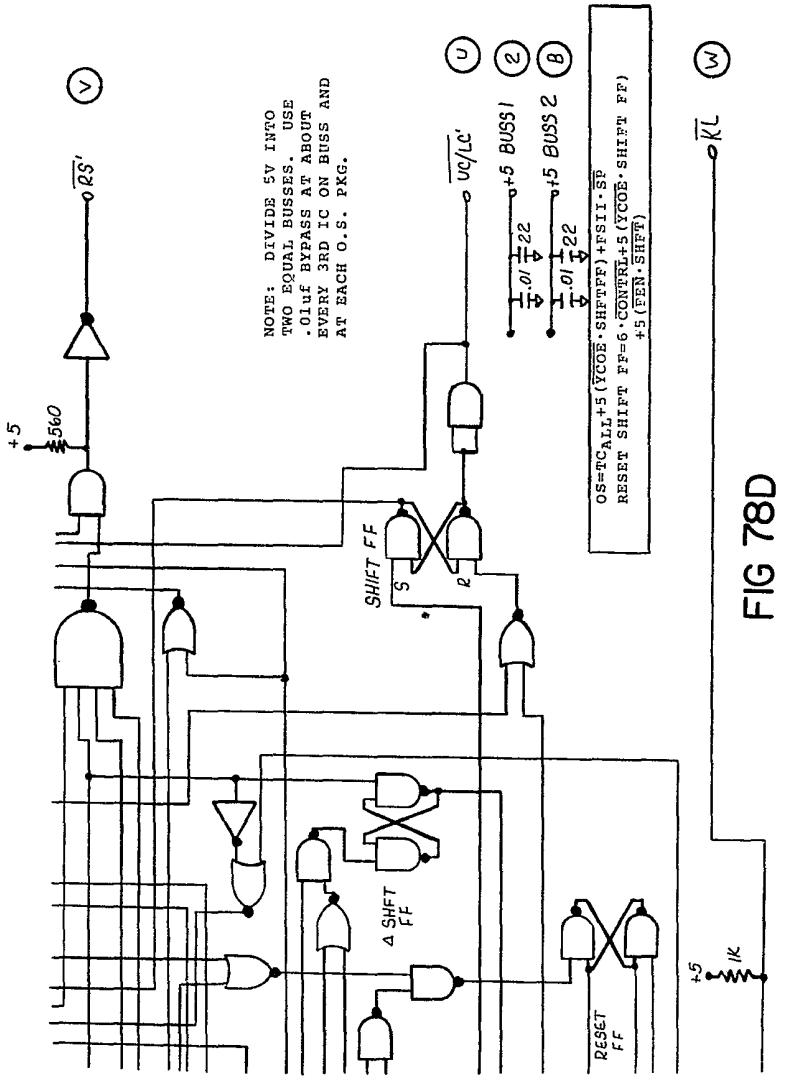

NOTE: DIVIDE 5V INTO TWO EQUAL BUSSES. USE .01uf BYPASS AT ABOUT EVERY 3RD IC ON BUSS AND AT EACH O.S. PKG.
OS=TC_ALL+5(YCOE·SHFTFF)+FSII·SP
RESET SHIFT FF=6·CONTRL+5(YCOB·SHIFT FF)
+5(EEN·SHFT)
+5 BUSS 1
+5 BUSS 2
.01
22
+5
560
SHIFT FF
Δ SHFT FF
RESET FF
1K
S
R
V
U
2
8
W

FIG 78D

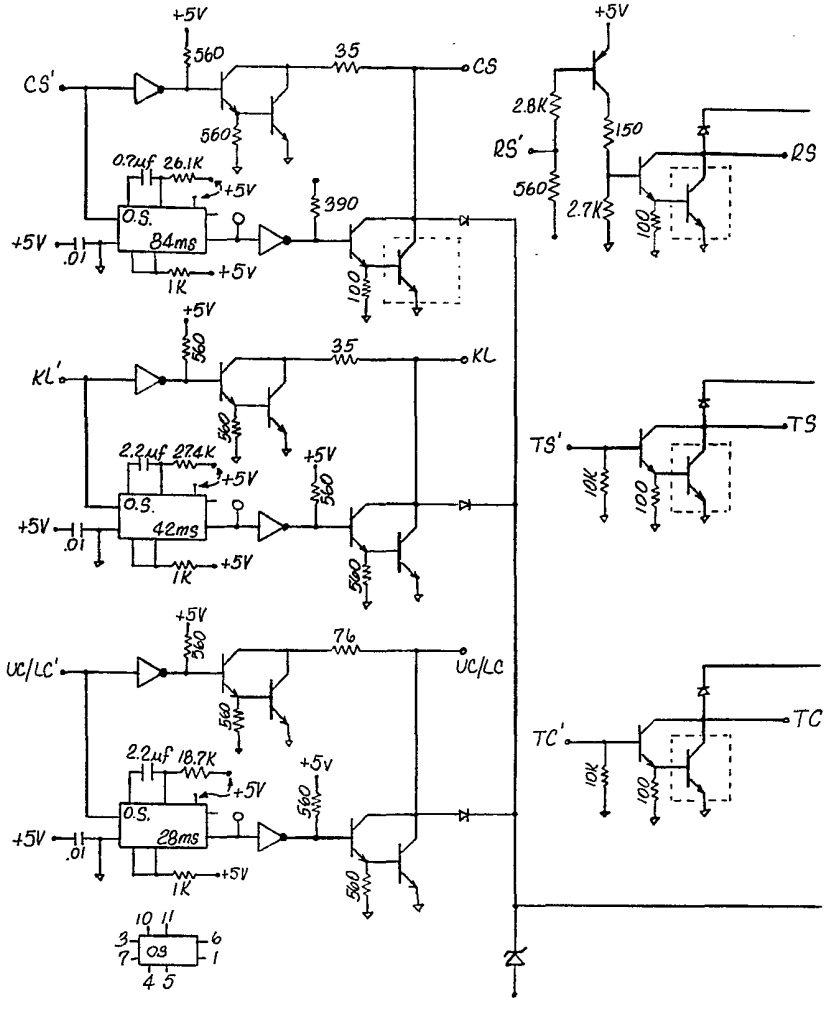

+5V
560
35
CS'
CS
560
0.7μf 26.1K
+5V
O.S.
84ms
390
+5V
.01
1K
+5V
100
KL'
KL
2.2μf 27.4K
42ms
UC/LC'
UC/LC
76
2.2μf 18.7K
28ms
10 11
3
7
09
6
1
4 5
2.8K
150
RS'
RS
560
2.7K
100
TS'
TS
10K
TC'
TC

FIG 79A

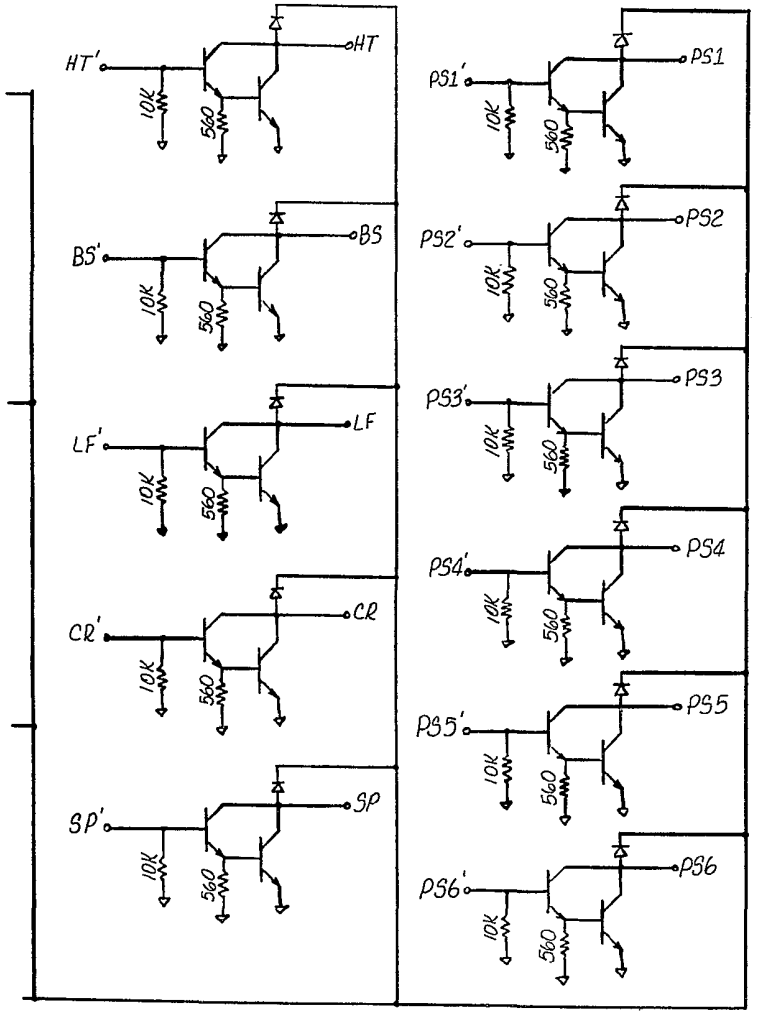

HT'
HT
10K
560
BS'
BS
LF'
LF
CR'
CR
SP'
SP
PS1'
PS1
PS2'
PS2
PS3'
PS3
PS4'
PS4
PS5'
PS5
PS6'
PS6

FIG 79B

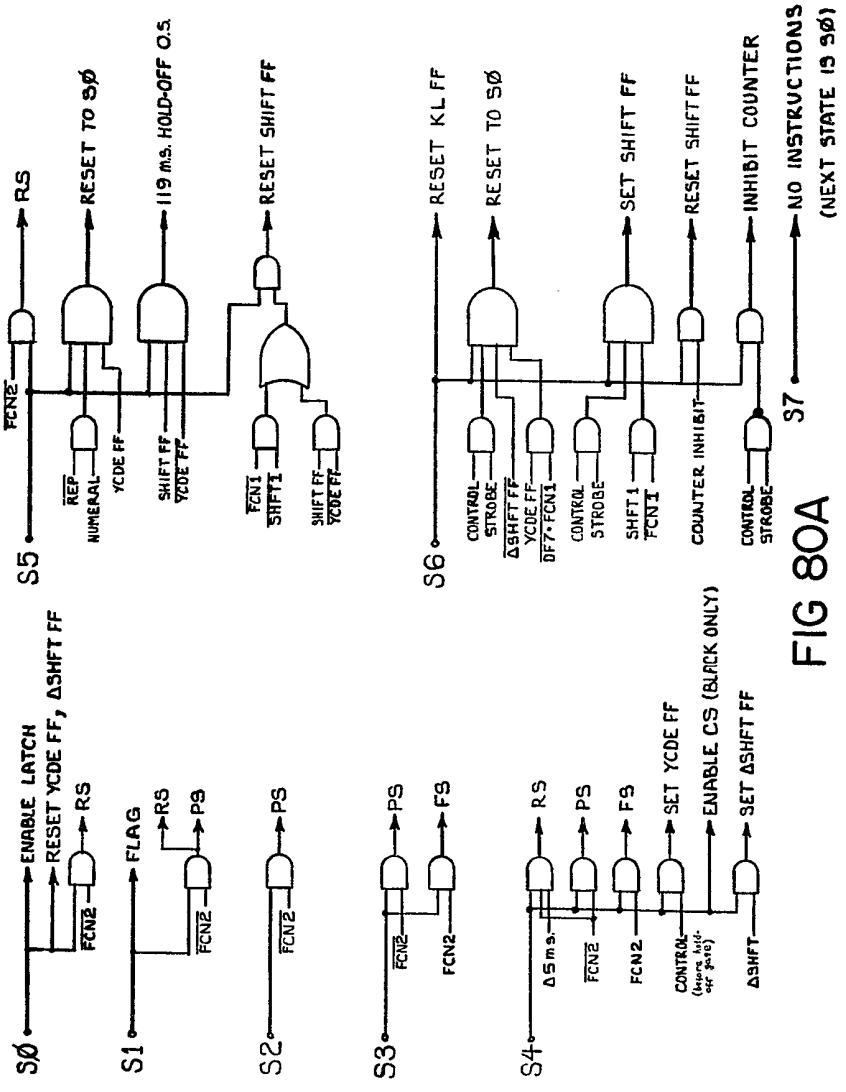

S0
ENABLE LATCH
RESET YCDE FF, ΔSHFT FF
RS
FCN2
S1
FLAG
RS
PS
FCN2
S2
PS
FCN2
S3
PS
FS
FCN2
FCN2
S4
RS
PS
FS
SET YCDE FF
ENABLE CS (BLOCK ONLY)
SET ΔSHFT FF
Δ5 m.s.
FCN2
FCN2
CONTROL
ΔSHFT
S5
RS
RESET TO SØ
119 m.s. HOLD-OFF O.S.
RESET SHIFT FF
REP
NUMERAL
YCDE FF
SHIFT FF
YCDE FF
FCN1
SHIFT 1
SHIFT FF
YCDE FF
S6
RESET KL FF
RESET TO SØ
SET SHIFT FF
RESET SHIFT FF
INHIBIT COUNTER
CONTROL
STROBE
ΔSHIFT FF
YCDE FF
DF7 • FCN1
CONTROL
STROBE
SHIFT 1
FCN1
COUNTER INHIBIT
CONTROL
STROBE
S7
NO INSTRUCTIONS
(NEXT STATE IS SØ)

FIG 80A

INPUTS

S0-S7 : 14 m.s. STATES
FCN 2 = CODE ON LATCH OUTPUTS IS A FUNCTION
FCN 1 = " " " INPUTS = " "
CONTROL = SAME AS CEO FROM 9810
REP = REPEATING CHARACTER
SHFT 1 = CODE ON LATCH INPUTS IS FOR UPPER CASE CHARACTER ON WRITER
STROBE = 8 μsec PULSE DURING STATE TRANSITION
ΔSHFT = SHIFT BIT AT INPUT AND STATE OF SHIFT FF NOT THE SAME
DF7 = DATA, FACIT CODE BIT 7
(USED IN CODING "LEFT SIDE" FUNCTIONS : COLOR SHIFT, TAB CLEAR, TABSET)

OUTPUTS

RS = "RESET SOLENOIDS"
YCDE FF = "YES CODE FLIP FLOP
FLAG = REQUEST TO CALCULATOR FOR NEXT CODE
PS = "PROGRAM SOLENOIDS"
FS = "FUNCTION SOLENOIDS"
CS = RIBBON COLOR SHIFT
SHIFT FF = INSTRUCTS WRITER TO SHIFT TO UPPER CASE (also called 12VFF)
KLFF = KEYBOARD LOCK FF
INHIBIT COUNTER = STOP INPUT PULSES TO COUNTER

FIG 80B

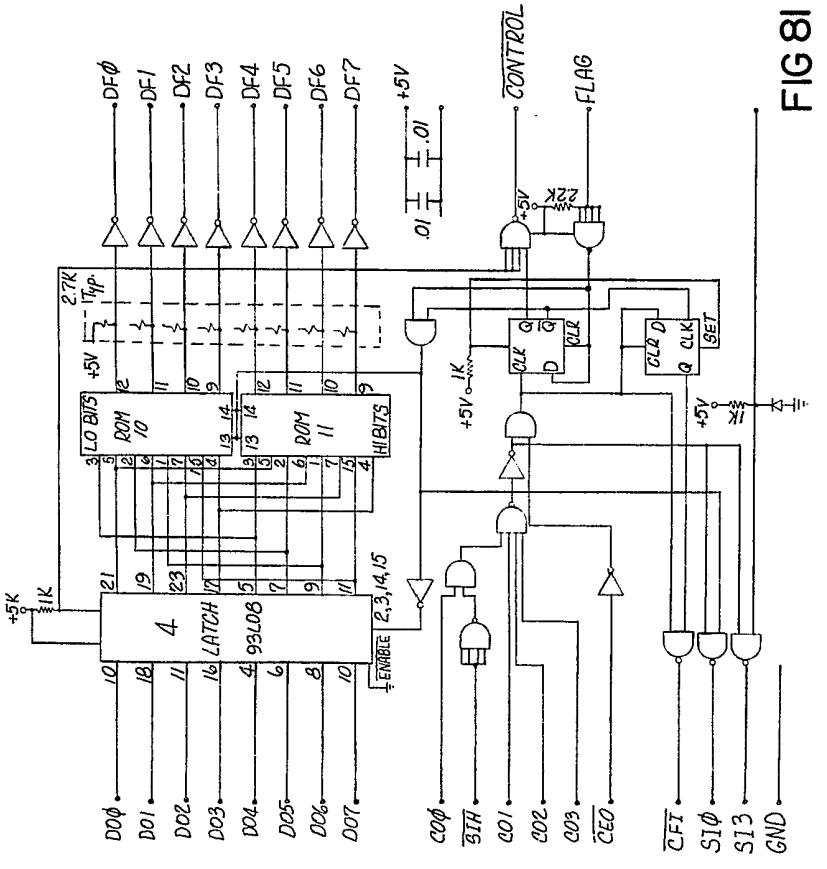

DF0
DF1
DF2
DF3
DF4
DF5
DF6
DF7
+5V
.01
CONTROL
FLAG
2.7K
1/4p.
LO BITS
ROM 10
ROM 11
HI BITS
+5K
1K
4
LATCH
93L08
2,3,14,15
ENABLE
DO0
DO1
DO2
DO3
DO4
DO5
DO6
DO7
CO0
3TH
CO1
CO2
CO3
CEO
CFI
SI0
SI3
GND

FIG 81

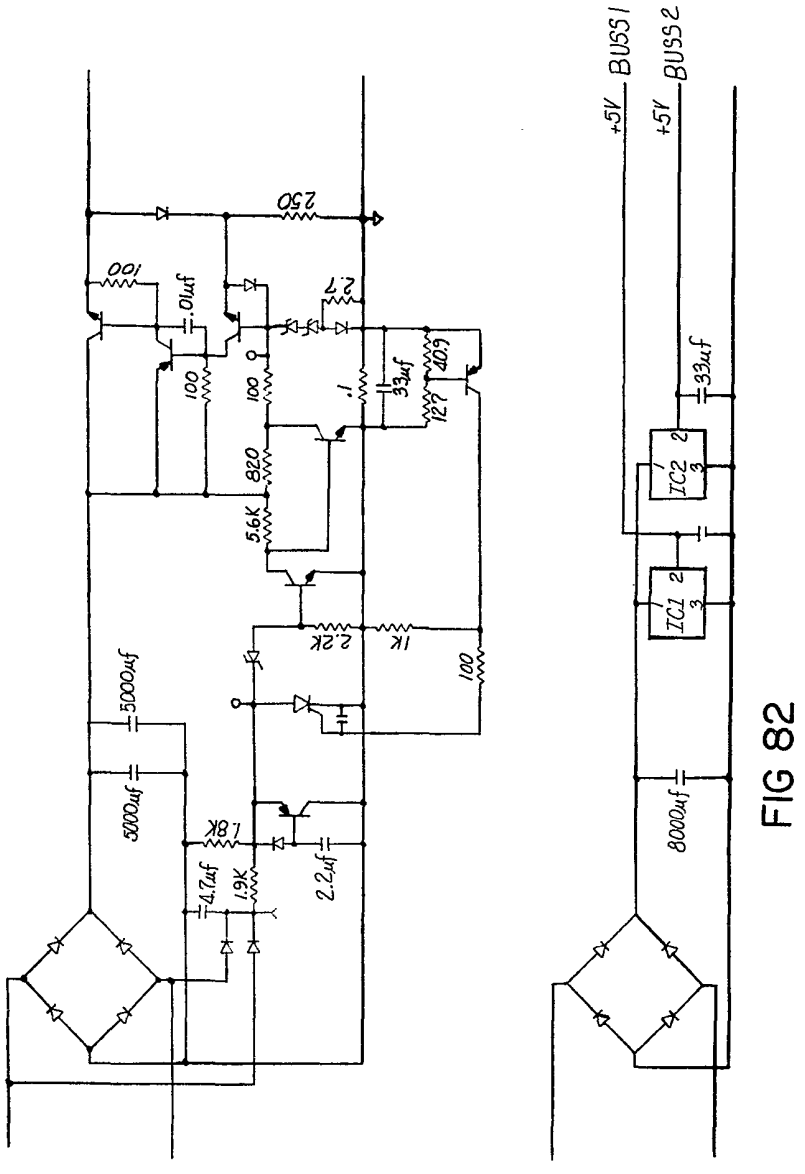

+5V BUSS1
+5V BUSS2
250
100
.01uf
2.7
100
100
.1
33uf
820
5.6K
2.2K
1K
100
5000uf
5000uf
8000uf
33uf
IC2
IC1
7.8K
4.7uf
1.9K
2.2uf

FIG 82

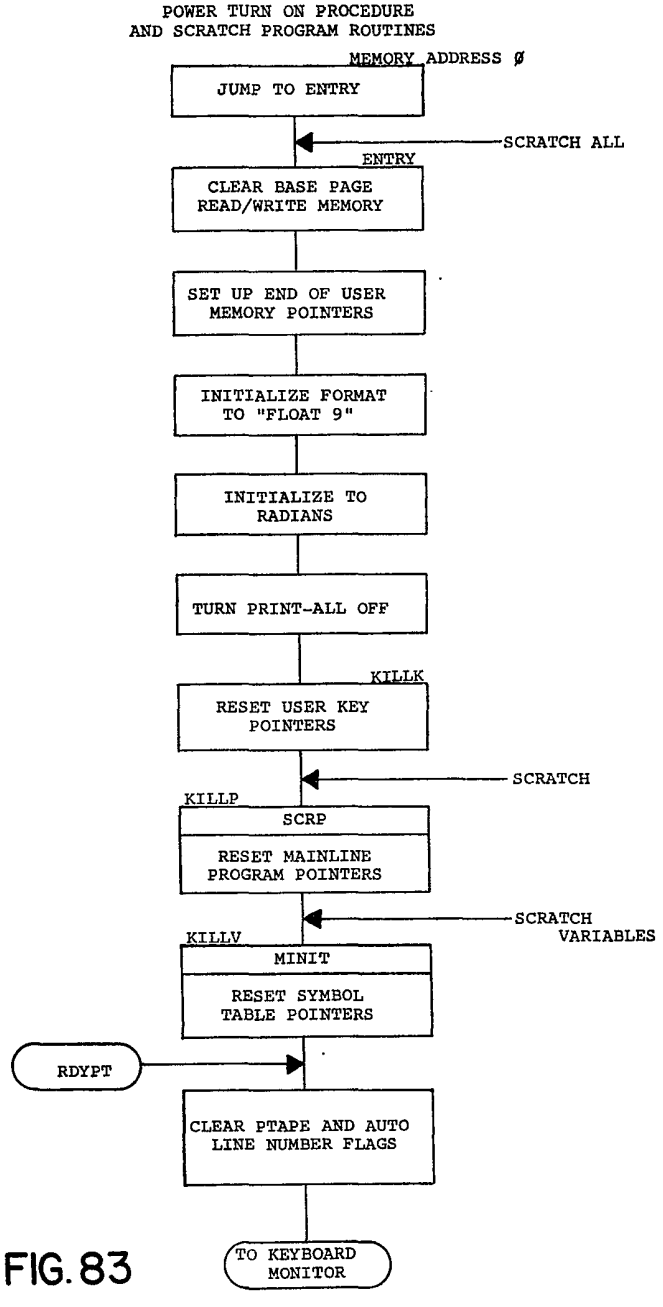

POWER TURN ON PROCEDURE
AND SCRATCH PROGRAM ROUTINES
MEMORY ADDRESS Ø
JUMP TO ENTRY
SCRATCH ALL
ENTRY
CLEAR BASE PAGE
READ/WRITE MEMORY
SET UP END OF USER
MEMORY POINTERS
INITIALIZE FORMAT
TO "FLOAT 9"
INITIALIZE TO
RADIANS
TURN PRINT-ALL OFF
KILLK
RESET USER KEY
POINTERS
SCRATCH
KILLP
SCRP
RESET MAINLINE
PROGRAM POINTERS
SCRATCH
VARIABLES
KILLV
MINIT
RESET SYMBOL
TABLE POINTERS
RDYPT
CLEAR PTAPE AND AUTO
LINE NUMBER FLAGS
TO KEYBOARD
MONITOR

FIG. 83

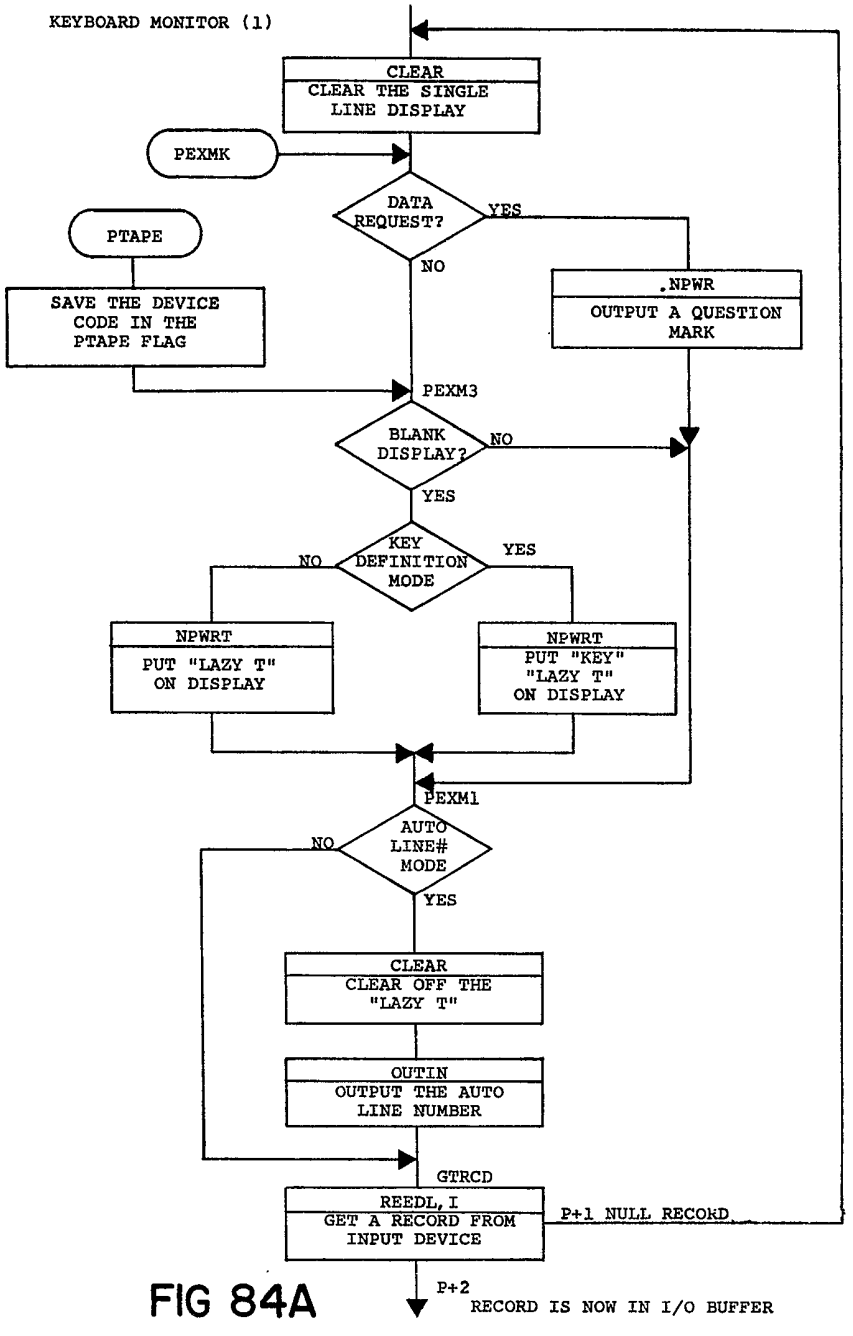

KEYBOARD MONITOR (1)
CLEAR
CLEAR THE SINGLE LINE DISPLAY
PEXMK
DATA REQUEST?
YES
NO
PTAPE
SAVE THE DEVICE CODE IN THE PTAPE FLAG
.NPWR
OUTPUT A QUESTION MARK
PEXM3
BLANK DISPLAY?
NO
YES
KEY DEFINITION MODE
NO
YES
NPWRT
PUT "LAZY T" ON DISPLAY
NPWRT
PUT "KEY" "LAZY T" ON DISPLAY
PEXM1
AUTO LINE# MODE
NO
YES
CLEAR
CLEAR OFF THE "LAZY T"
OUTIN
OUTPUT THE AUTO LINE NUMBER
GTRCD
REEDL, I
GET A RECORD FROM INPUT DEVICE
P+1 NULL RECORD
P+2
RECORD IS NOW IN I/O BUFFER

FIG 84A

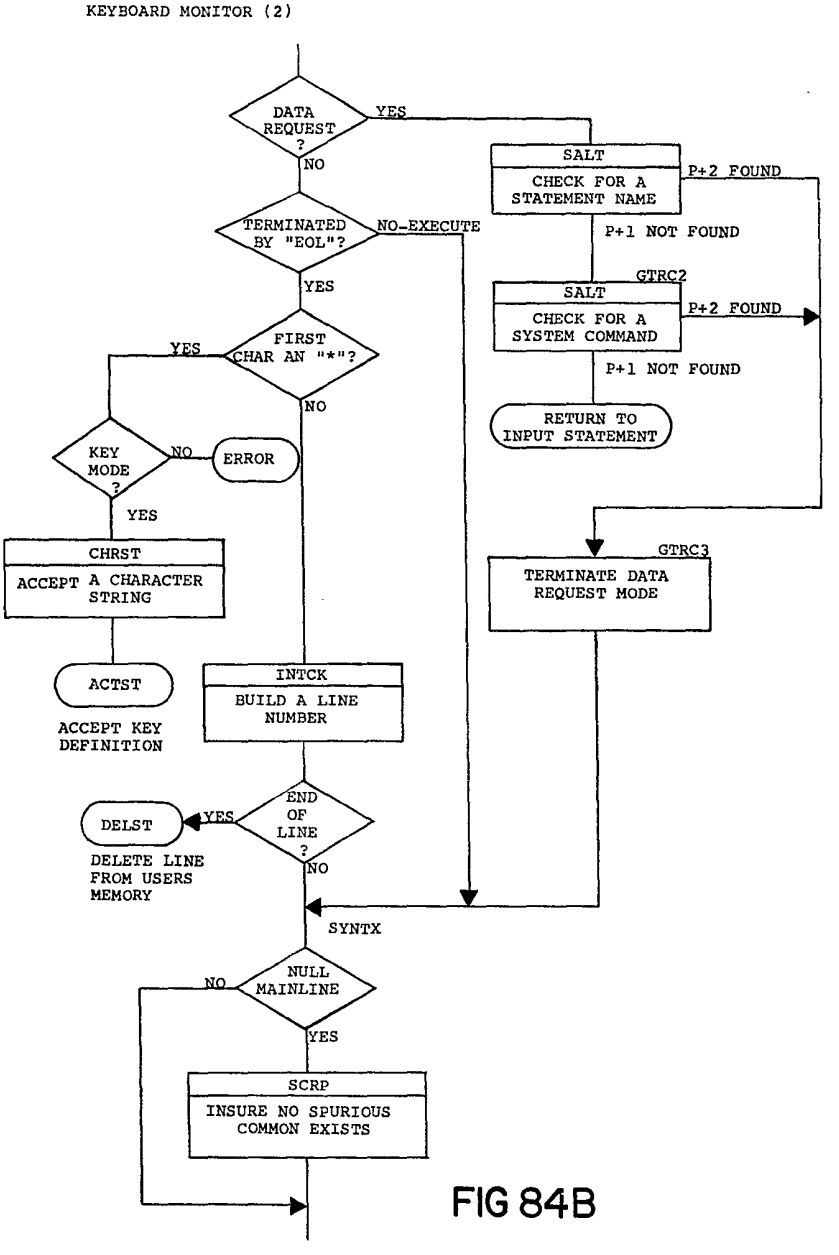

KEYBOARD MONITOR (2)
DATA REQUEST ?
YES
NO
SALT
CHECK FOR A STATEMENT NAME
P+2 FOUND
P+1 NOT FOUND
TERMINATED BY "EOL"?
NO-EXECUTE
YES
GTRC2
SALT
CHECK FOR A SYSTEM COMMAND
P+2 FOUND
P+1 NOT FOUND
FIRST CHAR AN "*"?
YES
NO
RETURN TO INPUT STATEMENT
KEY MODE ?
NO
ERROR
YES
GTRC3
TERMINATE DATA REQUEST MODE
CHRST
ACCEPT A CHARACTER STRING
ACTST
ACCEPT KEY DEFINITION
INTCK
BUILD A LINE NUMBER
END OF LINE ?
YES
DELST
DELETE LINE FROM USERS MEMORY
NO
SYNTX
NULL MAINLINE
NO
YES
SCRP
INSURE NO SPURIOUS COMMON EXISTS

FIG 84B

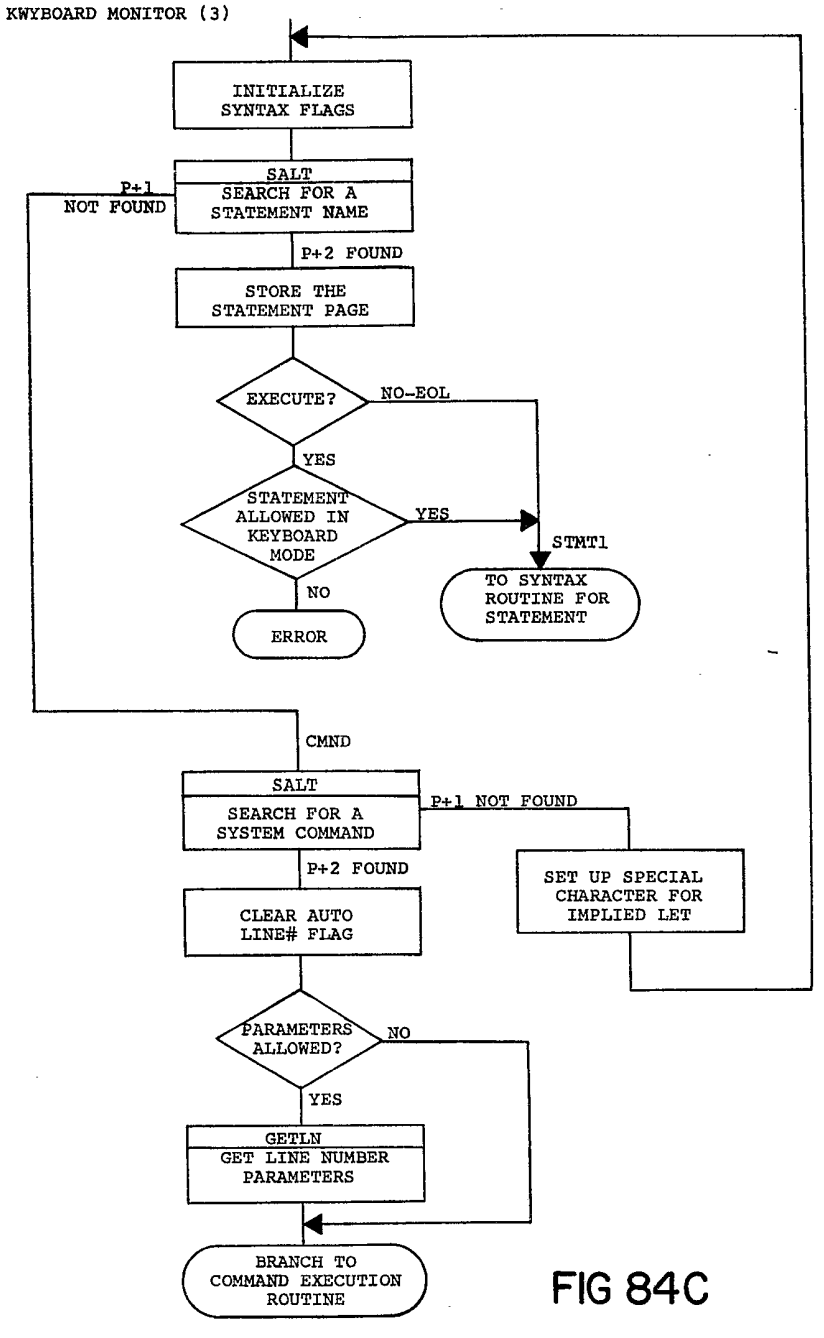

KWYBOARD MONITOR (3)
INITIALIZE SYNTAX FLAGS
SALT
SEARCH FOR A STATEMENT NAME
P+1 NOT FOUND
P+2 FOUND
STORE THE STATEMENT PAGE
EXECUTE?
NO-EOL
YES
STATEMENT ALLOWED IN KEYBOARD MODE
YES
STMT1
TO SYNTAX ROUTINE FOR STATEMENT
NO
ERROR
CMND
SALT
SEARCH FOR A SYSTEM COMMAND
P+1 NOT FOUND
SET UP SPECIAL CHARACTER FOR IMPLIED LET
P+2 FOUND
CLEAR AUTO LINE# FLAG
PARAMETERS ALLOWED?
NO
YES
GETLN
GET LINE NUMBER PARAMETERS
BRANCH TO COMMAND EXECUTION ROUTINE

FIG 84C

KEYBOARD MONITOR (4)

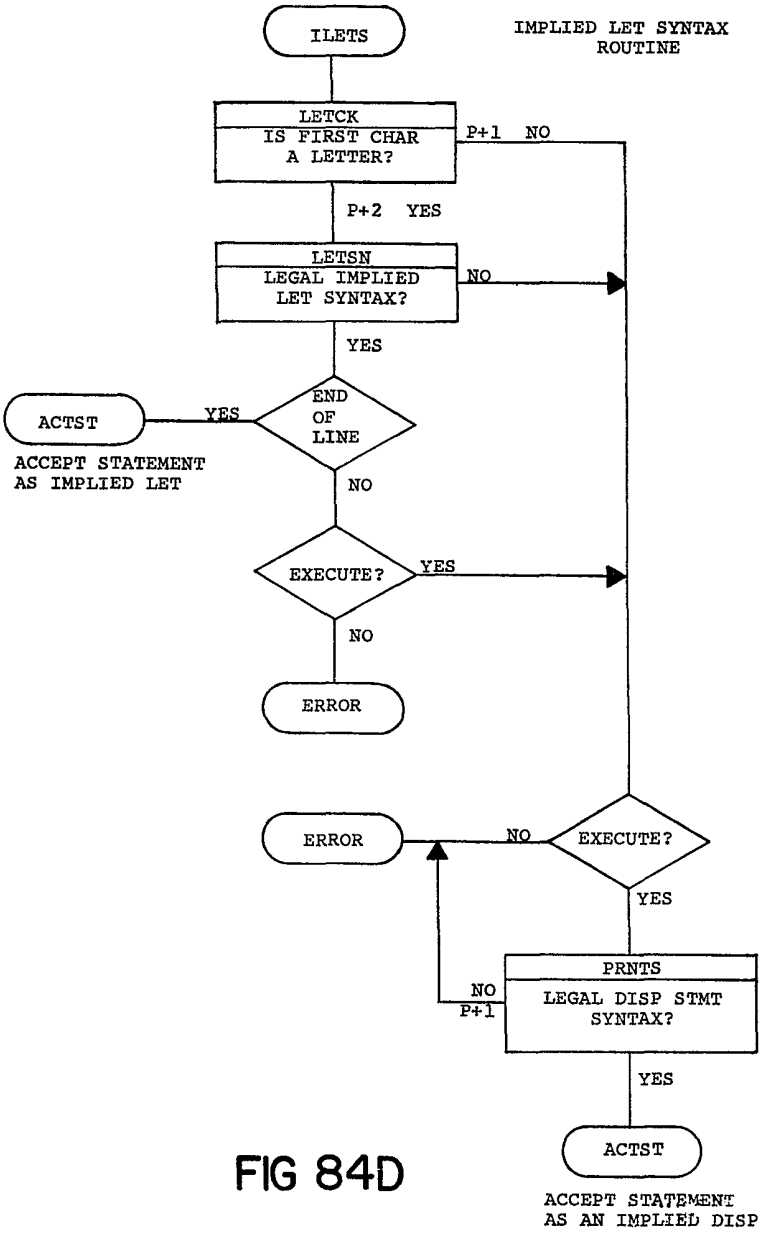
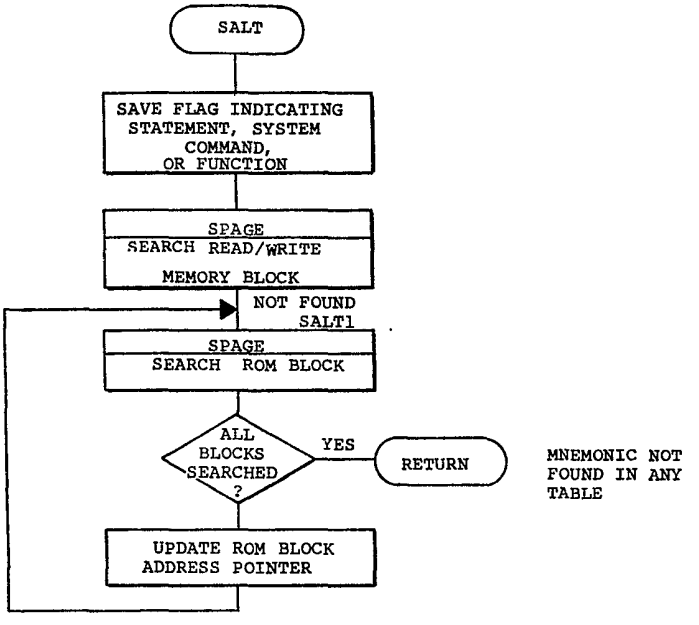
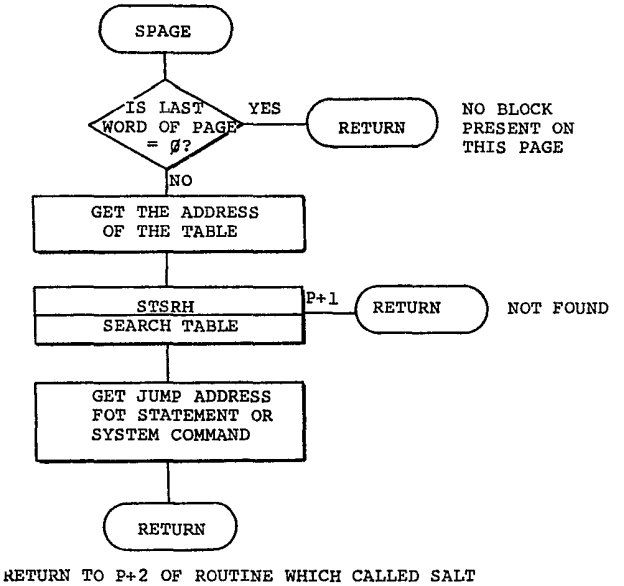


FIG 84D



SEARCH A TABLE ON A GIVEN PAGE

FIG 85



RETURN TO P+2 OF ROUTINE WHICH CALLED SALT

FIG 86

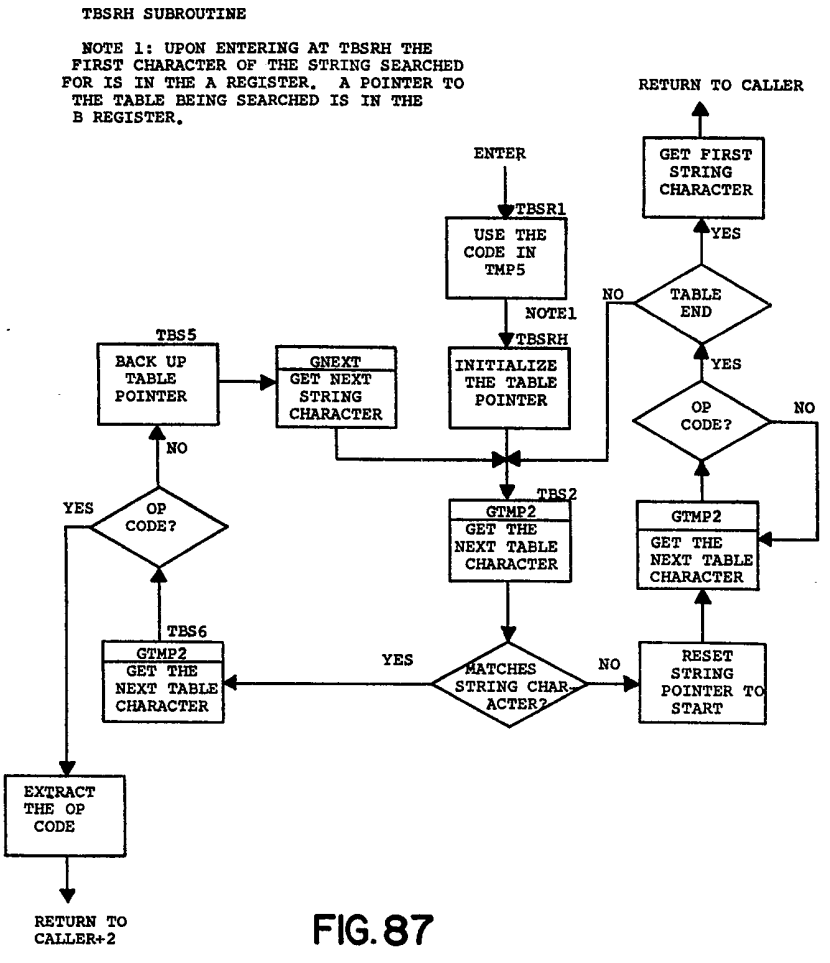
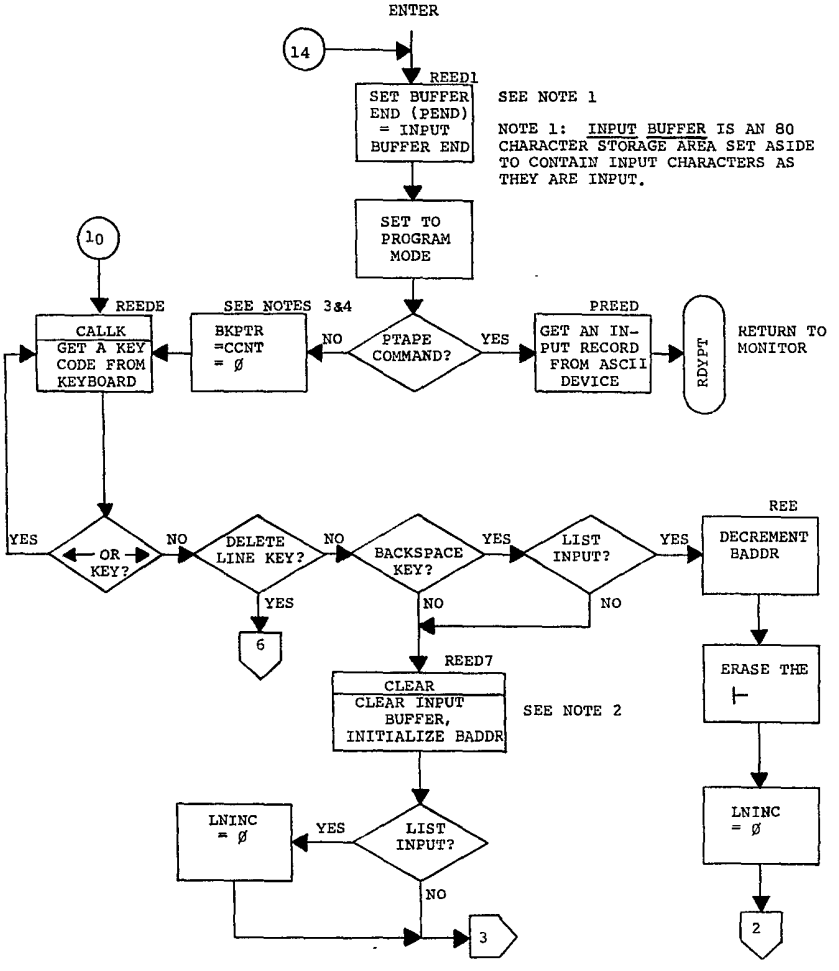

TBSRH SUBROUTINE
NOTE 1: UPON ENTERING AT TBSRH THE FIRST CHARACTER OF THE STRING SEARCHED FOR IS IN THE A REGISTER. A POINTER TO THE TABLE BEING SEARCHED IS IN THE B REGISTER.
ENTER
TBSR1
USE THE CODE IN TMP5
NOTE1
TBSRH
INITIALIZE THE TABLE POINTER
TBS5
BACK UP TABLE POINTER
GNEXT
GET NEXT STRING CHARACTER
NO
YES
OP CODE?
TBS6
GTMP2
GET THE NEXT TABLE CHARACTER
EXTRACT THE OP CODE
RETURN TO CALLER+2
TBS2
GTMP2
GET THE NEXT TABLE CHARACTER
YES
MATCHES STRING CHARACTER?
NO
RESET STRING POINTER TO START
GTMP2
GET THE NEXT TABLE CHARACTER
OP CODE?
YES
NO
TABLE END
NO
YES
GET FIRST STRING CHARACTER
RETURN TO CALLER

FIG. 87



NOTE 2: BADDR IS A CHARACTER POINTER WHICH POINTS TO THE NEXT CHARACTER POSITION IN THE INPUT BUFFER ALTHOUGH IT CAN BE USED WITH ANY BUFFER. IT CONSISTS OF A WORD POINTER SHIFTED LEFT ONE BIT POSITION. THE LEAST SIGNIFICANT BIT INDICATES UPPER OR LOWER HALF CHARACTER (0 OR 1). THIS TYPE OF POINTER ALLOWS DIRECT INCREMENTING AND DECREMENTING SINCE THE WORD ADDRESS PORTION AUTOMATICALLY INCREMENTS WHEN THE POINTER POINTS TO THE SECOND CHARACTER POSITION.
NOTE 3: BKPTR POINTS TO THE POSITION OF THE CURSOR CHARACTER IN THE INPUT BUFFER. IT IS ZERO IF THE CURSOR IS NOT VISABLE ON THE DISPLAY i.e. A BACKSPACE HAS NOT BEEN EXECUTED.
NOTE 4: CCNT IS A CHARACTER COUNT WHICH INDICATES THE NUMBER OF CHARACTERS IN A STRING TO BE TAKEN AS INPUT BEFORE A KEYCODE IS ENTERED.

FIG 88A

REED SUBROUTINE (2)

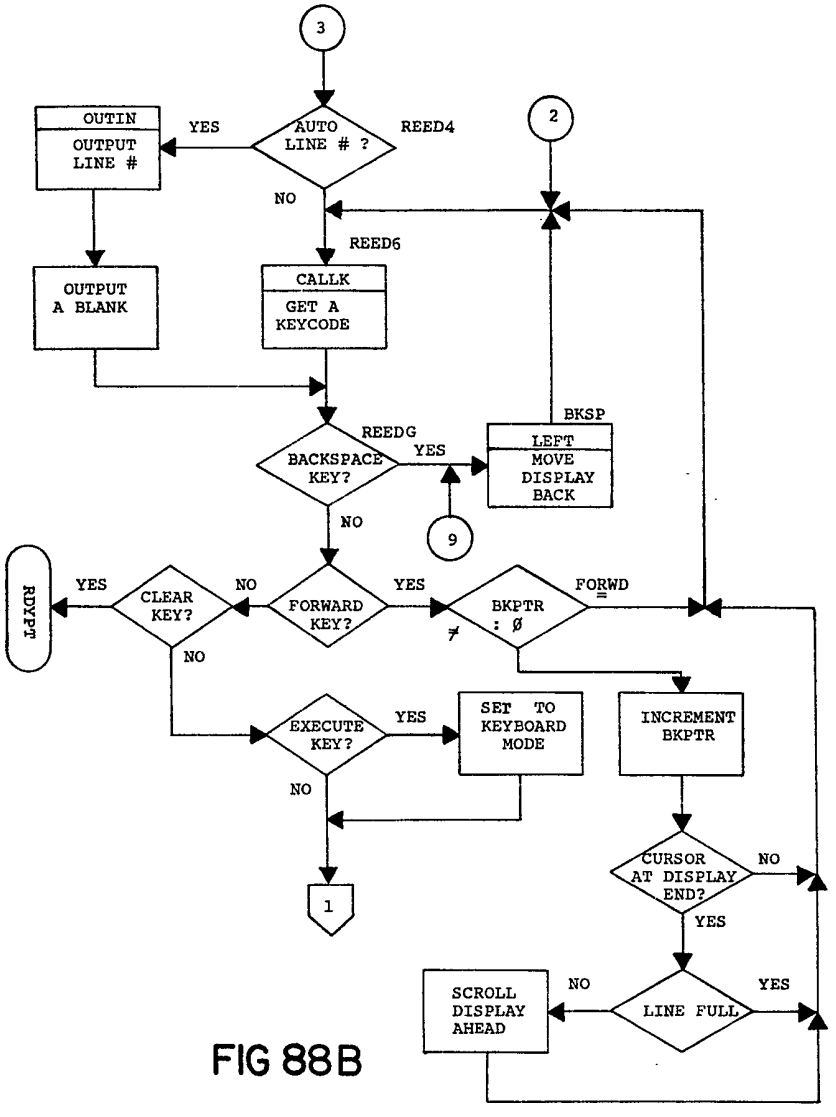


FIG 88B

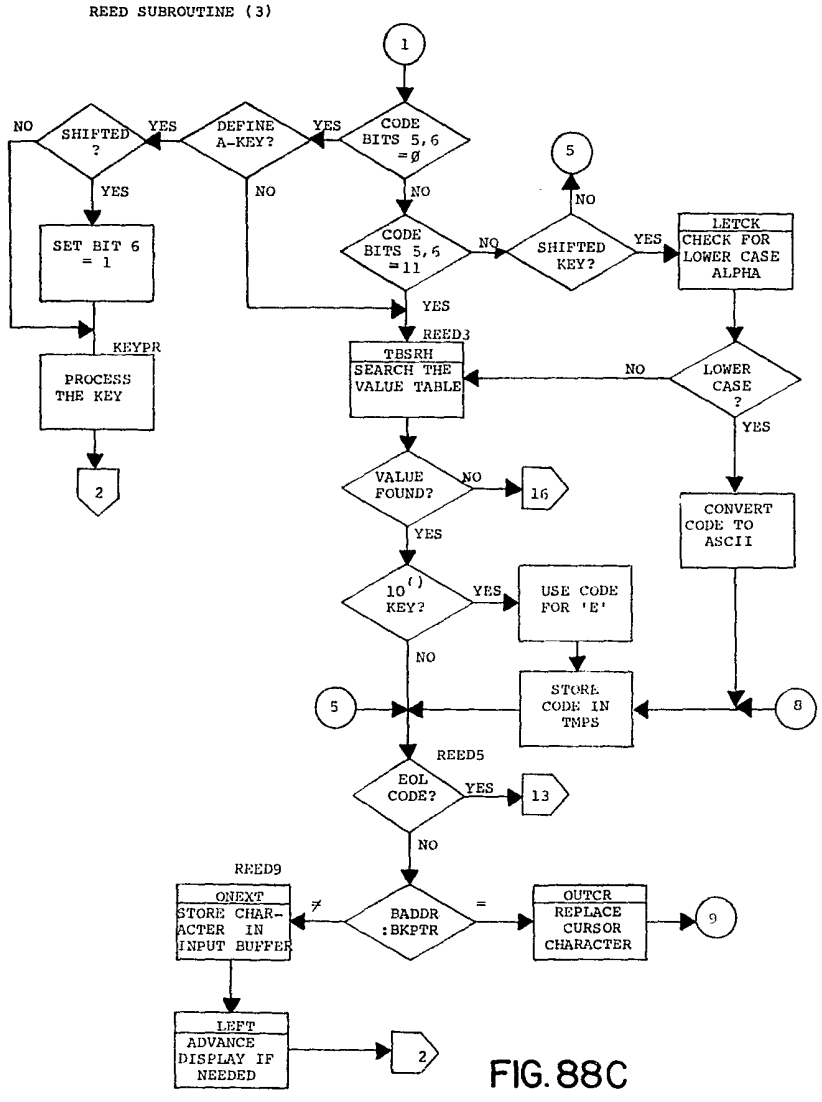

REED SUBROUTINE (3)
1
CODE BITS 5,6 =ø
NO
YES
DEFINE A-KEY?
YES
NO
SHIFTED ?
NO
YES
SET BIT 6 = 1
KEYPR
PROCESS THE KEY
2
CODE BITS 5,6 =11
NO
YES
5
NO
SHIFTED KEY?
YES
LETCK
CHECK FOR LOWER CASE ALPHA
LOWER CASE ?
NO
YES
CONVERT CODE TO ASCII
REED3
TBSRH
SEARCH THE VALUE TABLE
VALUE FOUND?
NO
16
YES
10( ) KEY?
YES
USE CODE FOR 'E'
NO
5
STORE CODE IN TMPS
8
REED5
EOL CODE?
YES
13
NO
REED9
ONEXT
STORE CHARACTER IN INPUT BUFFER
≠
BADDR :BKPTR
=
OUTCR
REPLACE CURSOR CHARACTER
9
LEFT
ADVANCE DISPLAY IF NEEDED
2

FIG. 88C

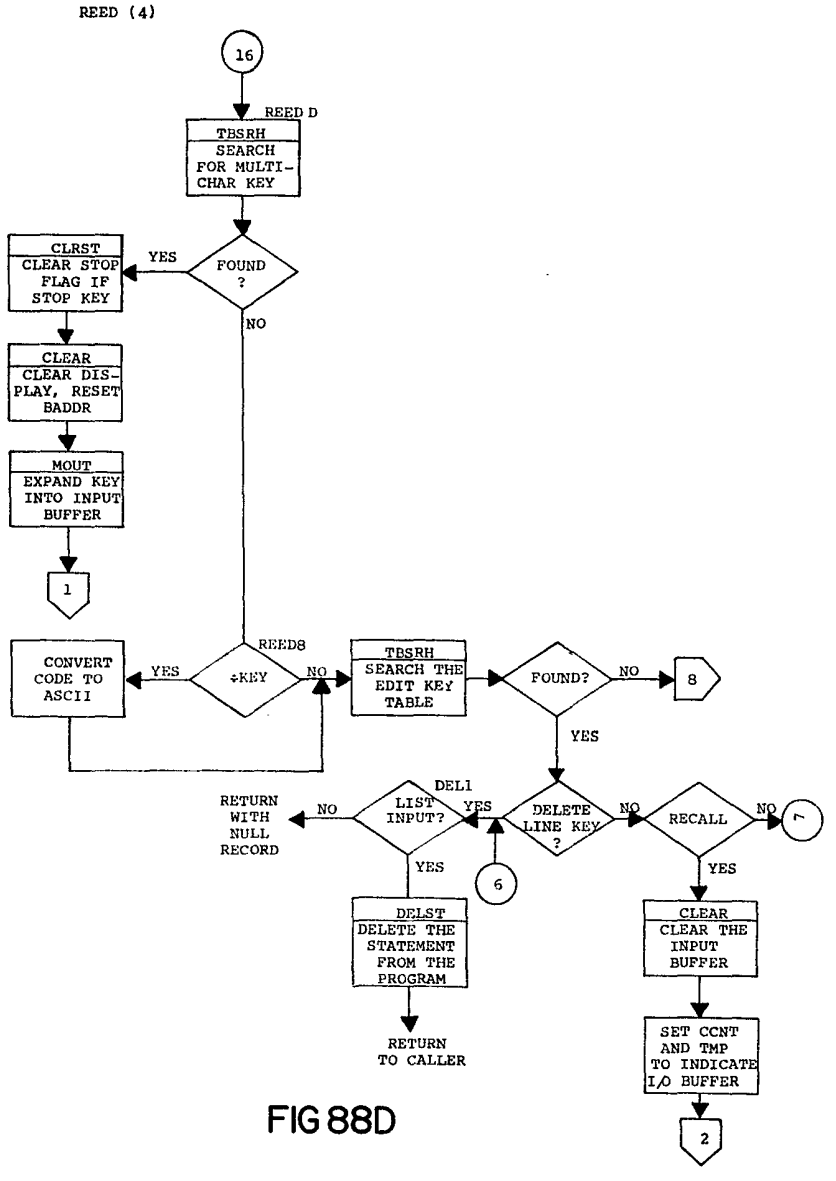

REED (4)
16
REED D
TBSRH
SEARCH FOR MULTI-CHAR KEY
FOUND ?
YES
CLRST
CLEAR STOP FLAG IF STOP KEY
NO
CLEAR
CLEAR DIS-PLAY, RESET BADDR
MOUT
EXPAND KEY INTO INPUT BUFFER
1
REED8
CONVERT CODE TO ASCII
YES
÷KEY
NO
TBSRH
SEARCH THE EDIT KEY TABLE
FOUND?
NO
8
YES
DEL1
RETURN WITH NULL RECORD
NO
LIST INPUT?
YES
DELETE LINE KEY ?
NO
RECALL
NO
7
YES
6
YES
DELST
DELETE THE STATEMENT FROM THE PROGRAM
RETURN TO CALLER
CLEAR
CLEAR THE INPUT BUFFER
SET CCNT AND TMP TO INDICATE I/O BUFFER
2

FIG 88D

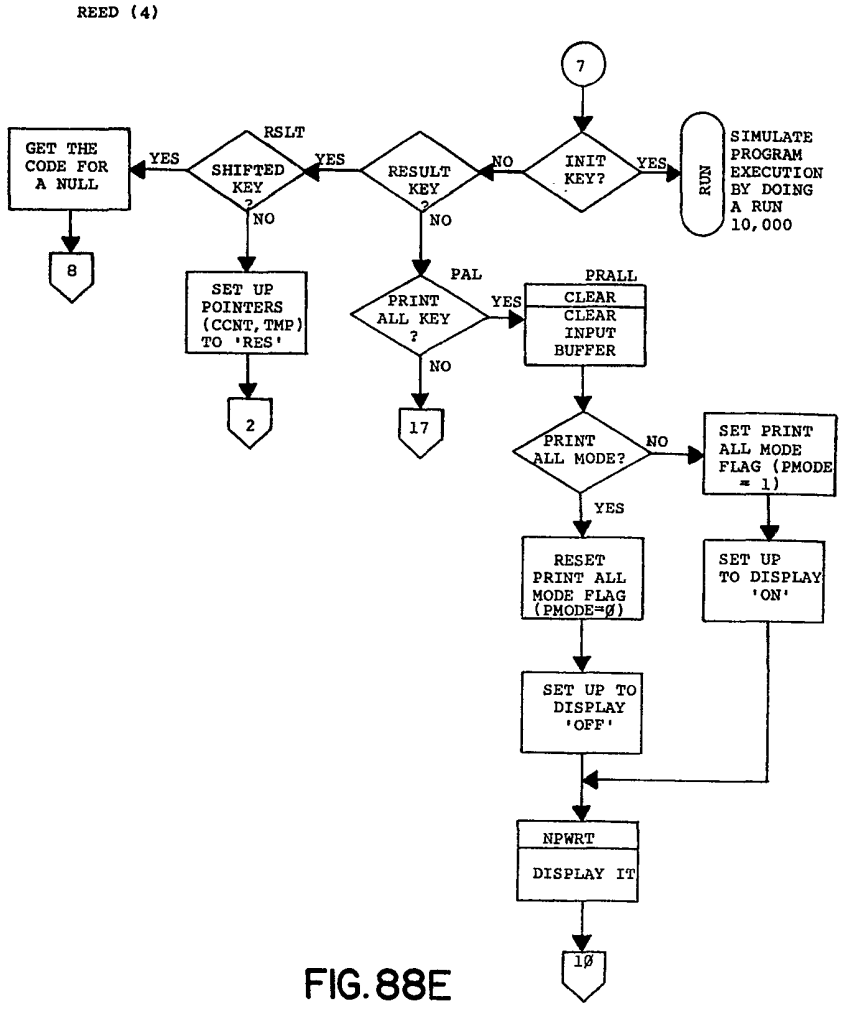

REED (4)
7
INIT KEY?
YES
NO
RUN
SIMULATE PROGRAM EXECUTION BY DOING A RUN 10,000
RESULT KEY ?
NO
YES
RSLT
SHIFTED KEY ?
NO
YES
GET THE CODE FOR A NULL
8
SET UP POINTERS (CCNT, TMP) TO 'RES'
2
PAL
PRINT ALL KEY ?
YES
NO
17
PRALL
CLEAR
CLEAR INPUT BUFFER
PRINT ALL MODE?
NO
YES
SET PRINT ALL MODE FLAG (PMODE = 1)
SET UP TO DISPLAY 'ON'
RESET PRINT ALL MODE FLAG (PMODE=Ø)
SET UP TO DISPLAY 'OFF'
NPWRT
DISPLAY IT
1Ø

FIG. 88E

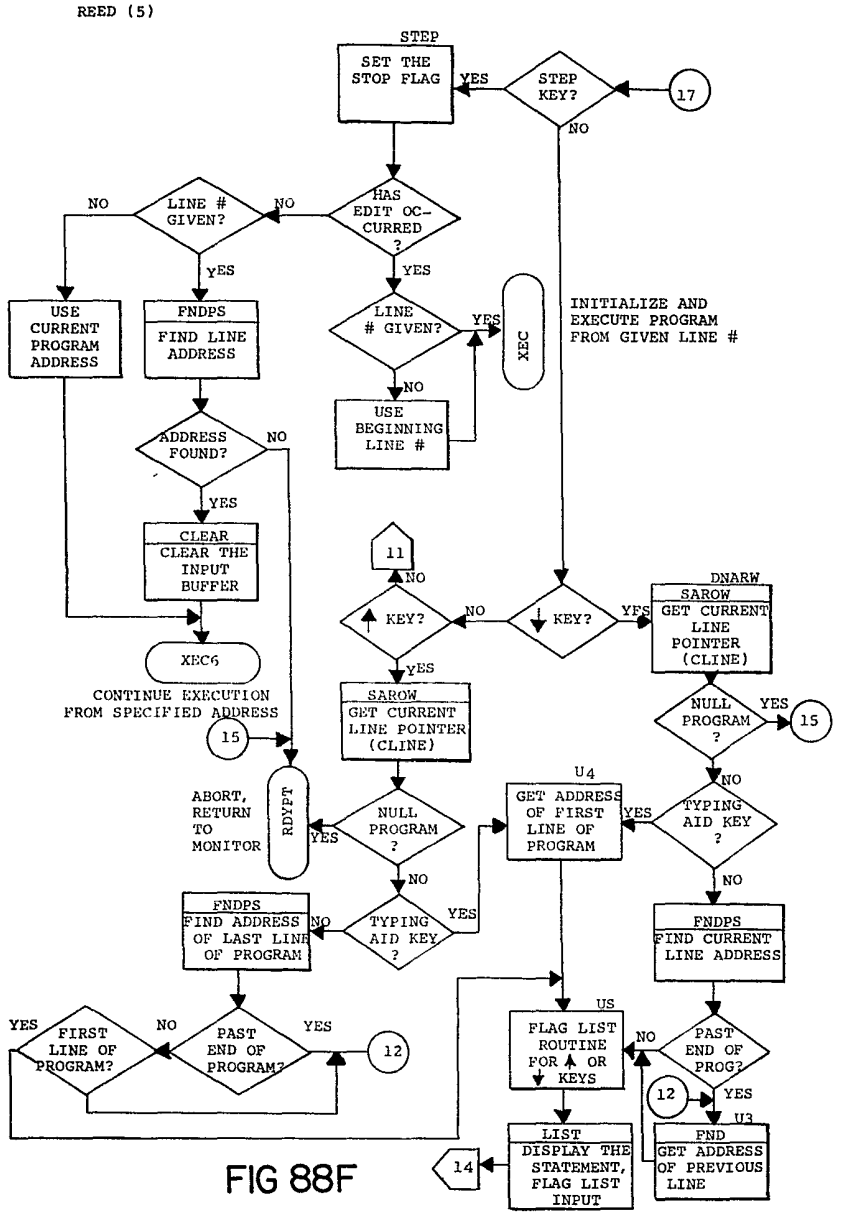

REED (5)
STEP
SET THE STOP FLAG
STEP KEY?
YES
NO
17
HAS EDIT OCCURRED ?
LINE # GIVEN?
NO
YES
USE CURRENT PROGRAM ADDRESS
FNDPS
FIND LINE ADDRESS
LINE # GIVEN?
XEC
INITIALIZE AND EXECUTE PROGRAM FROM GIVEN LINE #
USE BEGINNING LINE #
ADDRESS FOUND?
CLEAR
CLEAR THE INPUT BUFFER
XEC6
CONTINUE EXECUTION FROM SPECIFIED ADDRESS
15
11
↑ KEY?
↓ KEY?
DNARW
SAROW
GET CURRENT LINE POINTER (CLINE)
NULL PROGRAM ?
SAROW
GET CURRENT LINE POINTER (CLINE)
ABORT, RETURN TO MONITOR
RDYPT
NULL PROGRAM ?
U4
GET ADDRESS OF FIRST LINE OF PROGRAM
TYPING AID KEY ?
FNDPS
FIND ADDRESS OF LAST LINE OF PROGRAM
TYPING AID KEY ?
FNDPS
FIND CURRENT LINE ADDRESS
FIRST LINE OF PROGRAM?
PAST END OF PROGRAM?
12
U5
FLAG LIST ROUTINE FOR ↑ OR ↓ KEYS
PAST END OF PROG?
U3
FND
GET ADDRESS OF PREVIOUS LINE
LIST
DISPLAY THE STATEMENT, FLAG LIST INPUT
14

FIG 88F

REED (6)

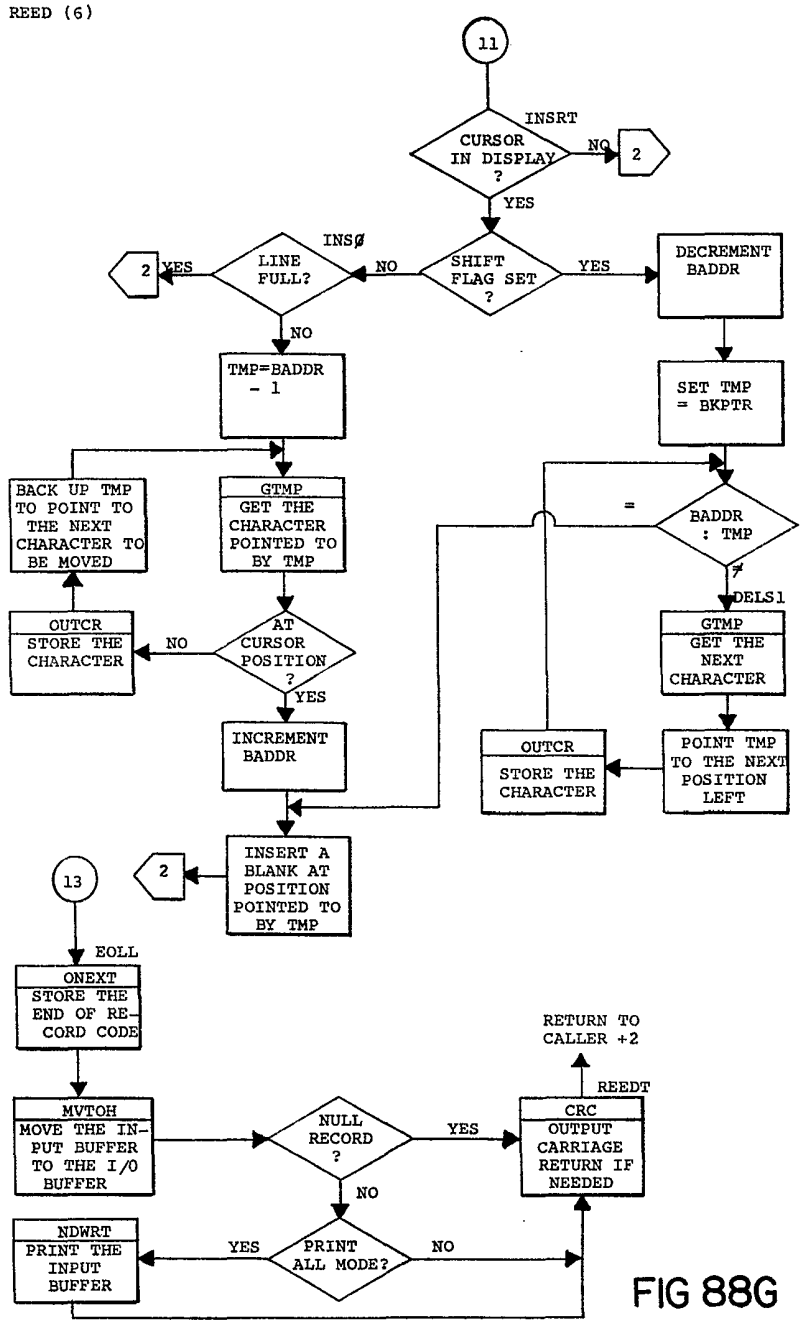


FIG 88G

LEFT SUBROUTINE

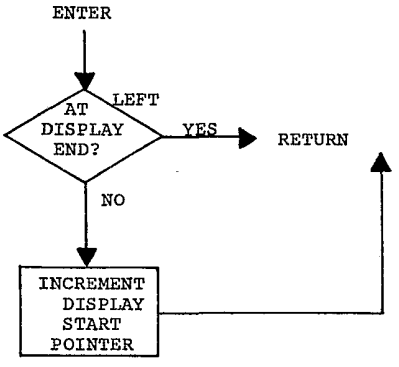


FIG 89A

RIGHT SUBROUTINE

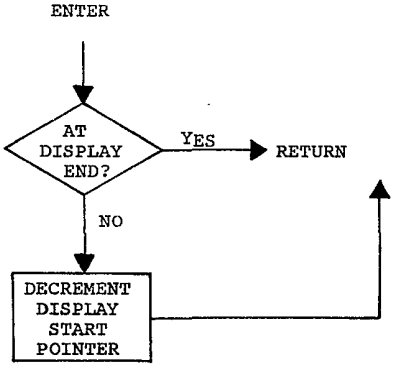


FIG 89B

CLEAR SUBROUTINE

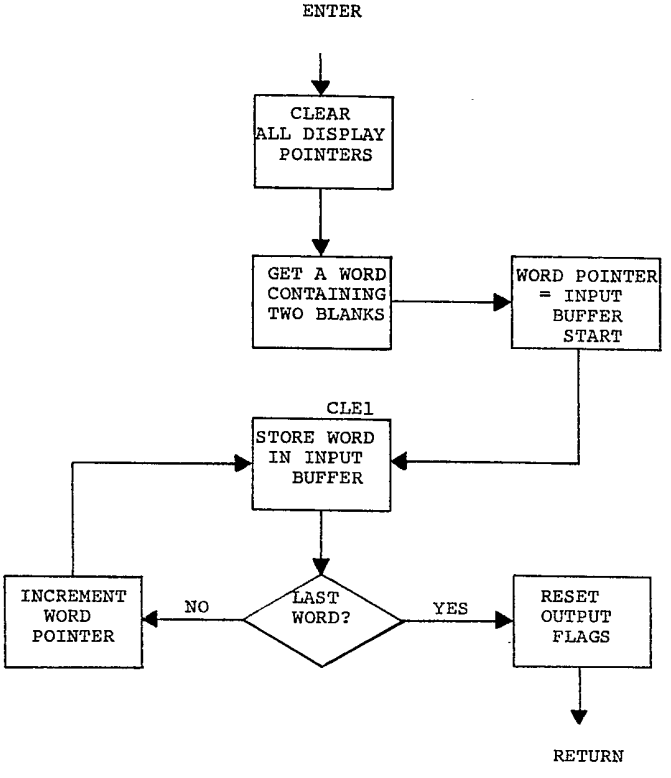


FIG 90

SAROW SUBROUTINE

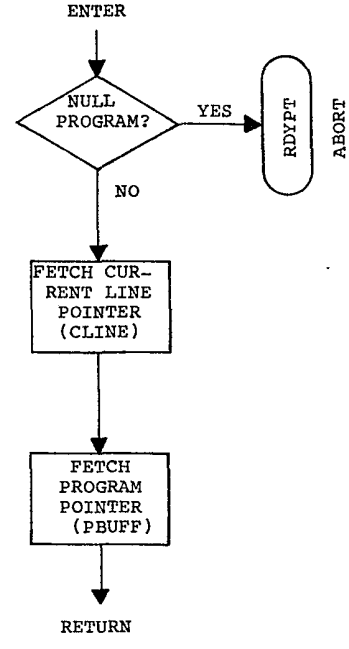


FIG 91

CALLK SUBROUTINE

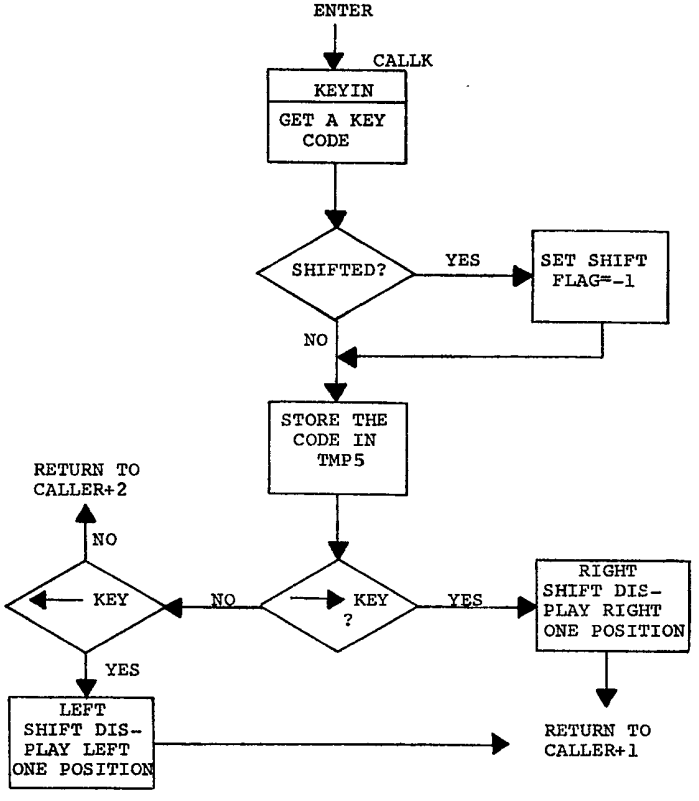


FIG. 92

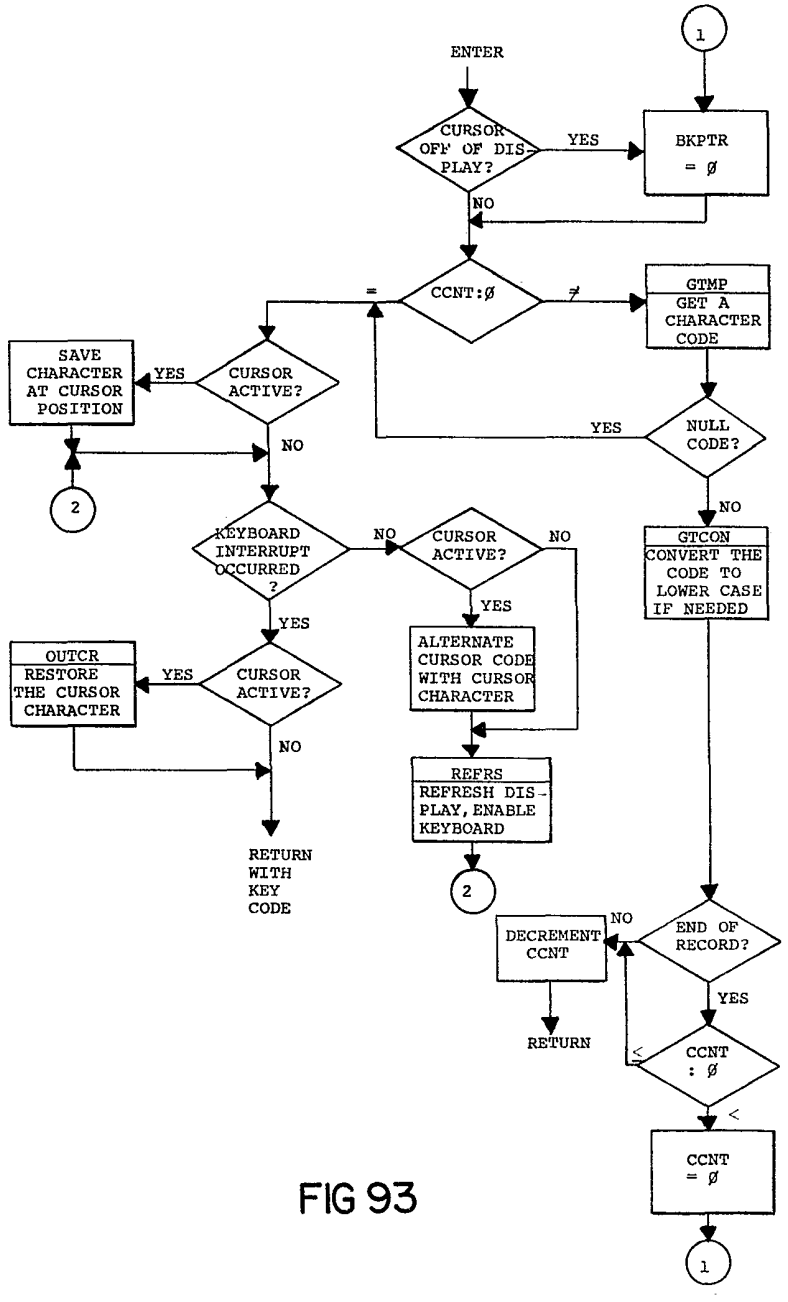
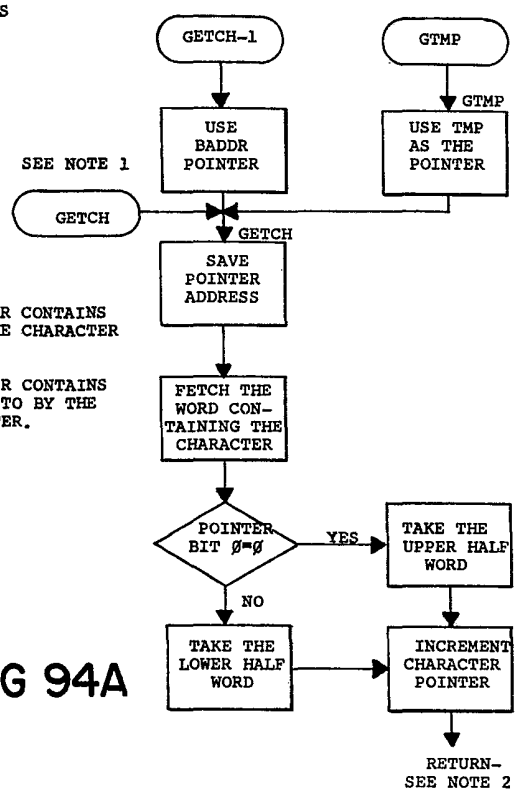

ENTER
CURSOR OFF OF DISPLAY?
YES
BKPTR = ø
NO
CCNT:ø
=
≠
GTMP
GET A CHARACTER CODE
NULL CODE?
YES
NO
SAVE CHARACTER AT CURSOR POSITION
YES
CURSOR ACTIVE?
NO
2
KEYBOARD INTERRUPT OCCURRED ?
NO
CURSOR ACTIVE?
NO
YES
GTCON
CONVERT THE CODE TO LOWER CASE IF NEEDED
YES
OUTCR
RESTORE THE CURSOR CHARACTER
YES
CURSOR ACTIVE?
NO
ALTERNATE CURSOR CODE WITH CURSOR CHARACTER
REFRS
REFRESH DISPLAY, ENABLE KEYBOARD
RETURN WITH KEY CODE
2
DECREMENT CCNT
NO
END OF RECORD?
YES
RETURN
≤
CCNT : ø
<
CCNT = ø
1
1

FIG 93

GETCH
GTMP
GNEXT
GTCON

GET CHARACTER SUBROUTINES



NOTE 1: THE B REGISTER CONTAINS THE WORD ADDRESS OF THE CHARACTER POINTER UPON ENTRY.

NOTE 2: THE A REGISTER CONTAINS THE CHARACTER POINTED TO BY THE PASSED CHARACTER POINTER.

FIG 94A

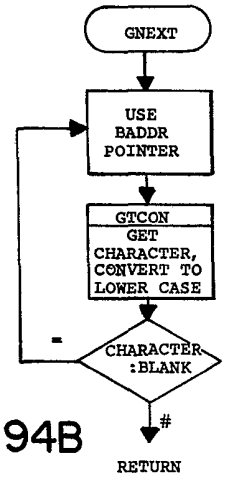


FIG 94B

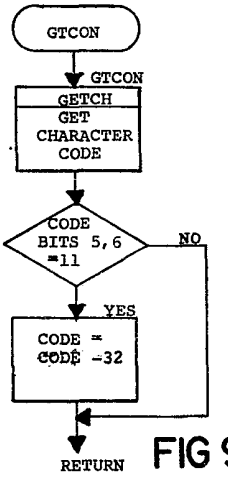


FIG 94C

OBLNK
ONEXT OUTPUT SUBROUTINES
OUTCR

NOTE 1: UPON ENTERING OUTCR THE A REGISTER HAS THE CHARACTER TO BE STORED, THE B REGISTER HAS THE ADDRESS OF THE CHARACTER POINTER WHERE THE CHARACTER IS TO BE STORED.

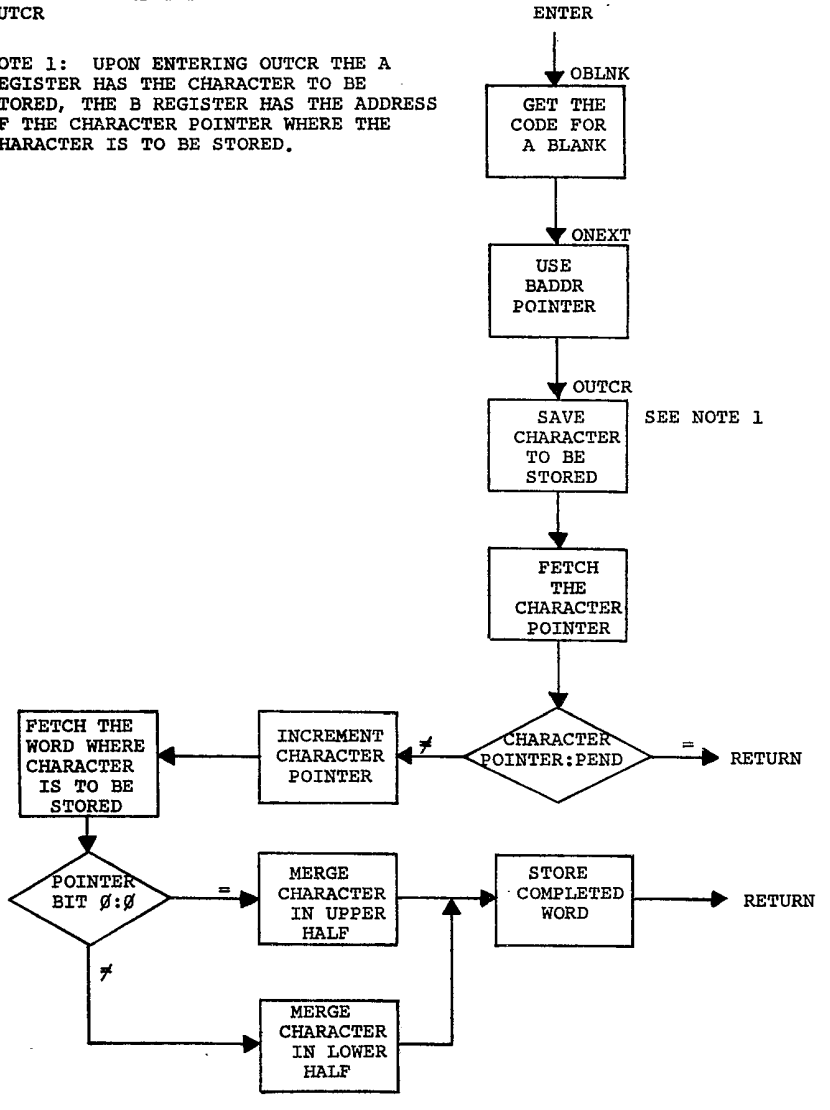


FIG. 94D

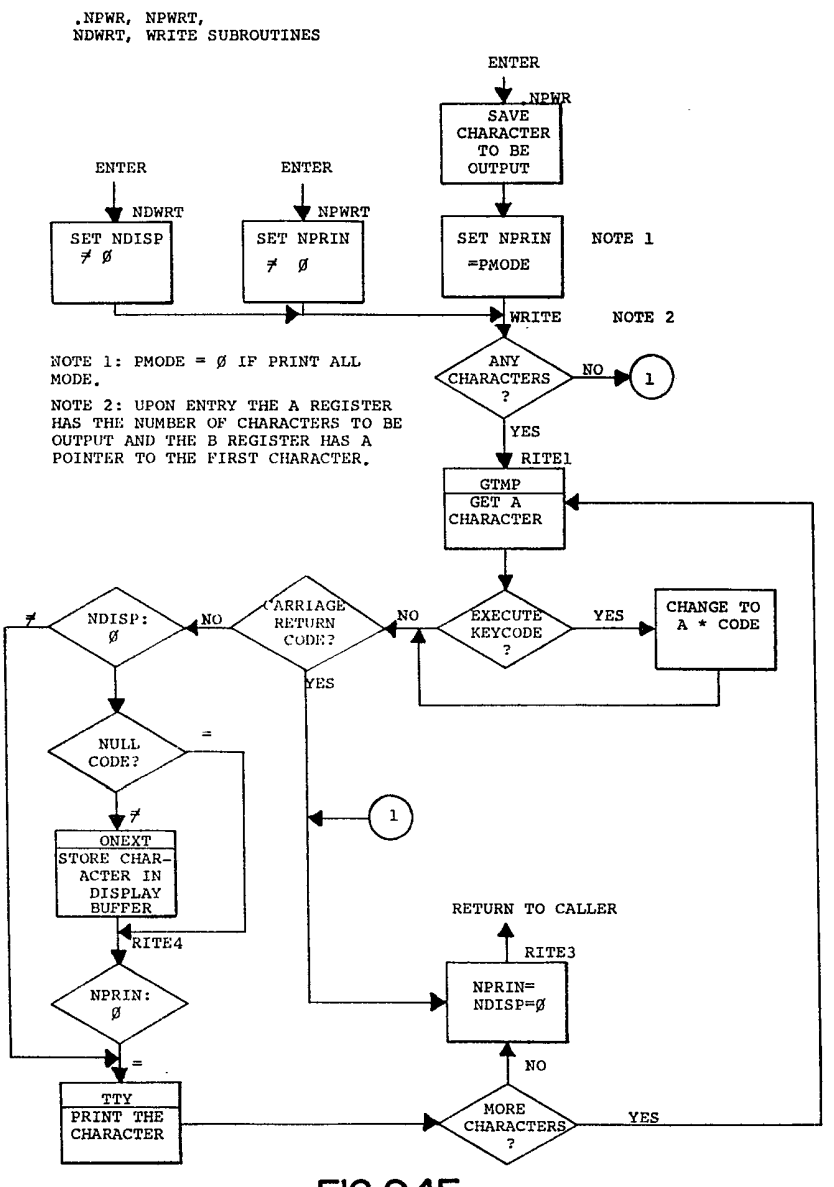

.NPWR, NPWRT,
NDWRT, WRITE SUBROUTINES
ENTER
.NPWR
SAVE CHARACTER TO BE OUTPUT
ENTER
NDWRT
SET NDISP ≠ Ø
ENTER
NPWRT
SET NPRIN ≠ Ø
SET NPRIN =PMODE
NOTE 1
WRITE
NOTE 2
NOTE 1: PMODE = Ø IF PRINT ALL MODE.
NOTE 2: UPON ENTRY THE A REGISTER HAS THE NUMBER OF CHARACTERS TO BE OUTPUT AND THE B REGISTER HAS A POINTER TO THE FIRST CHARACTER.
ANY CHARACTERS ?
NO
1
YES
RITE1
GTMP
GET A CHARACTER
EXECUTE KEYCODE ?
YES
CHANGE TO A * CODE
NO
CARRIAGE RETURN CODE?
NO
NDISP: Ø
≠
YES
NULL CODE?
=
≠
ONEXT
STORE CHARACTER IN DISPLAY BUFFER
RITE4
NPRIN: Ø
=
1
RETURN TO CALLER
RITE3
NPRIN= NDISP=Ø
NO
TTY
PRINT THE CHARACTER
MORE CHARACTERS ?
YES

FIG 94E

TTY SUBROUTINE

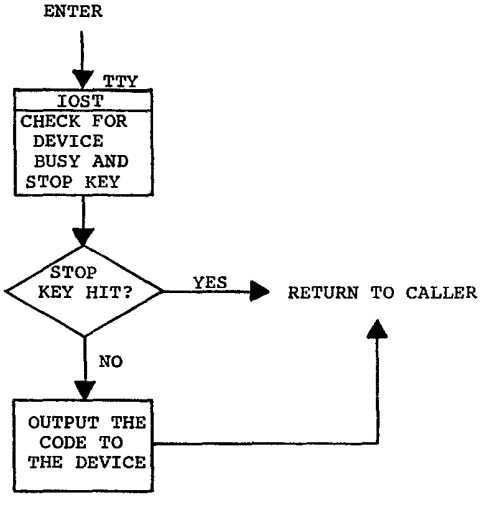


FIG 94F

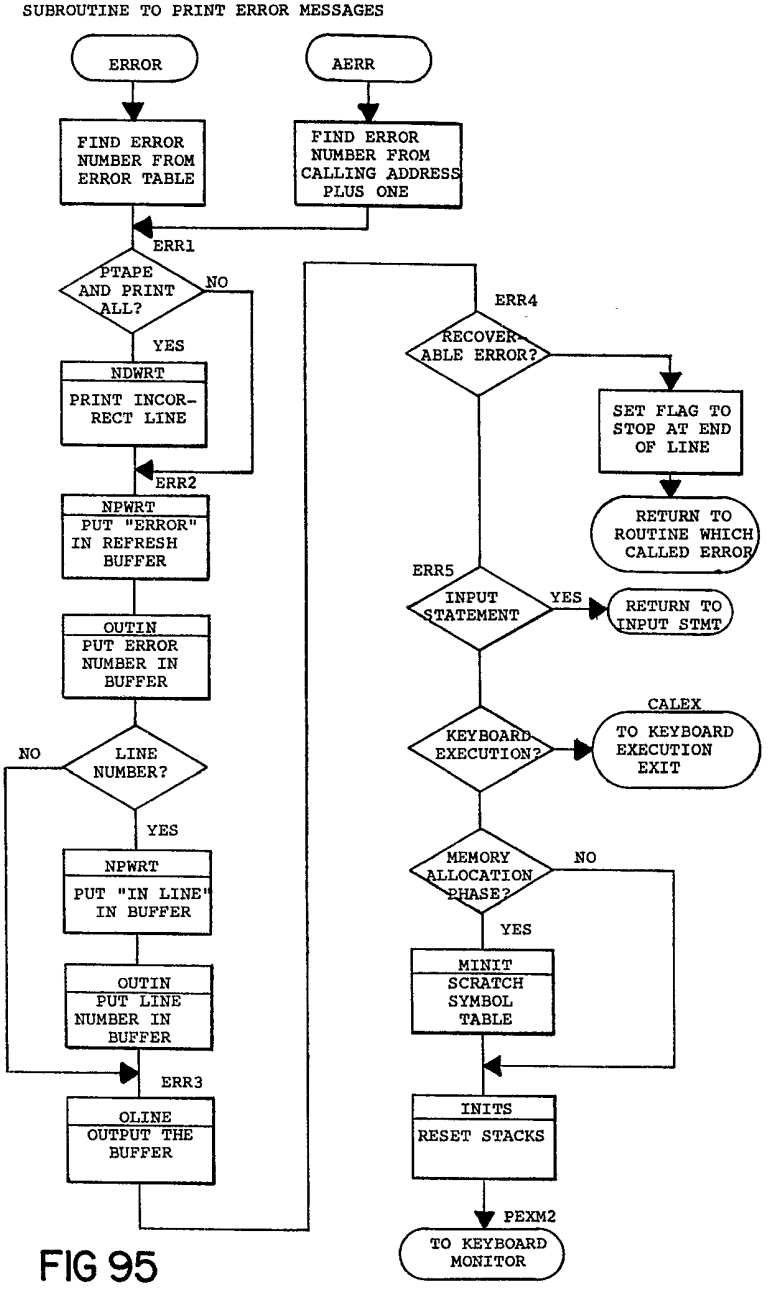

SUBROUTINE TO PRINT ERROR MESSAGES
ERROR
AERR
FIND ERROR NUMBER FROM ERROR TABLE
FIND ERROR NUMBER FROM CALLING ADDRESS PLUS ONE
ERR1
PTAPE AND PRINT ALL?
NO
YES
NDWRT
PRINT INCORRECT LINE
ERR2
NPWRT
PUT "ERROR" IN REFRESH BUFFER
OUTIN
PUT ERROR NUMBER IN BUFFER
NO
LINE NUMBER?
YES
NPWRT
PUT "IN LINE" IN BUFFER
OUTIN
PUT LINE NUMBER IN BUFFER
ERR3
OLINE
OUTPUT THE BUFFER
ERR4
RECOVERABLE ERROR?
SET FLAG TO STOP AT END OF LINE
RETURN TO ROUTINE WHICH CALLED ERROR
ERR5
INPUT STATEMENT
YES
RETURN TO INPUT STMT
CALEX
KEYBOARD EXECUTION?
TO KEYBOARD EXECUTION EXIT
MEMORY ALLOCATION PHASE?
NO
YES
MINIT
SCRATCH SYMBOL TABLE
INITS
RESET STACKS
PEXM2
TO KEYBOARD MONITOR

FIG 95

ROUTINE TO ADD OR REPLACE A STATEMENT IN USER'S MEMORY

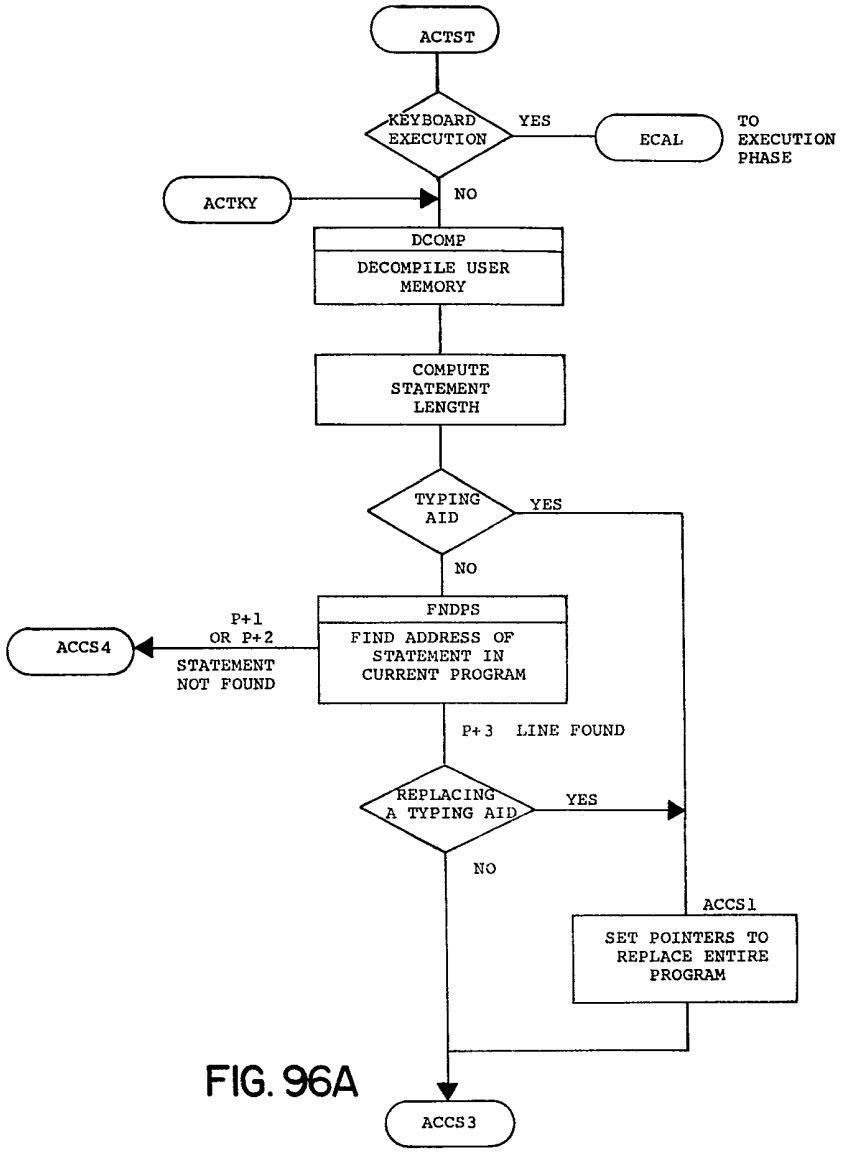


FIG. 96A

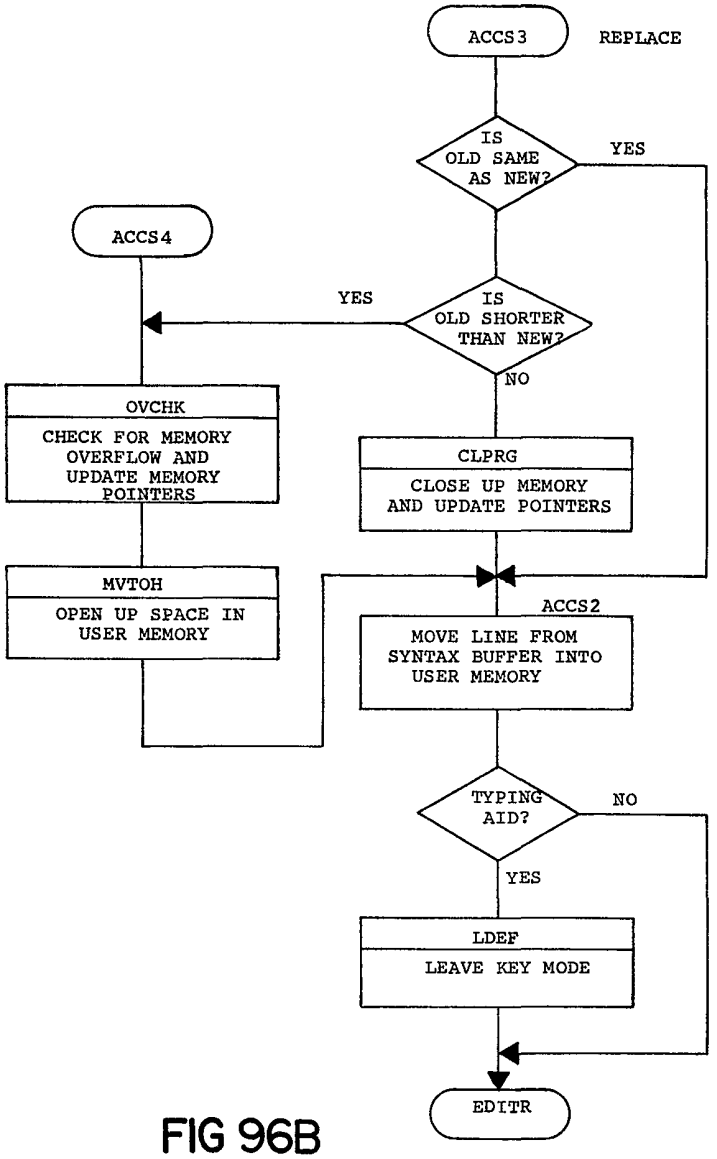

ACCS3
REPLACE
IS OLD SAME AS NEW?
YES
ACCS4
YES
IS OLD SHORTER THAN NEW?
NO
OVCHK
CHECK FOR MEMORY OVERFLOW AND UPDATE MEMORY POINTERS
CLPRG
CLOSE UP MEMORY AND UPDATE POINTERS
MVTOH
OPEN UP SPACE IN USER MEMORY
ACCS2
MOVE LINE FROM SYNTAX BUFFER INTO USER MEMORY
TYPING AID?
NO
YES
LDEF
LEAVE KEY MODE
EDITR

FIG 96B

ROUTINE TO DELETE A STATEMENT FROM USER'S MEMORY

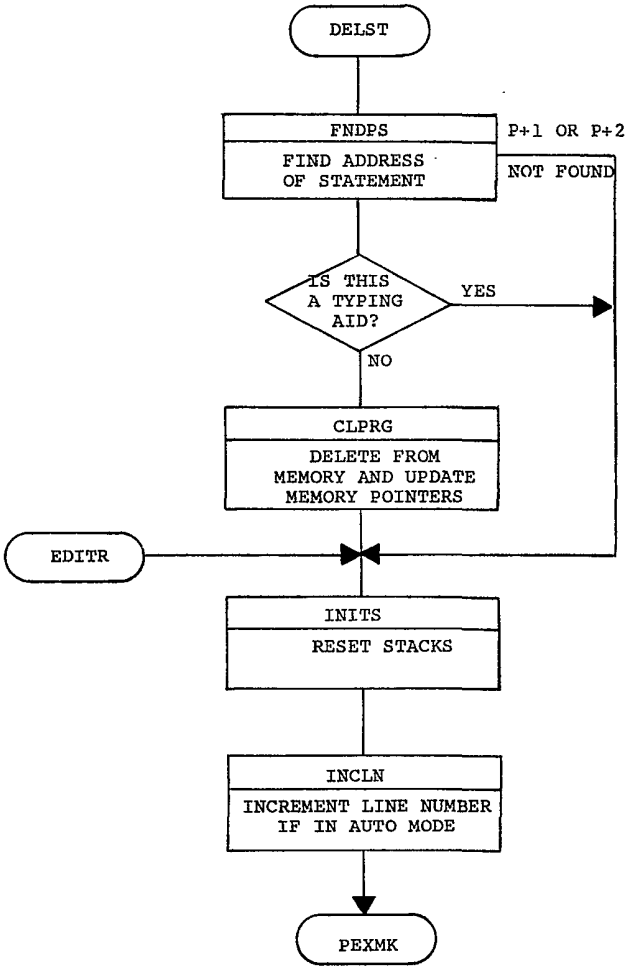


FIG 96C

SUBROUTINES TO ADJUST USER MEMORY AND UPDATE USER MEMORY POINTERS

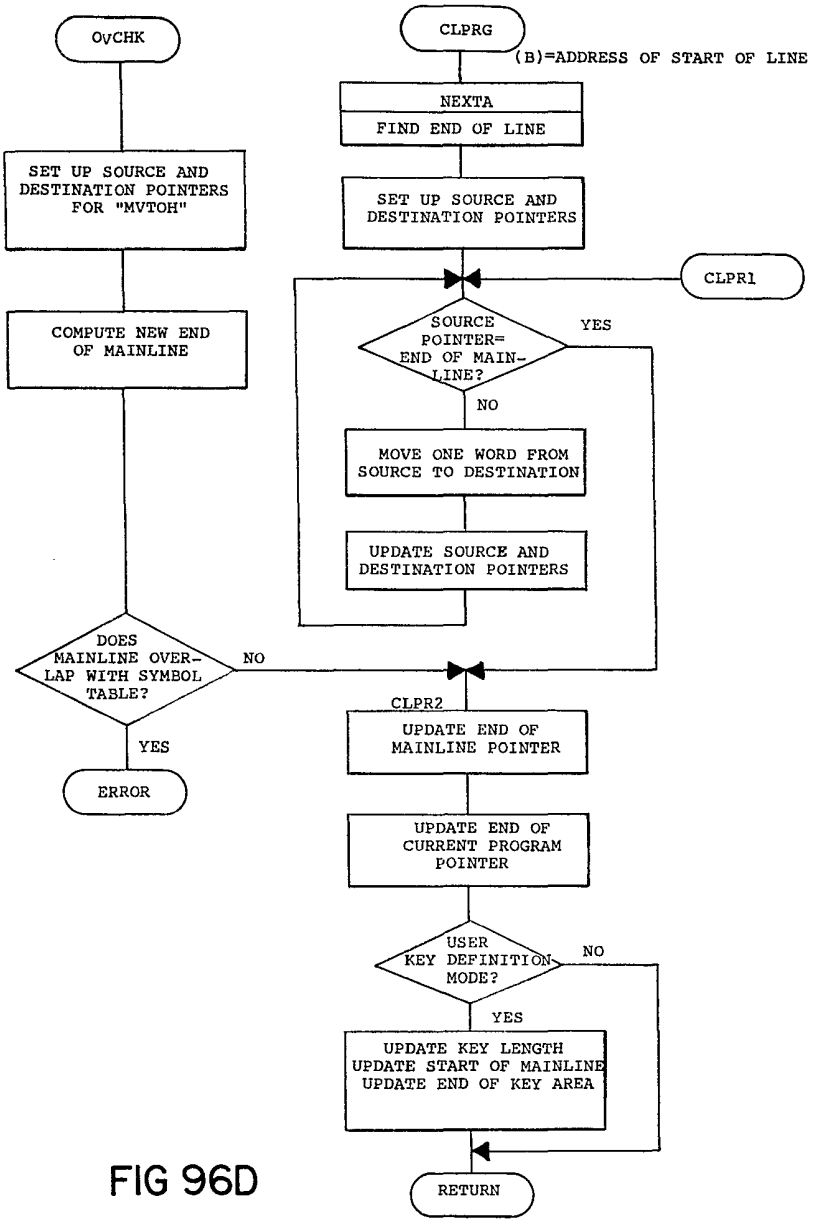


FIG 96D

MVTOH SUBROUTINE

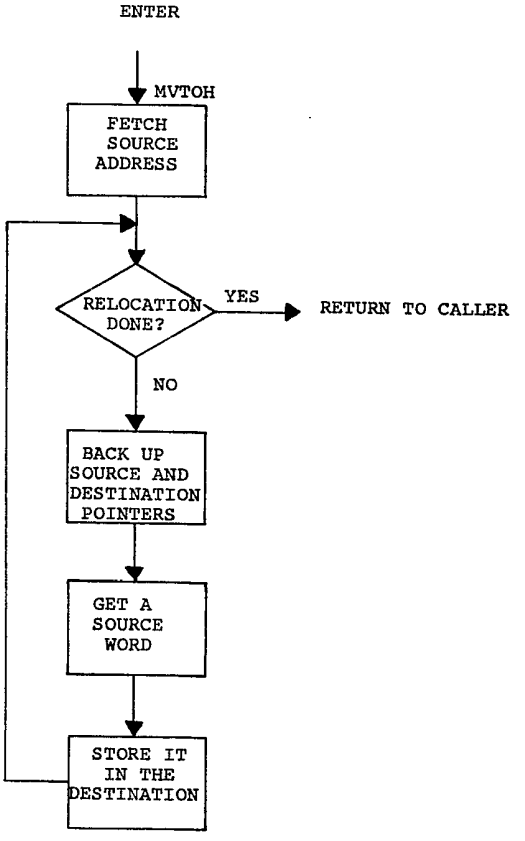


FIG. 97

FNDPS SUBROUTINE

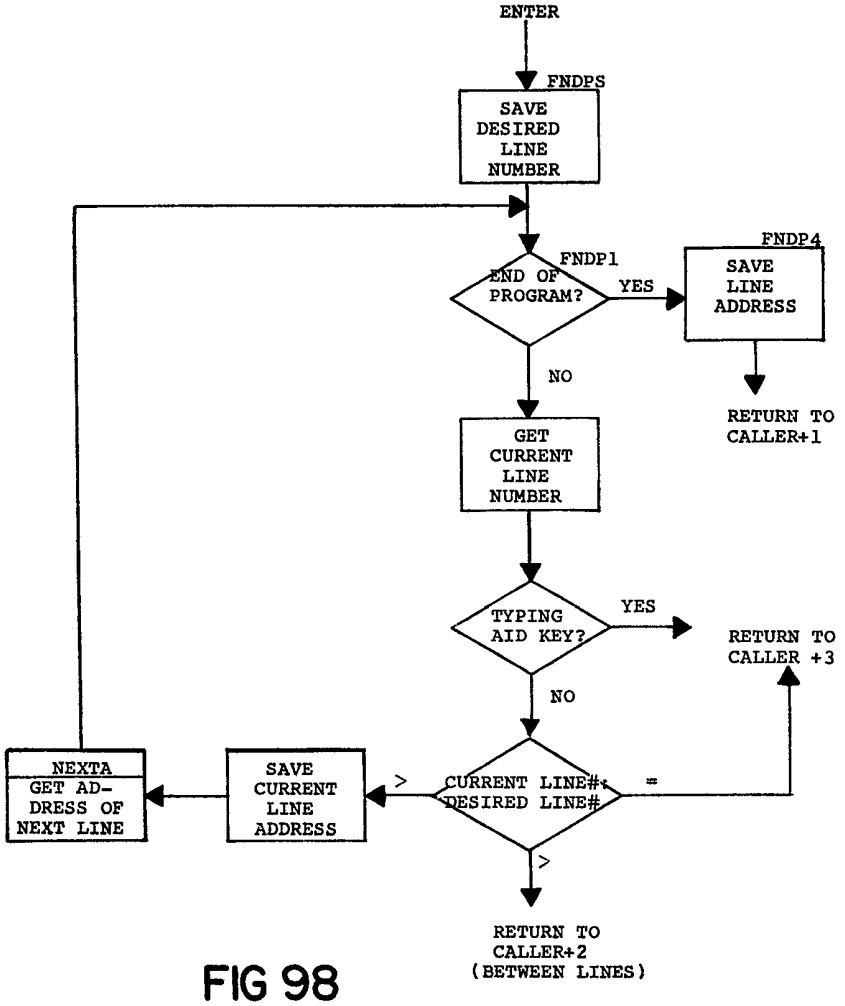


FIG 98

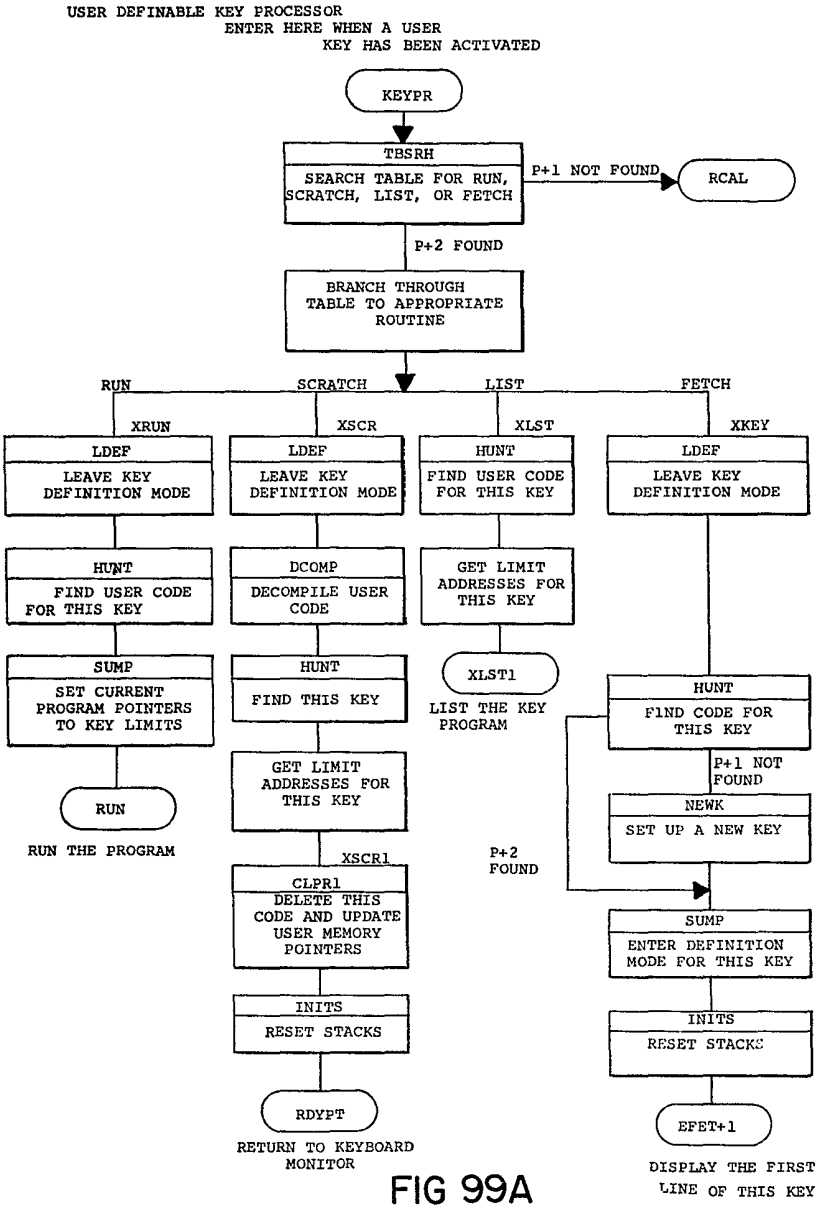

USER DEFINABLE KEY PROCESSOR
ENTER HERE WHEN A USER KEY HAS BEEN ACTIVATED
KEYPR
TBSRH
SEARCH TABLE FOR RUN, SCRATCH, LIST, OR FETCH
P+1 NOT FOUND
RCAL
P+2 FOUND
BRANCH THROUGH TABLE TO APPROPRIATE ROUTINE
RUN
SCRATCH
LIST
FETCH
XRUN
XSCR
XLST
XKEY
LDEF
LEAVE KEY DEFINITION MODE
LDEF
LEAVE KEY DEFINITION MODE
HUNT
FIND USER CODE FOR THIS KEY
LDEF
LEAVE KEY DEFINITION MODE
HUNT
FIND USER CODE FOR THIS KEY
DCOMP
DECOMPILE USER CODE
GET LIMIT ADDRESSES FOR THIS KEY
SUMP
SET CURRENT PROGRAM POINTERS TO KEY LIMITS
HUNT
FIND THIS KEY
XLST1
LIST THE KEY PROGRAM
HUNT
FIND CODE FOR THIS KEY
RUN
RUN THE PROGRAM
GET LIMIT ADDRESSES FOR THIS KEY
P+1 NOT FOUND
NEWK
SET UP A NEW KEY
XSCR1
P+2 FOUND
CLPR1
DELETE THIS CODE AND UPDATE USER MEMORY POINTERS
SUMP
ENTER DEFINITION MODE FOR THIS KEY
INITS
RESET STACKS
INITS
RESET STACKS
RDYPT
RETURN TO KEYBOARD MONITOR
EFET+1
DISPLAY THE FIRST LINE OF THIS KEY

FIG 99A

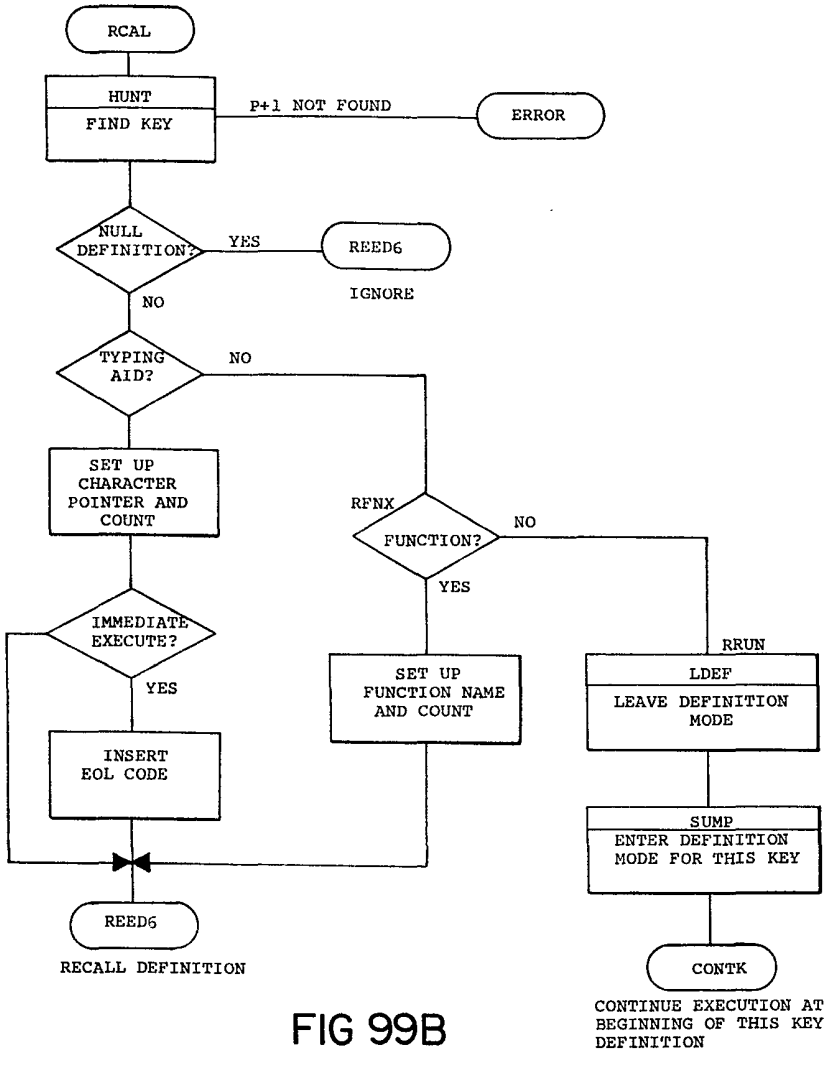

RCAL
HUNT
FIND KEY
P+1 NOT FOUND
ERROR
NULL DEFINITION?
YES
REED6
IGNORE
NO
TYPING AID?
NO
SET UP CHARACTER POINTER AND COUNT
RFNX
FUNCTION?
NO
YES
IMMEDIATE EXECUTE?
YES
INSERT EOL CODE
SET UP FUNCTION NAME AND COUNT
RRUN
LDEF
LEAVE DEFINITION MODE
SUMP
ENTER DEFINITION MODE FOR THIS KEY
REED6
RECALL DEFINITION
CONTK
CONTINUE EXECUTION AT BEGINNING OF THIS KEY DEFINITION

FIG 99B

USER DEFINABLE KEY SUBROUTINES

SET UP MEMORY POINTERS AND ENTER INTO DEFINITION MODE FOR A KEY

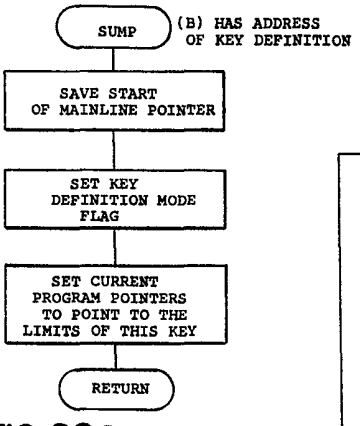


FIG 99C

FIND THE USER CODE FOR A PARTICULAR KEY

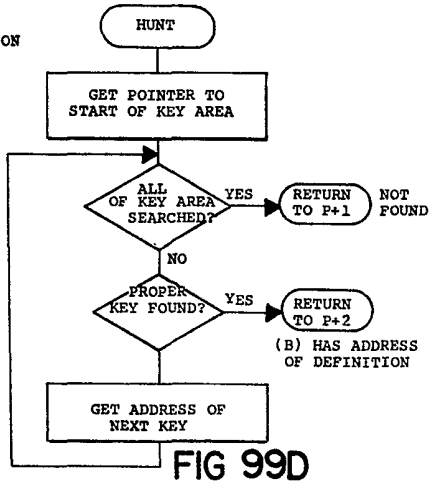


FIG 99D

SET UP A NEW KEY

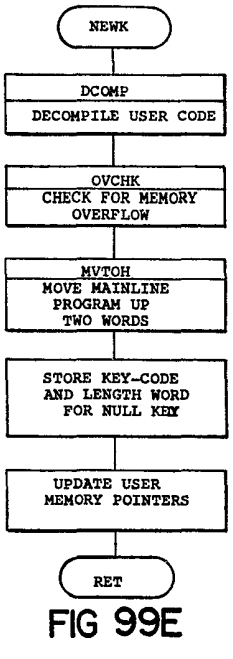


FIG 99E

LEAVE KEY DEFINITION MODE

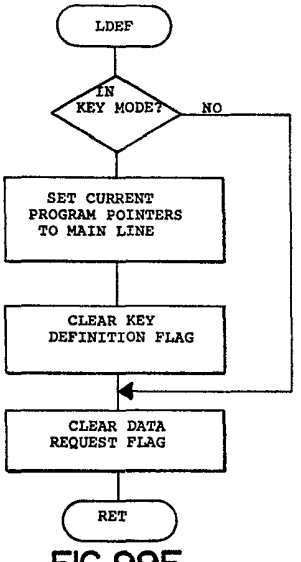


FIG 99F

1444141 COMPLETE SPECIFICATION
233 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 180

EXECUTION MONITOR (1)

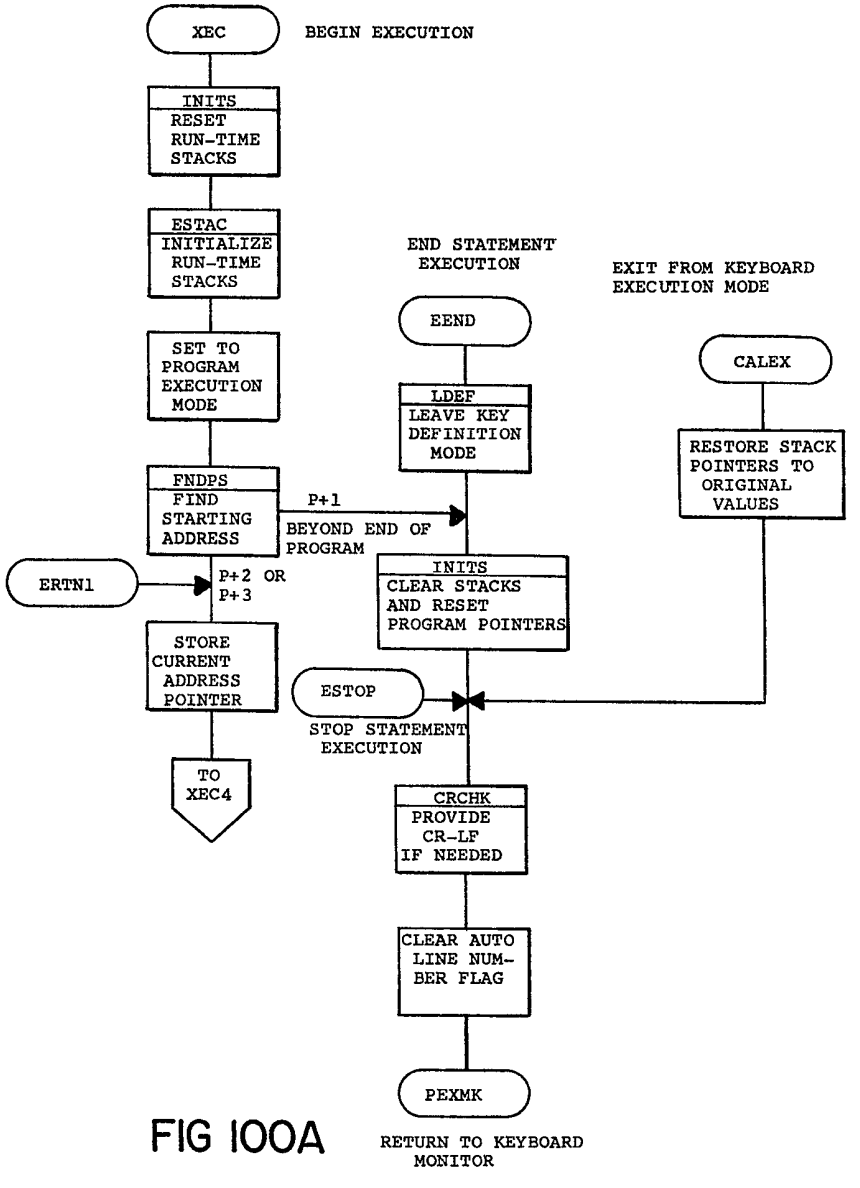


FIG 100A

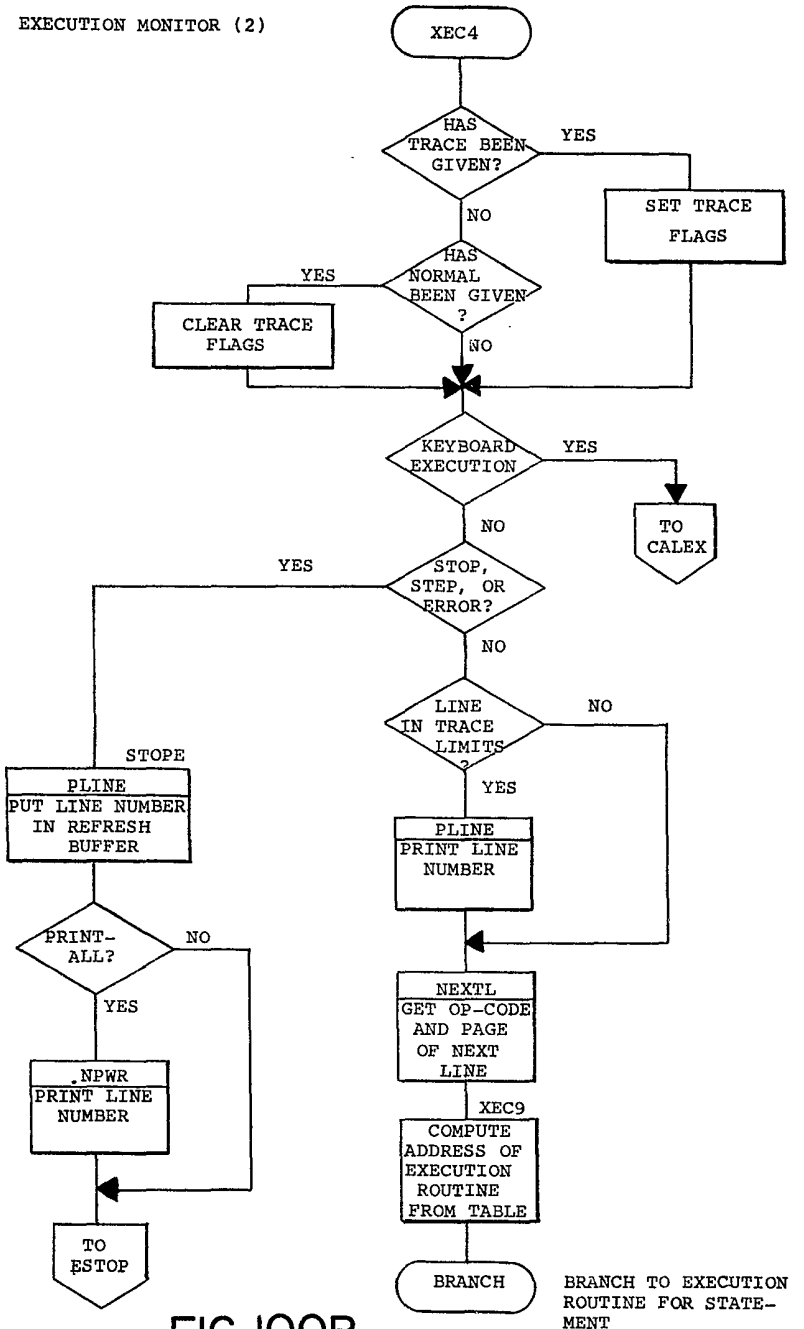

EXECUTION MONITOR (2)
XEC4
HAS TRACE BEEN GIVEN?
YES
NO
SET TRACE FLAGS
HAS NORMAL BEEN GIVEN ?
YES
NO
CLEAR TRACE FLAGS
KEYBOARD EXECUTION
YES
NO
TO CALEX
STOP, STEP, OR ERROR?
YES
NO
LINE IN TRACE LIMITS ?
NO
YES
STOPE
PLINE
PUT LINE NUMBER IN REFRESH BUFFER
PLINE
PRINT LINE NUMBER
PRINT-ALL?
NO
YES
NEXTL
GET OP-CODE AND PAGE OF NEXT LINE
.NPWR
PRINT LINE NUMBER
XEC9
COMPUTE ADDRESS OF EXECUTION ROUTINE FROM TABLE
TO ESTOP
BRANCH
BRANCH TO EXECUTION ROUTINE FOR STATE-MENT

FIG 100B

INITIALIZATION FOR KEYBOARD EXECUTION

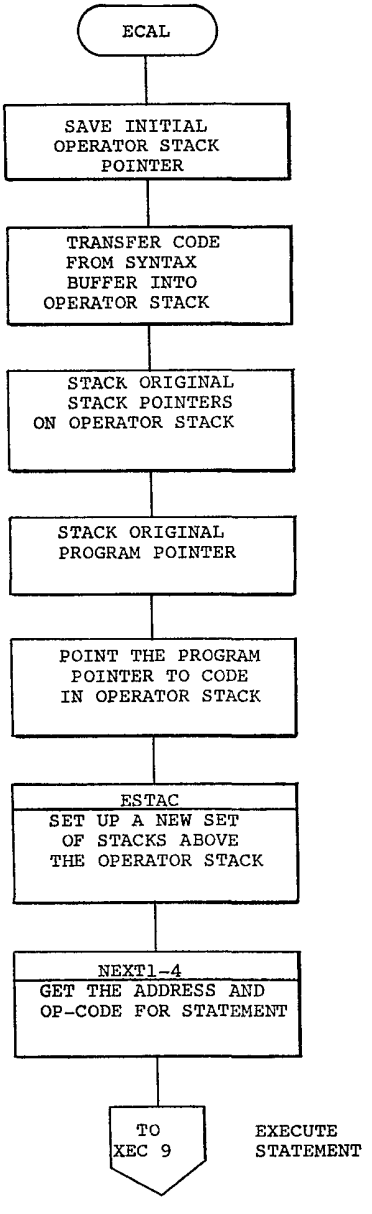


FIG 100C

SUBROUTINE TO SET UP RUN-TIME STACKS

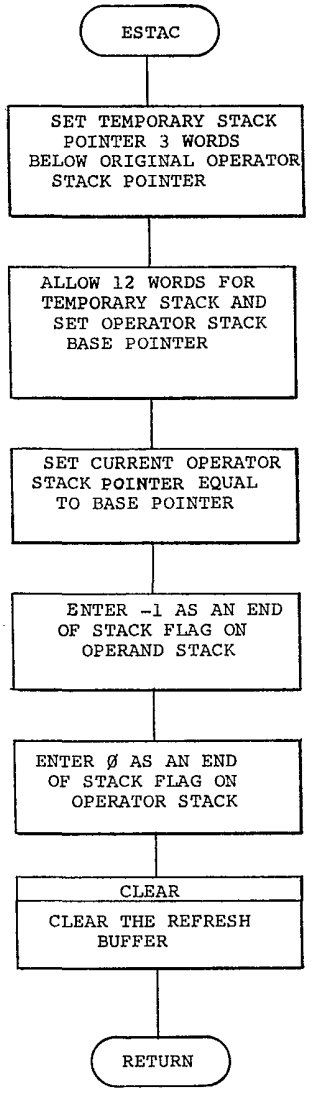


FIG 100D

LOAD A PROGRAM FROM THE CASSETTE

THE COMMAND IS: LOAD #UNIT, FILE NO.,
LNX1, LNX2

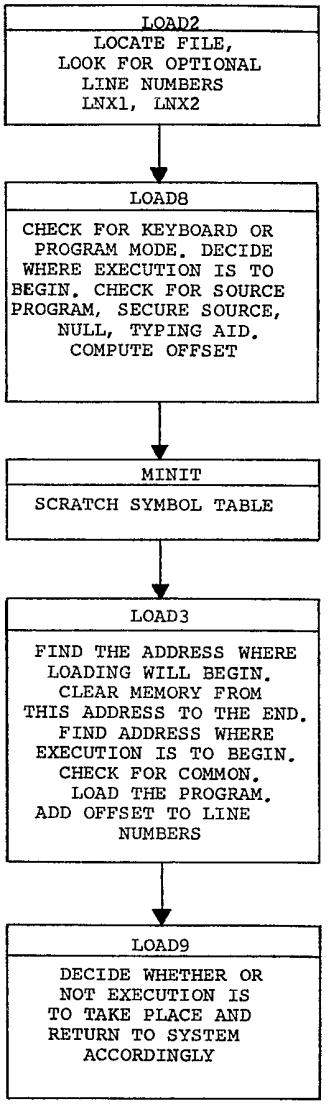


FIG. 101

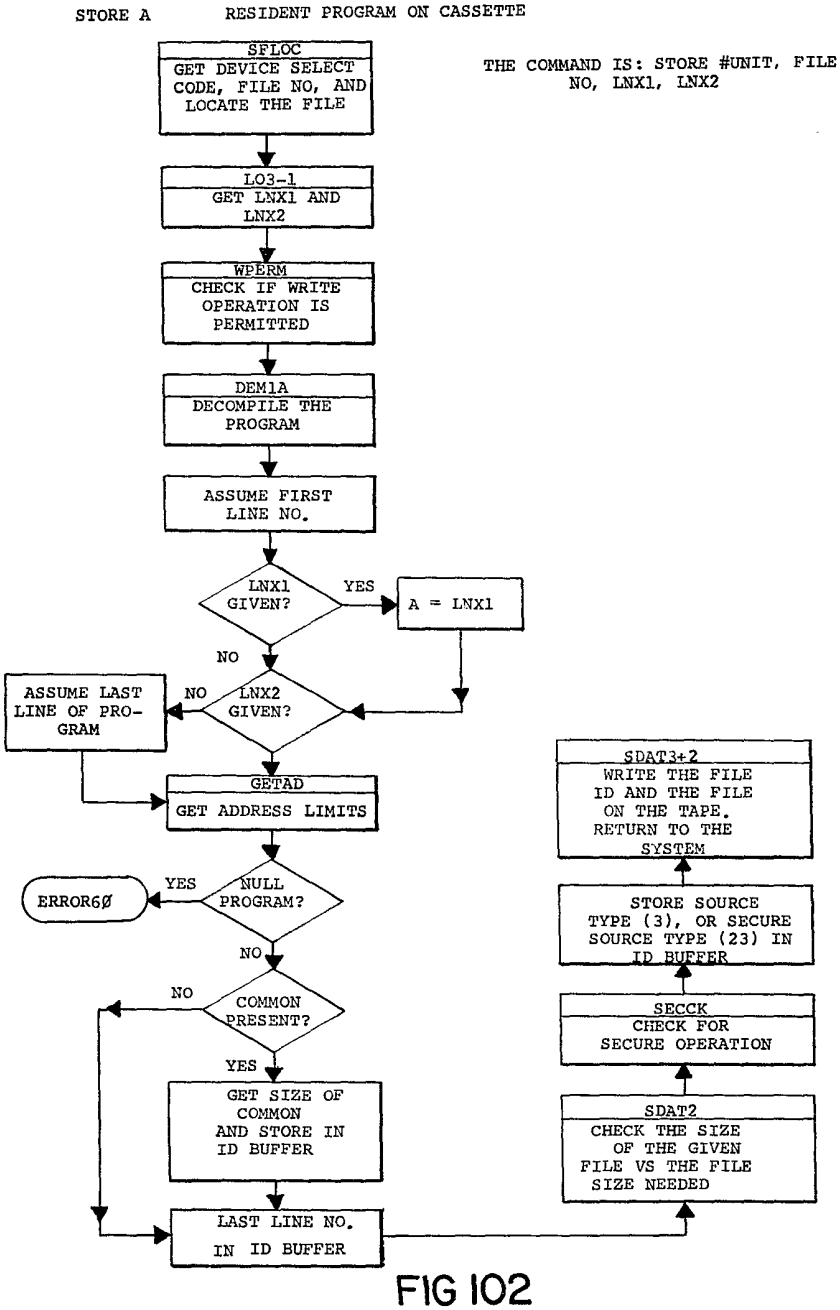

STORE A RESIDENT PROGRAM ON CASSETTE
THE COMMAND IS: STORE #UNIT, FILE NO, LNX1, LNX2
SFLOC
GET DEVICE SELECT CODE, FILE NO, AND LOCATE THE FILE
LO3-1
GET LNX1 AND LNX2
WPERM
CHECK IF WRITE OPERATION IS PERMITTED
DEM1A
DECOMPILE THE PROGRAM
ASSUME FIRST LINE NO.
LNX1 GIVEN?
YES
A = LNX1
NO
ASSUME LAST LINE OF PRO-GRAM
NO
LNX2 GIVEN?
GETAD
GET ADDRESS LIMITS
YES
ERROR6Ø
NULL PROGRAM?
NO
NO
COMMON PRESENT?
YES
GET SIZE OF COMMON AND STORE IN ID BUFFER
LAST LINE NO. IN ID BUFFER
SDAT2
CHECK THE SIZE OF THE GIVEN FILE VS THE FILE SIZE NEEDED
SECCK
CHECK FOR SECURE OPERATION
STORE SOURCE TYPE (3), OR SECURE SOURCE TYPE (23) IN ID BUFFER
SDAT3+2
WRITE THE FILE ID AND THE FILE ON THE TAPE. RETURN TO THE SYSTEM

FIG 102

MERGE ROUTINE

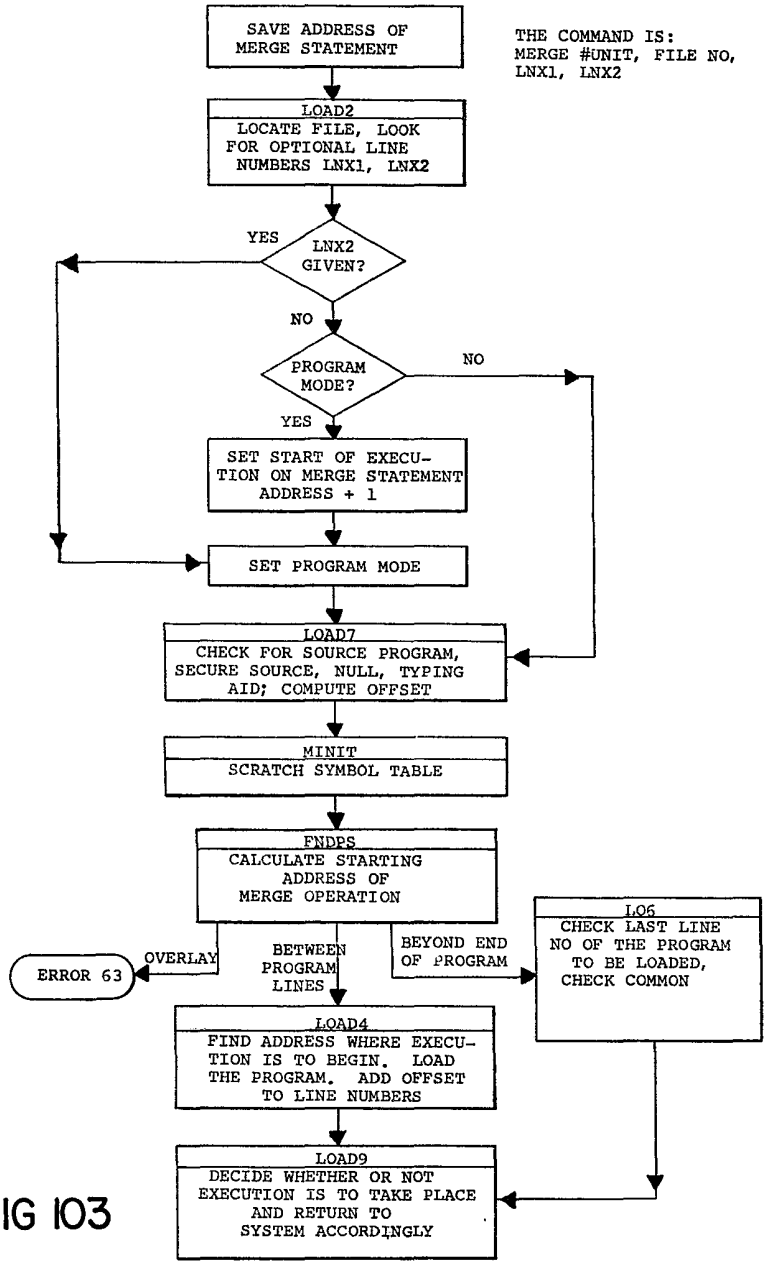


FIG 103

LINK ROUTINE

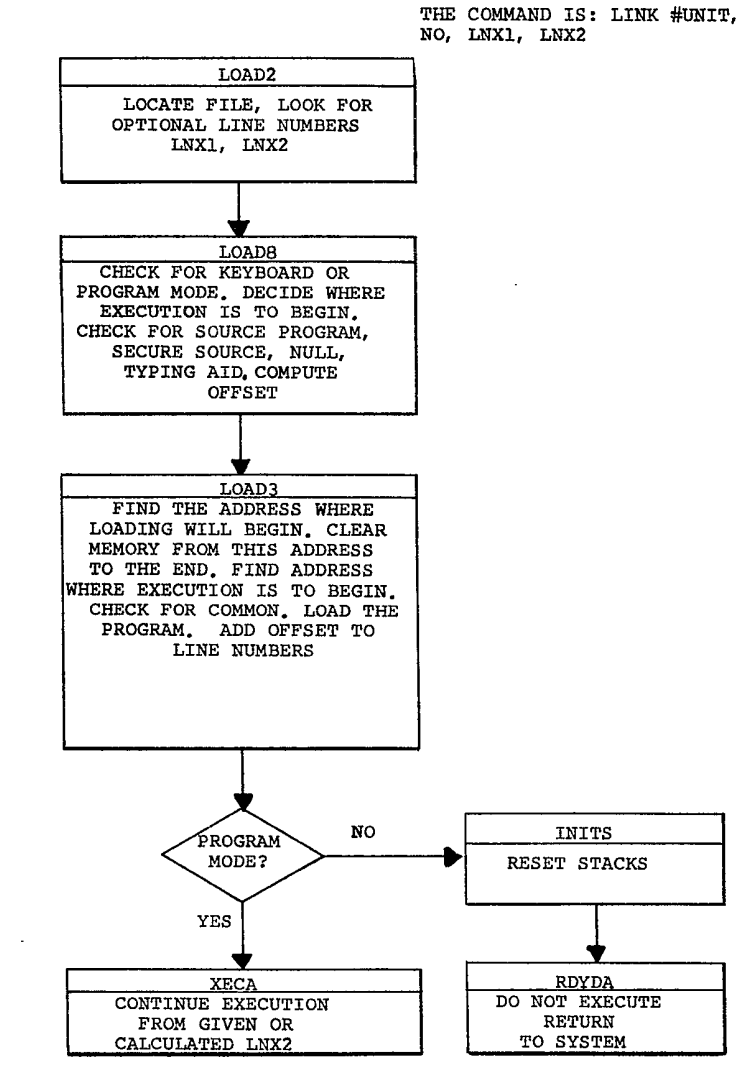


FIG 104

FIND COMMAND EXECUTION

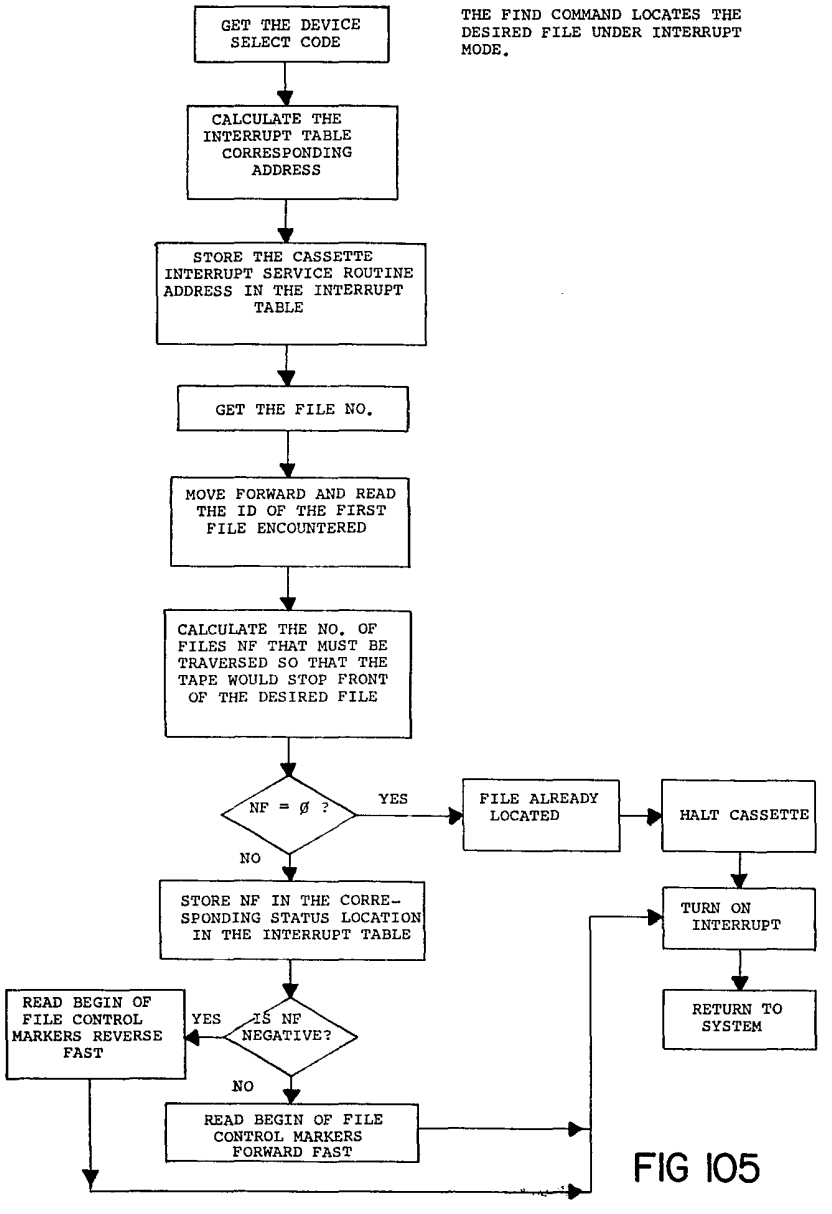


FIG 105

LOAD2 SUBROUTINE

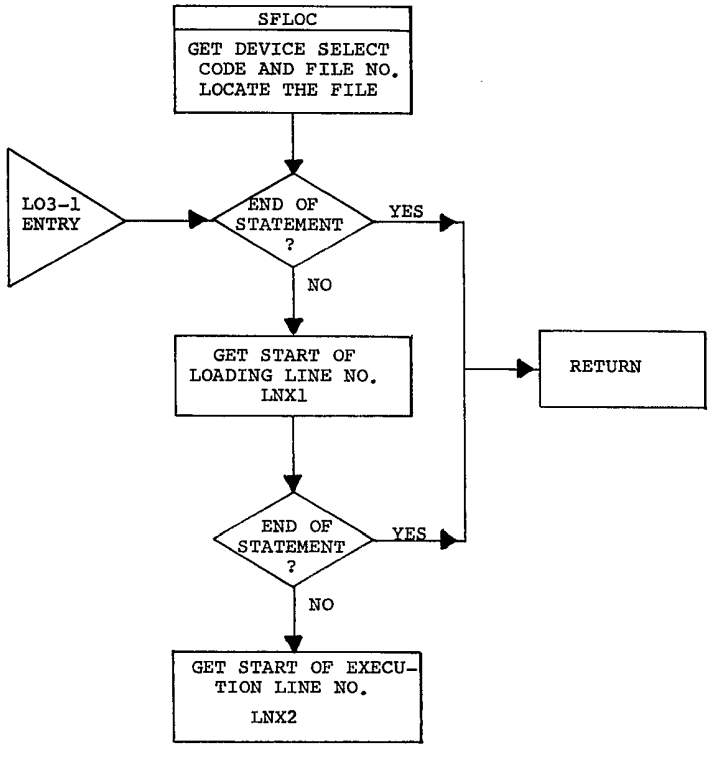


FIG 106A

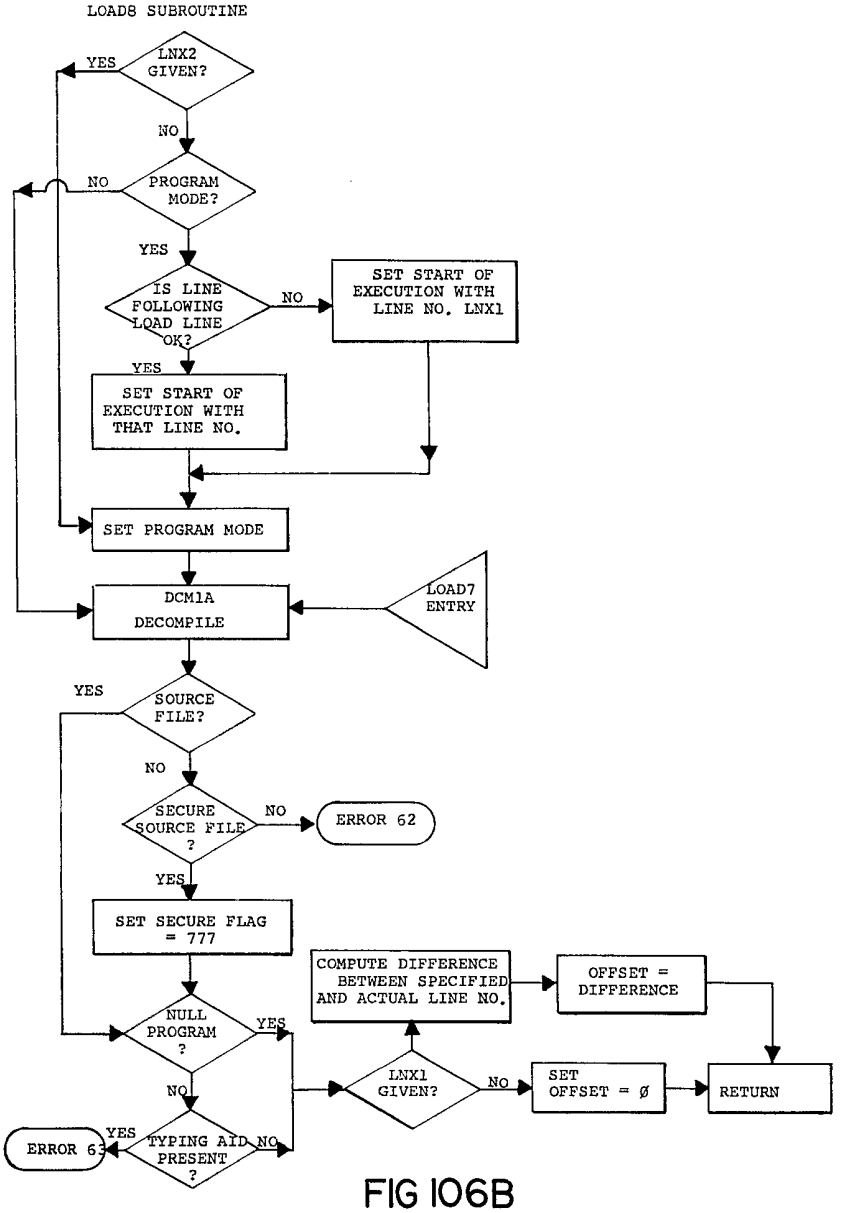

LOAD8 SUBROUTINE
LNX2 GIVEN?
YES
NO
PROGRAM MODE?
NO
YES
IS LINE FOLLOWING LOAD LINE OK?
NO
SET START OF EXECUTION WITH LINE NO. LNX1
YES
SET START OF EXECUTION WITH THAT LINE NO.
SET PROGRAM MODE
DCM1A DECOMPILE
LOAD7 ENTRY
SOURCE FILE?
YES
NO
SECURE SOURCE FILE ?
NO
ERROR 62
YES
SET SECURE FLAG = 777
NULL PROGRAM ?
YES
NO
TYPING AID PRESENT ?
YES
ERROR 63
NO
LNX1 GIVEN?
NO
COMPUTE DIFFERENCE BETWEEN SPECIFIED AND ACTUAL LINE NO.
OFFSET = DIFFERENCE
SET OFFSET = ø
RETURN

FIG 106B

LOAD3 SUBROUTINE

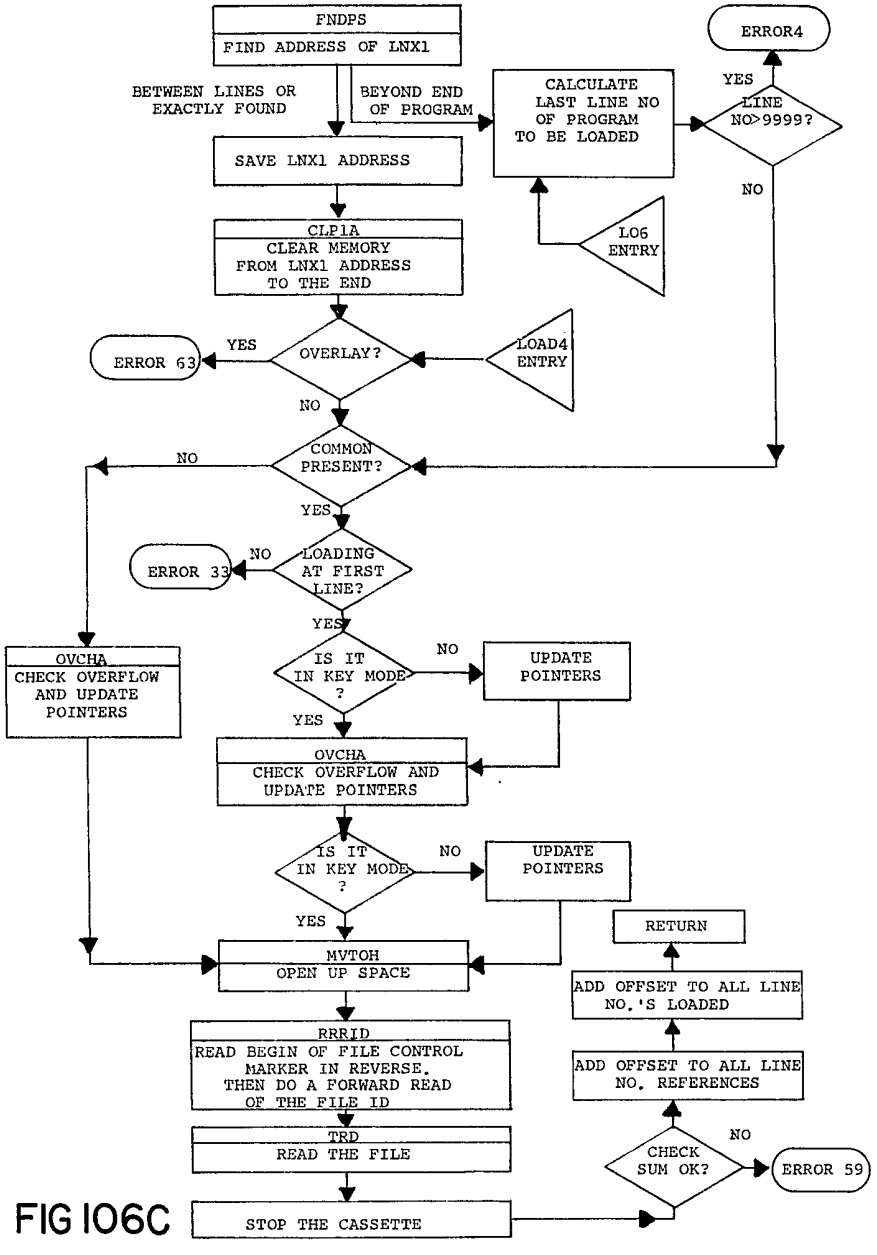


FIG 106C

LOAD9 SUBROUTINE

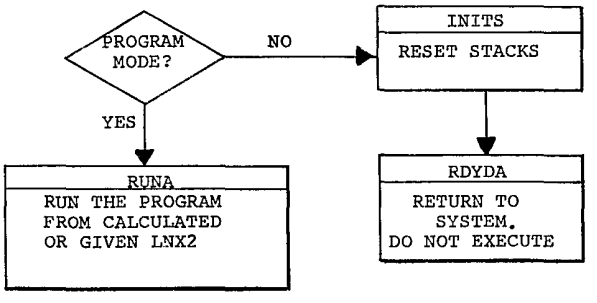


FIG 106D

LOAD DATA ROUTINE

THE COMMAND IS: LOAD DATA #UNIT, FILE NO, ARRAY NAME

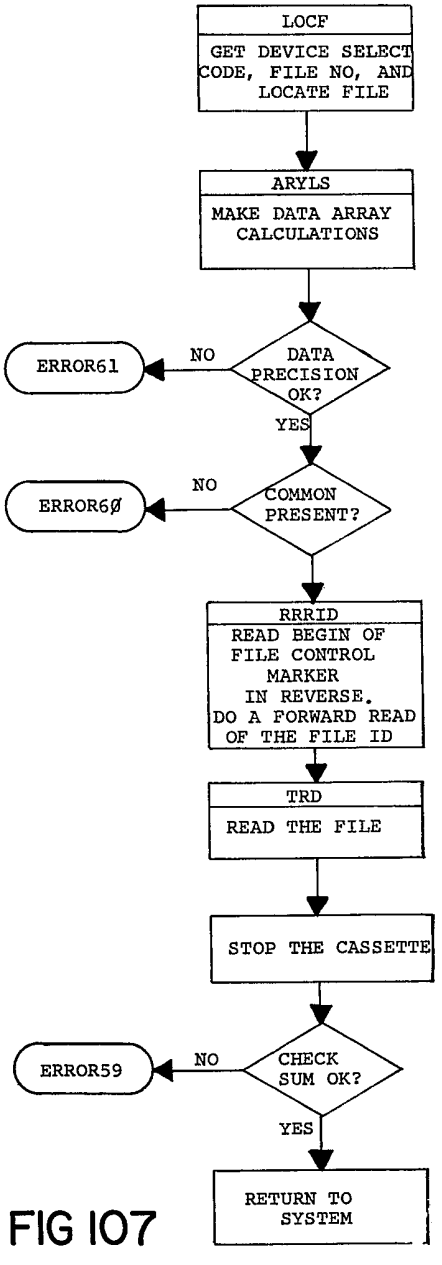


FIG 107

STORE DATA ROUTINE

THE COMMAND IS: STORE DATA #UNIT, FILE NO., ARRAY NAME

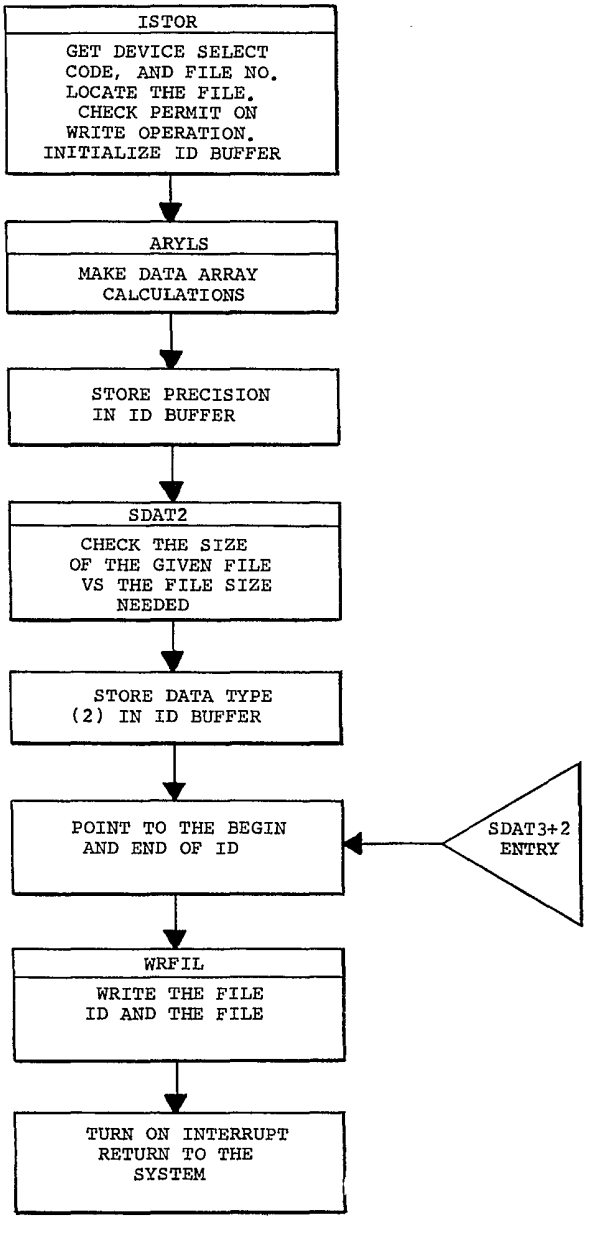


FIG 108

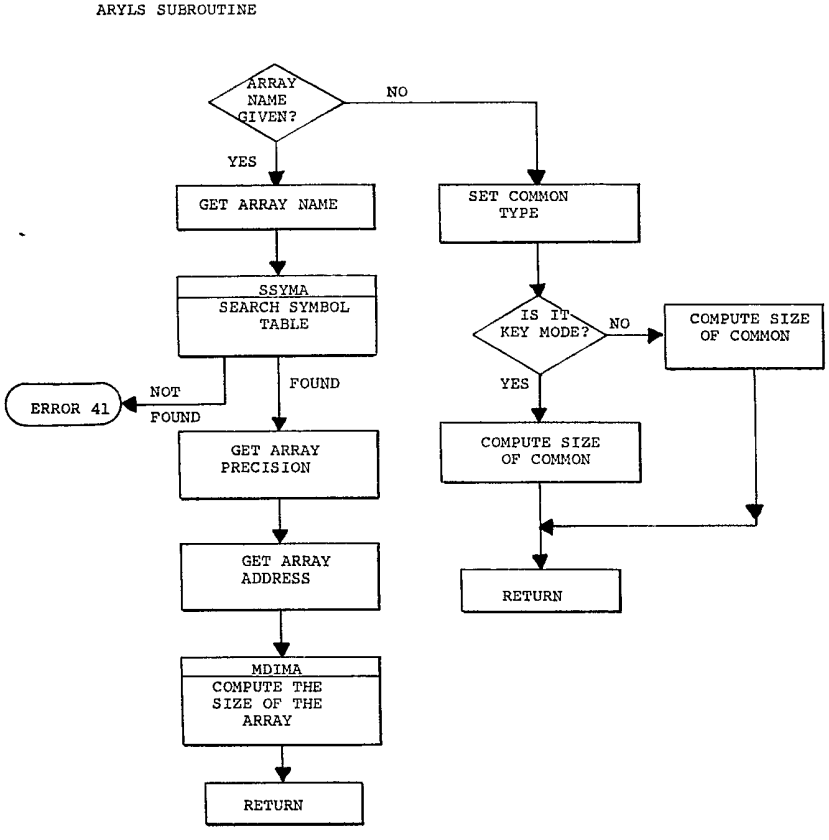

ARYLS SUBROUTINE
ARRAY NAME GIVEN?
NO
YES
GET ARRAY NAME
SSYMA
SEARCH SYMBOL TABLE
NOT FOUND
ERROR 41
FOUND
GET ARRAY PRECISION
GET ARRAY ADDRESS
MDIMA
COMPUTE THE SIZE OF THE ARRAY
RETURN
SET COMMON TYPE
IS IT KEY MODE?
NO
COMPUTE SIZE OF COMMON
YES
COMPUTE SIZE OF COMMON
RETURN

FIG 109

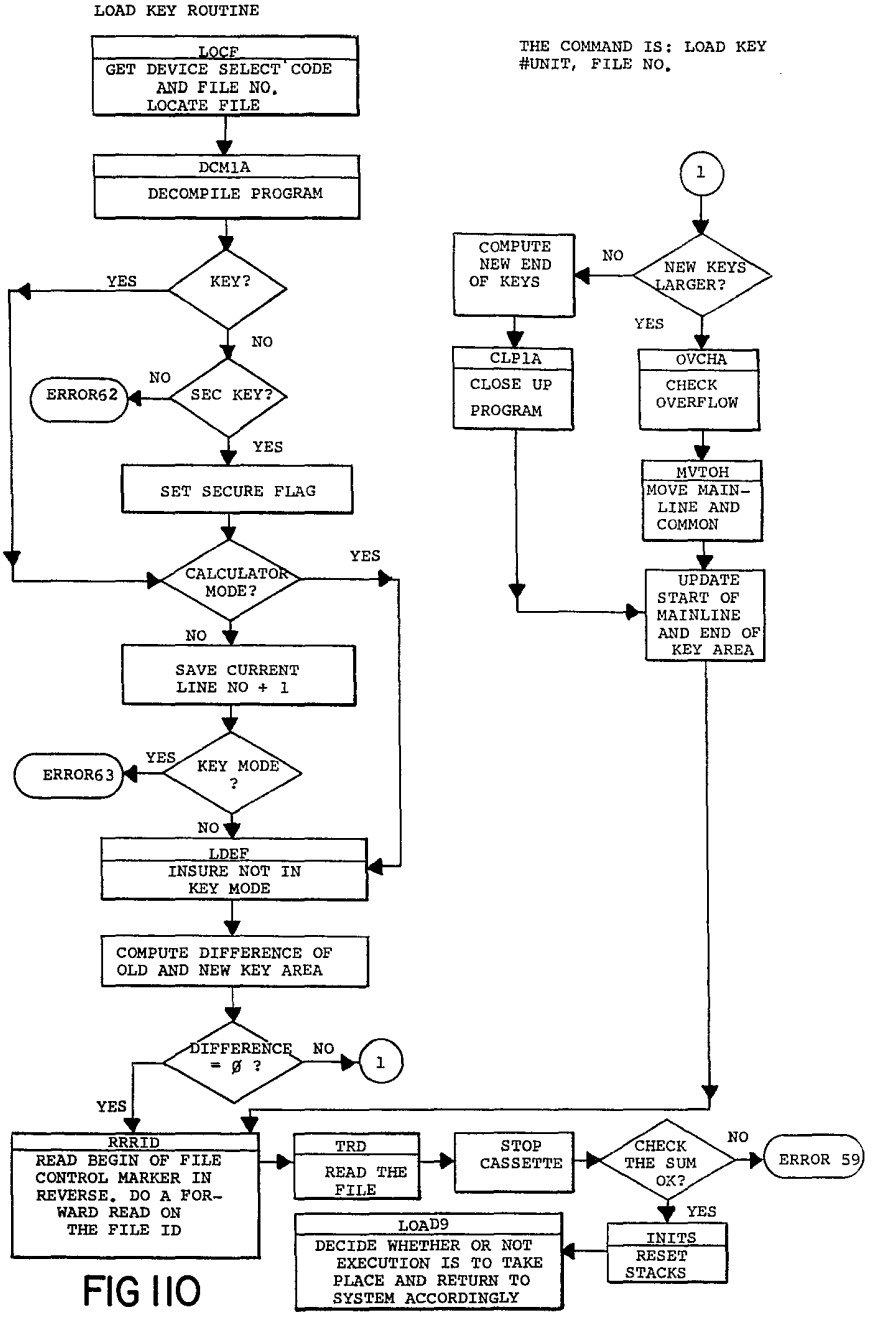

LOAD KEY ROUTINE
LOCF
GET DEVICE SELECT CODE AND FILE NO. LOCATE FILE
DCM1A
DECOMPILE PROGRAM
KEY?
YES
NO
SEC KEY?
NO
ERROR62
YES
SET SECURE FLAG
CALCULATOR MODE?
YES
NO
SAVE CURRENT LINE NO + 1
KEY MODE ?
YES
ERROR63
NO
LDEF
INSURE NOT IN KEY MODE
COMPUTE DIFFERENCE OF OLD AND NEW KEY AREA
DIFFERENCE = Ø ?
NO
1
YES
RRRID
READ BEGIN OF FILE CONTROL MARKER IN REVERSE. DO A FORWARD READ ON THE FILE ID
TRD
READ THE FILE
STOP CASSETTE
CHECK THE SUM OK?
NO
ERROR 59
YES
INITS
RESET STACKS
LOAD9
DECIDE WHETHER OR NOT EXECUTION IS TO TAKE PLACE AND RETURN TO SYSTEM ACCORDINGLY
THE COMMAND IS: LOAD KEY #UNIT, FILE NO.
1
NEW KEYS LARGER?
NO
COMPUTE NEW END OF KEYS
YES
OVCHA
CHECK OVERFLOW
CLP1A
CLOSE UP PROGRAM
MVTOH
MOVE MAINLINE AND COMMON
UPDATE START OF MAINLINE AND END OF KEY AREA

FIG 110

STORE KEY ROUTINE

THE COMMAND IS: STORE KEY #UNIT, FILE NO.

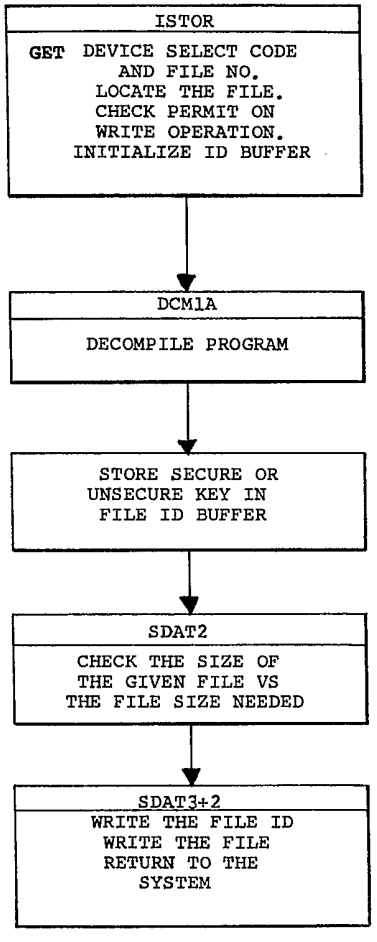


FIG III

LOAD ASSEMBLY LANGUAGE PROGRAM

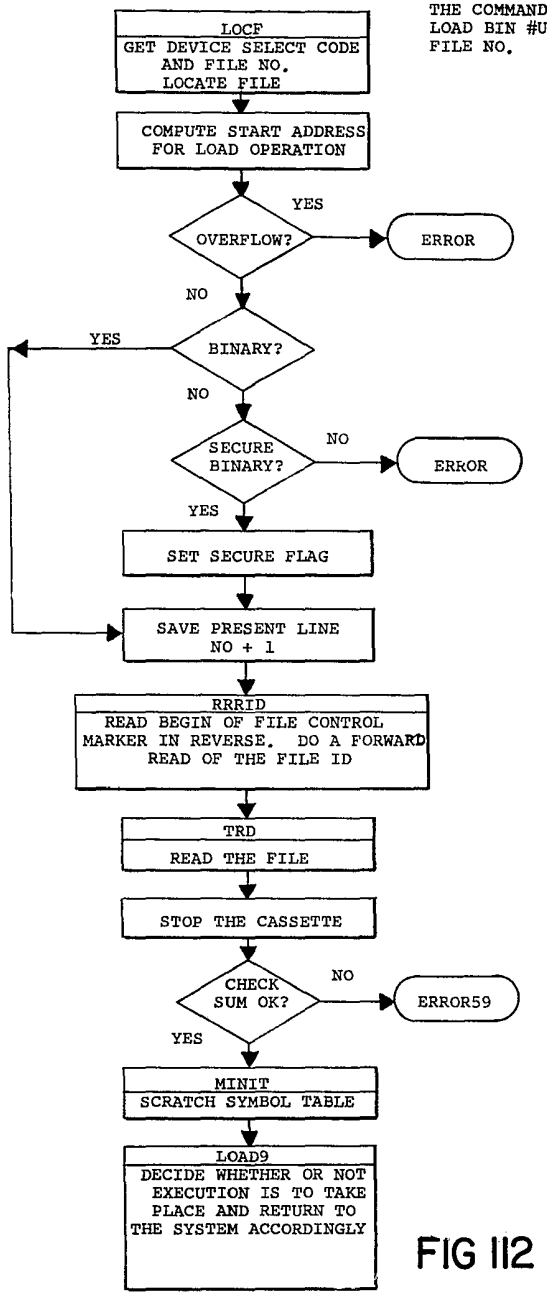


FIG 112

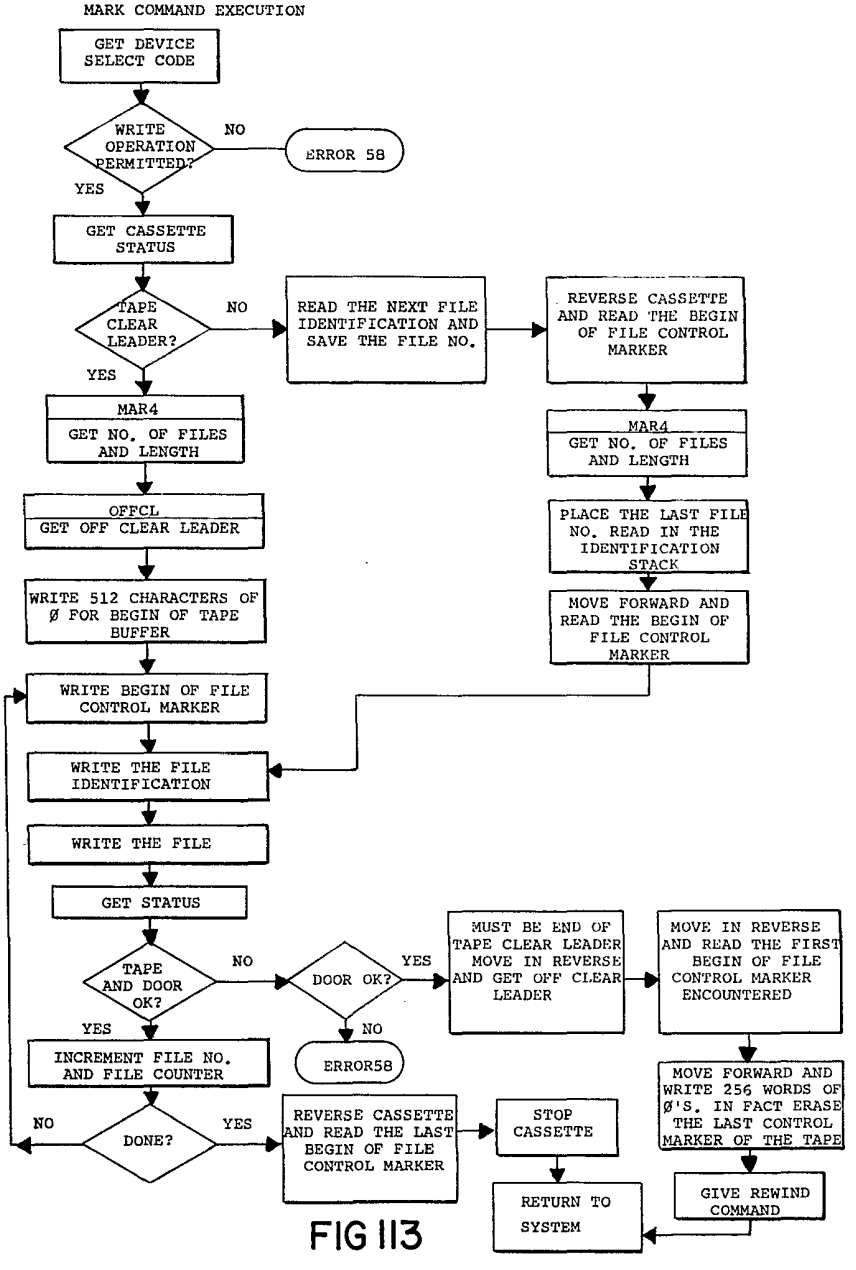

MARK COMMAND EXECUTION
GET DEVICE SELECT CODE
WRITE OPERATION PERMITTED?
NO
ERROR 58
YES
GET CASSETTE STATUS
TAPE CLEAR LEADER?
NO
READ THE NEXT FILE IDENTIFICATION AND SAVE THE FILE NO.
REVERSE CASSETTE AND READ THE BEGIN OF FILE CONTROL MARKER
YES
MAR4
GET NO. OF FILES AND LENGTH
MAR4
GET NO. OF FILES AND LENGTH
OFFCL
GET OFF CLEAR LEADER
PLACE THE LAST FILE NO. READ IN THE IDENTIFICATION STACK
WRITE 512 CHARACTERS OF Ø FOR BEGIN OF TAPE BUFFER
MOVE FORWARD AND READ THE BEGIN OF FILE CONTROL MARKER
WRITE BEGIN OF FILE CONTROL MARKER
WRITE THE FILE IDENTIFICATION
WRITE THE FILE
GET STATUS
TAPE AND DOOR OK?
NO
DOOR OK?
YES
MUST BE END OF TAPE CLEAR LEADER MOVE IN REVERSE AND GET OFF CLEAR LEADER
MOVE IN REVERSE AND READ THE FIRST BEGIN OF FILE CONTROL MARKER ENCOUNTERED
YES
NO
INCREMENT FILE NO. AND FILE COUNTER
ERROR58
MOVE FORWARD AND WRITE 256 WORDS OF Ø'S. IN FACT ERASE THE LAST CONTROL MARKER OF THE TAPE
NO
DONE?
YES
REVERSE CASSETTE AND READ THE LAST BEGIN OF FILE CONTROL MARKER
STOP CASSETTE
GIVE REWIND COMMAND
RETURN TO SYSTEM

FIG 113

MAR4 - SUBROUTINE USED BY THE MARK COMMAND

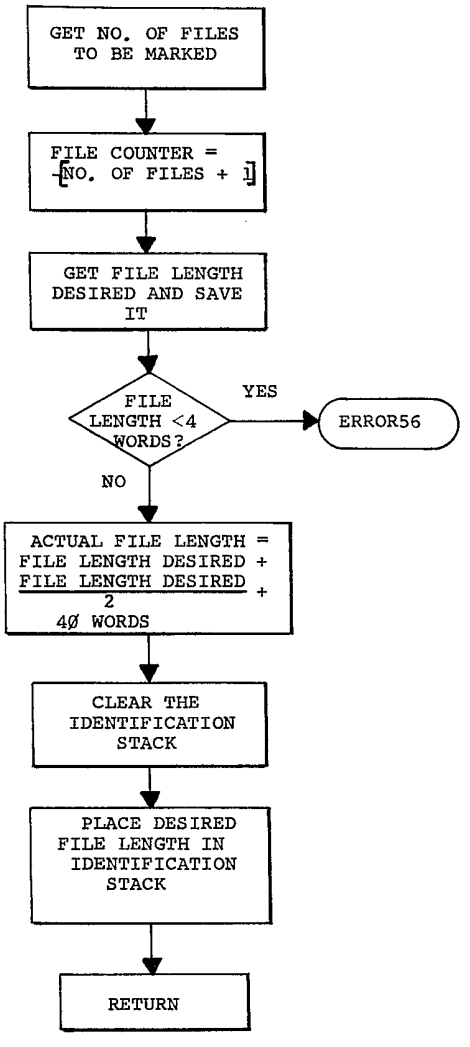


FIG 114

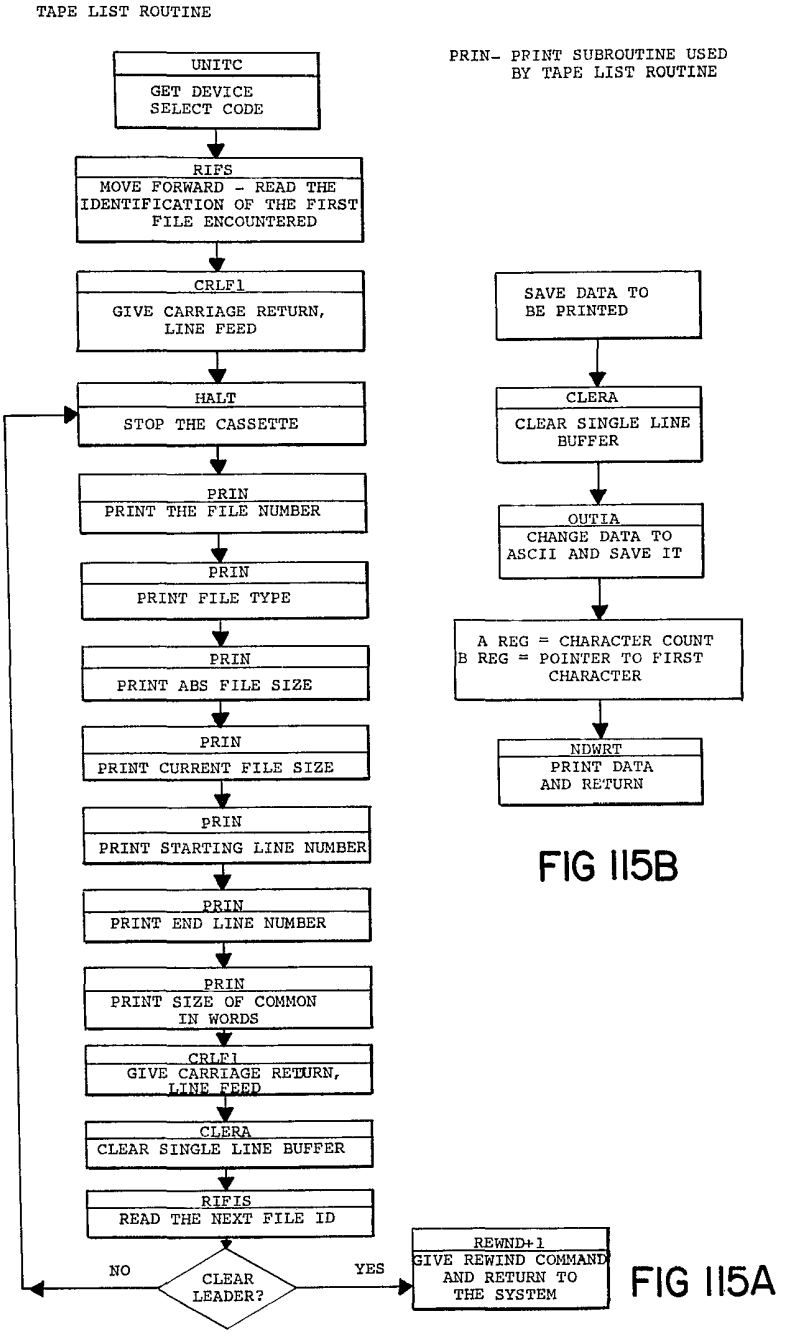


FIG 115B

FIG 115A

THE COMMAND IS: SEC (LNX1
(,LNX2))

WHERE: LNX1 IS THE FIRST LINE
TO BE SECURED

LNX2 IS THE LAST LINE
TO BE SECURED

SECURE ROUTINE

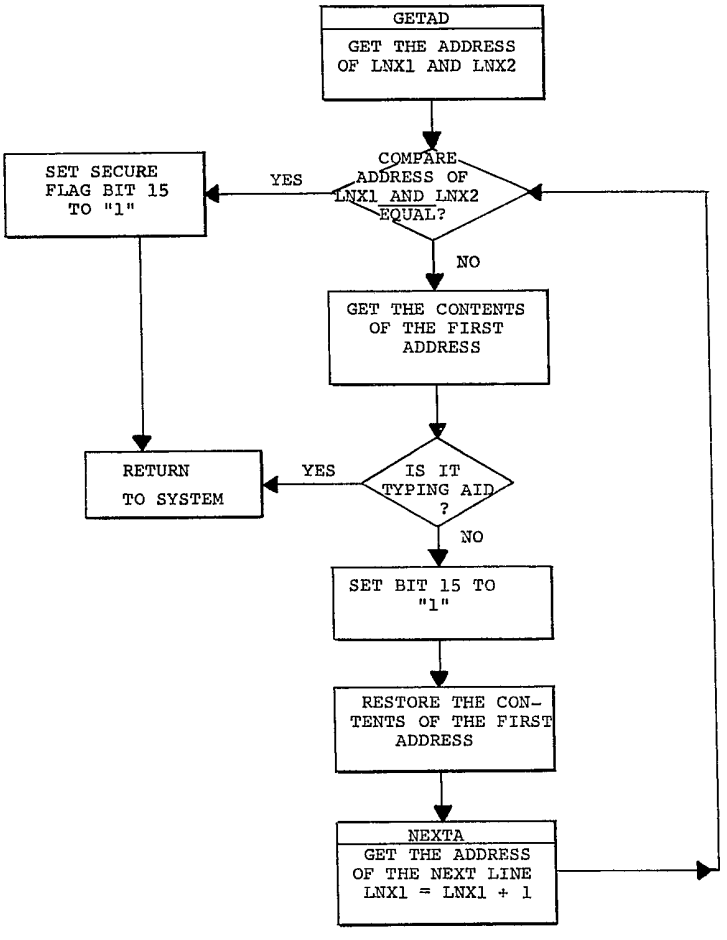


FIG 116

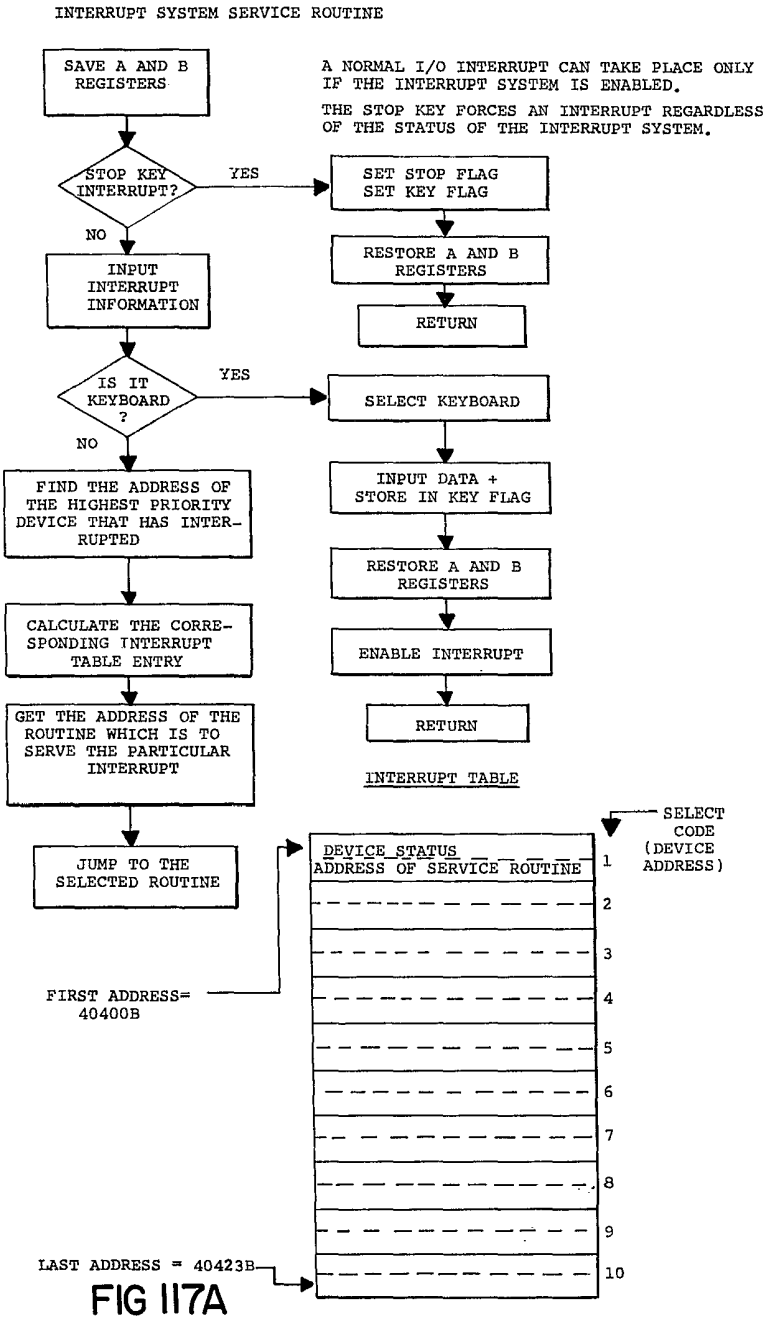

INTERRUPT SYSTEM SERVICE ROUTINE
SAVE A AND B REGISTERS
STOP KEY INTERRUPT?
YES
NO
INPUT INTERRUPT INFORMATION
IS IT KEYBOARD ?
YES
NO
FIND THE ADDRESS OF THE HIGHEST PRIORITY DEVICE THAT HAS INTERRUPTED
CALCULATE THE CORRESPONDING INTERRUPT TABLE ENTRY
GET THE ADDRESS OF THE ROUTINE WHICH IS TO SERVE THE PARTICULAR INTERRUPT
JUMP TO THE SELECTED ROUTINE
A NORMAL I/O INTERRUPT CAN TAKE PLACE ONLY IF THE INTERRUPT SYSTEM IS ENABLED.
THE STOP KEY FORCES AN INTERRUPT REGARDLESS OF THE STATUS OF THE INTERRUPT SYSTEM.
SET STOP FLAG
SET KEY FLAG
RESTORE A AND B REGISTERS
RETURN
SELECT KEYBOARD
INPUT DATA + STORE IN KEY FLAG
RESTORE A AND B REGISTERS
ENABLE INTERRUPT
RETURN
INTERRUPT TABLE
SELECT CODE (DEVICE ADDRESS)
DEVICE STATUS
ADDRESS OF SERVICE ROUTINE
1
2
3
4
5
6
7
8
9
10
FIRST ADDRESS= 40400B
LAST ADDRESS = 40423B

FIG 117A

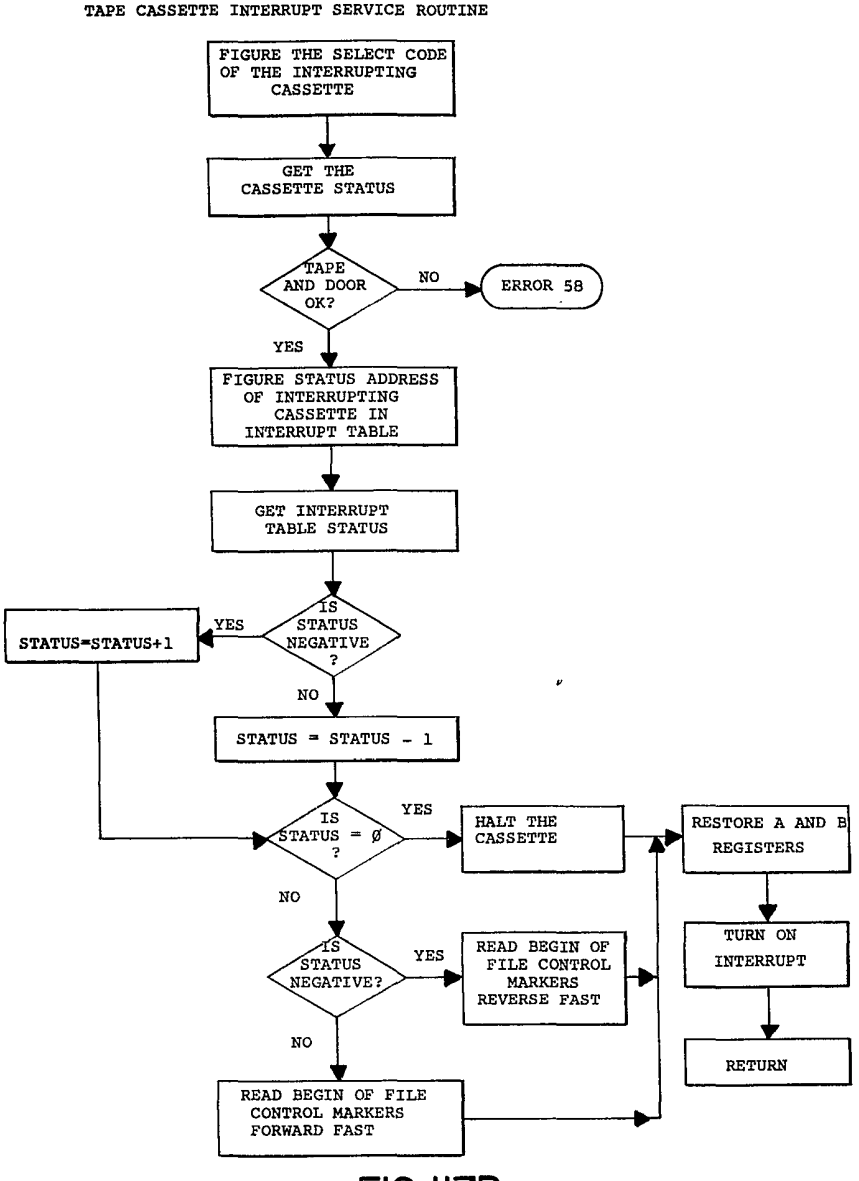

TAPE CASSETTE INTERRUPT SERVICE ROUTINE
FIGURE THE SELECT CODE OF THE INTERRUPTING CASSETTE
GET THE CASSETTE STATUS
TAPE AND DOOR OK?
NO
ERROR 58
YES
FIGURE STATUS ADDRESS OF INTERRUPTING CASSETTE IN INTERRUPT TABLE
GET INTERRUPT TABLE STATUS
IS STATUS NEGATIVE ?
YES
STATUS=STATUS+1
NO
STATUS = STATUS - 1
IS STATUS = Ø ?
YES
HALT THE CASSETTE
RESTORE A AND B REGISTERS
NO
IS STATUS NEGATIVE?
YES
READ BEGIN OF FILE CONTROL MARKERS REVERSE FAST
TURN ON INTERRUPT
NO
RETURN
READ BEGIN OF FILE CONTROL MARKERS FORWARD FAST

FIG 117B

FLOWCHART OF OFFSET COMMAND FOR PLOTTER BLOCK

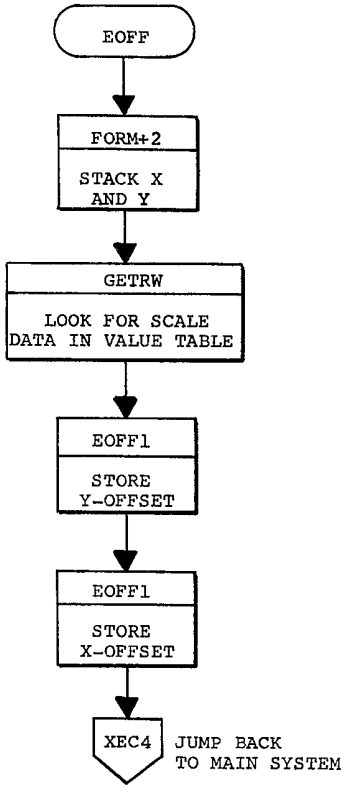


FIG 118A

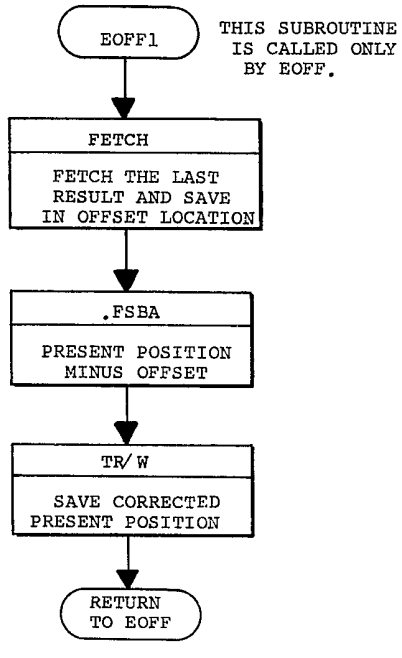


FIG 118B

FLOWCHART OF I PLOT COMMAND FOR PLOTTER BLOCK

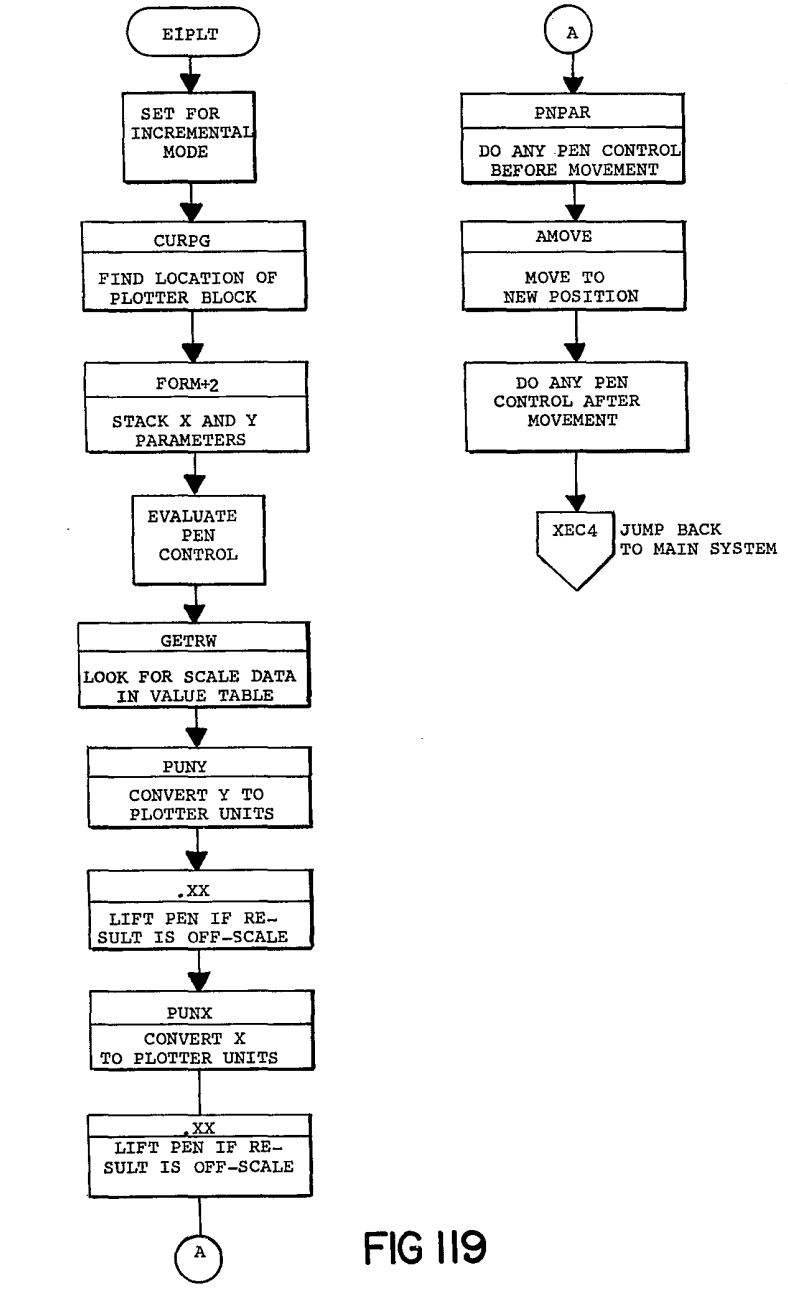


FIG 119

FLOWCHART OF LABEL COMMAND FOR PLOTTER BLOCK

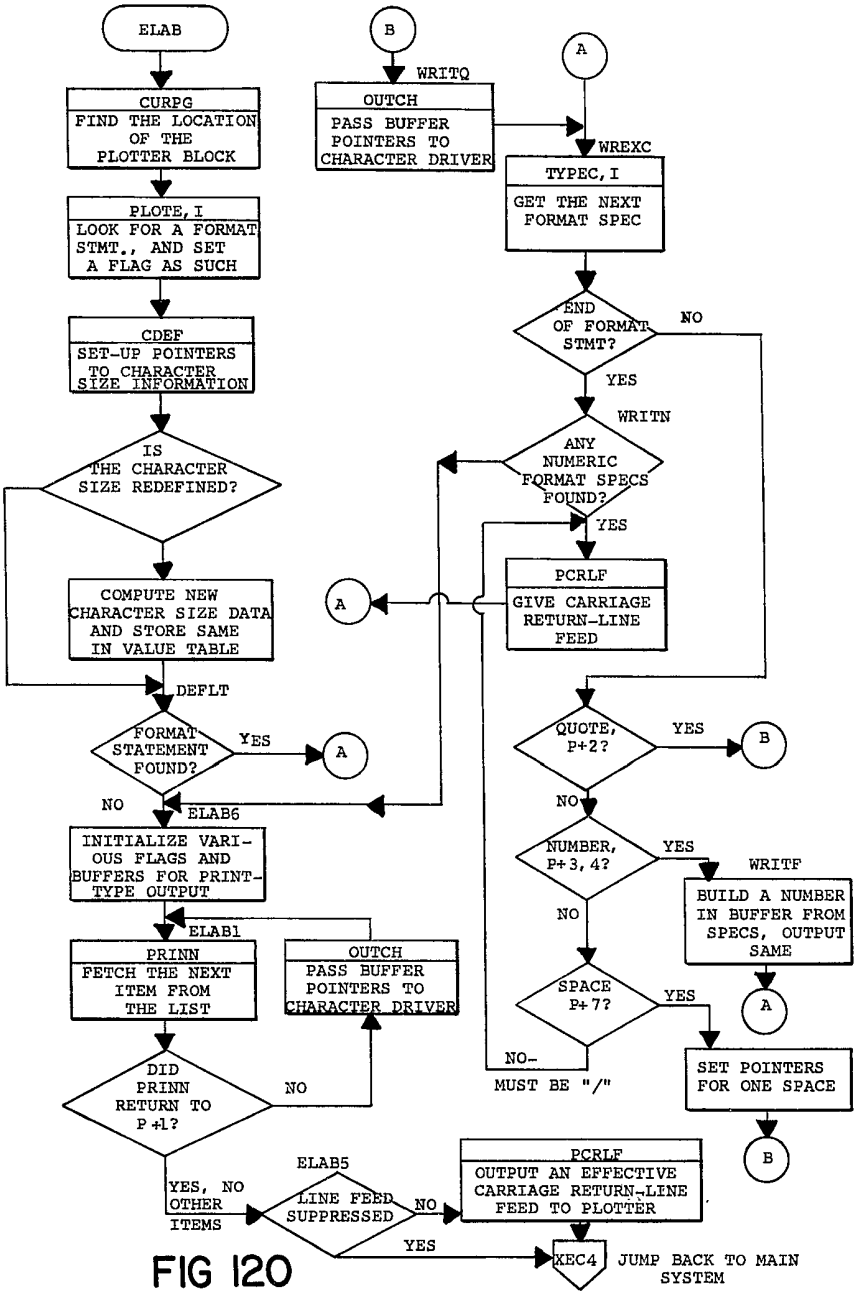


FIG 120

FLOWCHART OF LETTER COMMAND FOR PLOTTER BLOCK

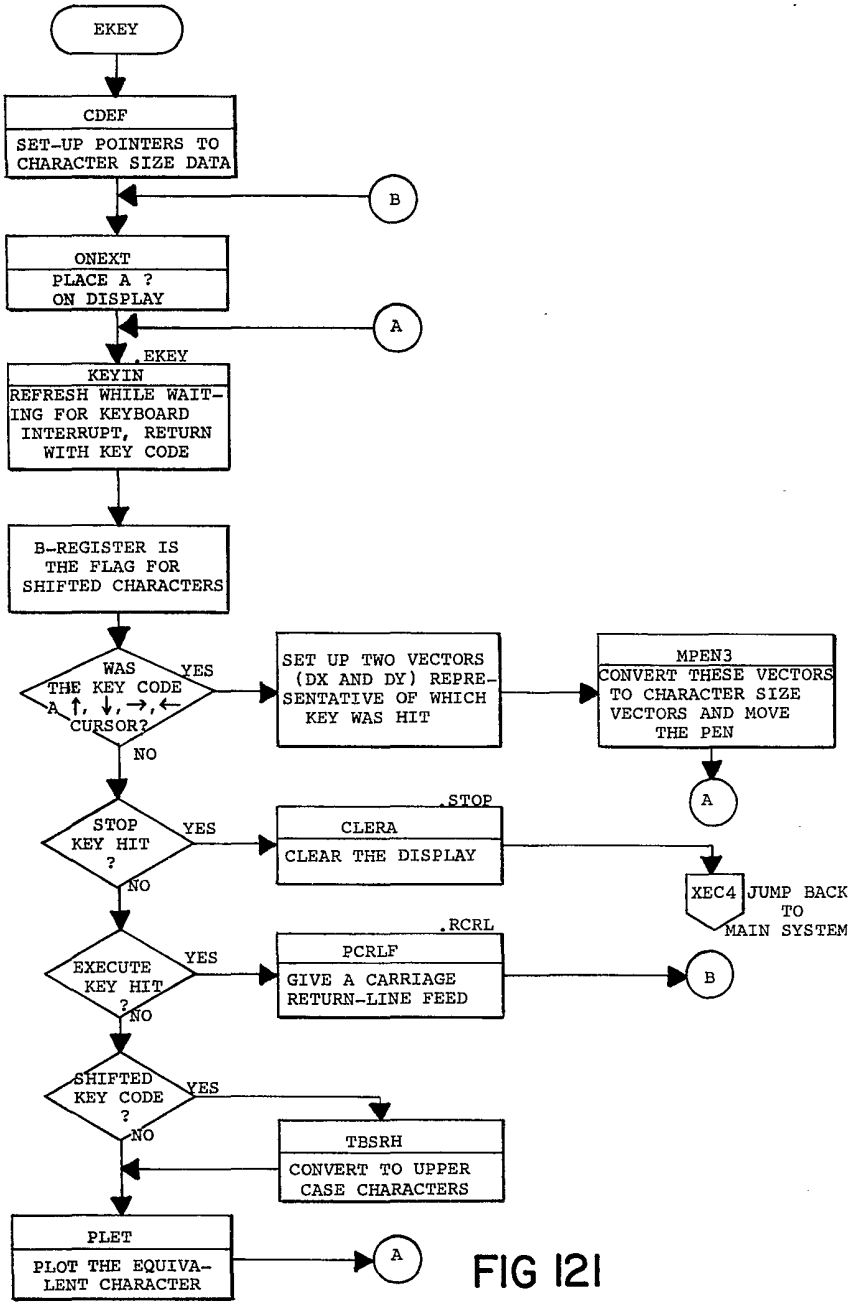


FIG 121

FLOWCHART OF CPLOT COMMAND FOR PLOTTER BLOCK

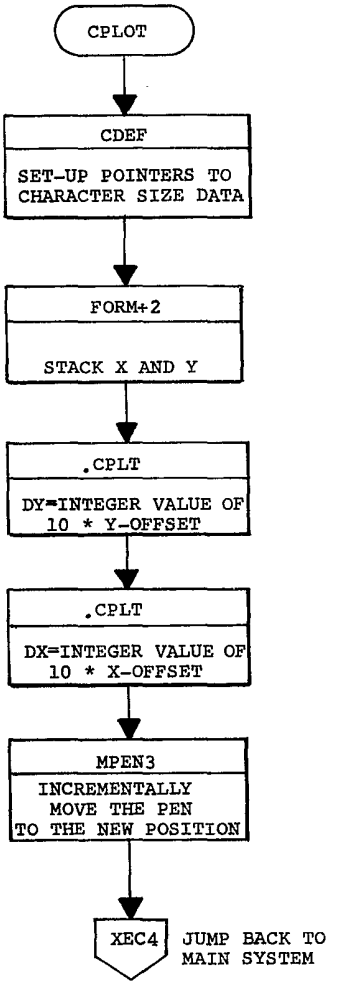


FIG 122

.CPLT SUBROUTINE CALLED BY CPLOT ONLY

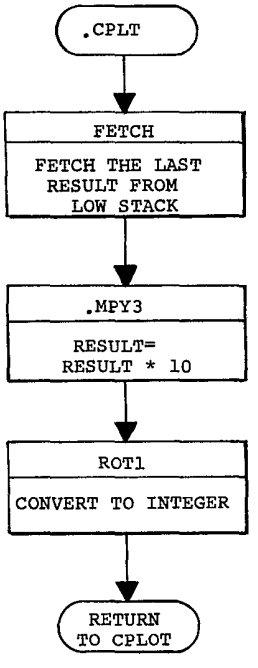


FIG 123

FLOWCHART OF XAXIS AND YAXIS COMMAND FOR PLOTTER BLOCK

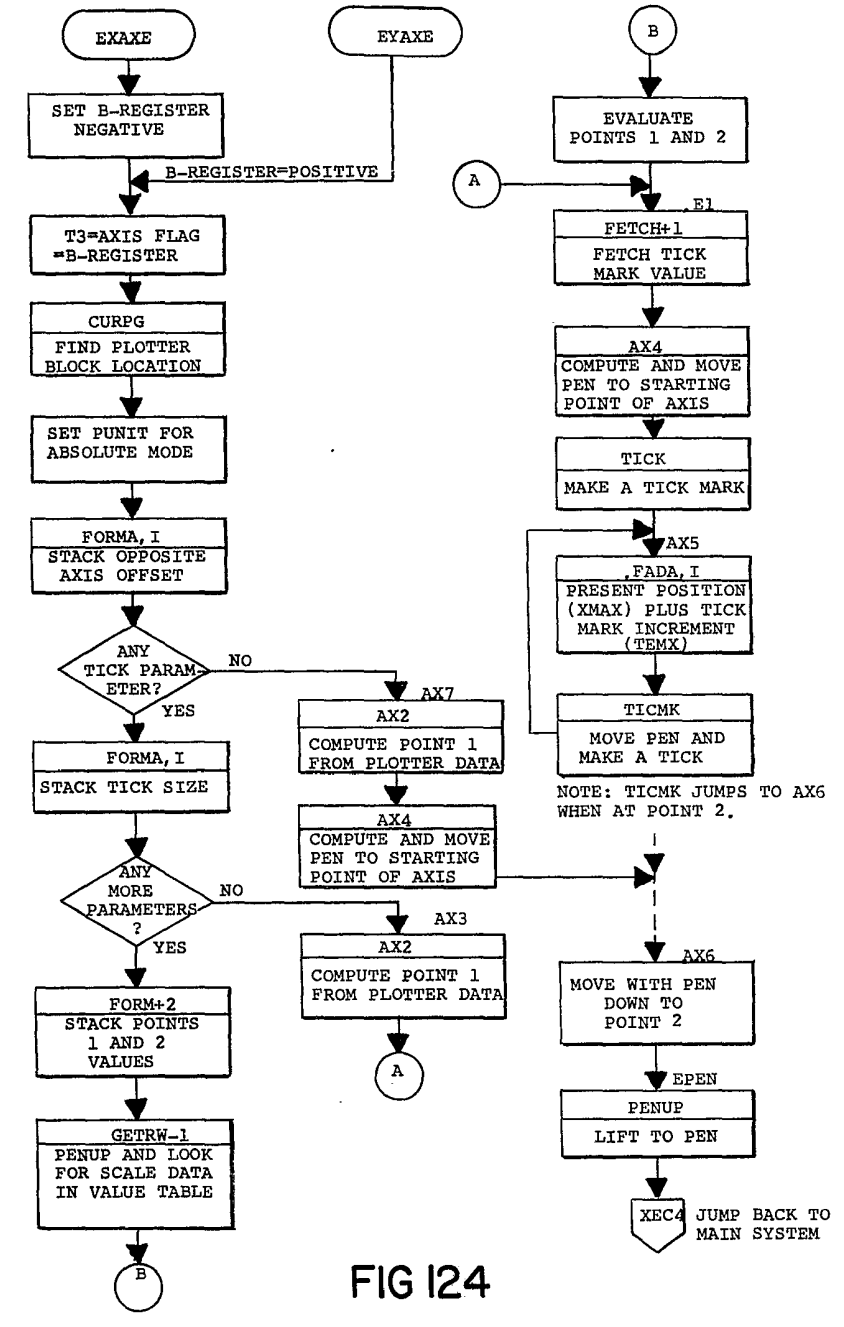


FIG 124

FLOWCHART OF AXIS SUBROUTINES FOR PLOTTER BLOCK

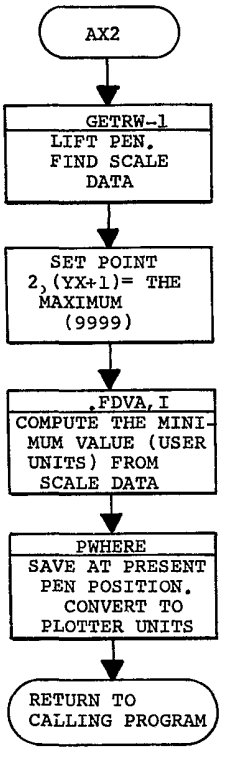


FIG 125A

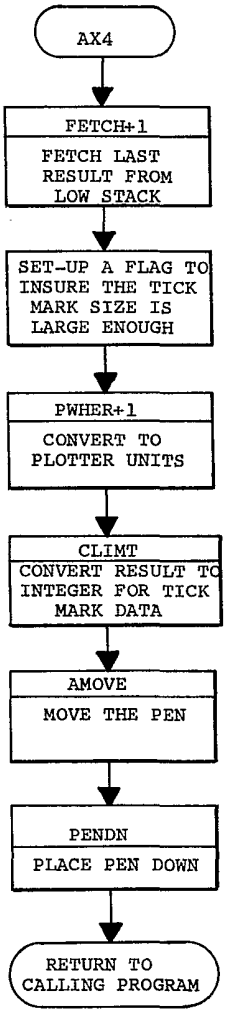


FIG 125B

FLOWCHART OF
AXIS SUBROUTINES FOR PLOTTER BLOCK

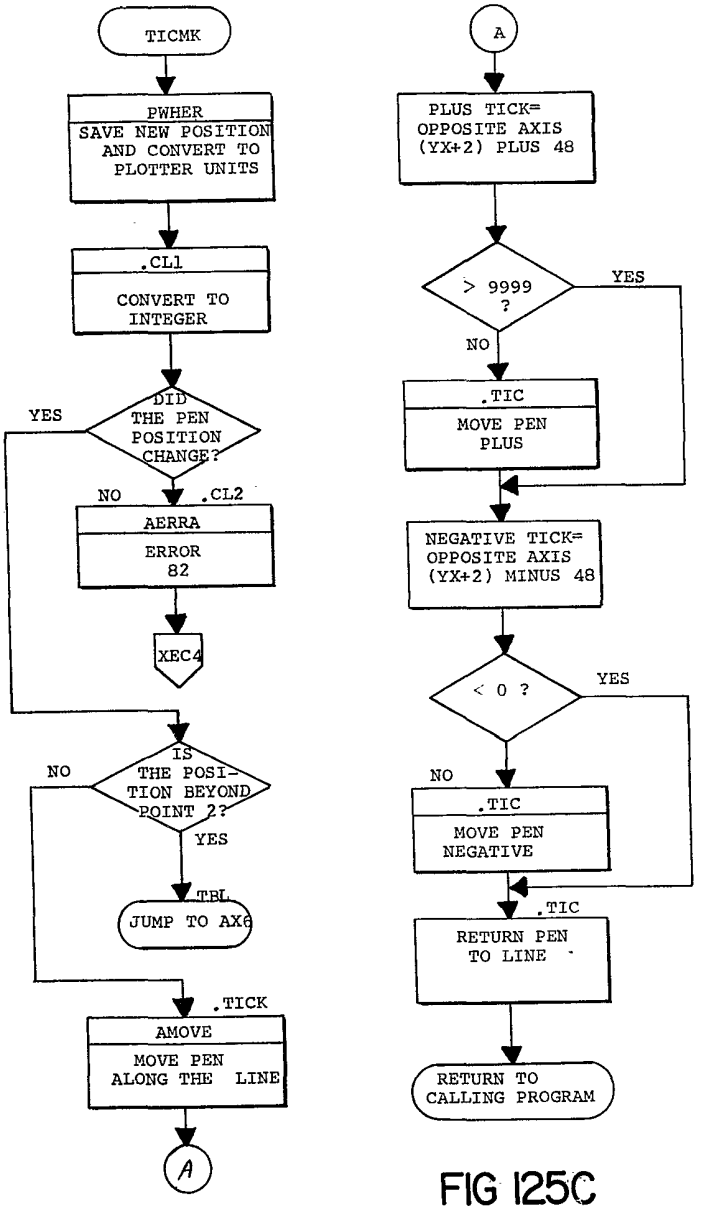


FIG 125C

FLOWCHART OF PLOTTER BLOCK SUBROUTINES

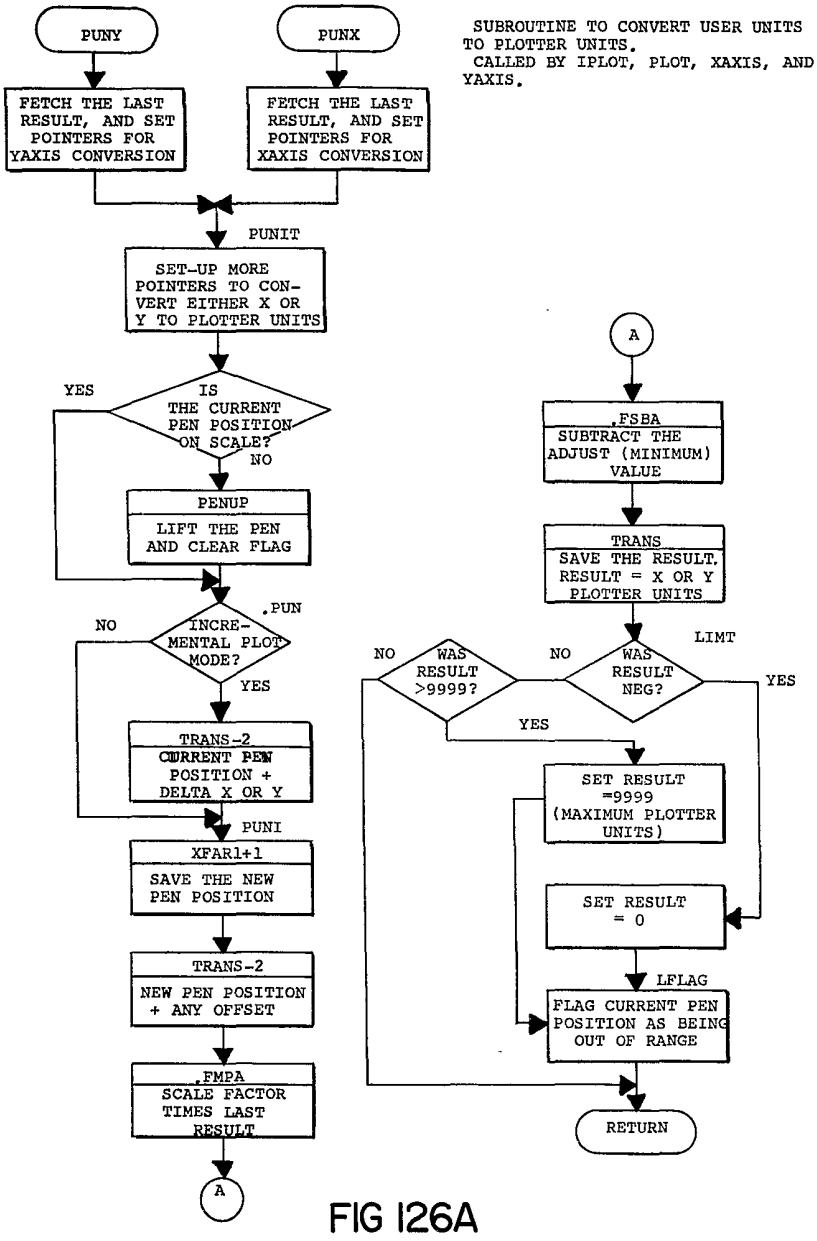


FIG 126A

FLOWCHART OF PLOTTER BLOCK SUBROUTINES

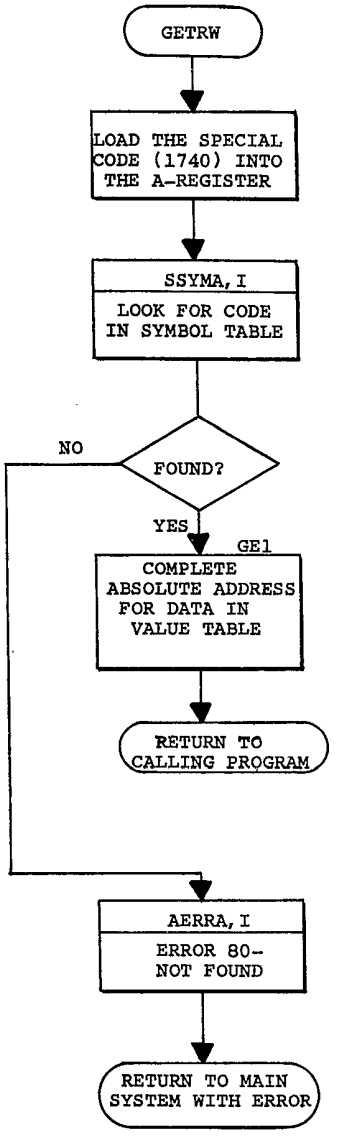


FIG 126B

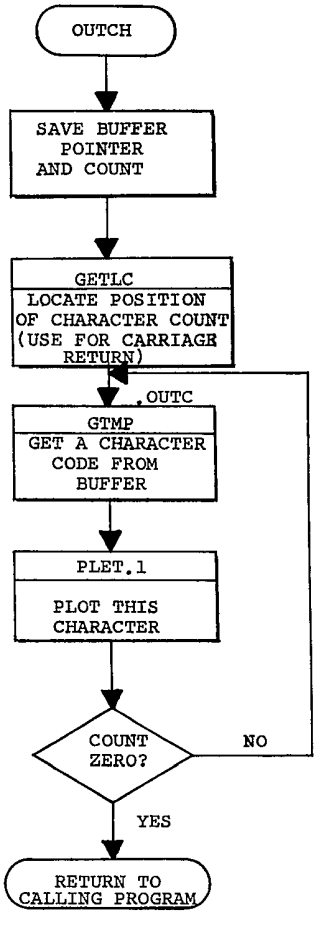


FIG 126C

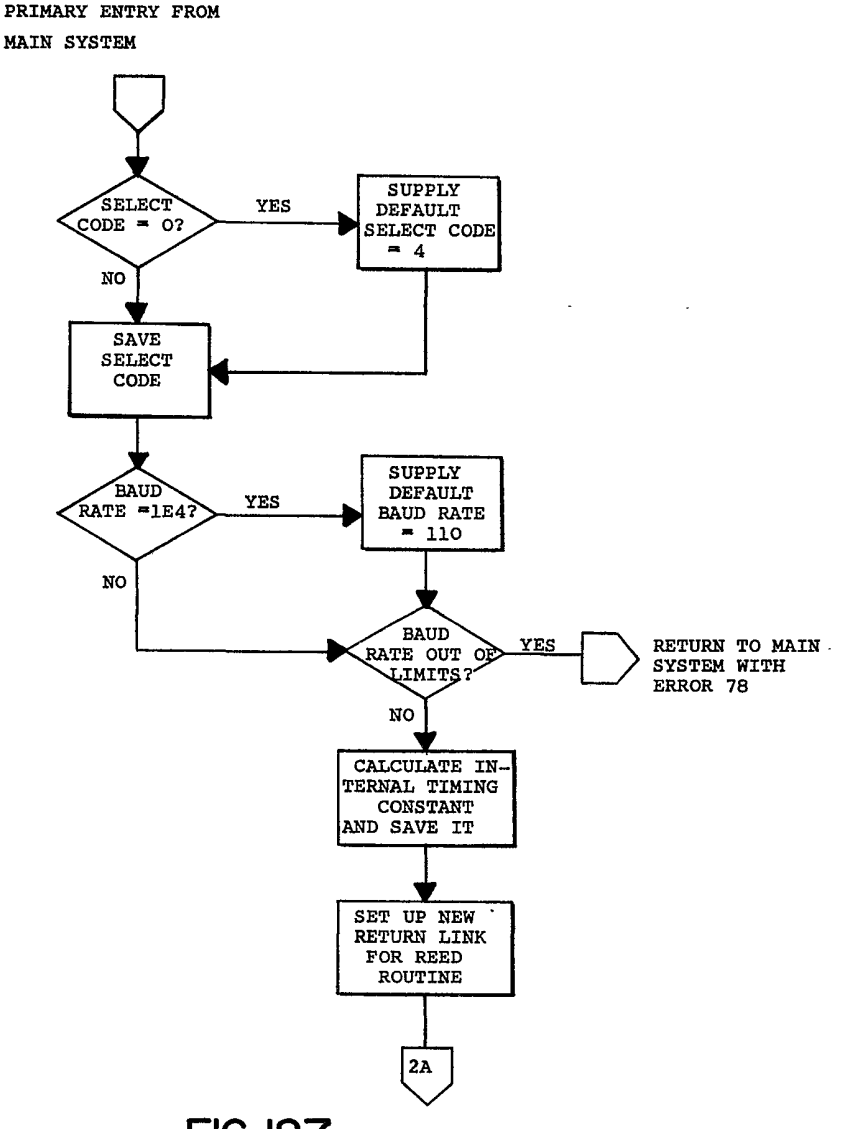

PRIMARY ENTRY FROM MAIN SYSTEM
SELECT CODE = 0?
YES
SUPPLY DEFAULT SELECT CODE = 4
NO
SAVE SELECT CODE
BAUD RATE =1E4?
YES
SUPPLY DEFAULT BAUD RATE = 110
NO
BAUD RATE OUT OF LIMITS?
YES
RETURN TO MAIN SYSTEM WITH ERROR 78
NO
CALCULATE INTERNAL TIMING CONSTANT AND SAVE IT
SET UP NEW RETURN LINK FOR REED ROUTINE
2A

FIG 127

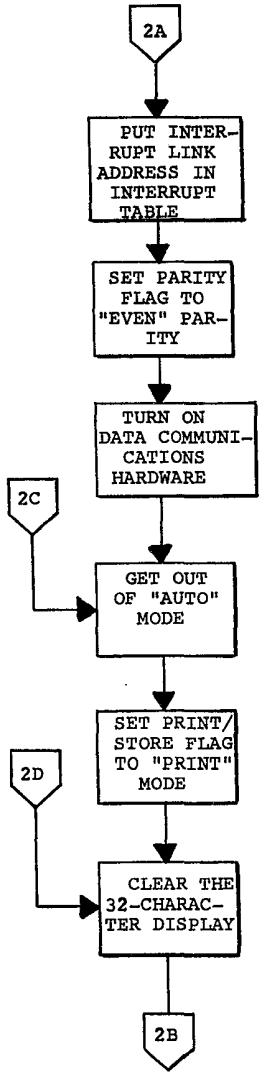


FIG 128A

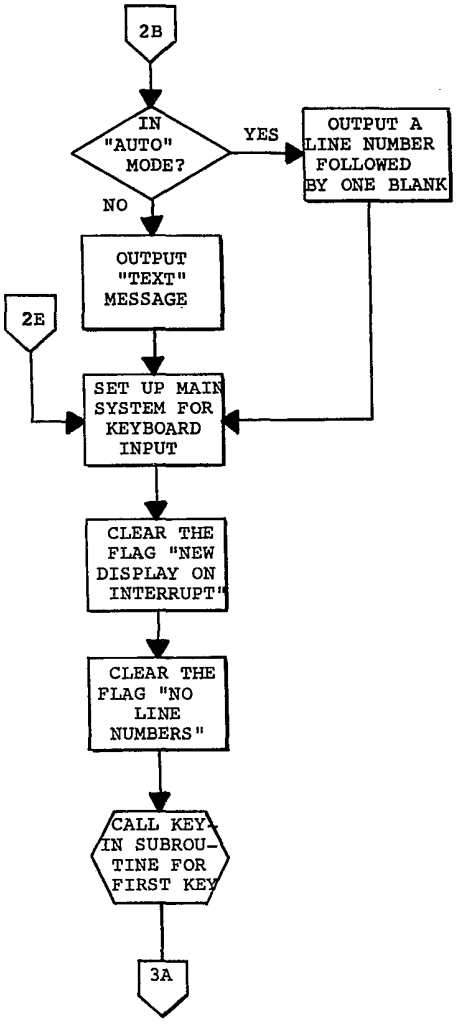


FIG 128B

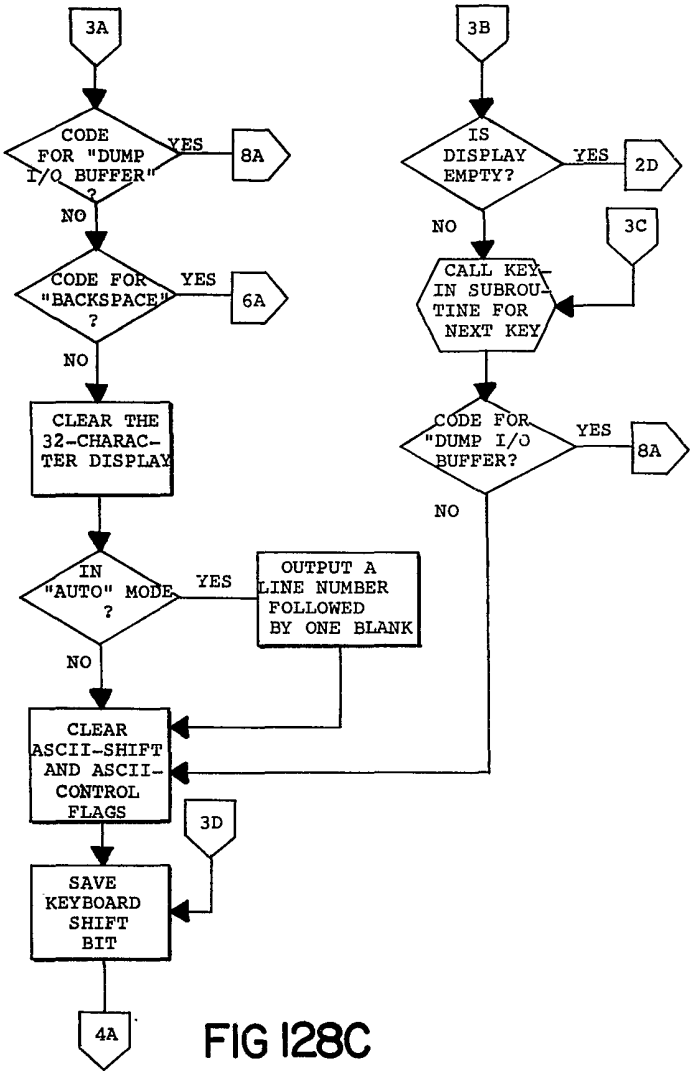

3A
CODE FOR "DUMP I/O BUFFER" ?
YES
8A
NO
CODE FOR "BACKSPACE" ?
YES
6A
NO
CLEAR THE 32-CHARACTER DISPLAY
IN "AUTO" MODE ?
YES
OUTPUT A LINE NUMBER FOLLOWED BY ONE BLANK
NO
CLEAR ASCII-SHIFT AND ASCII-CONTROL FLAGS
3D
SAVE KEYBOARD SHIFT BIT
4A
3B
IS DISPLAY EMPTY?
YES
2D
NO
3C
CALL KEY-IN SUBROUTINE FOR NEXT KEY
CODE FOR "DUMP I/O BUFFER?
YES
8A
NO

FIG 128C

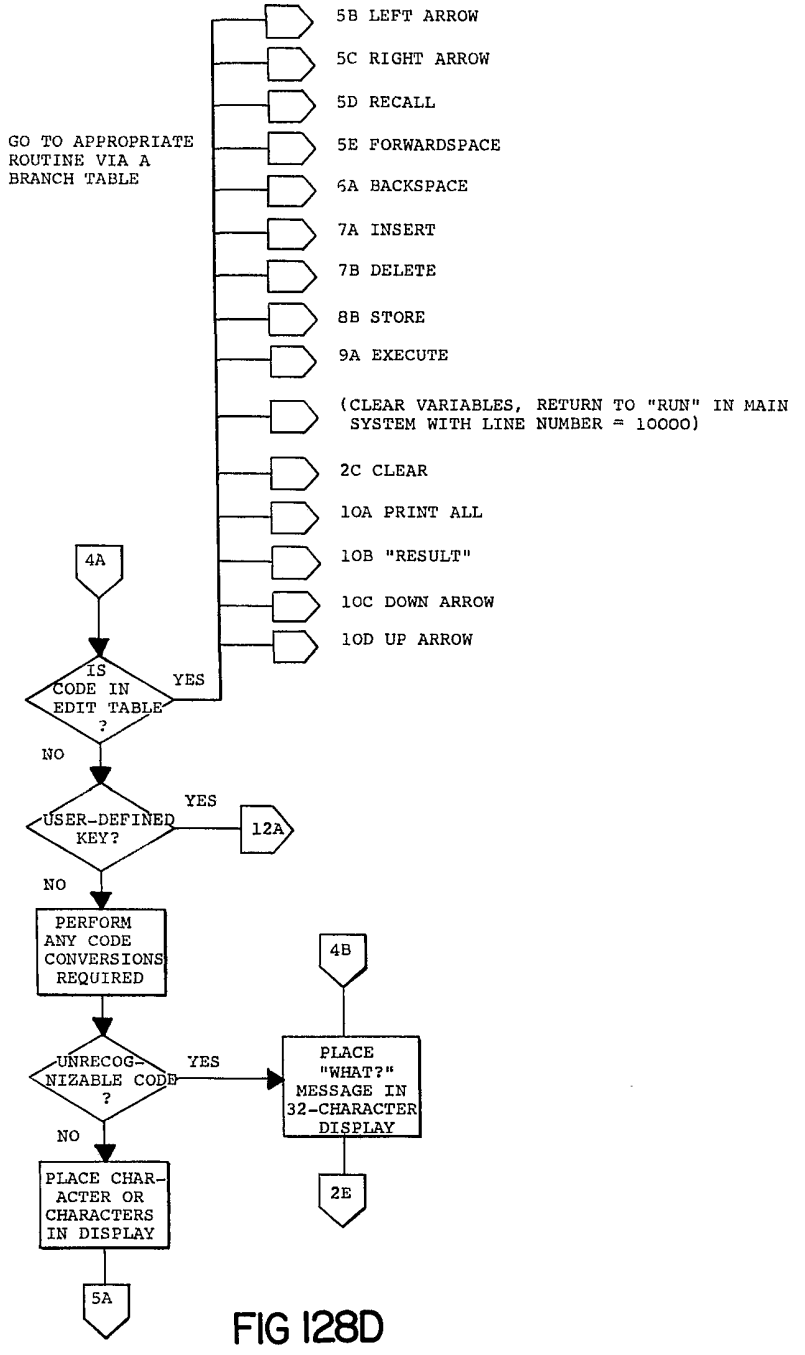

5B LEFT ARROW
5C RIGHT ARROW
5D RECALL
GO TO APPROPRIATE ROUTINE VIA A BRANCH TABLE
5E FORWARDSPACE
6A BACKSPACE
7A INSERT
7B DELETE
8B STORE
9A EXECUTE
(CLEAR VARIABLES, RETURN TO "RUN" IN MAIN SYSTEM WITH LINE NUMBER = 10000)
2C CLEAR
10A PRINT ALL
10B "RESULT"
10C DOWN ARROW
10D UP ARROW
4A
IS CODE IN EDIT TABLE ?
YES
NO
USER-DEFINED KEY?
YES
12A
NO
PERFORM ANY CODE CONVERSIONS REQUIRED
4B
UNRECOG-NIZABLE CODE ?
YES
PLACE "WHAT?" MESSAGE IN 32-CHARACTER DISPLAY
2E
NO
PLACE CHAR-ACTER OR CHARACTERS IN DISPLAY
5A

FIG 128D

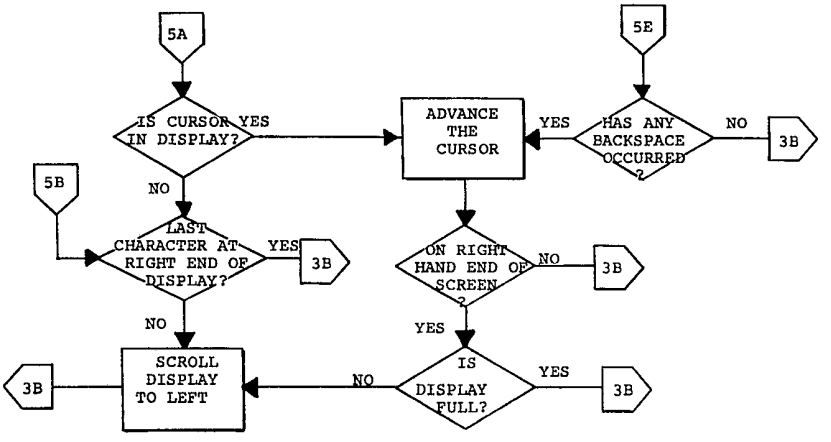


FIG 128E

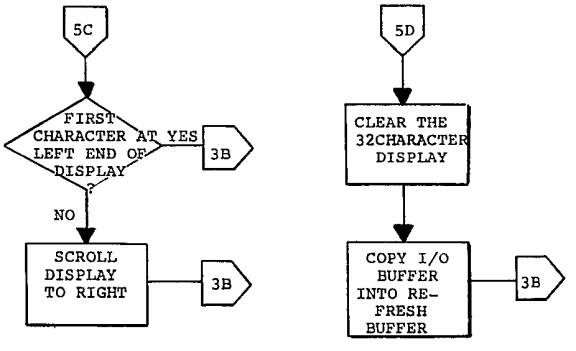


FIG 128F

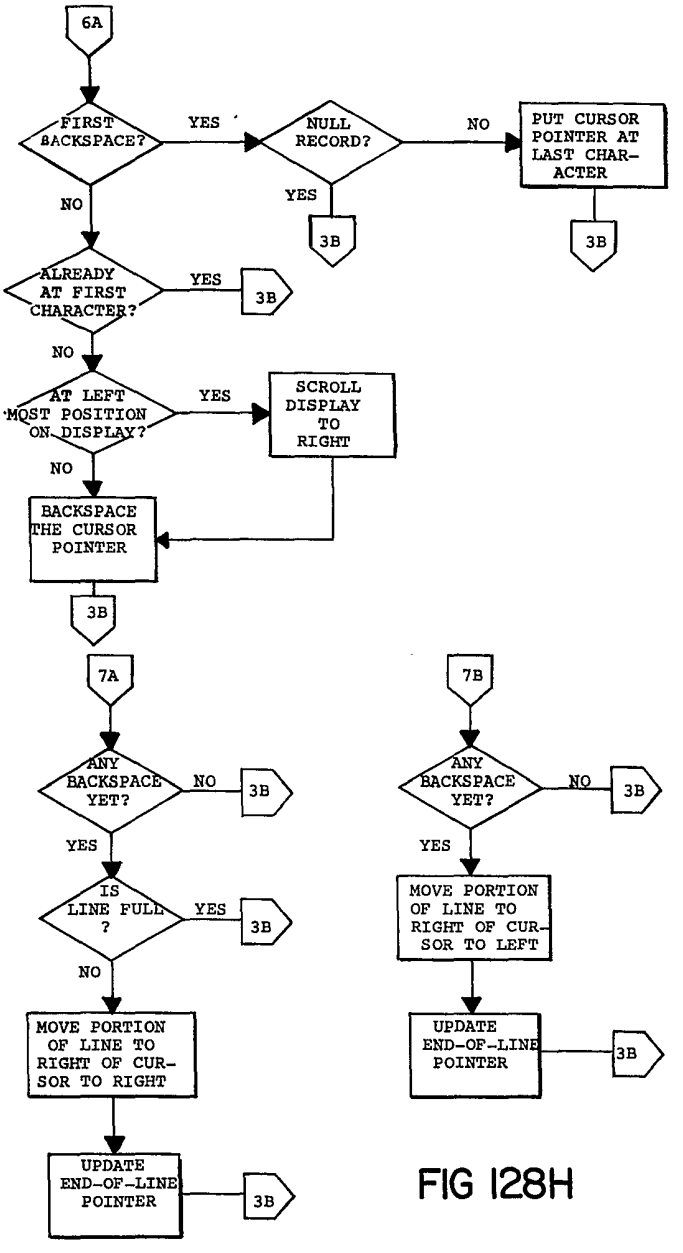


FIG 128G

FIG 128H

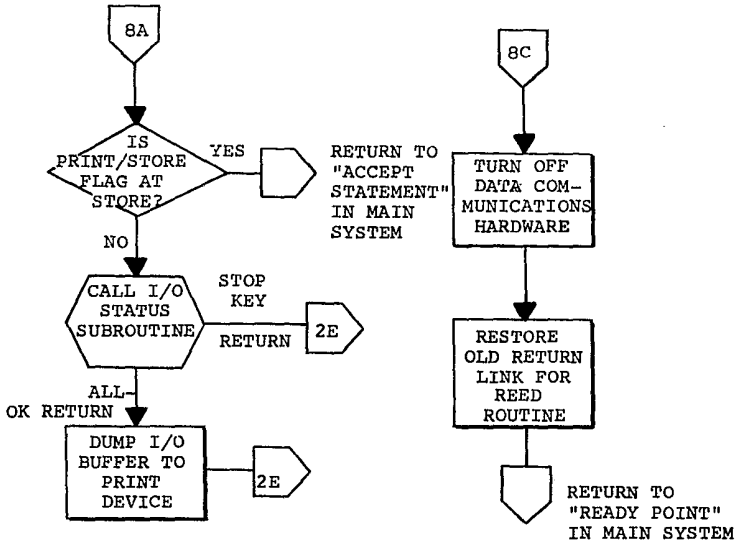


FIG 128I

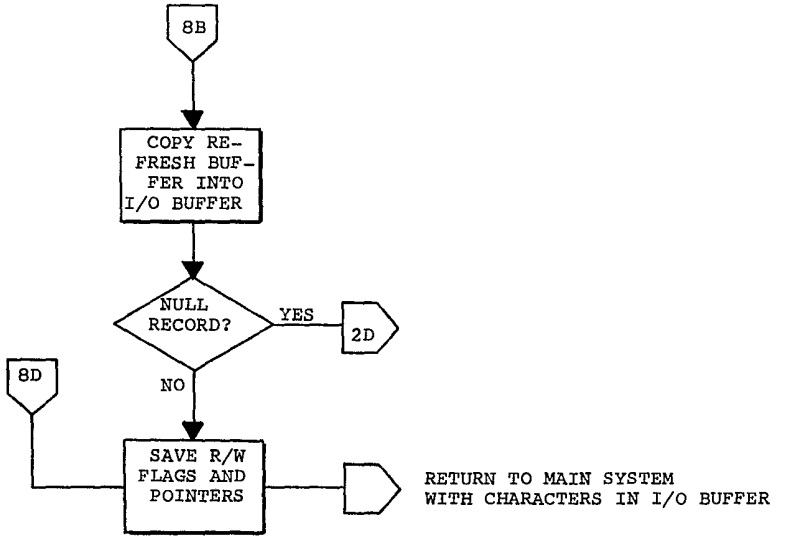


FIG 128J

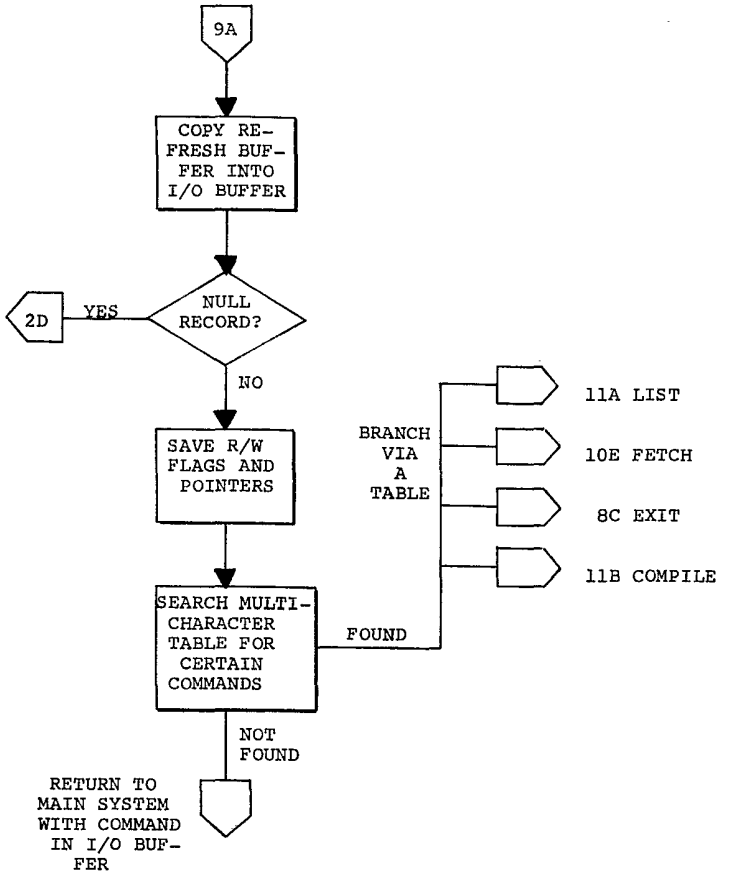

9A
COPY RE-FRESH BUF-FER INTO I/O BUFFER
2D
YES
NULL RECORD?
NO
SAVE R/W FLAGS AND POINTERS
SEARCH MULTI-CHARACTER TABLE FOR CERTAIN COMMANDS
FOUND
BRANCH VIA A TABLE
11A LIST
10E FETCH
8C EXIT
11B COMPILE
NOT FOUND
RETURN TO MAIN SYSTEM WITH COMMAND IN I/O BUF-FER

FIG 128K

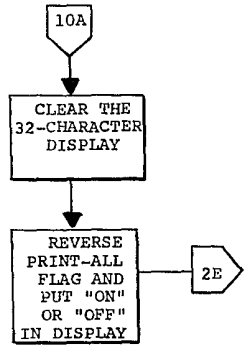


FIG 128L

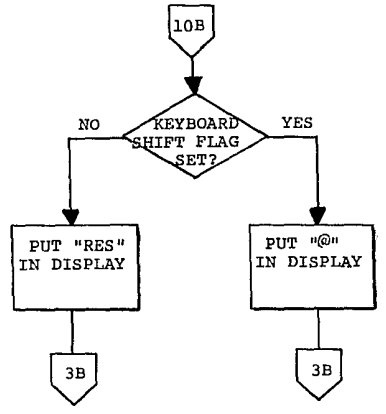


FIG 128M

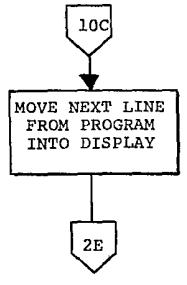


FIG 128N

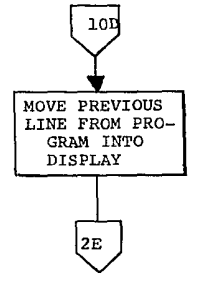


FIG 128O

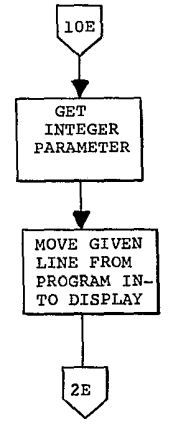


FIG 128P

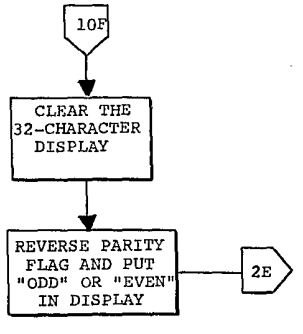


FIG 128Q

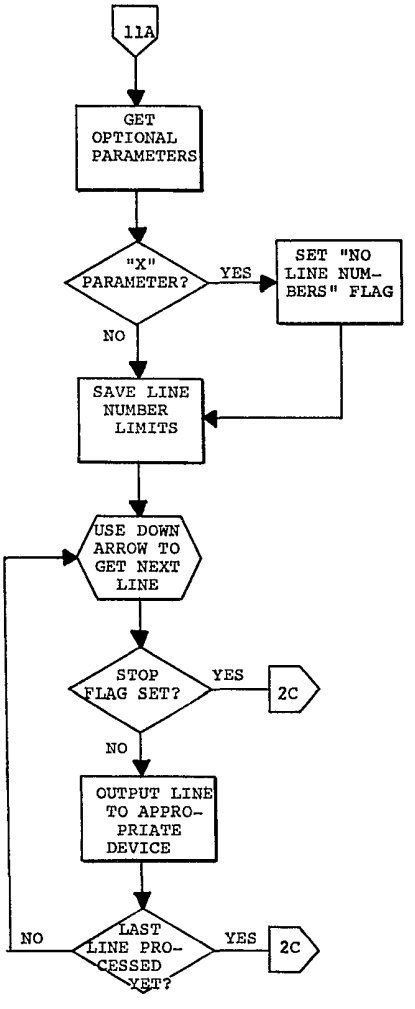


FIG 128R

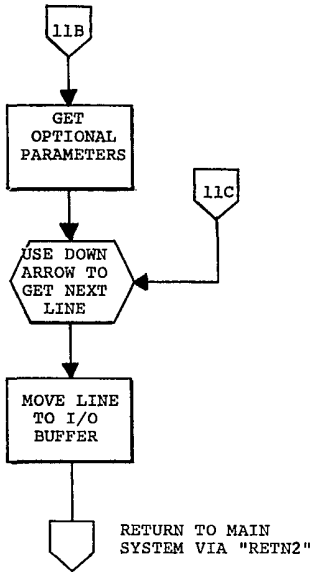


FIG 128S

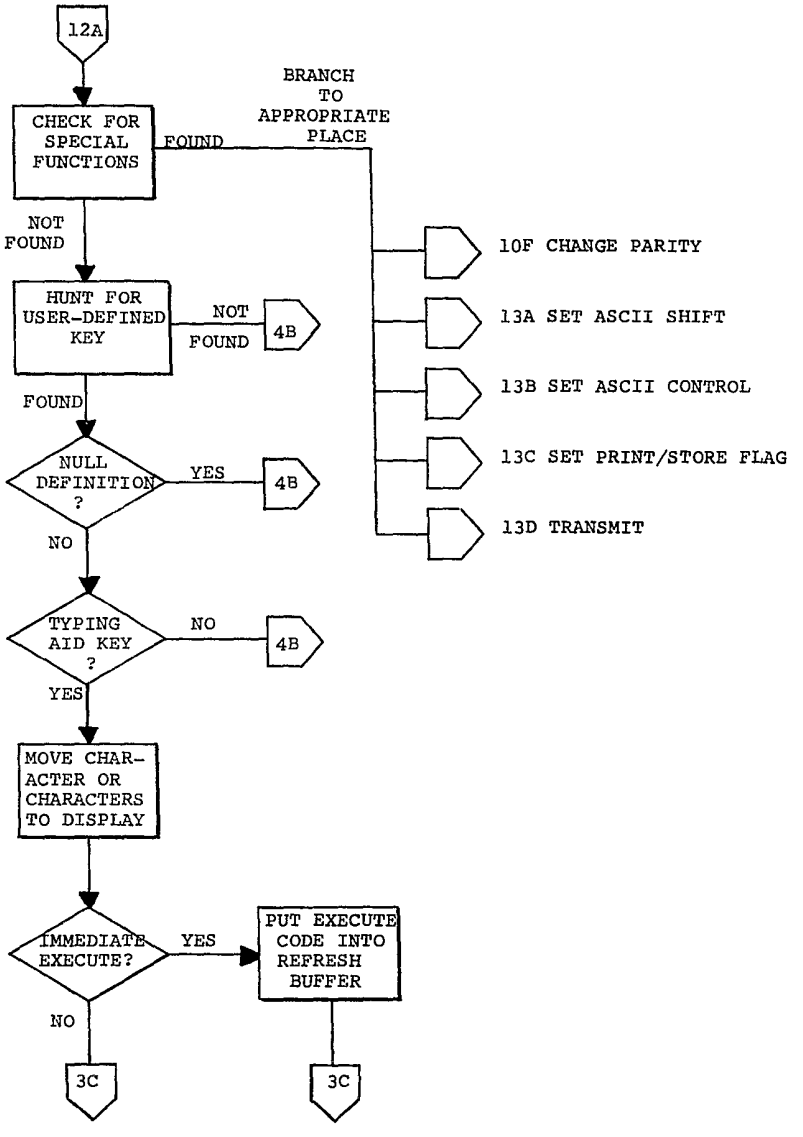

12A
CHECK FOR SPECIAL FUNCTIONS
FOUND
BRANCH TO APPROPRIATE PLACE
NOT FOUND
HUNT FOR USER-DEFINED KEY
NOT FOUND
4B
FOUND
NULL DEFINITION ?
YES
4B
NO
TYPING AID KEY ?
NO
4B
YES
MOVE CHAR-ACTER OR CHARACTERS TO DISPLAY
IMMEDIATE EXECUTE?
YES
PUT EXECUTE CODE INTO REFRESH BUFFER
NO
3C
3C
10F CHANGE PARITY
13A SET ASCII SHIFT
13B SET ASCII CONTROL
13C SET PRINT/STORE FLAG
13D TRANSMIT

FIG 128T

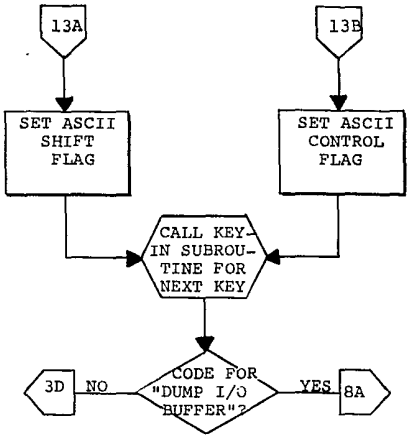


FIG 128U

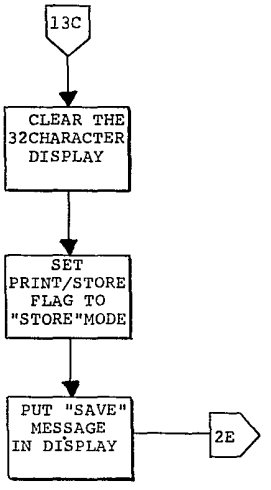


FIG 128V

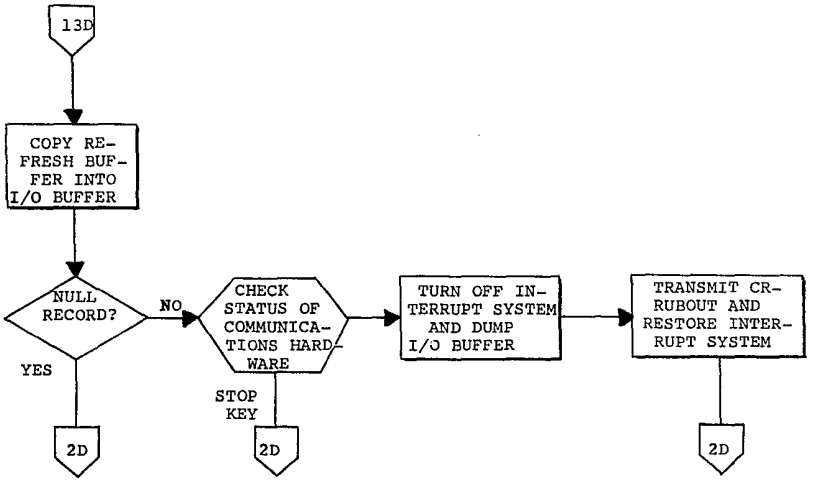


FIG 128W

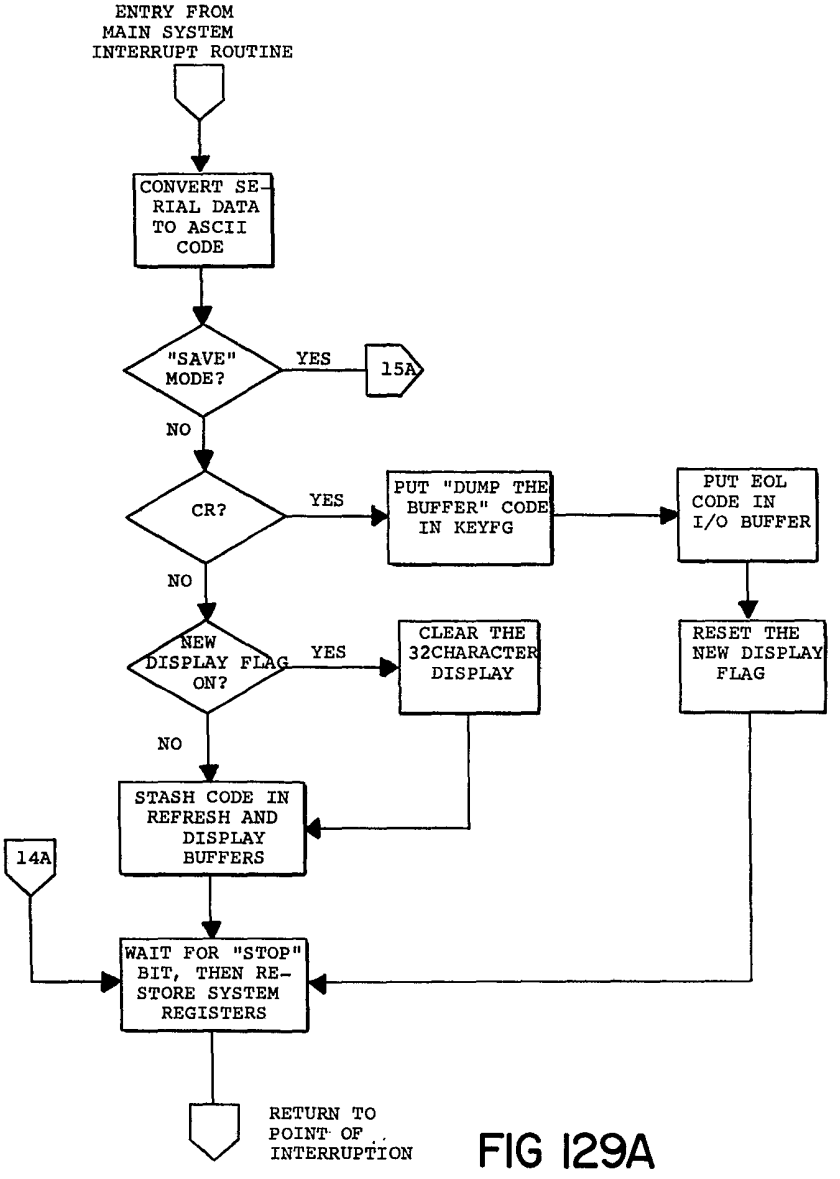

ENTRY FROM MAIN SYSTEM INTERRUPT ROUTINE
CONVERT SERIAL DATA TO ASCII CODE
"SAVE" MODE?
YES
15A
NO
CR?
YES
PUT "DUMP THE BUFFER" CODE IN KEYFG
PUT EOL CODE IN I/O BUFFER
NO
NEW DISPLAY FLAG ON?
YES
CLEAR THE 32CHARACTER DISPLAY
RESET THE NEW DISPLAY FLAG
NO
STASH CODE IN REFRESH AND DISPLAY BUFFERS
14A
WAIT FOR "STOP" BIT, THEN RESTORE SYSTEM REGISTERS
RETURN TO POINT OF INTERRUPTION

FIG 129A

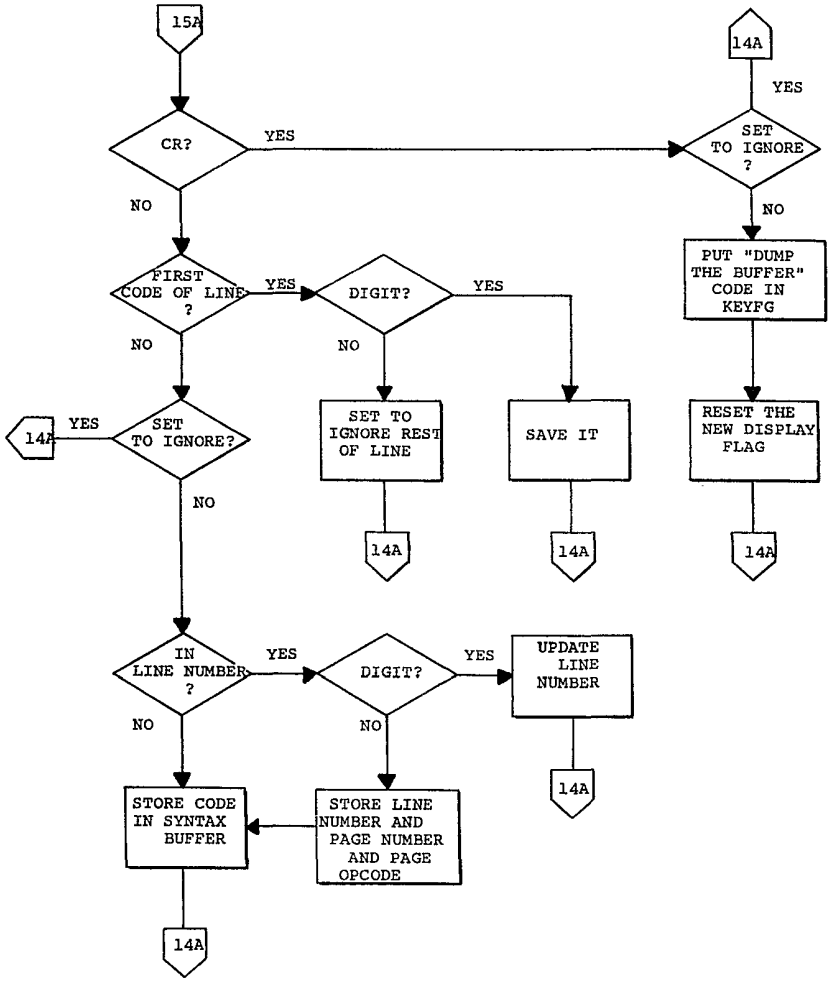

15A
CR?
YES
NO
14A
YES
SET TO IGNORE ?
NO
PUT "DUMP THE BUFFER" CODE IN KEYFG
RESET THE NEW DISPLAY FLAG
14A
FIRST CODE OF LINE ?
YES
DIGIT?
YES
NO
NO
SET TO IGNORE REST OF LINE
SAVE IT
14A
14A
14A
YES
14A
SET TO IGNORE?
NO
IN LINE NUMBER ?
YES
DIGIT?
YES
UPDATE LINE NUMBER
NO
NO
14A
STORE CODE IN SYNTAX BUFFER
STORE LINE NUMBER AND PAGE NUMBER AND PAGE OPCODE
14A

FIG 129B

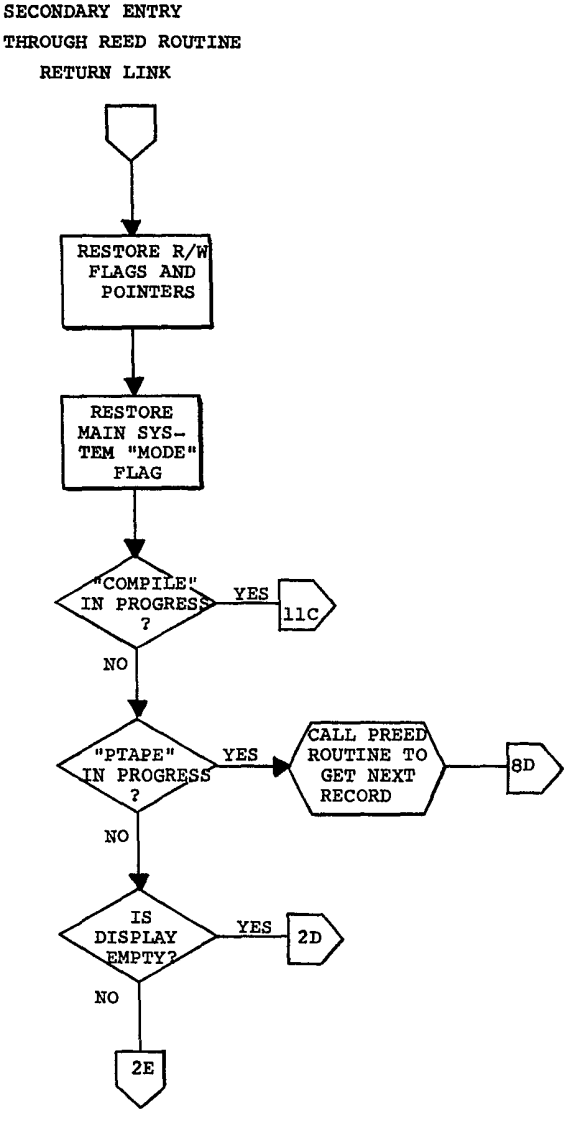

SECONDARY ENTRY
THROUGH REED ROUTINE
RETURN LINK
RESTORE R/W FLAGS AND POINTERS
RESTORE MAIN SYS-TEM "MODE" FLAG
"COMPILE" IN PROGRESS ?
YES
11C
NO
"PTAPE" IN PROGRESS ?
YES
CALL PREED ROUTINE TO GET NEXT RECORD
8D
NO
IS DISPLAY EMPTY?
YES
2D
NO
2E

FIG 130

FLOWCHART OF THE I/O BLOCK'S OUTPUT STATEMENT ILLUSTRATING INTERNAL CONVERSION AND CODE CONVERSION

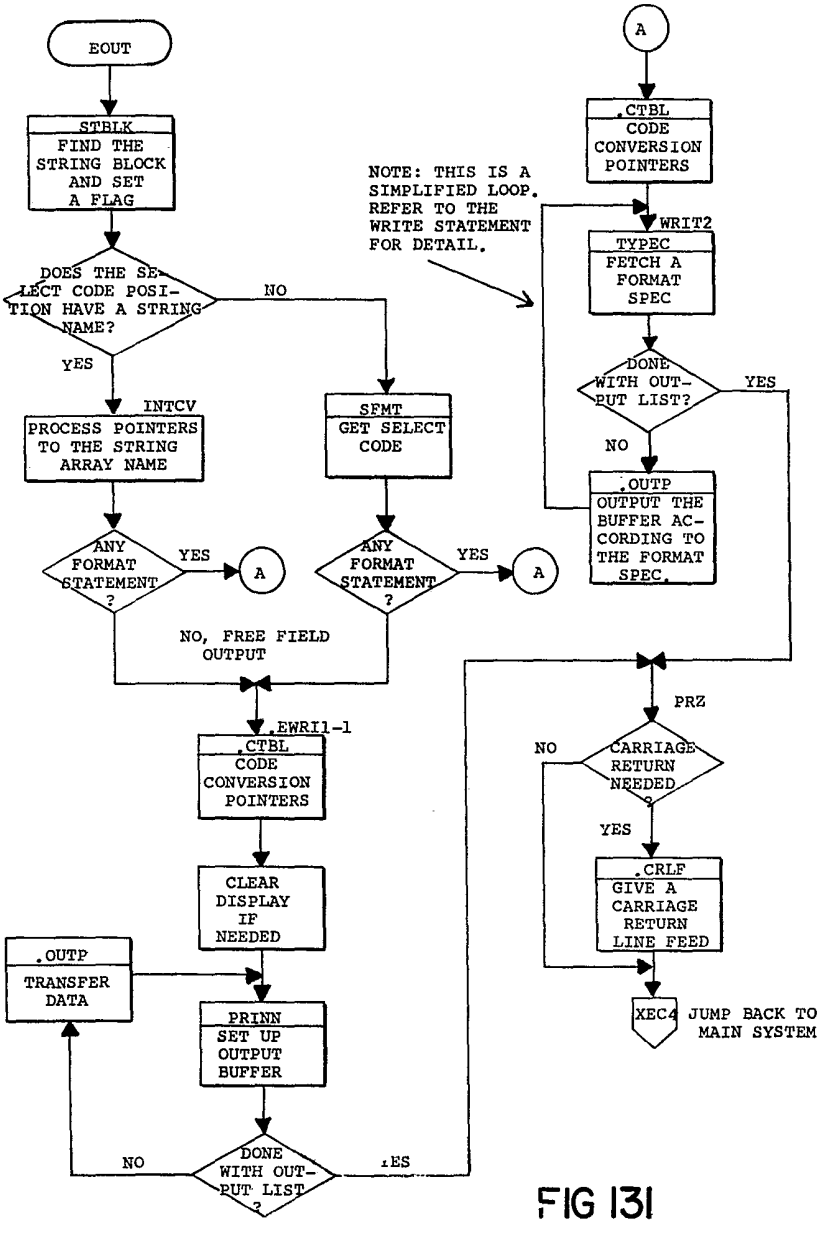


FIG 131

FLOWCHART OF THE I/O BLOCK'S OUTPUT ROUTINE
TO DO INTERNAL CONVERSION

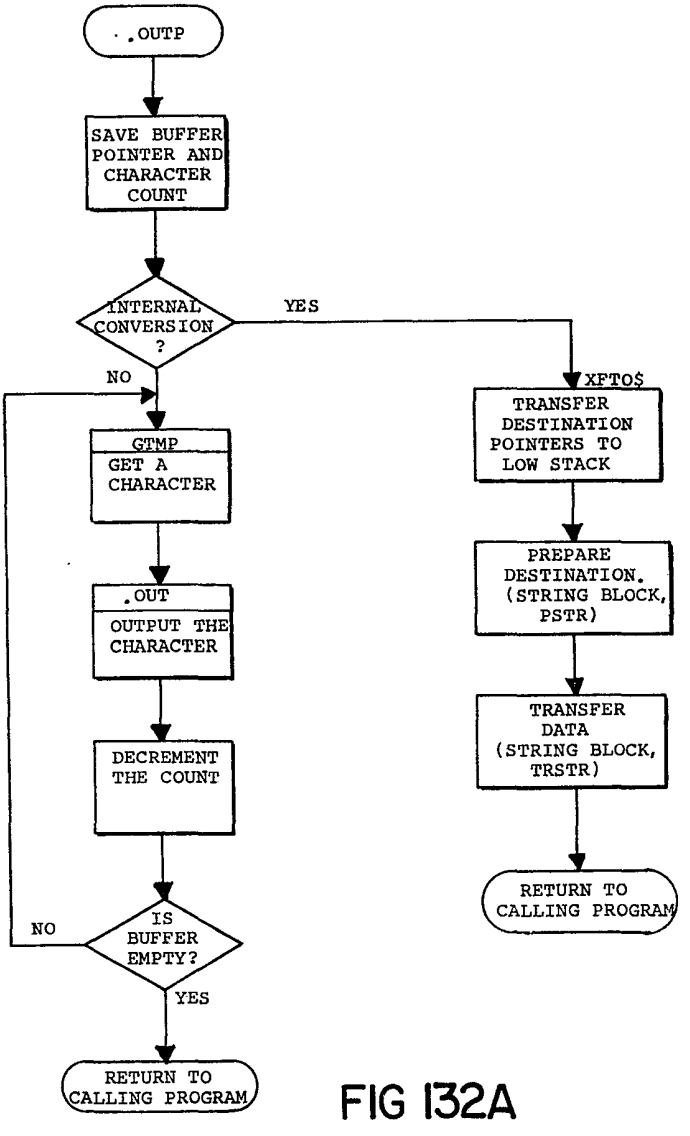


FIG 132A

FLOWCHART OF THE I/O BLOCKS CODE CONVERSION ROUTINES

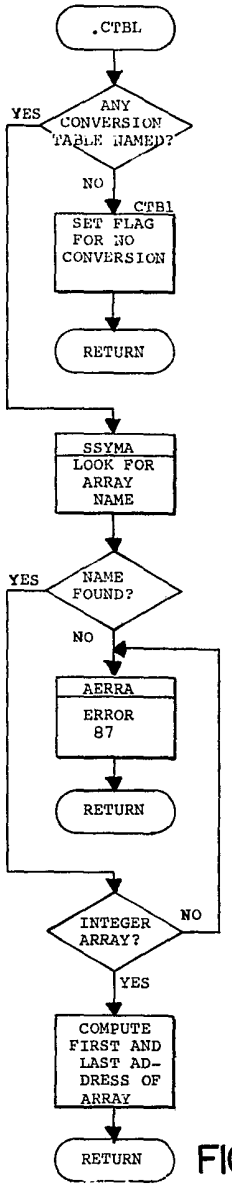


FIG 132B

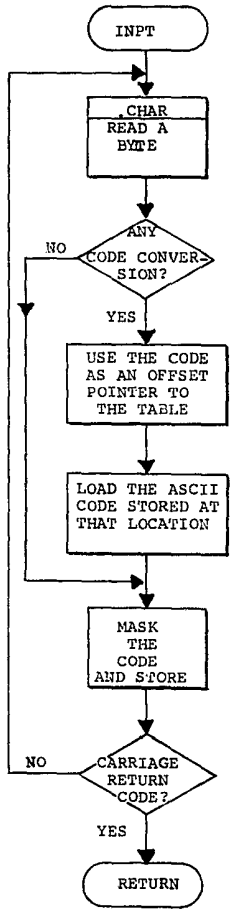


FIG 132C

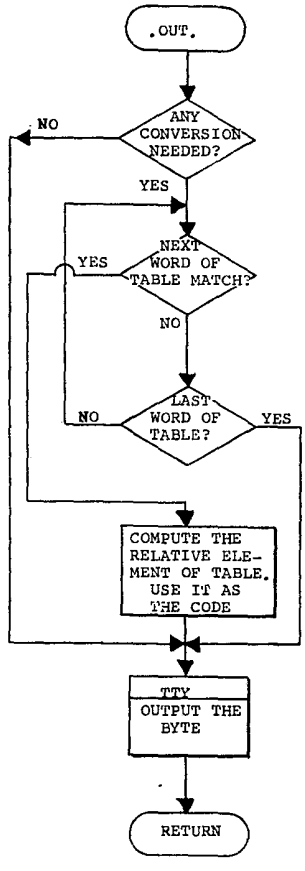


FIG 132D

FLOWCHART OF MISCELLANEOUS FUNCTIONS FOR I/O BLOCK

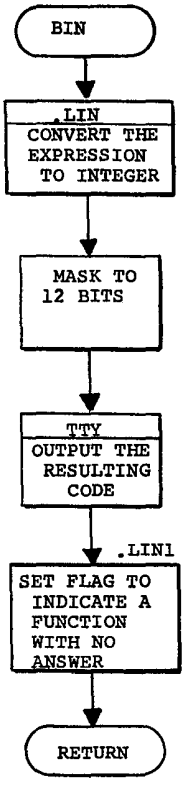


FIG 133

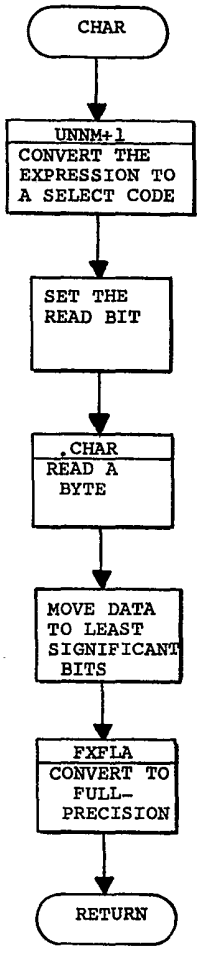


FIG 134

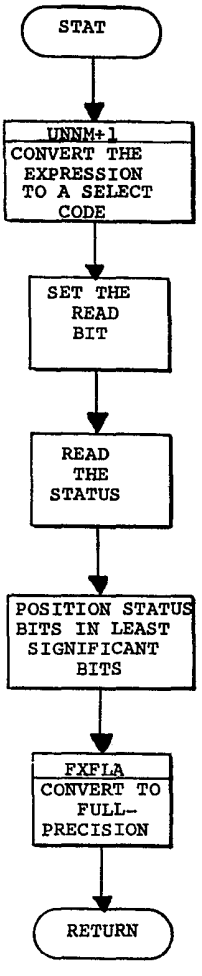


FIG 135

FLOWCHART OF MISCELLANEOUS FUNCTIONS FOR I/O BLOCK

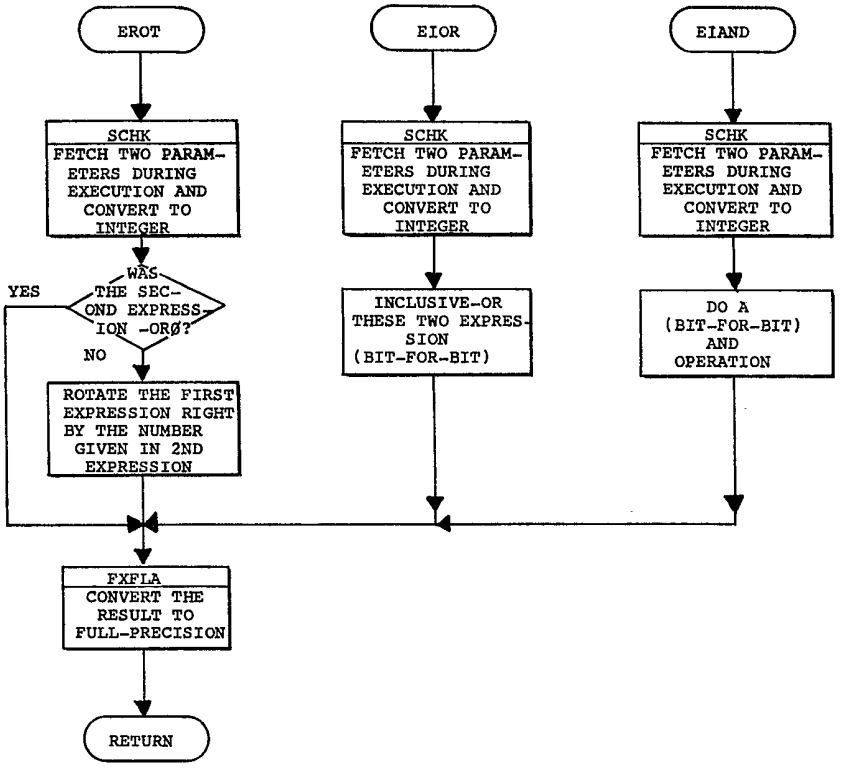


FIG 136