CB REPORT—CIRCUITS TO BUILD—HI-FI TESTS

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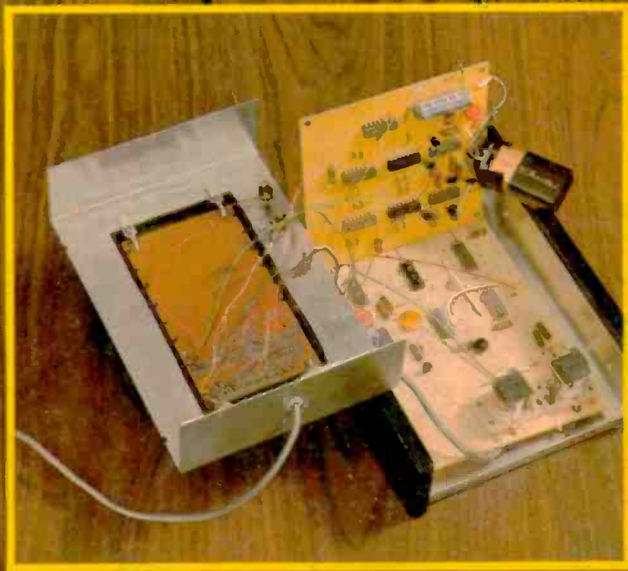

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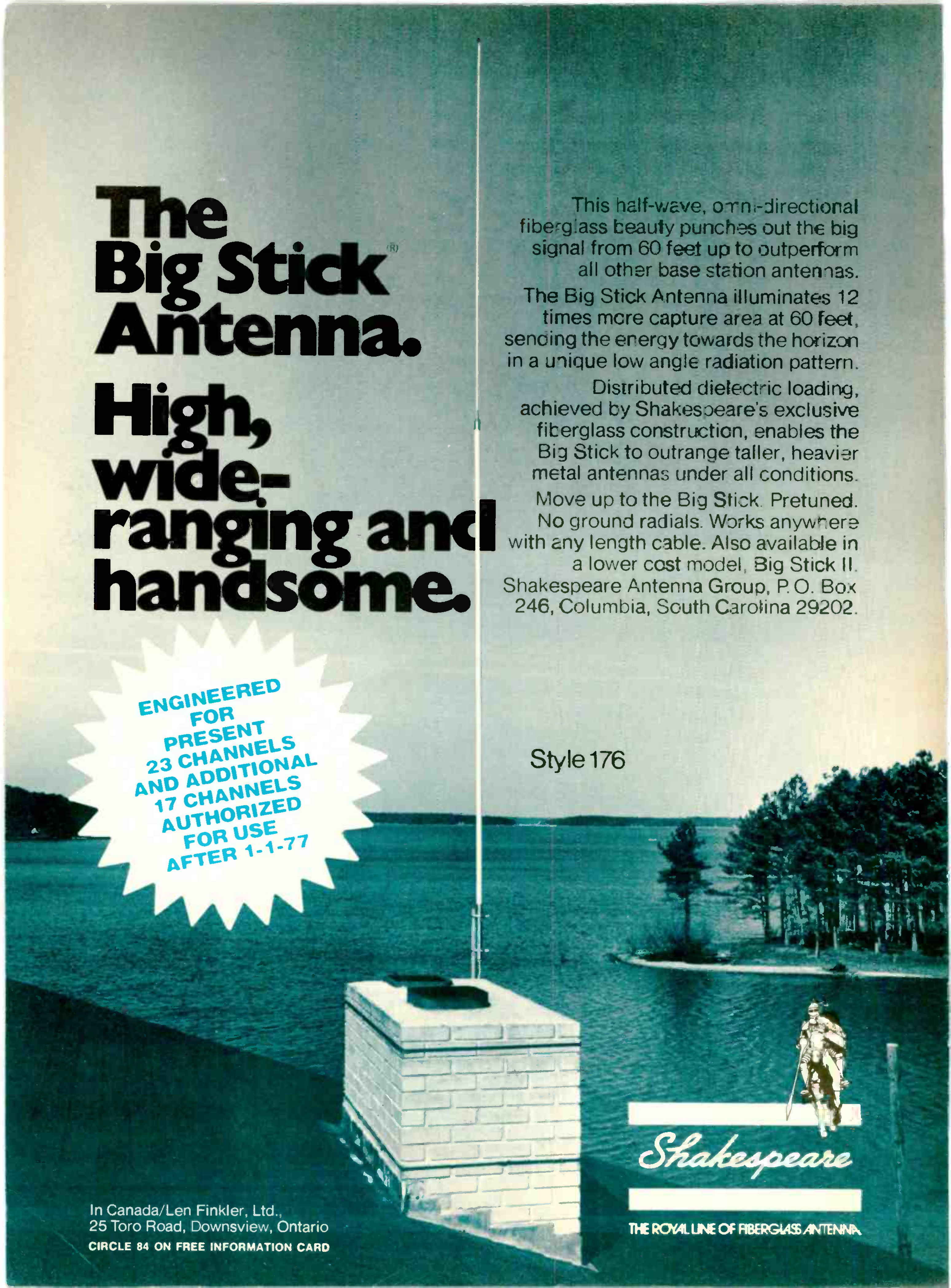
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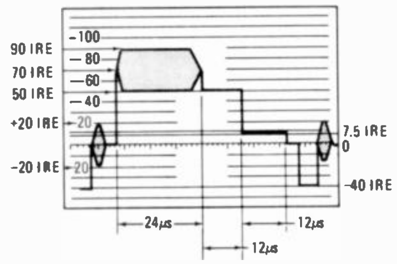
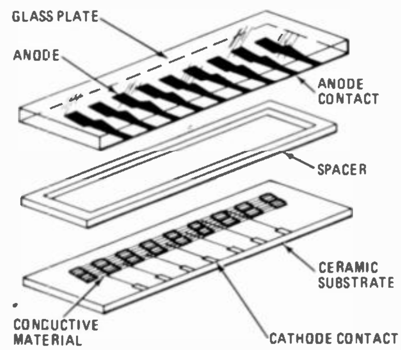
Electronics publishers since 1908 NOVEMBER 1976 Vol. 47 No. 11

ON THE COVER

It only looks like a calculator, but it's more. . . . It's an automatic telephone dialer. Punch in the number you want; then push the button. If the line is busy; hang up and punch the button again. Learn how to build your own. The story starts on page 48.



THE VIR SIGNAL makes color TV pictures perfect. It's tucked away on line 19 between two horizontal sync pulses. See how it works on page 83.



THIS GAS-DISCHARGE DISPLAY is a part of a digital clock you'll want to build. For details turn to page 67.

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looking ahead

TVI problem

The FCC says it's receiving complaints about RF interference at the rate of some 100,000 a year, and that 87% of these are attributable to CB. By far the majority involve interference to TV sets. In the FCC's channel-expansion decision, it specified that CB equipment must have harmonic suppression of 60 dB—far lower than the limit proposed by broadcasters and television set manufacturers. The Commission also said that any CB operator causing harmonic interference to TV Channels 2, 5 or 6 would be required to install a low-pass filter.

But CB can also cause interference across the entire TV band. A very small amount of this is the result of illegal CB equipment, such as linear amplifiers. But FCC officials say the vast majority of interference cases are the result of inadequate filtering and shielding of the TV receiver. Most TV set manufacturers have always followed a policy of providing a filter free of charge at the request of the set owner—but until the CB boom they haven't had many requests. Even now, the TV set owner is likely to blame the CB operator for interference, rather than his own set.

Why not include filters as standard equipment in all television sets? The set manufacturers say this would push prices up and force TV buyers to pay for filters whether they need them or not. But the rapid growth of CB and other devices that emit RF radiation may force a change. The FCC currently has no power to make television manufacturers include filters in all of their production, although there have been several bills introduced in Congress to give it that authority.

More 1977 TV's

The last of the 1977-model TV sets have now been introduced by Zenith. As expected, they included some 19-inch sets with Zenith's all-new color tube designed for precision automatic manufacture, using a new glass design, a new tri-potential gun, 100-degree deflection and a new shadow-mask (**Radio-Electronics,** June 1976). In addition, Zenith introduced a new series of slim 17-inch color sets using conventional-type tubes but with 100-degree deflection, as opposed to the standard 90 degrees.

All of Zenith's 25-inch sets and its newly-introduced 19-inch sets feature a new automatic color adjustment system, Zenith's answer to RCA's ColorTrak, Sylvania's GT-Matic and G-E's VIR. Zenith's Color Sentry combines five automatic circuits; a light sensor that adjusts color and contrast to room lighting, a color signal monitor that prevents oversaturation, a tint stabilizer to correct flesh tones, a contrast regulator that eliminates separate contrast control and keeps contrast, brightness and color at a constant ratio, and a color-level lock that balances color and tint.

Video game boom

At least 32 video-game attachments made by 22 different manufacturers have received FCC approval as we went to press. The simple tennis-type games are now beginning to yield to far more sophisticated home variations of coin-operated arcade games, involving races, battles, space travel and so forth with programmable microprocessor games on the verge of commercial introduction. Many major electronics names are getting into the video game business, which was pioneered by Magnavox. RCA plans a microprocessor game, as does Fairchild. National Semiconductor is already in the business, as is Radio Shack. Channel Master is also preparing an entry. Of course, prices of simple video games are rapidly dropping, the lowest mentioned so far being a two-player black-and-white tennis game entered in the toy market at $39.95 by First Dimension.

40 CB channels

The FCC's expansion of the Citizens band from the current 23 to 40 channels was, in effect, a compromise. The demands for more channels were almost overwhelming. At one time, the Commission had considered going to as many as 58 channels, but the potential for intermodulation interference and the fact that the remote-control hobbyist frequencies (Class C) would be wiped out if FCC went above 40 channels dictated the final choice.

Even these expanded frequencies in the 27-MHz band (26.965-27.405 MHz) are considered temporary, and the Commission stressed it was seeking a permanent home for personal communications "upstairs"—perhaps the 220- or 900-MHz range. But this is still fairly far in the future.

New transceivers operating on the full 40-channel band will be available starting January 1, 1977. The FCC decision prohibts the use of converters to extend 23-channel transceivers to 40, but it will permit the "remanufacture" of 23-channel sets to 40-channel specifications so long as they meet the Commission's type-acceptance requirements.

The FCC has also tightened specifications for type-acceptance of new CB units in an attempt to minimize interference with TV and other services—although it seems likely that TVI will increase with the enlargement of the band. The 23-channel units are capable of causing harmonic interference to TV Channels 2 and 5; with the extension of the band, Channel 6 will also be affected.

The Commission and CB equipment manufacturers stress that 23-channel transceivers will in no way be obsoleted. The major special-purpose channels—highway Channel-19 and emergency Channel-9—are located within the original 23-channel band. And it's certainly a good bet that from now through the end of the year there'll be some great bargains in 23-channel units in preparation for the start of marketing of the new, more costly, extended-band transceivers.

Home VTR chaos

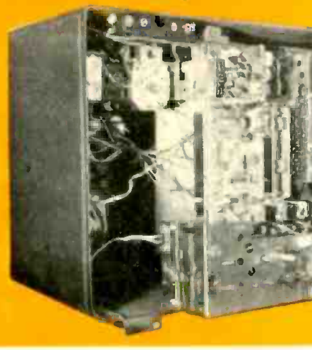
The videocassette recorder is now well launched as a consumer product, with Sony making and selling about 10,000 a month, 2,500 of these in the United States. As reported here, two other incompatible systems are on the market in Japan (all home units so far use half-inch tape)—Matsushita's Home Video, to be sold here by Quasar and Sanyo's V-Cord II, to be sold here under the Sanyo name.

A fourth—and also incompatible—system has been developed in Japan by Japan Victor (JVC). At presstime, it had not been demonstrated, but it is said to be an extremely compact machine with two hours recording or playing time for a cartridge of half-inch tape. Some observers feel the JVC machine will be the subject of an all-out attempt to "standardize" by winning over uncommitted (or even some already committed) Japanese manufacturers.

Meanwhile, Betamax continues to roll, with a production schedule of 200,000 set for 1977 and a two-hour cassette said to be in the works (current playing time is only 60 minutes). And in the U.S., Sony and Paramount Pictures have formed a joint venture to explore distribution of pre-recorded tapes as well as recorders. Thus Betamax is now being put forward as a competitor to the video disc systems that are tentatively scheduled for introduction in late 1977 by Magnavox and RCA.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Tuner Service Corporation



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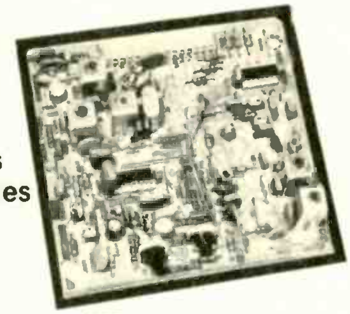

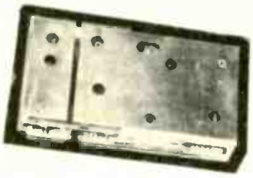

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CIRCLE 17 ON FREE INFORMATION CARD

new & timely

CB'ers see mixed prospects in future of Citizens band

The announcement that the Citizens band will go to 40 channels January 1 was unquestionably the good news that CB'ers have been awaiting for months. The first 23 channels extended from 26.965 to 27.255 MHz, with channels spaced 10-kHz apart except for a few gaps. The new channels begin with the addition of two channels at 27.235 MHz and 27.245 MHz (filling the gap between Channel 22 at 27.225 and Channel 23 at 27.255 MHz) and will continue 10 kHz apart—with only one gap—and end at 27.405 MHz for a total of 40 channels.

Not only will the new channels reduce interference, but the new 40-channel sets will be constructed to tighter standards and will not be as likely to create interference on other channels or to outside services.

The unhappy side of the picture is that many sets now in the field do not even measure up to present standards. Manufacturers, first rushing to supply sets for the CB explosion; later to get the 23-channel sets now in production off the lines to prepare for the 40-channel line, have tended to cut corners and relax quality control. The result has been sets with splatter that creates adjacent-channel interference and other weakness that cause interference to TV and other services. To add to the problems, FCC enforcement has actually been reduced instead of increased, due to the tremendous workload on the Commission because of the CB application jam during the rapid increase in CB use during the past year, and to the work on new standards and regulations for the 40-channel service.

A second cloud on the CB horizon is the coming sunspot peak. CB'ers who lived through the last sunspot peak remember (many with delight!) how signals took off into the wild blue yonder and permitted long-distance communications. They also remember that they were able to handle local traffic in spite of the occasional sporadic reception of stations hundreds of miles away, and are looking forward with little fear to a similar situation in 1979 or thereabouts.

Digital watches may have battery-life problems

The dealer who has been doing a good business in LED digital watches may be in for some surprises, thinks Henry Goldsmith, J.C. Penney merchandising manager. Many dealers, relying on their experience with older types of electronic watches, have sold the newer watches on the basis that the batteries will last a year. The average life for a man's LED digital watch is six to nine months, says Mr. Goldsmith, and of a woman's watch three to six months. The customer, of course, will expect and demand free replacement of batteries that give out sooner, regardless of whether the watch cost $20 or $200.

The situation can create real trouble for the dealer, who will not only be expected to replace the batteries free of charge, but will also have the expense of the labor required for their replacement—often a job that requires time and occasionally special instruments.

There are two bright spots in the picture. Some dealers have been alert to the situation and have explained to the LED watch customer that battery life depends on how much use is made of it. And experience has shown that the second battery lasts longer than the first. Apparently, once the novelty has worn off, the user does not need to know the time so often!

Manufacturers team to create vehicle hi-fi stereo system

An automobile (or other vehicle) hi-fi system presented jointly by Nakamichi Research (USA) of Carle Place, NY, and Analog Digital Systems, Wilmington, MA, introduces a number of unique features in mobile stereo systems. The cooperative project is an effort to "upset the popularly held notion that true hi-fi is wasted in automobiles."

The cassette player is a Nakamichi model 250, with a frequency response of ± 3 dB from 85 to 20,000 Hz and a signal-to-noise ratio of 62 dB. It features selectable playback equalization, Dolby noise reduction circuitry and a built-in preamplifier with volume, balance and tone controls. Maximum output is 500 millivolts.

The model 250 feeds into a pair of ADS model 2002 loudspeakers. Secret of the 2002's effectiveness is in their amplifier system. Three power amplifiers are built into each system. Two of them are bridged to power the 4-inch miniature woofer; the third drives a 1-inch diameter soft dome tweeter. The 2002 measures 6.85 × 4.5 × 4.9 inches. Output is 40 watts. Price of the system is listed as $696.

Television now 30 years old

In the Fall of 1946, as American industry turned from war to peace production, RCA introduced black-and-white television on a commercial basis. Through July of 1976, more than 76,000,000 color sets alone had been sold in this country. (Color came along in 1954.)

According to experts, the curves indicate that progress is just beginning. David E. Dáley of RCA Consumer Electronics states that all indications are that nearly 40 million sets will be sold between now and 1980.

Among the factors responsible for this acceleration, Mr. Daly notes: the fact that more than half the nation's population is 30 years old or younger—people who think of television as a natural adjunct to

continued on page 12

THE HI-FI CAR STEREO SYSTEM combines the Nakamichi model 250 tape player and ADS model 2002 speaker system to make up a high fidelity system for cars, boats and similar vehicles. Rated at an undistorted acoustical output of 104 dB SPL, these units claim to be the world's smallest truly high-fidelity speakers.

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CIRCLE 25 ON FREE INFORMATION CARD

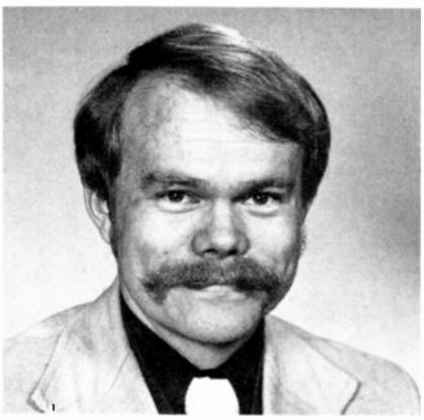
new & timely

continued from page 6

their lifestyles, the growth of cable TV and the new features being introduced into that facility, the growing demand for video games that connect to the antenna terminals, the video tape-recorder-player and the video disc player.

Quernemoen, Fablet and Piazza win Hugo Gernsback Award

Wayne Quernemoen of Alexandria, MN, is this month's winner of the Hugo Gernsback Memorial Award, a $150 check presented annually to an outstanding student in each of eight leading electronics home study schools. Through the generosity of two test instrument manufacturers, students who place second and third in the contests held by the schools to determine the award winners also receive prizes.

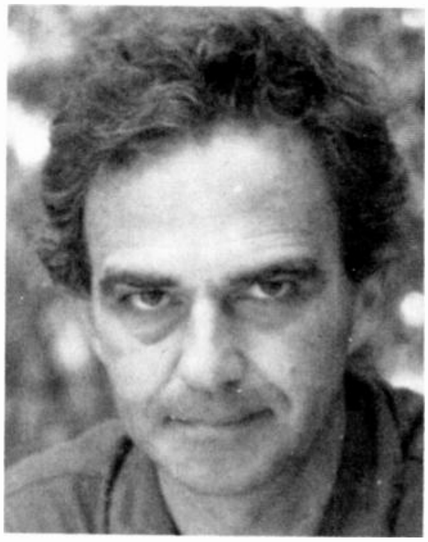


WAYNE QUERNEMOEN

Wayne Quernemoen was and is a radio amateur. He had worked in a TV repair shop and at TV station KCMT—where he is now studio engineer, before enrolling with Grantham School of Engineering. Enrolled in the Electronics Engineering Technology course, he has completed the first four phases and is nearing completion of the fifth (engineering calculus, electrical networks and solid-state design). After completion and a seminar at the school, he will have earned the degree of Associate in Science in Electronics Engineering (ASEE).

Mr. Quernemoen intends to continue in his field of TV broadcast engineering, with possibly some attention to biomedical electronics, and to do some technical writing in those two fields. Eventually he hopes to continue his education to include an MSEE degree.

Runner-up Jose Luis Fablet, who receives a B&K Model 280 Digital Voltmeter, was born in Buenos Aires, Argentina, and now lives in Montevideo, Uruguay. He owns a factory making TV tuners, handles TV repairs on all brands, and deals in TV replacement parts, having a staff of 20 employees in all. He is



JOSE LUIS FABLET

enrolled in the Electronics Engineering Course and, having completed three of its four phases, has received the degree of Associate in Electronics Engineering Technology (ASET). He expects to enroll in Part 4 to earn a higher degree.

NICHOLAS A. PIAZZA

Third-place Nicholas Piazza, Newport Beach, CA, is the winner of a VIZ WV-529A service VOM. He was introduced to electronics in the Navy, receiving 94 weeks of formal training. He is at present assigned to the Defense Communications Support Detachment at Marine Corps Air Station, El Toro, CA. Like Mr. Fablet, he has completed three phases of the Electronics Engineering course, receiving the ASET degree on May 6, 1975. He is now continuing in the course to earn an ASEE degree.

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MITS' plug-in compatible boards for the Altair 8800b now include: 4K static memory, 4K dynamic memory, 16K static memory, multi-port serial interface, multi-port parallel interface, audio cassette record interface, vectored interrupt, real time clock, PROM board, multiplexer, A/D corvertor, extender card, disc controller, and line printer interface.

MITS' peripherals for the Altair 8800b include the Altair Floppy Disc, Altair Line Printer, teletypewriters, and the soon-to-be-announced Altair CRT terminal.

Introductory prices for the Altair 8800b are $840 for a kit with complete assembly instructions, and $1100 for an assembled unit. Complete documentation, membership into the Altair Users Club, subscription to "Computer Notes;" access to the Altair Software Library, and a copy of Charles J. Sippl's Microcomputer Dictionary are included. BankAmericard or Master Charge accepted for mail order sales. Include $8 for postage and handling.

Shouldn't you know more about the Altair 8800b? Send for our free Altair Information Package, or contact one of our many retail Altair Computer Centers.

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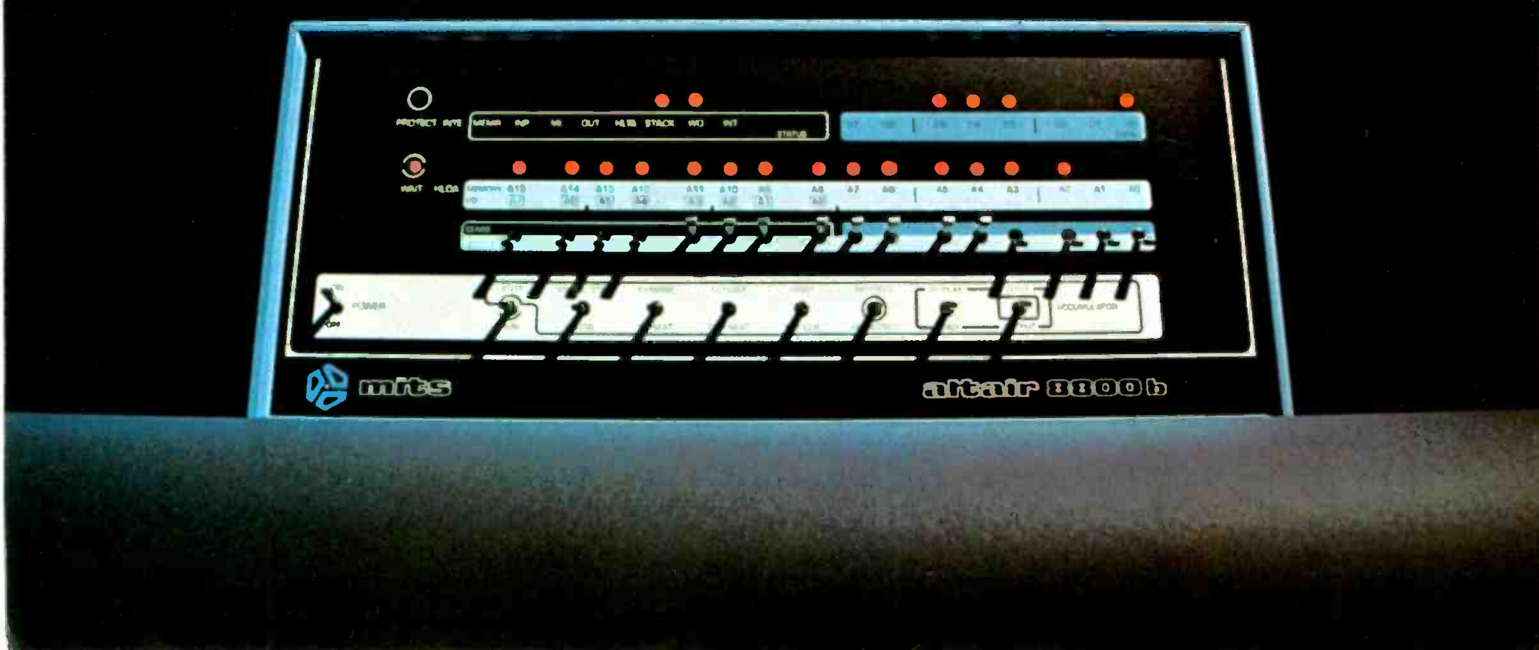

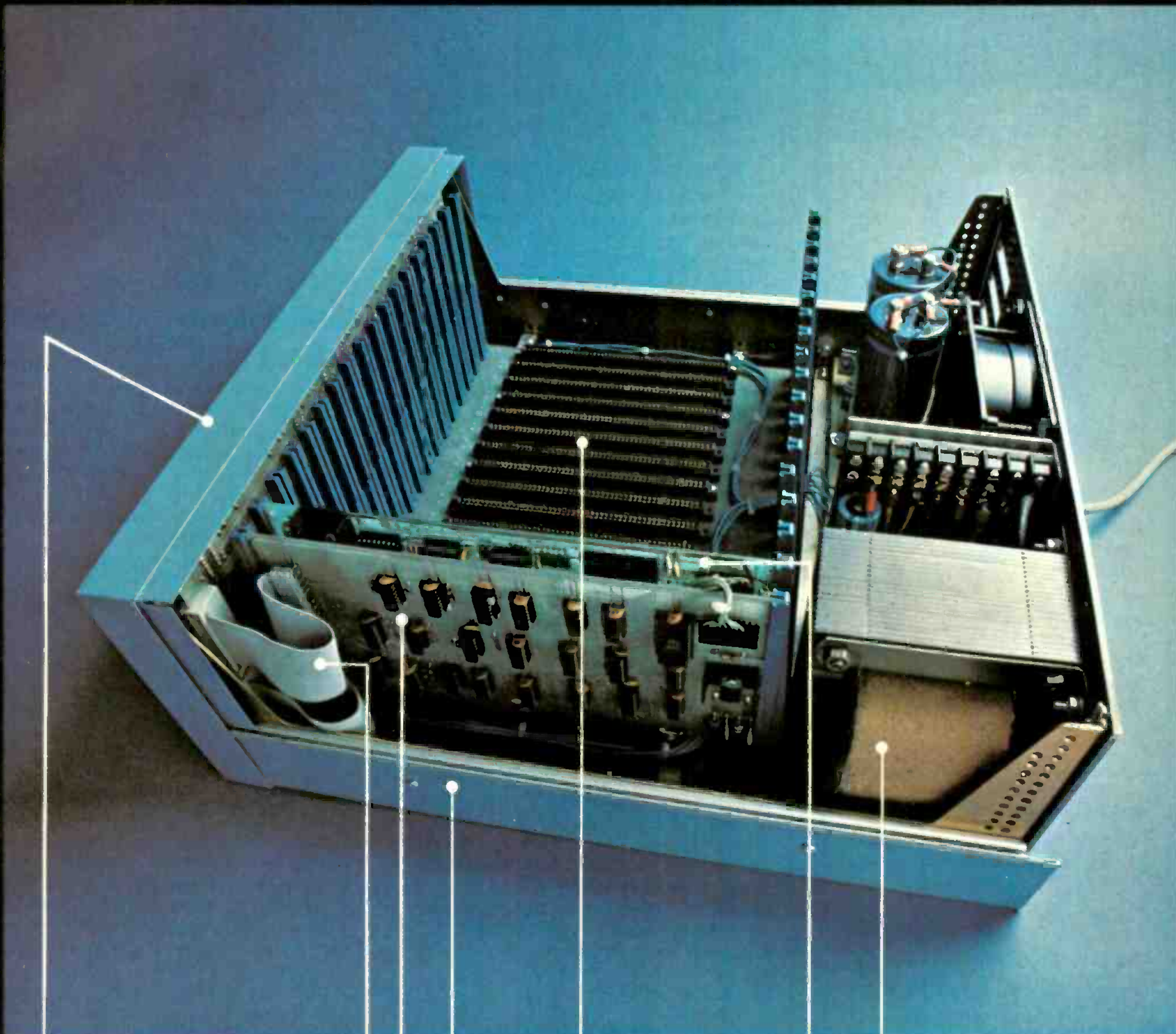

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letters

MCS6501 MICROPROCESSOR

In the June, 1976 issue of **Radio-Electronics** there are two mistakes in the *State-of-Solid-State* article. These mistakes concern the MCS6501.

MOS Technology's announcement of April, 1976 states they have "agreed to withdraw the MCS6501 from the marketplace . . ." This microprocessor IC was introduced about September, 1975, as was a second chip, the MCS6502.

The MCS6501 IC did not have an on-the-chip clock. It required an input from an external two-phase clock. The MCS6502, which is still produced by MOS Technology, is similar to the MCS6501 except that it does have an on-the-chip clock.

WILLIAM J. HARTWEG
Staten Island, NY

SR-52 CALCULATOR MEMORY

There is a rebuttal to a previous letter I had written concerning the availability of memory registers on Texas Instruments calculators printed in the September issue of **Radio-Electronics.**

Mr. Lemmon is absolutely correct in his statements concerning the SR-51. However, reader Lemmon infers that there are no extra memory registers available on other T.I. calculators. This is incorrect. The memory registers 98 and 99 are definitely accessible on the SR-52. Program registers 70 through 97 are addressable from the keyboard, as are the operational stack registers 60 through 69.

THOMAS S. COX
Greenville, SC

DYNA-MICRO

I am a third-year computer systems engineering student at Oregon Institute of Technology, with my major interest in microcomputers. I have been searching for a good basic microcomputer to use as the core of my system. The Dyna-Micro, as described in the May, June, and July issues of **Radio-Electronics**, fit my plans beautifully.

After modifying the logic diagrams to fit my requirements, I began wire-wrapping my system. When I checked out the keyboard logic diagram in preparation to wire-wrapping it, I noticed a mistake. The keyswitches are encoded by two 74148 8-to-3 line priority-encoder IC's. One handles the numeric values and the other handles the alphanumeric values. For these IC's to operate, a wire must be connected from pin 5 (ENABLE IN) to ground or a low signal.

I checked out the logic diagram and the foil patterns to see if these connections were included. The foil pattern is complete and ready to go. I imagine the connections on the logic diagram were overlooked in the process of printing the article. Perhaps this letter can save others some trouble-shooting time if they decide to build the Dyna-Micro and employ wire-wrapping in the construction.

DARREL WRIGHT
Klamath Falls, OR

MICROCOMPUTER APPLICATIONS PROGRAMS

On page 14 of the June 1976 issue of **Radio-Electronics**, Jonathan Titus states: "The PDP-8, PDP-11 and NOVA families have thousands of applications programs that just aren't available for microcomputers."

The facts are:

1. The IM6100 microprocessor emulates the PDP-8.
2. The LSI-11 microprocessor emulates the PDP-11.
3. The mN601 microprocessor emulates the NOVA.

Virtually all of the existing applications programs for the above machines will run on the emulating microcomputers with no change whatever.

J. GORDON
Los Angeles, CA

The Intersil IM6100 is compatible with PDP-8 software. This is an exception. It is, however, difficult to use the system with subroutines in PROM or ROM. This is because of the method used in the PDP-8 to recover a return address when it is finished with a subroutine. Front-panel controls aren't easy to add to an IM6100. I'd rather buy a PDP-8.

The LSI-11 from Digital Equipment Corporation is compatible with the PDP-11 software at the source level. This means that the software must all be converted before you can transfer it. The LSI-11 is not compatible with PDP-11 peripherals without a converter unit, available at additional cost. If you're not an OEM, I'd suggest you buy a PDP-11 and forget the LSI-11 for now.

The Data General mN601 (Micro Nova) is supposed to be a nice machine. They can't deliver before December according to the Data General people at the National Computer Conference. You can't run software on a machine you don't have.

I stand by my statement, but I expect the situation to change in a couple of years.

JON TITUS

IT ISN'T! OR IS IT?

I read, with interest, the letter sent to you by Continental Specialties and Sharp Advertising. Their contention that their product is a direct replacement for the SK-10/IF-18 solderless interface socket included in the parts list for the Dyna Micro (**Radio-Electronics**, May 1976 is-

continued on page 22

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CIRCLE 69 ON FREE INFORMATION CARD

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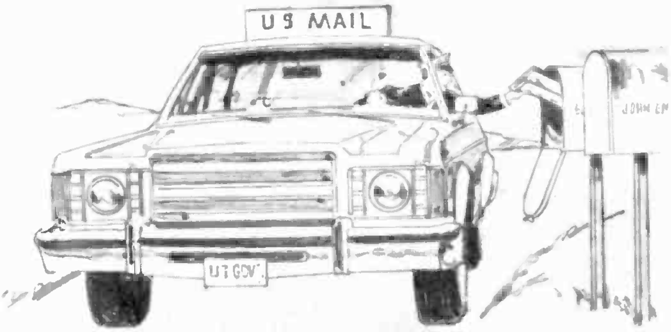
The Heathkit Christmas Catalog is off the press, and that's good news for gift-givers, kitbuilders and everyone else, too. It's brim-full of the latest electronic products in easy-to-build kit form. Everything from lamp dimmers to color TV's, nearly 400 great gift ideas. Gifts for homeowners, businessmen and people interested in electronics, sports, fishing,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12:35
handy index

LETTERS
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sue) is not correct. This socket is not a standard breadboarding socket, but one designed especially for direct connection at the rear plane of the socket.

Your readers should be aware that until Continental and AP manufacture an interfacing/type of socket, E&L is the only vendor. The correct part number for the Dyna Micro interface/breadboarding socket is SK-10/IF-18. It sells for $18.75 in single quantity.

RICHARD J. VUILLEQUEZ
Vice President, Sales
E&L Instruments, Incorporated
Derby, CT

PRO SOUND SYSTEMS

Your article "Microphones in Pro Sound Systems" was notable for the things not included rather than what was said. Though you got off to a good start and provided some interesting basics, it is beyond me that the writer of the article should actually believe that condenser microphones should be omitted entirely from the body of the article. We are informed that there are five major types of microphones used in Pro Sound systems, but the thought that ceramic and crystal-type microphones are frequently used could only be sustained by someone looking into the state-of-the-art fifteen years ago! Or perhaps twenty-five! Hurrah for getting some good basics (albeit skimpy), but the selection of information on specific microphones could perhaps have been better by mentioning fewer types and going into just a little bit more detail on some of the weaknesses and strengths of each.

Finally, I think it's ironic that in an article having information supplied solely by Shure Brothers, Incorporated of Evanston, Illinois, the microphone picture on the front page is an *obsolete* Electro-Voice microphone.

WILLIAM A. RAVENTOS
Buchanan, MI

MICROCOMPUTER/TV INTERFACE

In reference to Mr. Paul Hyde Jr.'s letter (July 1976 issue) concerning microcomputer/TV interface: I purchased a kit from a company in Dallas to interface my Intel 8080 with my TV. It was very reasonably priced. I believe that this kit will meet Mr. Hyde's needs, as it did mine. The company name is IOR, Box 28823, Dallas, TX 75228.

WAYNE FOX
Garland, TX **R-E**

General Motors, dealers competing on car radios

General Motors is finding itself in a dispute with some of its dealers over what radios are to go into GM cars. Delco, GM's radio division, reports that it has been losing orders because dealers have been purchasing and installing foreign radios instead of Delco. The parent company has been bothered enough about the situation to start an ad campaign, urging buyers to "Tell your dealer 'Delco.' Don't settle for a look-alike radio in your new GM car."

The matter is apparently not one that will threaten the survival of either GM or the dealers, since radios come already factory-installed in nearly 90 percent of the company's cars. **R-E**

PILOT PRODUCTION LINE for making optical waveguides, now operating in Atlanta, GA. To make the lightguides, high-silica-content glass rods are prepared on a glass lathe (glowing area, upper right), then softened (upper left) and pulled into hair-thin fiber lightguides through equipment in lower left.

KOMPUTER KORNER

A look at the arithmetic/logic instructions and processor flags of the 8080 microprocessor

TIM BARRY

WE PREVIOUSLY DISCUSSED THE DATA-TRANSfer instructions that can be performed by the 8080. This month we will continue on with this presentation by examining the arithmetic/logic instructions that the 8080 uses to operate upon the data located in its registers and the system memory. (You may wish to refer to the previous column for an explanation of some of the notations used to represent various register groups, data types, and data transfers.)

Arithmetic/logic instructions

Any computer instruction that modifies the contents of a register, memory location or flag by any arithmetic or logic operation is considered to be a member of this group. As with data-transfer instructions, we can consider arithmetic/logic instructions in the context of data sources and data destinations. The execution of an arithmetic/logic operation causes the contents of one or more data sources to be operated upon by the computer's arithmetic/logic unit. The result of the operation is then placed into the data destination. The contents of the data sources used in the operation are called *operands*. Most computer arithmetic/logic operations use one, two or occasionally three operands. The 8080 uses arithmetic/logic operations that require either one or two operands.

Processor flags

Intimately related to the concept of arithmetic/logic instructions is the concept of *processor flags*, or simply *flags*. A flag is an internal logic element (usually a flip-flop) that indicates the state of the processor. Some of these flags are set and reset based upon the result of the various arithmetic/logic operations. These flags can then be tested and their state used to determine whether or not some operation is to be executed. For example, the operation to take place after an addition operation has been performed may depend on whether or not the result of the operation was zero. If the processor has a flag that is set if the result of an operation is zero, it could be tested and the next step based on whether or not it was set or clear. Without flags to set and test, the ability of the computer to modify its operation based upon the results of operations performed would be lost, and with it the flexibility of programmed control.

The 8080 provides four flags that are affected by arithmetic/logic operations and they are tested under program control. These are the carry flag, the zero flag, the sign flag and the parity flag. The conditions that are indicated by these flags are described below:

Carry flag: The carry flag is set or reset under the following conditions:

1. Set if the result of an addition is greater than 256
2. Set if the result of a subtraction is less than 0
3. Cleared by all logic operations (AND, XRA, ORA)
4. Set or cleared by the rotate instructions

In addition, there are two 8080 instructions that can be used to directly modify the state of the carry flag. Each instruction is listed below (in bold) followed by the data-transfer notation and the meaning.

STC (1)
Operation performed: 1 ⟶ C
The carry flag is set to 1.

CMC (1)
Operation performed: $\bar{C}$ ⟶ C
The state of the carry flag is complemented.

Zero flag: The zero flag is set to a logic-one anytime an arithmetic or logic operation results in a zero in the accumulator.

Sign flag: The sign flag corresponds to the sign of the two's compliment number in the accumulator after an arithmetic or logic operation has been performed. If bit-7 of the accumulator is a zero (the number is positive), the sign flag will be set to a logic-0. If bit-7 of the accumulator is a logic-1 (the number is negative), the sign flag will be set to a logic-1.

Parity flag: The parity flag is set or reset based upon the number of logic-1's left in the accumulator as the result of an arithmetic or logic operation. If the number of bits set to logic-1 in the accumulator is even (even parity), then the parity flag will be set to logic-1. If the number of bits set to logic-1 in the accumulator is odd (odd parity), then the parity flag will be set to logic-0.

It is important to remember that the flags are only set or cleared as the result of arithmetic and logic operations. With one exception, data-transfer instructions do not alter the state of the flags. This means that to test a value from memory or an input device, you must perform an arithmetic or logic operation with that value to set the flags. The act of transferring data, by itself, does not set flags to correspond to the data transferred.

When using the 8080, the contents of the accumulator and all flags can be treated as a program status word (PSW). PSW can be saved in the stack by using the PUSH PSW instruction. This saves the status of the flags when the push instruction is executed. This status can then be restored later by using a POP PSW instruction. (POP PSW is the data transfer-instruction that violates the general statement that data transfers don't alter flags.)

continued on page 26

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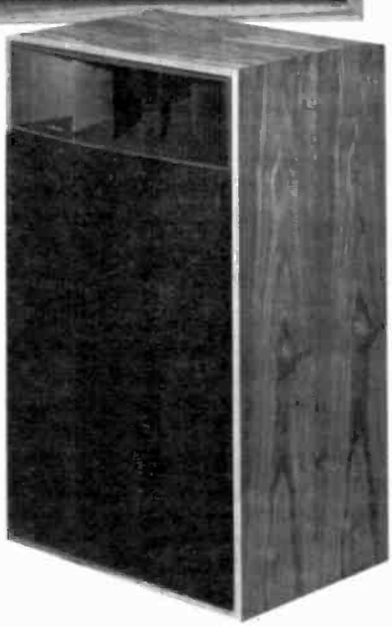

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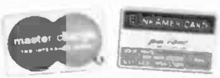

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KOMPUTER KORNER

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Two-operand instructions

The 8080 provides nine basic two-operand arithmetic/logic operations. Eight of these are 8-bit operations and one is a 16-bit operation. For the 8-bit operations, the two data-sources are the A register and one of the following: A single register (A, B, C, D, E, H, or L), the contents of memory as addressed by the HL register pair (M), or an 8-bit immediate data value (D8). The data destination is always the A register. For the 16-bit operation, the two data-sources are the HL register pair and one of the 16-bit register pairs (BD, DE, HL) or the stack pointer (SP). The data destination is always the HL register pair.

ADD S	$(A) + (S) \rightarrow A$	(1)
ADD M	$(A) + ([HL]) \rightarrow A$	(1)
ADI D8	$(A) + D8 \rightarrow A$	(2)

The above program adds the contents of the specified data source to the contents of A and the result is placed in A. All flags are affected.

ADC S	$(A) + (S) + C \rightarrow A$	(1)
ADC M	$(A) + ([HL]) + C \rightarrow A$	(1)
ACI D8	$(A) + D8 + C \rightarrow A$	(2)

The above program adds together the contents of the specified data source, the contents of A and the carry flag, and the result is placed in A. All flags are affected.

SUB S	$(A) - (S) \rightarrow A$	(1)
SUB M	$(A) - ([HL]) \rightarrow A$	(1)
SUI D8	$(A) - D8 \rightarrow A$	(2)

Here, the contents of the selected data source are subtracted from the contents of A and the result is placed in A. All flags are affected by this operation.

SBB S	$(A) - (S) - C \rightarrow A$	(1)
SBB M	$(A) - ([HL]) - C \rightarrow A$	(1)
SBI D8	$(A) - D8 - C \rightarrow A$	(2)

The contents of the selected data source and the carry flag are subtracted from the contents of A and the result is placed in A. All flags are affected.

ANA S	$(A) \wedge (S) \rightarrow A$	(1)
ANA M	$(A) \wedge ([HL]) \rightarrow A$	(1)
ANI D8	$(A) \wedge D8 \rightarrow A$	(2)

The logic and operation is performed using the contents of A and the selected data source. The result is placed in A. All flags are affected.

XRA S	$(A) \veebar (S) \rightarrow A$	(1)
XRA M	$(A) \veebar ([HL]) \rightarrow A$	(1)
XRI D8	$(A) \veebar D8 \rightarrow A$	(2)

The exclusive-or operation is performed using the contents of A and the selected data source. The result is placed in A. All flags are affected.

ORA S	$(A) \vee (S) \rightarrow A$	(1)
ORA M	$(A) \vee ([HL]) \rightarrow A$	(1)
ORI D8	$(A) \vee D8 \rightarrow A$	(2)

The logic-or operation is performed using the contents of A and the selected data source. The result is placed in A. All flags are affected.

CMP S	$(A)-(S)$	(1)
CMP M	$(A)-([HL])$	(1)
CPI D8	$(A)-D8$	(2)

The contents of the selected data-source are compared to the contents of A. The comparison is made by subtracting the contents of the data source from A, with the flags set based on what the result would have been. *Neither A nor the data source is modified by the operation.* All flags are affected.

DAD RP	$(HL) + (RP) \rightarrow HL$	(1)

The contents of the selected register pair are added to the contents of the HL register pair. The result is placed in HL. Only the carry flag is affected.

Single-operand instructions

Single operand arithmetic/logic instructions use the same data resource as both data source and data destination. These operations are used to modify the individual registers, register pairs, and memory locations in the 8080 system.

RLC	$(A_7) \rightarrow C, (A_7) \rightarrow A_0, (A_n) \rightarrow A_{n+1}$	(1)
RRC	$(A_0) \rightarrow C, (A_0) \rightarrow A_7, (A_n) \rightarrow A_{n-1}$	(1)
RAL	$(A_7) \rightarrow C, C \rightarrow A_0, (A_n) \rightarrow A_{n+1}$	(1)
RAR	$(A_0) \rightarrow C, C \rightarrow A_7, (A_n) \rightarrow A_{n-1}$	(1)

These four instructions treat the A register and carry flag as a serial rotation register. The graphical representation of these rotations is shown in Fig. 1. Note how RAL and

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KOMPUTER KORNER

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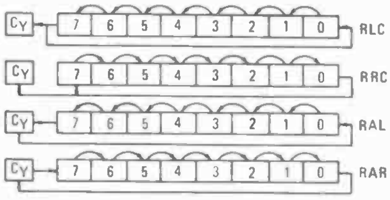


FIG. 1

RAR actually include the contents of the carry flag in the rotation. RLC and RRC modify the carry flag but do not include it in the rotation. No flags other than carry are affected by these instructions.

INR S $(S) + 1 \longrightarrow S$ (1)
INR M $([HL]) + 1 \longrightarrow [HL]$ (1)
The contents of the selected data source are incremented by one. All flags *except* carry are affected.

DCR S $(S) - 1 \longrightarrow S$ (1)
DCR M $([HL]) - 1 \longrightarrow [HL]$ (1)
The contents of the selected data source are decremented by one. All flags *except* carry are affected.

INX RP $(RP) + 1 \longrightarrow RP$ (1)
The contents of the selected register pair are incremented by 1. No flags are affected.

DCX RP $(RP) - 1 \longrightarrow RP$ (1)
The contents of the selected register pair are decremented by 1. No flags are affected.

DAA IF $(A_0 - A_3) > 9$, (1)
then $(A) + 6 \longrightarrow A$
If $(A_4 - A_7) > 9$,
then $(A) + 60H \longrightarrow A$
The DAA instruction is used to adjust the hexidecimal contents of A into two BCD digits. If the four least-significant bits of A (commonly called the least significant nibble, since a nibble is about half a byte) is a value greater than nine, six is added to A. This forces the least significant nibble into the range zero to nine. The most significant nibble is then tested. If it is now greater than nine, 60H is added to A to force the value into the range zero to nine. If the result of adjusting the value in A results in a value greater than 99 decimal, the carry flag is set. All flags are affected by the operation.

CMA $\bar{A} \longrightarrow A$ (1)
The contents of the accumulator are complemented. No flags are affected.

This column has presented a look at the arithmetic/logic instructions offered by the 8080. In this short space it is practically impossible to provide all the details of a complex computer instruction set. We have attempted instead to give a good overview into the operation of these instructions. In future articles we will use these instructions as the building blocks of more complex operations. If we need a more detailed analysis of the operation of a particular instruction, it will be presented at that time.

This article was the second in our series on the 8080 instruction set. In a future column we will conclude the presentation by examining the transfer of control and processor control instructions. **R-E**

Optoelectronics now used in auto ignition systems

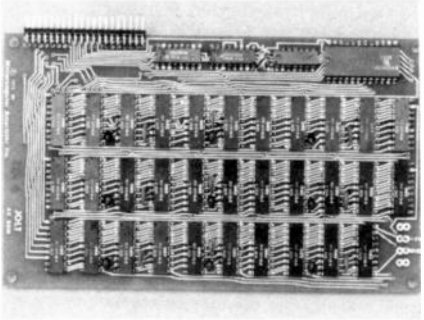
As a new type of "breaker points" for the transistor auto ignition system, Siemens is experimenting with what they call a "light barrier", or light switch, as being simpler and longer lasting than systems now in use. The first electronic ignition systems simply used the breaker points already on the car, on the basis that the points might last indefinitely with the negligible current drawn by a transistor circuit. Later, magnetic pick-up systems that require no physical contact of the "breaker points" have been used, and the Siemens report also speaks of magnetoresistor sensors and Hall generators being used to trigger the transistor ignition.

In the Siemens device, an LED transmits the trigger signal for the ignition and a phototransistor picks it up. Between the light-emitting diode and the phototransistor is a slotted disc that rotates on the distributor shaft, allowing a narrow beam of light to pass at the firing point. The duration, or dwell, depends on the slot width.

Before full-scale production can be started, there are temperature and economic problems to be ironed out. Metal cases would be satisfactory at the temperatures to be withstood, but cost considerations indicate the use of plastic. **R-E**

equipment reports

Jolt 4K RAM Module



CIRCLE 87 ON FREE INFORMATION CARD

I WAS INTRODUCED TO THE EXCITING REALM OF microcomputers and machine language programming through the JOLT CPU board, and I continue to have great respect for the system. For some time, I have been eager to expand the system's memory and get on to bigger and better things. And that is what the 4K RAM board is all about—a nice large chunk of additional programming space.

Packaged onto the 4.25 × 7-inch JOLT board are a total of 36 integrated circuits, of which 32 are the memory devices. The only other components are 18 bypass-capacitors and three jumper wires. Each memory IC is organized as 256 4-bit words. Multiplying 256 by the 32 IC's gives 8192 4-bit words. Converting to the 8-bit word length of the 6502 μP, the number of words is halved to 4096, or 4K for short.

There are 8 input-address leads to each memory IC to address the 2^8 (256) words, and 4 output lines. The eight least-significant address lines (A0–A8) originating from the CPU card, feed the eight memory-address terminals of all the memory IC's in parallel. CPU address lines A8 through A11 are the inputs for a 74154 4-line to 16-line decoder. Each output from this IC connects to the enable pins on a pair of memory IC's. The four input/output data leads on one of the pair connects to the RAM board data lines D0 through D3, and the other circuit to D4 through D7.

This leaves the upper four address lines A12 through A15. In the JOLT scheme of things, one-half the total memory space has been reserved for user RAM and the other half for inputs, outputs and other peripheral functions such as the interval timer on the MOS Technology 6530 IC. The $\overline{A14}$ input is permanently wired to the chip-enable pins of all the 32 memory circuits, which blocks off two 16K blocks from 4000_{16} to $7FFF_{16}$ and $COOO_{16}$ to $FFFF_{16}$.

Address lines A12, A13, and A15 or their complements are connected to assign the 4K board to a segment of the remaining 32K memory space. Two gates of a 7400 quad 2-input NAND gate are wired as a three-input gate that connects to the two enable pins of the 4-to-16 line decoder. As an example, when A12, A13 and A15 are all complemented, and since A14 is permanently complemented, the most significant hex address digit of 0 would enable the decoder and the memory will respond to addressing from 0000 to 0FFF.

The basic CPU board comes with 512 words of RAM assigned to 0000 to 01FF. If the 4K board is assigned 0000 to 0FFF, the

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EQUIPMENT REPORTS

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first 512 words would overlap the CPU memory space and the memory on the CPU board would have to be removed. Microcomputer Associates recommends that additional memory space be filled starting at 1000. That makes good sense and that is precisely where I wired it by inverting A15 and A13, while using the noninverted A12 lead. Two CMOS circuits (a 4050 non-inverting hex-buffer and a 4049 inverting hex-buffer) buffer these high-order address lines as well as A8 through A11.

Don't get worried by all this: the documentation is excellent and there is a simple chart telling where to connect the three jumpers for all possible memory space allocations.

Also interconnecting the CPU and RAM boards are the eight D0 through D7 data leads and the $\overline{RW}$ (read-write) and $\overline{WRITE}$ signals. The data lines are bi-directional for both reading and writing data. $\overline{RW}$ is wired to the 32 output-disable pins in parallel. When the signal is at a logical 1—a read condition—the data lines become high-impedance inputs. The R/W memory IC pins connect to the CPU $\overline{WRITE}$ lead: when it is low the memory is in its write state. Only the pair of memory IC's selected to write at any time will present a low drive impedance to the data lines.

Construction of this board calls for the same care as all computer boards. The right tools are a must and should include a first-class soldering iron and a magnifying glass.

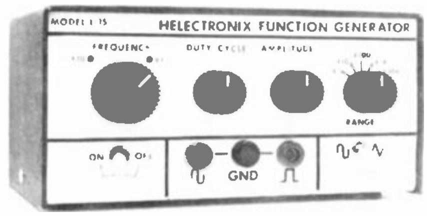
The 4K memory board can be stacked with the CPU, PIA, power supply, and future options using connectors for the address, data, and control lines, or with simple wire loops.

Typical current drain is 1-amp from a single 5-volt power supply. And typical boards do exist since our sample took just about 1 amp. The maximum current drain is 1.9 amps. You must evaluate your power-supply situation and may have to beef up its capacity. The standard JOLT supply will support a CPU, 4K RAM, and an I/O card.

Just what does 4K of memory do for you? A mathematical operating system easily fits. I have just finished writing a floating point package that uses a little more than 1K of memory.

The JOLT 4K RAM card sells for $199 in kit form and $249 assembled. It is available from Microcomputer Associates, 2589 Scott Boulevard, Santa Clara, CA 95050. Also available are cards for the Intel 8080A and the Motorola 6800. The Signetics 2650 system is on the drawing board. **R-E**

Helectronix L-15 Pulse-Sweep Function Generator



CIRCLE 88 ON FREE INFORMATION CARD

THE FUNCTION GENERATOR IS RAPIDLY REPLACING the audio-signal generator on the service bench. It is actually an audio-signal generator, but much more versatile and covers a wider range of frequencies and waveforms. With modern IC's, it can do many tricks not before possible. A good example of this is the model L-15 Pulse-Sweep Function Generator made by Helectronix, 8100 St. Clair Av., North Hollywood, CA 91605.

This is an extremely compact little instrument, only 6 × 2 × 4 inches (16 × 8 × 10 cm.) It has all of the standard function generator outputs—sine, square and triangle waveforms. We've used squarewaves for audio testing for quite a while and they're still good. You'd be surprised, though, at how handy a triangle wave really is! It will show up any tendency of the equipment to clip (when the wave form peaks flatten). Any other kind of distortion will show up as a curvature of the straight (sloping) sections of the waveform.

The frequency coverage of the L-15 is wide—from 1 Hz to 100 kHz in 5 switched ranges. A variable control calibrated from ×1 to ×10 is also provided for fine-tuning the frequency, if needed. An AMPLITUDE control sets the output level of the sine and triangle waveforms. The waveforms can be selected by a switch. The squarewave has its own output jack on the front panel. All outputs have an impedance of 600-ohms and are short-circuit proof.

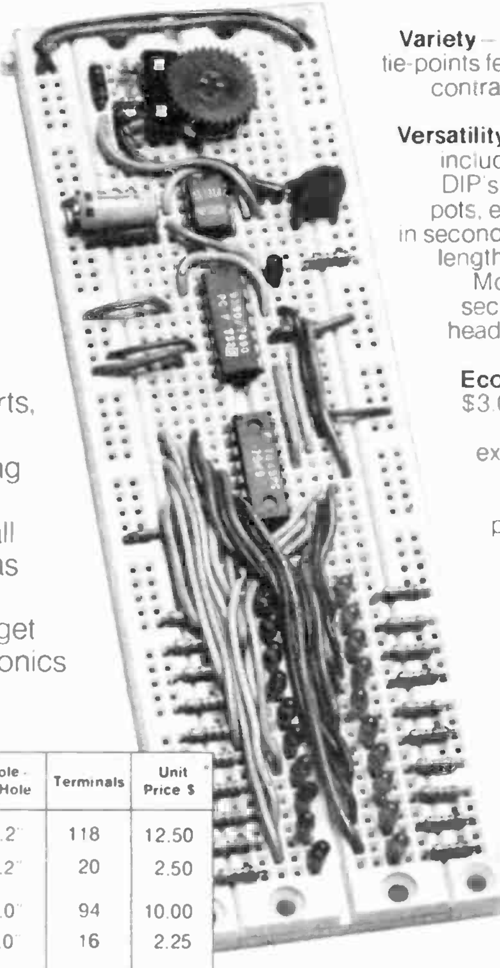
continued on page 34

EVERY PROJECT IN THIS BOOK IS ANOTHER REASON TO OWN CSC'S QT SOCKETS AND BUS STRIPS.

With QT solderless breadboarding sockets and bus strips, you can build twice the projects in half the time. Because making connections or circuit changes is as fast as pushing in—or pulling out—component leads. No special clips or jumpers required, either.

When you're building circuits just for the fun of it, you can take them apart in minutes—not hours. So you save money by re-using parts, while eliminating heat damage to expensive components. Interlocking QT Sockets and Bus Strips are infinitely expandable, too: start small and "grow" breadboards as large as you wish.

For as little as $3.00, you can get a lot more out of your time in electronics—so why not treat yourself to a QT Socket today?



Length / Hole-to-Hole	Length	Hole-to-Hole	Terminals	Unit Price $
QT-59S	6.5"	6.2"	118	12.50
QT-59B	6.5"	6.2"	20	2.50
QT-47S	5.3"	5.0"	94	10.00
QT-47B	5.3"	5.0"	16	2.25
QT-35S	4.1"	3.8"	70	8.50
QT-35B	4.1"	3.8"	12	2.00
QT-18S	2.4"	2.1"	36	4.75
QT-12S	1.8"	1.5"	24	3.75
QT-8S	1.4"	1.1"	16	3.25
QT-7S	1.3"	1.0"	14	3.00

1.32" · .7" · All QT units are .33" thick

Variety—10 models from 70 to 590 solderless tie-points feature snap/lock design to expand or contract your breadboard to fit every circuit and budget requirement.

Versatility—Use with virtually all types of parts, including resistors, capacitors, transistors, DIP's, TO-5's, LED's, transformers, relays, pots, etc. Most plug-in directly and instantly, in seconds. No special jumpers required—just lengths of #22-30 AWG solid hookup wire. Molded-in holes let you mount QT units securely on any flat surface with 4-40 flat head screws, or 6-32 self-tapping screws from behind panel.

Economy—Sockets are priced as low as $3.00.* Save more money by eliminating heat and mechanical damage to expensive parts, re-using components.

Speed—For fast circuit layouts. QT Sockets have 5 interconnecting tie-points per terminal; Bus Strips feature 2 separate rows of interconnecting terminals. Both connect and disconnect easily, without damage to socket or parts.

Visibility—All parts are instantly and easily visible and accessible, for quick signal tracing, circuit analysis and diagramming.

Durability—Higher-temperature sockets with abrasion-resistant, glass-filled plastic, rated better than 100°C. Screw-down-and-interlocked design provides high mechanical strength.

Reliability—Ruggedly designed to professional engineering standards, for heavy day-in, day-out use. Non-corrosive prestressed nickel-silver contacts insure more secure mechanical and electrical connections. Vinyl backing prevents shorting when mounted on conductive surfaces.

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*Manufacturer's suggested list • Prices and specifications subject to change without notice.

CIRCLE 29 ON FREE INFORMATION CARD

EQUIPMENT REPORTS
continued from page 32

The squarewave output of the L-15 is fixed-amplitude (4.5-volts minimum) and TTL compatible. The risetime and falltime are 1.0 microsecond. Beside this, a DUTY CYCLE control can be used to give pulses of either polarity, from a 5% to 98% duty-cycle. (This controls the pulse-*width*. In tests on a scope, we found that we could make stable pulses that were very close to only 1.0 micro-second wide!)

You can also use one of my pet quick-check tests, an audio-frequency sweep with the L-15. All you have to do is apply a variable voltage to a jack that is provided on the back panel. The voltage-controlled oscillator will give sweep ranges from 100:1 to 1000:1. Sweep width depends on the amplitude of the applied voltage, which can be from 0.5 volt to 10 volts maximum. Excessive sweep voltage will make the output clip, so watch it!

The design *looks* simple. It is built around the Intersil 8038 VCO IC. Its sinewave and triangle wave outputs are fed into a high slew-rate op-amp for buffering. This op-amp also provides a short-proof output with a low impedance. The TTL squarewave is derived from the triangle wave and fed into another op-amp. The other input of this op-amp is pulse-width modulated between the + and − voltage supplies. This lets you get either a logic "1" or "0" by adjusting the duty-cycle control either fully clockwise or counter clockwise. Because all signals have a common source, the VCO, all of them can be swept if the need arises.

The sinewave output can be varied from 0 to 20 volts P-P, at a distortion of 0.5% typical. The triangle wave's amplitude varies over the same range, and its nonlinearity is 2% maximum.

The L-15 sells for $75.00 fully assembled and tested. You can also get it in kit form for $55.00 plus $2.00 for postage and insurance. The PC board, a complete schematic and parts list can be had for $10.00. A wide range of choices!

This is a versatile little instrument and one that you'll be seeing on more and more service benches pretty soon. It can be used for a great many tests on all kinds of home entertainment electronics and for testing digital circuitry, which is going to be showing up in our shops pretty soon. **R-E**

Non-Linear Systems FM-7 Frequency Meter

CIRCLE 89 ON FREE INFORMATION CARD

REMEMBER THIS OLD CLICHE: "GOOD THINGS come in small packages"? The cause of this

continued on page 36

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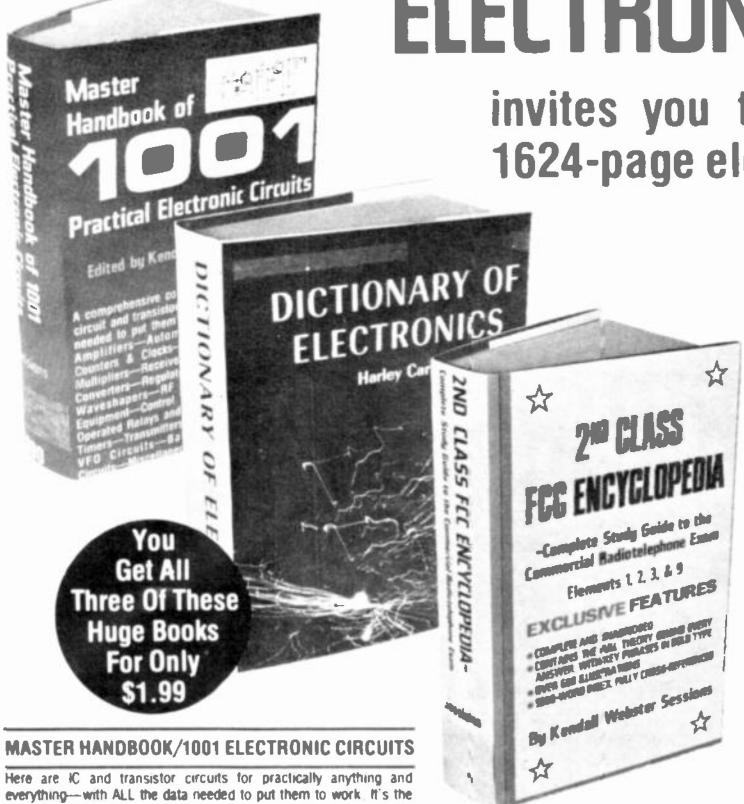

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This huge, quality dictionary is a handy reference that will serve most of your needs—extremely useful in whatever connection you have with electronics. Defines most all of the electronic terms you will run across in your everyday reading... from alpha particles through zoom lens... including those found in radio, TV, communications, radar, electronic instrumentation, broadcasting, industrial electronics, etc. The concise but clearly written definitions from all the various branches of electronics are of value to technicians, engineers, hobbyists, experimenters, and students. It provides full, complete and easily understandable explanations of thousands of specific electronics terms. A unique feature is the cross-indexing, whereby key words contained in the definitions (words that are defined more fully elsewhere in the book) are printed in small capitals so the user is not left in the dark by any definition. Appendices provide you with still more data—an extensive list of units and abbreviations, graphic symbols used in schematics, component color codes, db conversion tables, data on the electromagnetic spectrum, tube base diagrams, etc. 420 pps., 487 illus.

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CIRCLE 16 ON FREE INFORMATION CARD

EQUIPMENT REPORTS

continued from page 34

is a complex, accurate instrument in an unbelievably small box. It is the *FM-7* Frequency Meter manufactured by Non-Linear Systems. Inc. (Just when I was getting used to saying "frequency counter" they call this one a frequency meter.)

The whole instrument measures only 1.9 × 2.7 inches. and 4 inches deep. The panel has one BNC connector and a two-position switch: that's all. The top half of the panel is a nice-sized LED readout with *seven* digits. This small size includes the self-contained batteries that are rechargeable.

They've taken full advantage of the space saving possibilities of integrated circuits, of course. The *model FM-7* is a direct counter. The preamp circuitry conditions the input signal, amplifies it and then counts the input pulses for 1 second and displays the result for 1 second. This results in a display that is updated every two seconds. The display is multiplexed (each digit is scanned) which reduces power drain. The scan rate is fast enough so that there is no perceptible flicker. A highly accurate 2.097152 MHz crystal oscillator is used as the timebase: this controls the counting and gating circuitry, even the 1-second gate.

The switch selects one of two ranges: 0–10 MHz that gives a 1-hertz resolution on the 7-digit display. and a full-scale range of 100 MHz that is usable to 60 MHz with a resolution of 10 Hz. This is well within the FCC standards for frequency measurement. Because of the use of the 7-digit display, the instrument can be calibrated to 0.00001% for a given temperature and battery voltage.

The instrument comes complete with a coaxial cable terminated in alligator clips, the NiCad batteries and the battery charger. Fully charged batteries will give continuous operation for two hours; it can be recharged completely in 14 hours. It can be operated from the AC line while the batteries are being charged. Overcharge protection is built in, so there is no chance of over-charging. In emergencies, the NiCad cells may be taken out and the unit operated from four standard AA cells. These cannot be "charged" of course. Battery replacement is very simple; the back cover of the case snaps off and the works slide out so that you can get to the batteries.

For calibration testing, the display can be checked against a frequency standard. If the readout is not accurate to one part in 10^7, it can be adjusted: There is a trimmer capacitor that is accessible by taking off the back cover. Calibration should always be made with the batteries fully charged. Temperature stability is given as ± 10 PPM (parts-per-million) from 0°C to 40°C. The accuracy is ± 1 count ± timebase accuracy.

The sensitivity of the *model FM-7* is good. In fact, you can make frequency readings—for example, on CB radios—by simply wrapping the red lead of the input cable around the coax where it comes out of the CB case. There's enough RF leakage in a typical coax so that you get plenty of signal. To read the RF from the antenna, clip a short piece of wire in the red clip, about 8 inches long, and hold it up parallel with the antenna rod. I tried this both ways and they're right—it works!

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EQUIPMENT REPORTS

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We checked the *model FM-7* against a couple of other frequency counters that were much larger and more expensive, and it was right on the button. For mobile two-way radio (up to the high bands), CB radio and low-frequency aircraft radio, this compact little instrument can be very handy. The small size makes it very easy to use when working on mobile units, and in tight places.

They send along an instruction manual with full data for calibrating, checking batteries and so on. They also have Application Note No. 1 that gives a good deal of plain-language data on frequency testing.

For frequency testing in the 25–50-MHz band, the FCC requires that the transmitter be held to a tolerance of 0.002%. The frequency-measuring instrument must be capable of ten-times better accuracy, or reading within 0.0002%. This means 30-Hz resolution at 60 MHz where the tolerance is 0.00005%. The *FM-7* can be calibrated and certified to have accuracy of ± 10 Hz at 60 MHz. The stability with changing battery voltages is 0.0002% from 4.5 volts to 6.5 volts, which is 120 Hz—better than FCC standards. Below 50 MHz, it is quite a bit better than the required accuracy.

The price of the *model FM-7* is as $195.00, complete with cable and battery charging unit. **R-E**

Manufacturers feeling effect of in-warranty rates suit

At least one manufacturer has complained publicly about the side-effects of the current industry-supported struggle spearheaded by Electro-TV of California, in a lawsuit brought against 10 major TV manufacturers (**Radio-Electronics**, May 1976, page 12). The suit attempts to force them to cease violating California law by soliciting service repair work below cost. In an answer to the suit, Sylvania incorporated the statement:

"Sylvania has been compelled to pay higher rates to television and repair agencies than it otherwise would have paid." The statement went on to admit that the plaintiff (Electro-TV) had disrupted economic relationships between Sylvania and repair service agencies, and that this damaged Sylvania by denying it "the future economic benefits expected to flow therefrom." (Presumably some of the benefits have been diverted to the "service agencies.")

The *Scanner*, official publication of the Arizona State Electronics Association (ASEA), from whom we got this news, points out that: "Although Sylvania has not had all the profits it "expected," it should be noted that the service industry has not been seeking warranty profits. Rather, it has been the effort of the trade associations to save their members from *losing money* and *losing their businesses*," through servicing below cost.

The *Scanner* goes on: "Sylvania is still holding out a threat of countersuit, so keep the SIS contributions coming. Mail them to M. L. Finneburgh, The Finney Co., 34 W. Interstate St., Bedford, OH 44146, attention Electro-TV SIS Fund."

A contribution to this cause might be a worthwhile investment; the knowledge that an industry group has resources can be a deterrent to any contemplated counter-suit.

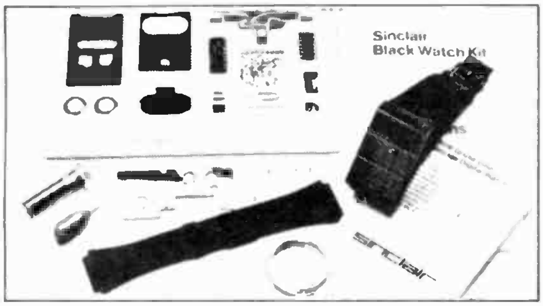
Satellites permit savings on business communications

RCA has instituted a new service that offers businesses the advantages of 24-hour-a-day private-line service but will be charged principally on a usage basis. The rate structure of the "Instant Private Network" is made possible by using Satcom I and II synchronous orbiting satellites. Each satellite has 24 communication channels, each channel is designed for 1,000 voice-grade circuits.

Normally a company's private line—permanently connected between two specific points—is charged for on a 24-hour basis, though generally used only during the regular daytime business hours. The Instant Private Line is a pool of trunk lines, one of which is brought into service at any time by the user, who cannot distinguish any difference between it and a conventional private line.

Each subscriber pays a $100 installation charge and a fixed monthly switch termination charge of $50, a local channel charge and a charge of three cents for each six-second period of satellite usage. The usage charge drops to 2.7 cents per six-second increment for the next 30 minutes, and to 2.5 cents after the first 90 minutes. Weekend rates are lower. **R-E**

The Black Watch Kit $19.95



The Black Watch Kit by Sinclair is unique. Controlled by a quartz crystal...powered by two hearing aid batteries. Styled in understated elegance the Sinclair way. No knobs no buttons. To see the exact time or date just touch the face of the case. A re-set control is on the back.

Dimensions:	1-1/2" X 1" X 3/10"
Weight:	1/2 ounce
Strap:	3/4" wide
Case:	Specially designed unbreakable black matte plastic. Water resistant.
Batteries:	Mallory RM41H
Accuracy:	On a built watch we guarantee accuracy within a second a day. In building it yourself you may be able to adjust the trimmer to achieve an accuracy within a second a week.

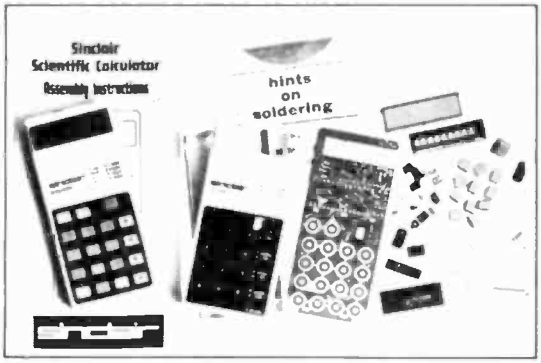
THE KIT CONTAINS

1. printed circuit boards
2. integrated circuits
3. encapsulated quartz crystals
4. trimmers
5. capacitors
6. LED displays
7. 2-part case with window in positions
8. batteries
9. battery-clip
10. black strap (black stainless-steel bracelet optional extra — see order form.)
11. full instructions for building and use.

All you provide is a fine soldering iron and a pair of cutters.

sinclair (Actual Size)

Scientific Calculator Kit $14.95



Designing the Sinclair Scientific was no small feat of engineering, but you don't have to be an engineer to assemble it with our kit.

You can put together the world's most remarkable scientific calculator from eight groups of components, using only a soldering iron and a pair of cutters. (Complete instructions are included.)

Less than 3/4-inch thin and 3-3/4 ounces light. British-made Sinclair Scientific isn't just portable, it's pocketable.

All parts are tested before shipment — and we guarantee any correcly assembled calculator for one year.

Features of the Sinclair Scientific

FUNCTIONS SUMMARY –

Algebraic logic
Five function memory
Sine, cosine, tangent, arcsine, arccosine, arctangent
Degrees/radians switch
Ln and e^x
Square root, pi and reciprocal
8 digit mantissa, plus 2 digit exponent
Automatic constant
Pocket-sized. 4-1/3" X 2" X 11/16".
Weight: 4 ounces.
Battery life. Low-cost, disposable AAA batteries (not included) operate for around 25 hours of continuous use.

KIT COMPONENTS

1. Coil
2. LSI chip
3. Interface chips
4. Printed circuit board
5. Keyboard panel
6. Electronic components pack
7. Battery assembly and on/off switch
8. Case moldings, with buttons windows and light-up/display in position. Soft carrying case
9. Comprehensive instructions
10. Assemble time is approximately 3 hours.

1. FREE TRIAL OFFER If you decide not to keep and assemble your kit, you may return it undamaged within 10 days for a refund of its purchase price.

2. SERVICE If a problem arises in building your kit, Sinclair Service Department will fix it for you at a nominal charge.

3. WARRANTY Your correctly assembled kit will be repaired or replaced by Sinclair if it fails to operate within one year of purchase free of charge (except in the case of misuse).

4. To order your kit, just use the coupon and mail it with your check or money order to: GFN Industries, Inc., 6 Commercial Street, Hicksville, New York 11801.

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RE-10W

CB Roundup

New and Unusual Accessories

NO MATTER WHAT OUR FIELDS OF EMPLOYMENT OR OUR HOBBIES may be, there will always be accessories available to simplify and expand the scope of our activities and to enable us to obtain more pleasure from them. Presently, this applies more to CB radio than to any other activity. There are a huge number of different types of devices and accessories available to the CB operator. To list all types and models of all devices and accessories that are possible additions to the basic transceiver/antenna combination would be impossible.

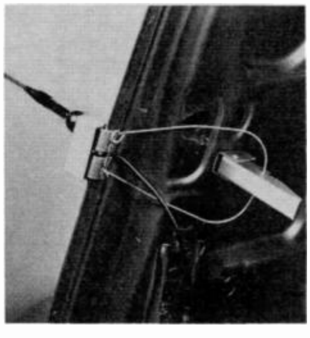
We can in no way list all possible CB accessories in this magazine, so we have elected to present thumb-nail descriptions of unique and unusual devices and accessories that we feel will enable you to realize maximum performance, security against theft and more pleasure from CB operation. The items described here will give you an idea as to the types of accessories available. You may decide on an item shown or shop around for similar devices that may prove to be more applicable to your needs.

Security

Any means that can be used to protect a CB radio and antenna against malicious damage and theft are prime considerations for the CB operator. This includes alarms and locks, various quick-release devices for rapid removal of the transceiver and antenna from the car and also various devices that help conceal the fact that your car is CB equipped.

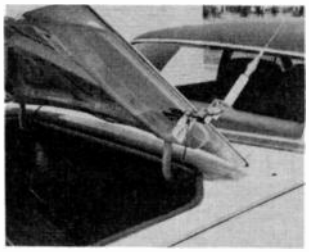
A standard CB antenna is a sure tip to the rip-off artist that your car has a CB radio. Disguise or remove your antenna and you lessen the chance that your car will be a target for a thief. You can do this with one of the following devices:

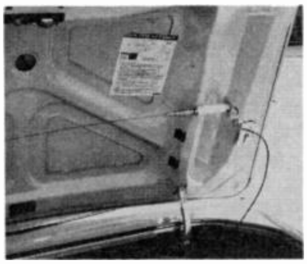
The Foiler converts your existing antenna and trunk-lip mount so the antenna can be removed and stowed in the trunk in a



matter of seconds. Mounts the antenna on the front edge or side lip of the trunk lid. $4.95.—**SouthCom, Inc.**

Stowit is a unique antenna mount providing a quick and easy method of concealing a CB antenna in the trunk of a car. Applicable to either a trunk-mount or roof-mount antenna. One photo shows the antenna in

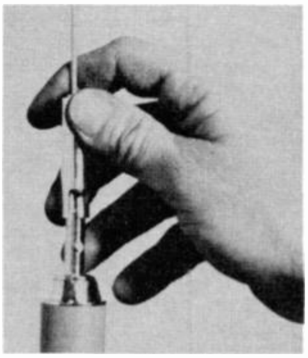


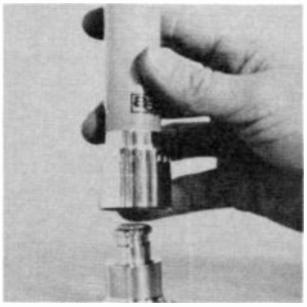


its normal position on the trunk lid and the other shows it folded to the underside of the trunk lid.—**Holly Enterprises.**

Quick-release mounts, *models M-450* and *M-460*, are two quick-release accessories that allow fast, temporary removal of mobile CB antennas to prevent theft or damage. The *model M-460* uses a combination lock on the antenna collar to discourage theft. The locking collar and base insert between the antenna's coil and mount; permitting only the user to remove the loading coil and whip. The quick-release allows temporary disassembly to prevent damage from automatic car washes.

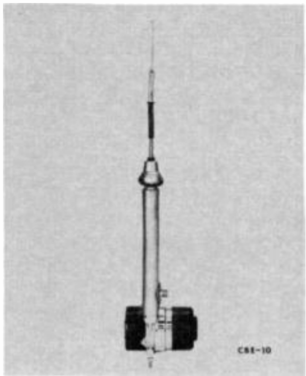
The *model M-450* is a quick-release kit that allows the whip to be removed from a base-loaded antenna for protection in car washes. A downward push and twist on the new knurled adapter releases the antenna's





whip from the base. Kit includes adapter, Allen wrench and whip trimming instructions. *Model M-460*, $16.95; *model M-450*, $4.25.—**Antenna Specialists Co.**

Electric antenna, *model CBE-10*, is designed for fender mounting. With a flick of a switch, the antenna extends to its full length and turns on the radio automatically. Another flick of the switch and it disappears into the fender, turning off the radio. The *CBE-10* (shown in the photograph) consists of approximately 31-



inches of chrome-plated stainless-steel telescoping mast with 18 feet of coaxial cable. Retracts into the fender well to within 3 inches of the mounting surface. The preferred location is in the left rear fender. Center loaded. SWR 1.3:1. $64.95.—**Tenna Corp.**

Pro-Elec-Tele-Tenna, *model VE-027-FR* (not shown), at the flick of a switch extends to a 5-section stainless-steel 48-inch antenna in 5 seconds. Impedance 50 ohms. SWR 2.0:1. Supplied with RG-58/U and PL-259 connector and extension cables for either front or rear mounting. $89.50.—**Valor Enterprises, Inc.**

Electric AM/FM/CB antenna, *model EMA-100* (not shown), that disappears into the fender of a passenger car or light truck when not in use. It replaces the existing AM or AM/FM radio antenna or can be mounted inde-

A look at a few of the new and unusual CB accessories that you can add to the basic transceiver and antenna

ROBERT F. SCOTT
TECHNICAL EDITOR

pendently in the front or rear fender of virtually any car or truck. The coil of this top-loaded antenna is connected directly to the output of the radio at all times; even when the coil is retracted into the fender. This precludes the possibility of damage to the transceiver if the mike is keyed into an open circuit of an antenna not fully extended or coupled. The SWR is 1.5:1 or better when fully extended and 3.0:1 when fully retracted into the fender. Depth of space required in fender well is 19 inches. Bandwidth is 26.5 to 27.5 MHz. The *EMA-100* incorporates a relay that can be connected to any convenient circuit such as the CB radio to allow automatic extension when the radio is turned on and automatic retraction when the set is turned off. $69.95.—**CPD Industries, Inc.**

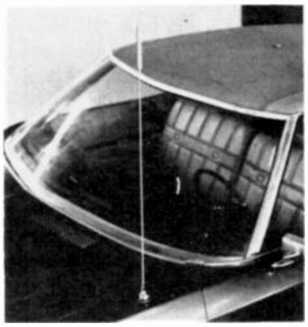
Low-Profile Anti-Rip-Off, *model GPL-69*, is an antenna tuner that permits the standard AM or AM FM radio antenna to be used for CB as well. It mounts under the dash in a convenient location and has a directional coupler to facilitate tuning. Just key the mike and adjust the tuning controls for

maximum brightness in the green indicator and minimum intensity in the red indicator. If someone changes the height of your broadcast antenna, the red indicator lights so you'll know to check the antenna height. Or, if it is more convenient, to readjust the tuning controls for the new antenna height.

The *GPL-69* includes a TVI-suppression filter and a circuit that protects your radio and isolates it from the full CB power output if a critical component fails. With the *GPL-69*, the average car radio antenna gives performance roughly equivalent to a gutter-mount antenna.—**Glatzer Industries Corp.**

Antenna converter, *model 210* (not shown), matches a CB transceiver to a car's broadcast radio antenna. A tuning set-screw enables you to adjust the matching network for the lowest SWR. An indicator light provides assurance of correct tuning. Measures $3\frac{1}{2} \times 2\frac{3}{4} \times 1\frac{1}{2}$ inches.—**Lake Electronics, Inc.**

AM/FM/CB Antennas, *models M-267 and M-264.* The *M-267* installs easily in the space that AM or AM/FM antennas occupy on the cowl of a car. Center-loaded 46-inch stainless-steel whip fits any existing $\frac{7}{8}$-inch to $\frac{15}{16}$-inch mounting hole.



Coax phasing harness comes with all connectors attached. It permits an exact match to both radio systems.

The *model M-264* AM/FM/CB *Disguise Antenna* (not shown) hides the fact that you have a CB radio in your car. Detachable 40-inch stainless-steel whip looks like normal cowl-mounted AM/FM antenna. Fits $\frac{15}{16}$-inch mounting hole and includes adapter for mounting in holes up to $1\frac{1}{4}$ inches. Includes coupler that permits you to operate AM or AM FM radio along with CB rig.—**The Antenna Specialists**

If you plan a permanent or semi-permanent installation in your vehicle, protect it with the most secure and substantial mounting hardware you can find. If you decide on a slide mount, select one with a cylinder-type lock. If you opt for the standard hanger brackets, consider the security offered by some models that come with a pair of cylinder locks instead of the two knurled thumb screws that fasten the bracket to the sides of the radio.

Another means of providing maximum security along with ease of portability is the use of the new *Brammall Barrels* as part of the installation hardware. Mounting screws pass through the barrels or lock bodies—cylinders with a hole just large enough to pass the shank of the mounting screw at one end and threads to engage a cylinder lock at the other—into the dashboard or the sides of the CB radio case. Figures 1 and 2 show how

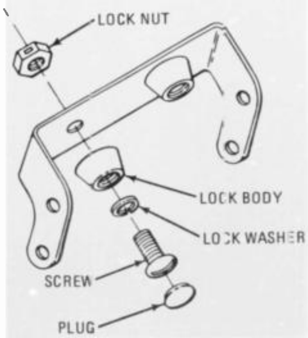


Fig. 1

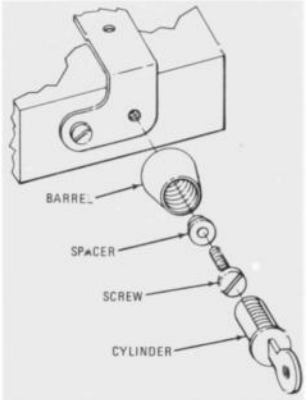


Fig. 2

Brammall Barrels are used.

When fastening mounting brackets to the dash, the screw heads are made inaccessible to plugs hammered into the threaded ends of the barrels as shown in Fig. 1. The CB set—or tape player or radio—is fastened to the hanger bracket with ordinary mounting screws whose heads are protected by lock-in plugs as in Fig. 2. The plugs can be removed with keys to provide easy access to the mounting screws. The radio can then be removed from the vehicle for maximum security.

The *Brammall Barrel* kit comes with all necessary hardware and a warning sticker to paste on the inside of one of the car's windows. The kit is $9.95.

If you must leave your car for long periods in unattended parking lots, you are advised to protect your radio with a good alarm system or remove the set and take it with you. In any event, here are several items to consider:

CB-Saver is a storage and travel case for CB radios. It is a

tough, attractive, molded case with a foam cushion interior that can be custom fitted for most CB radios measuring up to 3 × 9 × 12 inches.—**Falcon Enterprises, Inc.**

CB-Porta-Protector is made in three sizes: the basic 12 × 7 × 4-inch model being the most popular. Body material, includ-

ing the carrying strap, are 39-ounce expanded vinyl with cotton lining.—**Andor Corp.**

The Nailer is a protective device for CB radios and CB antennas that is hooked up to the car's horn or an auxiliary alarm system. If a thief tries to remove

either the radio or antenna and breaks a ground wire or removes the PL-259 connector from the set, the alarm will automatically sound. The *Nailer* works off the car's 12-volt battery and can be installed in a matter of minutes. $29.95.—**Valor Enterprises**

Radio-Sentry CB Theft Alarm can guard two units such as the CB radio and a tape player. Tampering with or removing either device activates a solid-state sensor that sets off the

alarm. Options include a siren and an expanded sensor that will operate as a vehicle burglar alarm in addition to providing CB protection. Basic *Radio Sentry* is $13.95, siren $14.50, expanded anti-theft alarm $19.95.—**Electronic Specialists**

Self-contained alarm system, *model CR10-33*, for installations

where no alarm is presently in operation. It emits a 100-dB signal the instant that an unattended CB radio is touched. The unit operates on a 9-volt transistor battery and can be concealed under the dash. Installation does not require a connection to the car's electrical system. Comes with sensor tape and interconnecting wire. $29.95.—**The Magitran Co.**

Convenience

Any device that increases the versatility, efficiency and operating ease is a worthwhile addition to any CB installation. There are a number of new "convenience" accessories that you welcome as adjuncts to your station. Dollars to doughnuts; you'll select a few of these for your Christmas shopping list.

Channel Monitor, *model CM-2*, operates in conjunction with the automobile radio and your CB transceiver. When a CB call is received, the car radio cuts out so the call can be heard. After a short delay, following the call, the car radio returns to normal

operation. The *OM-2* is sensitive to both audio and RF so it will also silence when you transmit.

It operates with any car radio that has an external speaker, and any CB, ham or marine radio that is equipped with an external speaker jack. Equipped with all necessary mounting hardware, installation instructions and details on modifying equipment that does not have the necessary "plug-in-and-play" connections. $29.95.—**EICO Electronic Instrument Co.**

Solid-state Killer switching system permits hands-free operation of both the broadcast radio and CB transceiver in a car. When a CB call is received, the

Killer immediately switches the cars speakers from the broadcast radio to the CB rig. The device is also actuated whenever the mike is keyed. A short time-delay on drop-out prevents switching back and forth between words and sentences.

The *Killer* operates with almost all types of two-way radio systems, monitor receivers, scanners, etc., and will control most audio sources such as AM/FM radios, tape players, etc. Works on both mono and stereo audio systems. Installation does not require opening either radio. $39.95.—**Rogers Electro-Matics, Inc.**

CB Boom Mike Headset, *model CB-88*, features a noise-cancelling power microphone that delivers clear, crisp speech even in a moving vehicle where wind, traffic and engine noises normally interfere with the transmission. The mike has a variable-gain amplifier and is mounted on a pivoting boom so

that it can be close to the lips and moved aside when not in use. The push-to-talk switch has a clip for convenient attachment to a shirt or blouse.

Can be used with either the right or left ear and, if desired, can be worn without the headband. An adapter is furnished which allows the ear-piece to be clipped to the user s eyeglasses. Less than $70.00.—**Telex Communications, Inc.**

Mobile headphone, *model CR10-2SMD*, has a noise-cancelling boom mike with a remote push-to-talk button that mounts quickly on the turn-signal or gear-shift levers. The unit includes a 500-ohm microphone with an adjustable noise-cancelling feature. The headphone has

a built-in automatic gain control that prevents ear "blasting" or overload from nearby transceivers. $45.00.

The *model CB10-2SVX* (not shown) is similar to the CB10-2SMD except that it includes a VOX circuit that automatically keys the mike at the sound of the operator's voice—allowing completely hands-free operation. $100.00.—**Superex Electronics Corp.**

CB Caddy is both an anti-theft device and a convenient mounting complete with a built-in 4-inch 8-ohm speaker that rests on the transmission hump, floor or seat of nearly any vehicle. It is adjustable to fit various shapes of mounting surfaces. Made of high-impact molded ABS plastic,

the *Caddy* adjusts to hold most CB radios up to 3 × 8½ × 8½ inches. Once the radio is clamped in place on the shock-resistant foam, only the 12-volt DC and antenna connections are required for installation. Compact and light weight, the *Caddy* stores easily in the trunk or can be carried anywhere with the convenient retractable handle.—**Falcon Enterprises, Inc.**

CB mounts, *Ten-Two* and *Good Buddy*, have all the features vital to safe and efficient operation of CB radios. Radios can be quickly and easily detached. There is nothing to unplug—antenna, power and speaker cables are wired through contacts in the mount. Controls and mike are easily reached and visible from the normal driving position. Each mount has a communications-type speaker that improves sound quality and filters out noise. Both mounts are positioned so sound is directed toward the driver and mount securely to the roof or transmission hump.

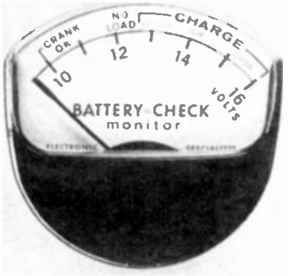
The *Ten Two* (shown) is made of textured ⅛-inch ABS plastic with a matte finish that complements the car's interior. It is 5½-inches high, 6¾-inchs wide and 9½-inches deep. The detachable

mike-mount section is inverted when the *Ten-Two* is roof mounted. The transceiver is fastened to the mount through a slide connector. $29.95 with antenna connector and $24.95 without.

The *Good Buddy* model (not shown) is made of heavy scuff-resistant wood-grain vinyl over ⅜-inch particle board. Measures 5½-inches high, 7¾-inches wide and 10-inches deep. $34.95 with antenna connector, $29.95 without.—**Gamber-Johnson, Inc.**

CB mount, *Port-A-Mount 302*, is a completely portable flat-based mounting unit designed for use in cab-over trucks, vans and recreational vehicles and cars without transmission humps. Mounts without drilling. Velcro fasteners securely adhere to carpeted surfaces. Mating self-adhesive Velcro fasteners furnished for surfaces without carpeting. Tilted surface design permits ready access to controls and limits sound dispersion from the built-in auxiliary speaker.—**SMA Products, Inc.**

Battery Check continuously monitors battery, charging system and electrical loads in vehicles equipped with 12-volt electrical systems. Maximum CB-range and trouble-free operation requires that the car's battery and electrical system be in top-notch condition. The *Battery*



Check, with its expanded-scale meter with its red and green "status bands" provides high accuracy and easy reading. Checks the electrical system when cranking, with no load and when charging. $39.95 to $45.95, depending on model and finish.

Flash-Cube CB transmitter monitor has LED's that form a light bar "meter" that glows as transmitter power is applied. The

LED's flash to show modulation. Has a detachable mount and can be used mobile or base. $25.95—**Electronic Specialists.**

Regulated power-supply, *model VRPS-6*, is designed to give maximum performance from mobile CB radios when used at

home or office. It has an output of 6.0 amperes. Comes complete with input power cord, switch, pilot light and operating instructions. Power input 120-VAC 60-Hz; output 13.8 VDC.—**Valor Enterprises.**

CB power supply, *model 138A3*, lets you operate a mobile CB transceiver, tape deck and other auto electronic devices from 117-VAC sources. The output is 13.8-volts 3-amps. The

voltage regulation is such that no-load to full-load results in a change of only 0.05 volt. Typical ripple is 2 to 5 mV P-P. Output is short-circuit protected by current limiting. Current is limited to 3.5 to 4 amps. $49.88—**E & G Research and Manufacturing, Inc.**

Power supply, *model AD-112*, is designed to power mobile CB transceivers and other mobile electronic devices. Equipped

with lever-type on-off switch and LED power indicator. 5½-inches wide, 3-inches high, 6¾-inches deep.—**Sharp Electronics Corp.**

Antenna Matcher, *model CBM-4*, is an antenna matching device designed for the Citizens

band. Most transceivers operate into 50-ohm loads, delivering maximum power with minimum distortion and harmonic radiation. A mismatch between antenna and transceiver occurs because the antenna impedance varies widely with frequency and physical location. The *Antenna Matcher* assures that the transceiver will be matched to the antenna at any time and on any channel with minimum harmonic radiation. Matches radio to antenna impedances of 35 to 150 ohms. Fitted with SO-239 connectors.

The *LP-7* low-pass filter is inserted between the output of the CB transceiver and the transmission line to attenuate the

TVI-producing harmonics that are produced by many radios. The cutoff frequency is 30 MHz. Impedance is 50 ohms. Maximum SWR is less than 1.2:1 at 27 MHz.—**Siltronix**

CB Receive Signal Preamp, *model VRSC-115*, is designed to provide a gain on weak received signals and attenute loud received signals to a desired level. It lets you receive weak signals with an additional gain of +15 dB and lets you attenuate loud

signals as much as −20 dB on all CB channels. Has bracket for under-dash mounting. Front panel includes GAIN/ATTENUATE control, power indicator light and transmit indicator light. $39.95—**Valor Enterprises, Inc.**

CB Range Controller, *model CRC-11*, is designed as the answer to crowded CB channels in metropolitan areas and the need for close-range private communications on CB. It independently controls the receive range and the transmit range of your CB set. It is essentially an adjustable linear RF attenuator with a solid-state transmit receive relay that insures full power output

when you transmit. In the receive mode, signals can be attenuated by as much as 50 dB, eliminating much of the cross-modulation and bleed-over and reducing the effective noise level.

The *GRC-11* has a privacy feature. When the mode switch is switched from NORMAL to PRIVATE, both transmit and receive signals are attenuated approximately 36 dB. This results in an effective range of approximately one-quarter mile. In this mode, you can have private, uninterrupted conversations with a friend traveling along with your convoy.—**Glazer Industries Corp.**

Mobile CB receive preamp, *model LR-3*, is a valuable adjunct to any CB communications system. It provides 20-dB voltage gain into 50 ohms. Connected in series between the antenna and

the receiver input, the LR-3 boosts received signals without in any way degrading the transmitted signal. A "sniffer" circuit senses the presence of transmitted RF signals and automatically causes the transmitted signal to bypass the receive preamplifier and be fed directly to the antenna.

Intended for negative-ground systems, the LR-3 operates from 12-volts DC so it is easily integrated into any mobile CB installation.—**EICO Electronic Instrument Co.**

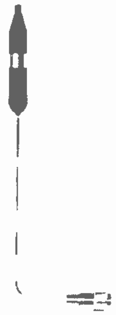
RF preamplifier, *model 3000*, is a small "put it anywhere" device that brings in those weak signals.

Typical gain is 25-dB with only 1.5-dB noise gain. Bandwidth is 2 MHz. Features dual MOSFET design, polarity protection and measures only 1⅝ × 3⅞ × 2 inches.—**Digital Sports Systems**

Signal Hunter, *model 1043*, is a direction-finding antenna that tracks any signal without triangulation. Mounts on car in seconds for simple, fool-proof operation. In emergencies, find lost or stranded motorists or boats in distress, day or night. Also useful in tracking down the source of interference from neon signs, leaky power-line insulators

and electrical machinery. Also useful to CB self-policing groups who want to locate illegal CB operators.

The *1094* portable CB antenna is a center-loaded antenna you can use at a base or other indoor installation where it is inconve-



nient to mount a regular outdoor antenna. This compact antenna simplifies carrying your mobile indoors to operate as a base.

Co-Phase Antenna Matcher, *model 1098,* tunes dual CB-antennas for lowest SWR without special harness. Length of cable from antennas to matcher is not critical. Correct co-phase

matching and low SWR contribute to more uniform coverage and increased antenna gain.

Twin-rig Transceiver Coupler, *model 1075,* is a line-splitter and

coupler that lets you hook up your main transceiver and a spare rig or receiver and work both off the same antenna. Impedance 50 ohms, frequency 11 to 65 MHz; insertion loss less than 0.5 dB.—**Gold Line**

Tools and test instruments

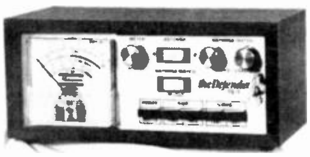
Installation aids and the proper tools are essential to a simple, attractive and efficient CB installation. Test instruments are vital when adjusting the transmitter and antenna for most efficient operation.

A field-strength meter is useful when tuning the antenna/transmitter combination for maximum signal output during the initial installation. Subsequently, it can be used to keep a constant check on transmitter performance.

Similarly, a SWR bridge or SWR meter is used to measure the degree of match between the transceiver and antenna and is a useful guide when positioning the antenna on the car and tuning it for best performance on the favorite channels.

The power-output meter or wattmeter is connected to the transmitter output as it feeds an antenna or dummy load. It reads the power leaving the transmitter but does not indicate possible losses due to transmission-line attenuation to a high SWR.

Precision test console, *Defender TS-1,* provides for a constant control of SWR and a constant



check on power output and modulation. Includes an antenna tuner or matcher, and a switch to select either one of two antennas.—**Shakespeare Co.**

Long terminal stud, *type 98-500,* fits all standard side-terminal auto batteries and replacement cables. The extended length provides for easier

DIRECTORY OF MANUFACTURERS

Antenna Specialists Co.
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Cleveland, OH 44106

Audnor Corp.
245 Old Meramac Station Road
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Brammall, Inc.
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CPD Industries, Inc.
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EICO Electronic Instrument Co.
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SouthCom, Inc.
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Superex Electronics Corp.
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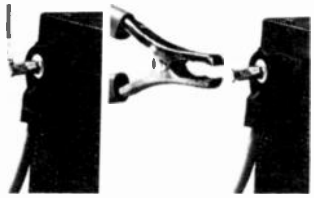
Telex Communications, Inc.
9600 Aldrich Ave. South
Minneapolis, MN 55420

Tenna Corp.
19201 Cranwood Parkway
Cleveland, OH 44128

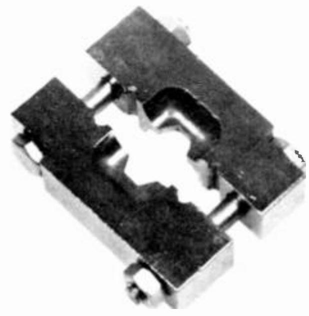
Valor Enterprises, Inc.
185 W. Hamilton St.
West Milton, OH 45383

booster-cable hook-ups and simplifies auxiliary power take-offs for accessories and tune-up ac-



cessories. Fits all GM cars from 1969 to date.—**Falcon Enterprises, Inc.**

Crimper, *model 1100,* for PL-259 connectors makes a no-solder connection that can withstand a 40-lb pull on the connector. With it, you can avoid taking a soldering iron to unusual



places such as to the top of a tower or on a rooftop.

Ground-strap kit, *model 1095* (not shown), helps eliminate static caused by poor ground connections between engine and frame, body and frame, hood or deck and frame and other areas where a good metal-to-metal contact must be maintained.—**Gold Line.**

Coax switch, *model 418-502,* is an accessory for the operator using multiple antennas of multiple transceivers. The switch has three switch positions plus a 10-watt dummy load in the fourth

position. All input and output connectors are on the rear panel to facilitate a neat base or mobile installation. $3\frac{1}{2} \times 8\frac{1}{4} \times 4$-inches. $12.95.—**Kris Inc.** **R-E**

PART I. *An in-depth look at digital multimeters—how they work, their specifications and applications*

all about digital multimeters

CHARLES M. GILMORE*

THE CONCEPT OF THE DIGITAL VOLTMETER HAS been around for some time. Nonlinear Systems introduced the first digital voltmeter in the early 1950's. This unit would measure only DC voltages, used a combination of vacuum tubes and relays, was not exactly portable, and cost thousands of dollars. But it was a start. From that point to the mid 60's the instrument remained the laboratory digital voltmeter. Major changes were made in the accuracy, type of conversion (analog to digital) and resolution. Circuit components changed from vacuum tubes to discrete solid-state and then to integrated circuits.

The first units barely classified as portable and cost nearly one thousand dollars. But the advances were rapid. The DMM as we know it today was brought to the market in the early 70's. To date there has been a great race to see who could build the lowest-cost, most accurate, highest-volume instrument. The result is hundreds of thousands of these instruments for many applications—for the user, a real dream come true.

Theory of digital instruments

The vast majority of DMM's are of one type of analog-to-digital conversion: dual-slope. Other types have been used to construct digital voltmeters. The single-slope converter is used in very-low-cost instruments. Although not too common today, it does have some special characteristics that make it interesting, and numerous instruments in the field employ this technique.

The single-slope converter

The fundamental concept of the single-slope converter is simple. It is to convert an unknown voltage to time. Time is chosen because simple digital counting circuits and an oscillator of known frequency may be used to display this time in a digital format. To make the single-slope converter work, it is necessary not only to convert the unknown voltage into time, but to do it linearly.

To convert voltage to time is relatively easy. If a voltage is used to charge a capacitor through a resistor, the voltage across the capacitor increases in time and approaches the charging voltage. The time required for the voltage across the capacitor to reach a particular value depends on the value of the voltage source, the capacitance and the resistance. Unfortunately, this charging rate is not linear but exponential.

A capacitor may be charged linearly, however, if a constant-current source is used instead of the more common constant voltage with a series resistance. Figure 1 shows three curves of voltage across a capacitor versus time. Figure 1-a shows the familiar exponential charge obtained from a constant-voltage source with a series resistance. Figure 1-b shows the linear charge obtained from a constant-current source. Figure 1-c shows a capacitor being discharged from some initial voltage by a constant-current source (source of negative current as the current flows out).

Figure 2 is a block diagram of a simple single-slope converter. The voltage (E_c) across the capacitor generated by charging the capacitor from the constant-current source, and the unknown voltage (E_x) are applied to separate inputs of a voltage comparator. The voltage comparator converts analog information on its input to a digital signal on its output. If the voltage at the + input of the comparator is greater than the voltage at the − input, the output will be a logic 1. But if the voltage on the + input is less than the voltage on the − input, the output will be a logic 0. The output of the comparator is connected to one input of a gate, the other input is connected to an oscillator of known frequency. When the output of the comparator is a logic 1 and switch S2 is at a logic 1, the oscillator signal passes from the gate to the counting circuits; if the output of the comparator is logic 0 or switch S2 is logic 0, no signal is passed to the counters.

Initial conditions of operation require the counters to be reset to zero, S1 closed, S2 at logic 0 (keeping the charge on the capacitor at zero and blocking any oscillator signal from passing through the gate), and that an unknown voltage be placed on the − input of the comparator.

The measurement cycle is initiated by simultaneously opening S1 and switching S2 to logic 1. When S2 is switched to logic 1, both control inputs of the gate become logic 1, as the unknown voltage at the + input of the comparator is greater than the initial voltage across the capacitor. With both the control inputs at logic 1, the oscillator signal passes to the counters, which begin to accumulate counts. Simultaneously, the voltage across the capacitor begins to rise as there is no longer a short across it. After some length of time has passed, the linearly rising voltage across the capacitor becomes equal to the unknown voltage at the + input of the comparator. An instant after these voltages become equal, the voltage at the + input is less than the voltage at the − input. The

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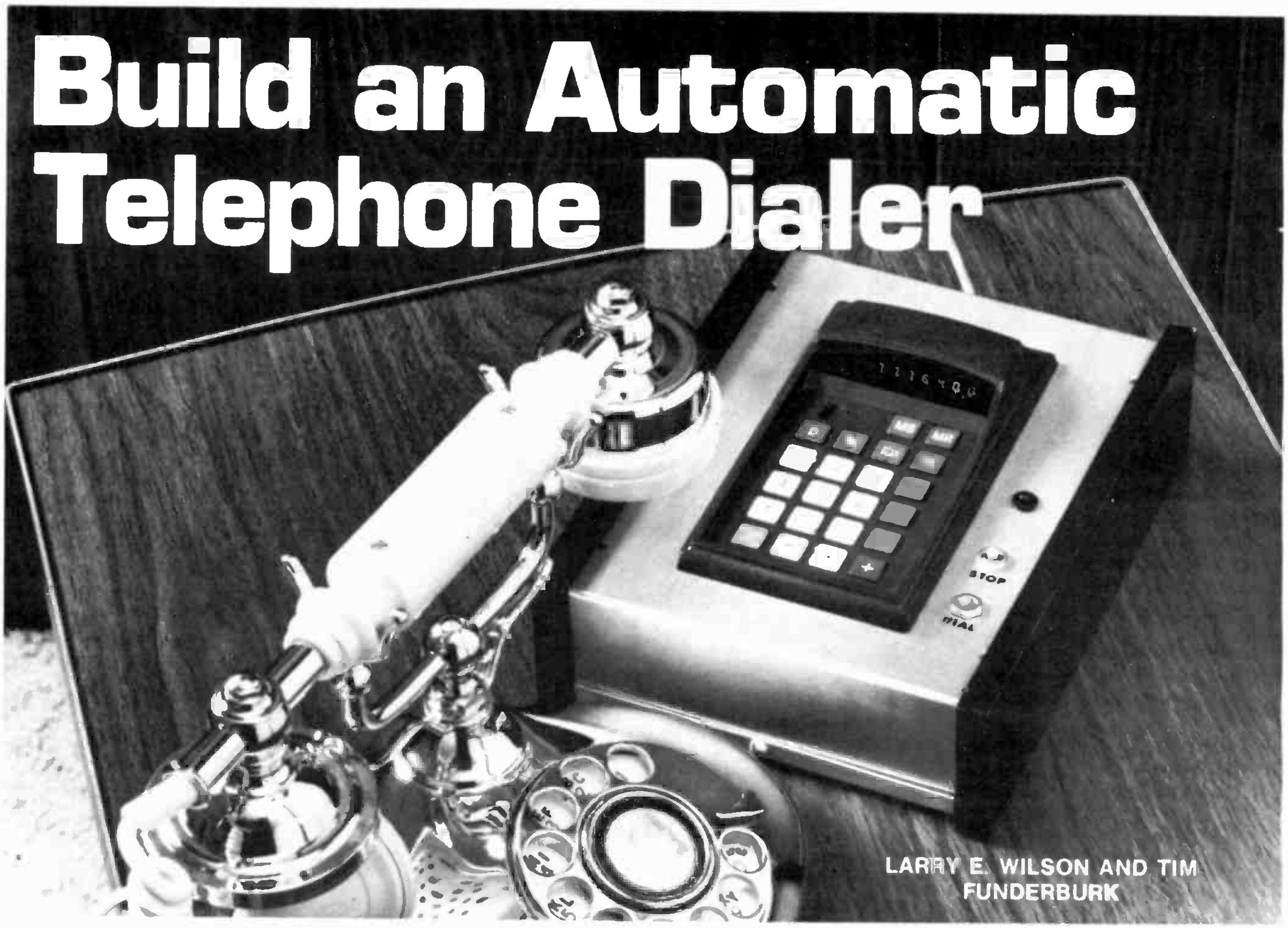
voltage of the integrator passes through zero

1000 at T_2, and 1500 at T_3. As the first

continued on page 92

output voltage of the comparator therefore switches from a logic 1 to a logic 0. This change on the output of the comparator unknown voltage, especially as the voltage on the capacitor approaches the unknown voltage. Like any charge-type converter, the cially long-term accuracy, forced development of an improved converter. It uses the linear charge concept of the single-slope type.

Build an Automatic Telephone Dialer



LARRY E. WILSON AND TIM FUNDERBURK

Convert an ordinary calculator into an automatic telephone dialer. If the calculator has a memory, you can store a telephone number as well. And when not dialing, the unit can be used as an ordinary calculator

TOUCH-TONE® DIALING IS GREAT! DIAL A zero just as quickly as dialing a one—and you don't have to watch all those holes go by! What's that—your telephone office doesn't offer Touch Tone®? Well, cheer up—build this dial converter and go Touch Tone® two better: the number you are dialing is displayed by an LED read-out, and you can use the converter as a calculator when it isn't dialing.

The dial converter accepts and displays a keyboard-entered telephone number (up to 8 digits). On command, this number is converted digit by digit (most significant digit first) into corresponding dial pulses, thus dialing a number. Dialing can be repeated by retaining the number in memory and pressing the DIAL switch again. The system is based on an IC that can be used as a calculator when not dialing. All telephone interfacing is with high-isolation relays to avoid any telephone network damage from stray voltages due to failures.

Operation

The converter is based on a calculator using the National Semiconductor MM5738 calculator IC and DM8864 digit driver. Twenty-two connections are made to the calculator; one for each of the 8 digits and two for each of the segments. Calculator operation is not affected.

A telephone number is entered as it appears in the book—most significant digit first. The number is displayed on the 8-digit LED read-out. The telephone receiver is taken "off hook" and the DIAL button is pressed.

The DIAL button loads a one into the first position of digit register IC12 (Fig. 1) at the same time overflow register IC11-a is cleared. Dial pulse oscillator IC7-c and IC9-d is enabled and begins to output 10–12-Hz pulses. Dial relay RY1 opens and closes the telephone circuit at this rate and commences "dialing" a digit. Counter IC10 accepts these pulses and synchronously decodes them to 7-segment format. The segment outputs from the calculator chip and from IC12 are compared in exclusive-OR gates IC3 and IC4 for coincidence. When all segment outputs agree, all exclusive-OR outputs are "zeros" and are inverted and applied to the input of IC13-c. Gates IC1 and IC2 serve to demultiplex the read-out information.

In the calculator, the read-out is multiplexed by having common segment-lines for all digits and presenting segment information for each digit in turn as the digits are sequentially enabled by the digit drivers. This is done very rapidly so the human eye cannot register the change and the eye sees a continuous display. Gates IC1 and IC2 serve to select a single digit regardless of the scanning. The output of the exclusive-OR gates may register coincidence several times as the digits are scanned; however, AND'ing the outputs of the digit gates and the exclusive-OR gates insures that only the digit selected by the shift register is detected. When the output of both the segment coincidence gates and the selected digit gate are at a logical-1 level, the dial pulser is stopped, IC10 is reset, and an interdigit pause is activated. The interdigit pause serves to identify the end of a digit to the telephone central office.

Since the number of pulses dialed corresponds to the number displayed on

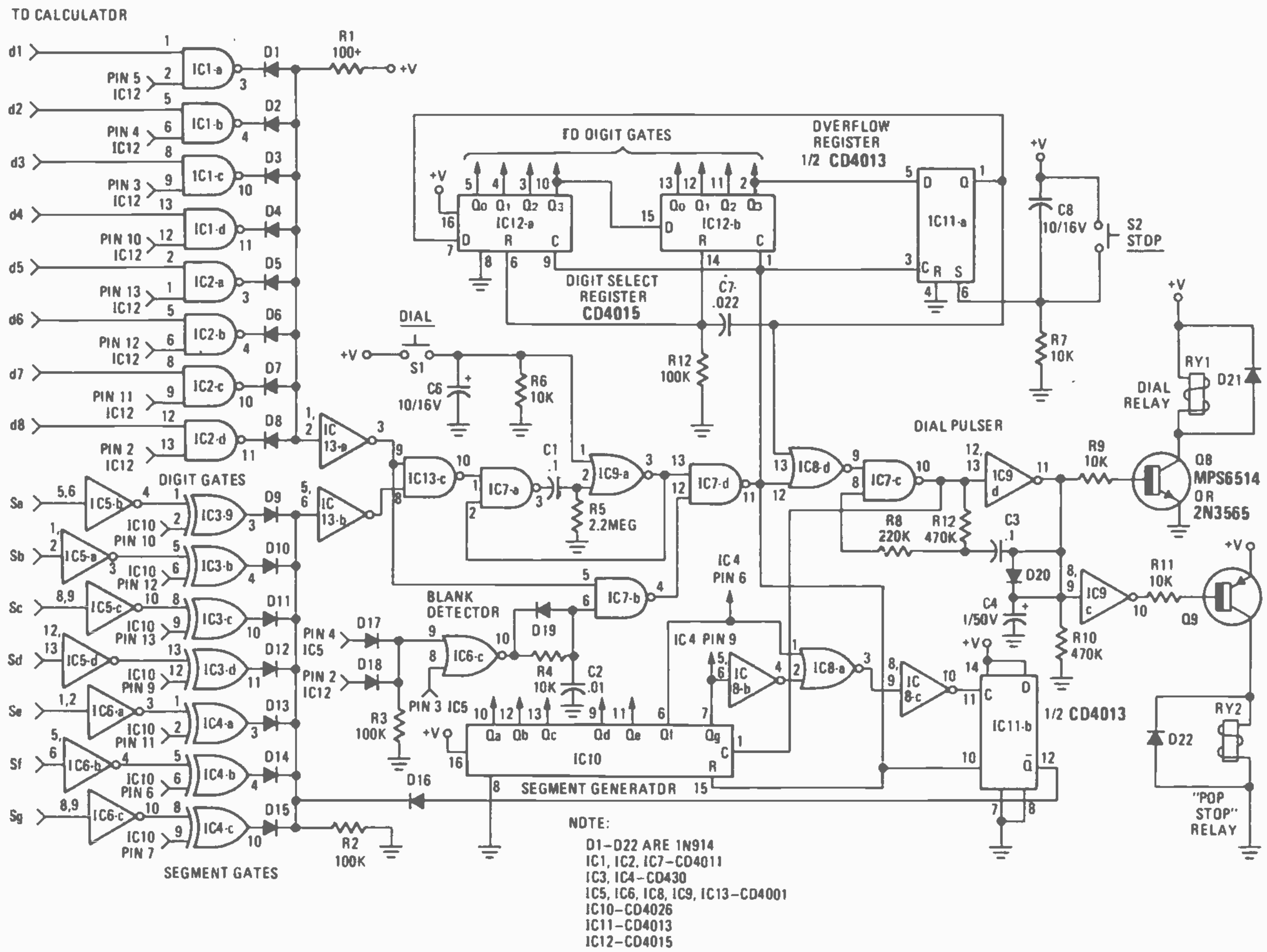


FIG. 1—THE TELEPHONE DIAL CONVERTER. Connections marked d_1, s_1, etc., are connections to the calculator (see Fig. 2).

the readout, we have just "dialed" the first number. At the end of the interdigit pause, the digit register is advanced, the next most significant digit is selected, and the dial pulser is again enabled.

This process continues until the least significant digit has been dialed. The "one" that was shifted across the digit register falls into the overflow register, disabling the dial pulser and hence the entire system. The telephone number you selected has now been dialed.

Special considerations

Dialing a zero: When the number to be dialed is a zero we have complications, since in seven-segment language a zero is 0, and in dial language a zero is 10. Thus we have to inhibit the coincidence gates on the initial zero. Initially, IC11-b is reset and the Q output (at a logic-1 level) prevents the coincidence gates from switching. As soon as IC10 goes from zero to one, IC11-b is clocked to a one via gates IC8-a and IC8-b (which detect the presence of a zero in the segment output of IC10) removing the inhibit from coincidence gates. The next time IC10 reaches zero, the normal end-of-digit is signalled and since IC10 has only stepped 10 times, a ten was "dialed."

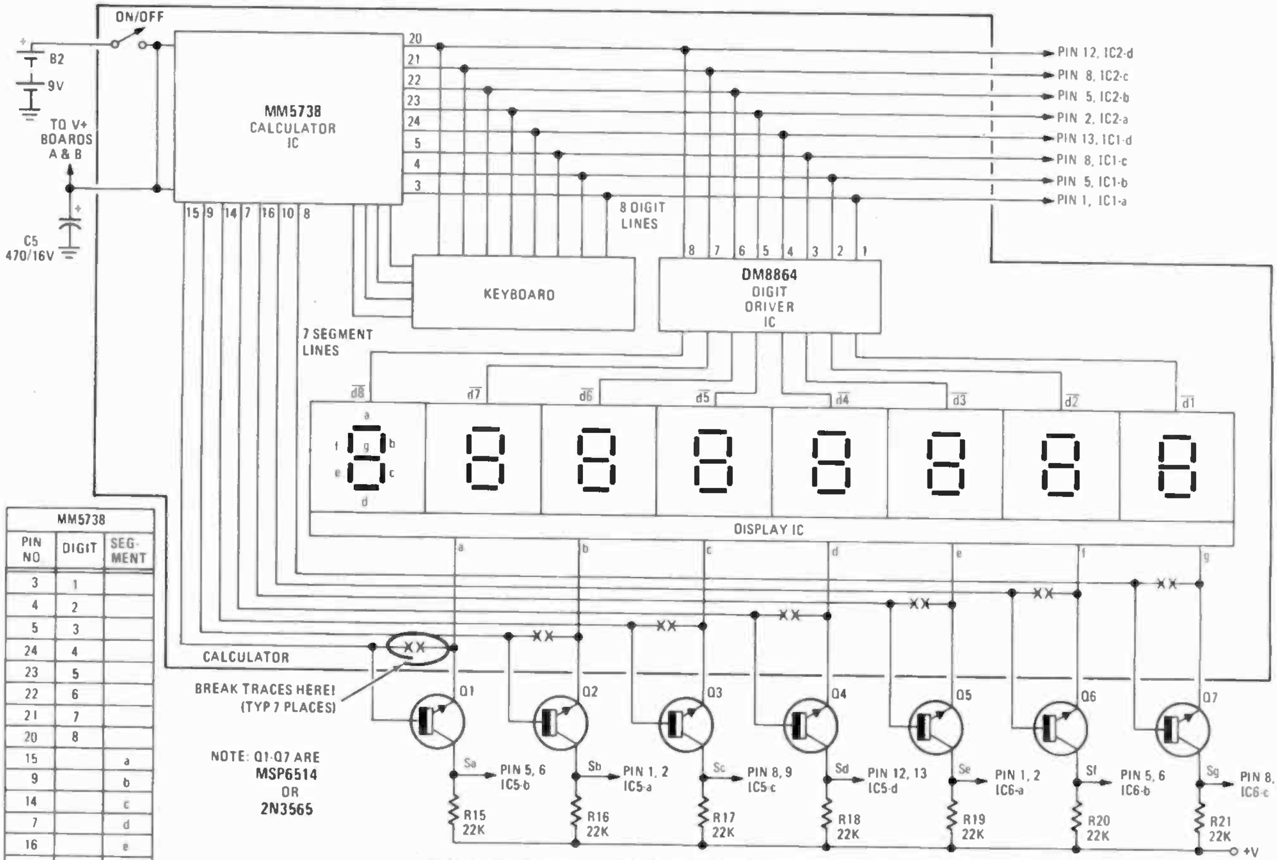
Skipping blank digits. Whenever less than 8 digits are entered in the calculator display (which will be most of the time), we must somehow tell the digit register to advance until a valid digit is present. Otherwise the counter and calculator segments would never agree and the dial pulser would dial forever.

Blank detector gates IC6-c and IC7-b sample segments that are always lighted as long as a number is displayed. The absence of both segments is interpreted as a blank. This output is AND'ed with the digit gates and clocks IC12 to the next digit position. This process repeats very rapidly until a non-blank digit position is found and dialing proceeds normally. This skip effect occurs so rapidly that the dial relay never has a chance to operate!

Resistor R4 and capacitor C2 filter out the very narrow pulses that occur in the calculator during the blanking period between each digit. Diode D18

PARTS LIST

All resistors ½-watt, 10%, unless noted
R1, R2, R3—100,000 ohms
R4, R6, R7, R9, R11—10,000 ohms
R5—2.2 megohms
R8—220,000 ohms
R10, R12—470,000 ohms
R13, R14—560 ohms
R15 to R21—22,000 ohms
C1, C3—0.1 μF, 25 volt, ceramic
C2—.01 μF, 25 volt ceramic
C4—1 μF, 35 volt electrolytic
C5—470 μF, 16 volt electrolytic
C6, C8—10 μF, 16 volt electrolytic
C7—.022 μF, 25 volt ceramic
D1-D22—1N914
IC1, IC2, IC7—CD4011 Quad 2-input NAND gate
IC3, IC4—CD4030 Quad exclusive-OR gate
IC5, IC6, IC8, IC9, IC13—CD4001 Quad 2-input NOR gate
IC10—CD4026 decade counter with decoded 7-segment outputs
IC11—CD4013 Dual type-D flip-flop
IC12—CD4015 Dual 4-bit shift register
Q1 to Q8—MPS6514, 2N3565
Q9—2N3638
RY1, RY2—Sigma 65F, 9 volts DC, PC mount
S1, S2—SPST Momentary pushbutton switches
Calculator—Any type using MM5738 calculator IC.
Misc—Chassis, ribbon cable, spacers, LED indicator.



MM5738

PIN NO.	DIGIT	SEGMENT
3	1	
4	2	
5	3	
24	4	
23	5	
22	6	
21	7	
20	8	
15		a
9		b
14		c
7		d
16		e
10		f
8		g

FIG. 2—BLOCK DIAGRAM OF CALCULATOR, showing interface with the Dial Converter.

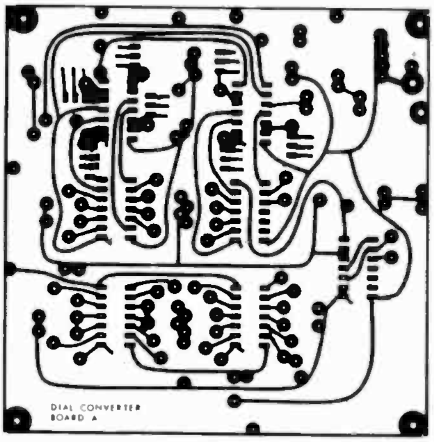


FIG. 3 (left)—PRINTED CIRCUIT pattern for Board-A shown half-size.

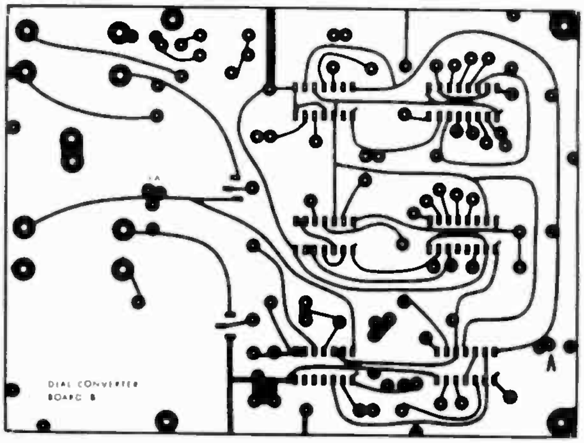


FIG. 4 (right)—PRINTED CIRCUIT pattern for Board-B shown half-size.

inhibits the blank detector when a digit-1 is selected. (The calculator scans digits from right to left but the dial converter reads out from just the opposite direction.) When we get to the last digit—calculator first digit—the end-of-word blanking pulse combines with the selection of digit one and immediately clocks IC12 into overflow. Since there never can be a blank in digit one position—the cleared calculator always displays a zero—it is safe to allow the pulser to always operate in this position.

Calculator converter interface

For the calculator to display a segment, the segment driver in the calculator chip raises the anodes of all the selected segments toward V_{DD}; the selected digit driver pulls the cathodes of all of the segments toward ground and current flows through the selected segment, causing it to light.

To interface with the calculator chip we have to obtain both digit and segment information. Digit interfacing is OK; the levels are compatible with CMOS thresholds. The segments, however, show very little usable voltage change from on to off. There is of course plenty of current change. Transistors Q1–Q7 (Fig. 2) translate the current change to a voltage change.

"Pop" elimination

In your telephone, the dial shunts the handset during pulsing to eliminate an annoying "pop" with each dial pulse. As we have the handset "off the hook" we need to simulate this consideration. The "pop stop" circuit-capacitor C4 is charged rapidly from the dial pulser and discharges only through R10. As long as the voltage on C4 is above IC9-c's threshold, relay RY2 will be operated. RY2's contacts remove the telephone from the line and replace it with approximately 600 ohms of resistance. This makes the central office think there is a phone across the line. It also gives us an indication that the converter is dialing, as part of the 600-ohm load is composed of an LED indicator. The level at IC9-c input will slowly decay after the last dial

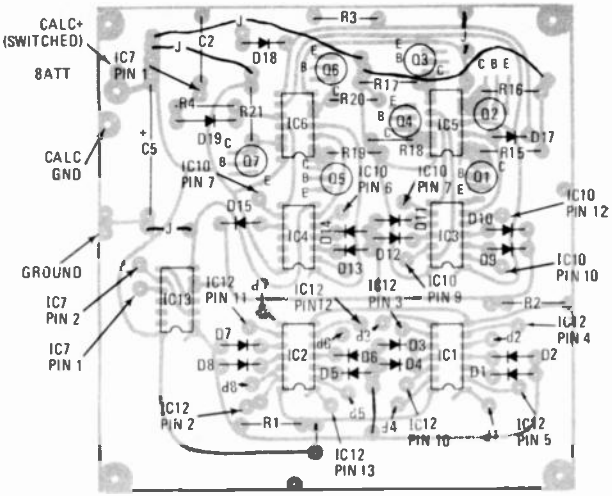


FIG. 5—COMPONENT LAYOUT of Board A.

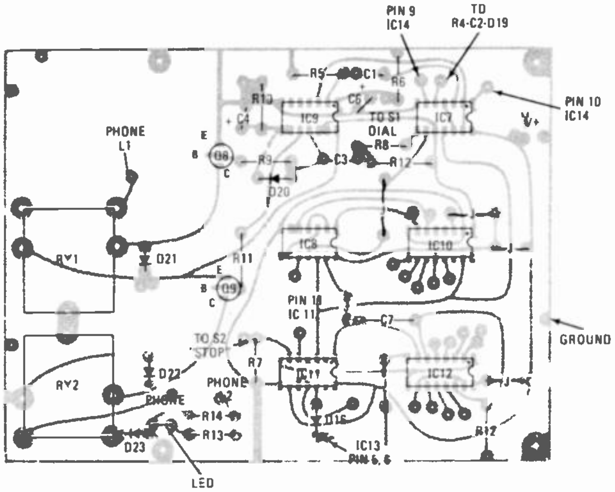


FIG. 6—COMPONENT LAYOUT of Board B.

pulse is received until finally RY2 will transfer and put the phone across the line, allowing normal conversation. The LED remains on as long as the converter is dialing.

Construction

Two printed-circuit boards are required to build the dial converter. Circuit board patterns for the single-sided boards are shown in Figs. 3 and 4. The circuit board method is the best approach but perf board can also be used. Component placement is illustrated in Figs. 5 and 6. The two boards are joined with half-inch threaded spacers.

Interboard wiring is best performed with ribbon cable but any No. 24 or 26 wire will do. Connections to the calculator are best made with very small wire such as the No. 36 used with a wiring pencil. Solder each wire directly to the chip pads to avoid lifting the foil on the calculator board. Use a small tip on your soldering iron.

The segment lines must be broken to insert the level translating transistors Q1-Q7. Use a sharp knife such as an X-ACTO and cut the foil in two places about 1/16 inch apart. Remove the 1/16 inch piece of foil to insure a complete break. Follow the segment lines and solder the emitter sides of Q1–Q7 wires at the readout connection pads; the base leads to the chip pads. It's best to do all the wires in one group at a time: first all the digit leads, then all the segment-emitter leads, etc., connecting each at both ends before proceeding to the next wire.

The converter can be housed in a cut-down LMB type 145 chassis box, but almost anything that will contain the circuit boards and calculator will do. The LMB 145 box is 7-inches long, 5-inches wide and 3-inches high. It was cut down to 1¼-inches high and 7½ by 2⅛ by 3/16-inch wood strips were painted black and bolted to the sides.

Calculator selection

The calculator used in the model was a surplus Bowmar and was purchased as a kit. Many other calculators use the MM5738 and now cost about the same as the kit. The Novus 850, 823 and 826 are good examples of a low-cost 8-digit with memory and uses the MM5738. You can of course buy a calculator IC, driver, readout, and keyboard and lay out your own calculator circuit board, but it's a lot easier (and probably cheaper) to let someone else do it for you.

(One of our editors has a model 850 Novus calculator of a different version from the one used by the author. The editor's instrument has the calculator IC potted onto the back of the read-out display board. You can probably identify the type you are about to purchase by opening the battery compartment and pulling out the battery holder. You'll be able to peek in and see either the PC board or the blob on the back of the read-out.—*Editor*)

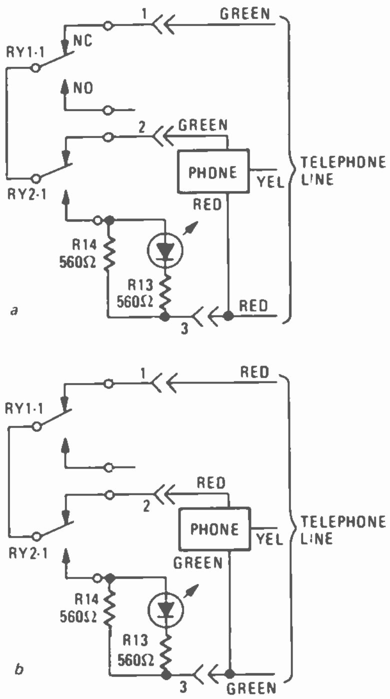


FIG. 7—TELEPHONE CONNECTIONS. Use the connection (*a* or *b*) that makes terminal 1 positive, or the one that causes dialing indicator to light when dialing.

How to use the converter

Connect the converter to the telephone line as shown in Fig. 7. (Reverse the L1 and L2 or the red and green connections if the LED does not light when dialing.) Turn on the calculator and clear it. Enter the telephone number you wish to dial just as you normally dial it. The readout verifies the number you have entered. Lift the telephone receiver and press the DIAL button after you hear the dial tone. The selected number will quickly be dialed. If the line is busy, either place the number in memory and clear the display (to conserve battery) or leave the number in the display. To redial, just press the DIAL button (or recall the number and press the DIAL button). A direct-dialed long distance number must be handled in two steps. Enter the telephone number and store it in memory. Clear the display and enter the access and area codes. Press the DIAL button and wait until the access and area codes have been dialed, then recall the telephone number and press the DIAL button again. To redial, all you have to re-enter is the access and area codes—the telephone number remains in the memory.

The calculator can be used normally any time it is not dialing.

Note: The MM5738 has a provision that blanks the display approximately 16 seconds after the last key activity has occurred. This can be disabled by tieing pin 1 to V_{DD}. (It may be desirable to disable this feature to avoid the sudden and embarrassing loss of the number you are dialing right in the middle of a digit.) **R-E**

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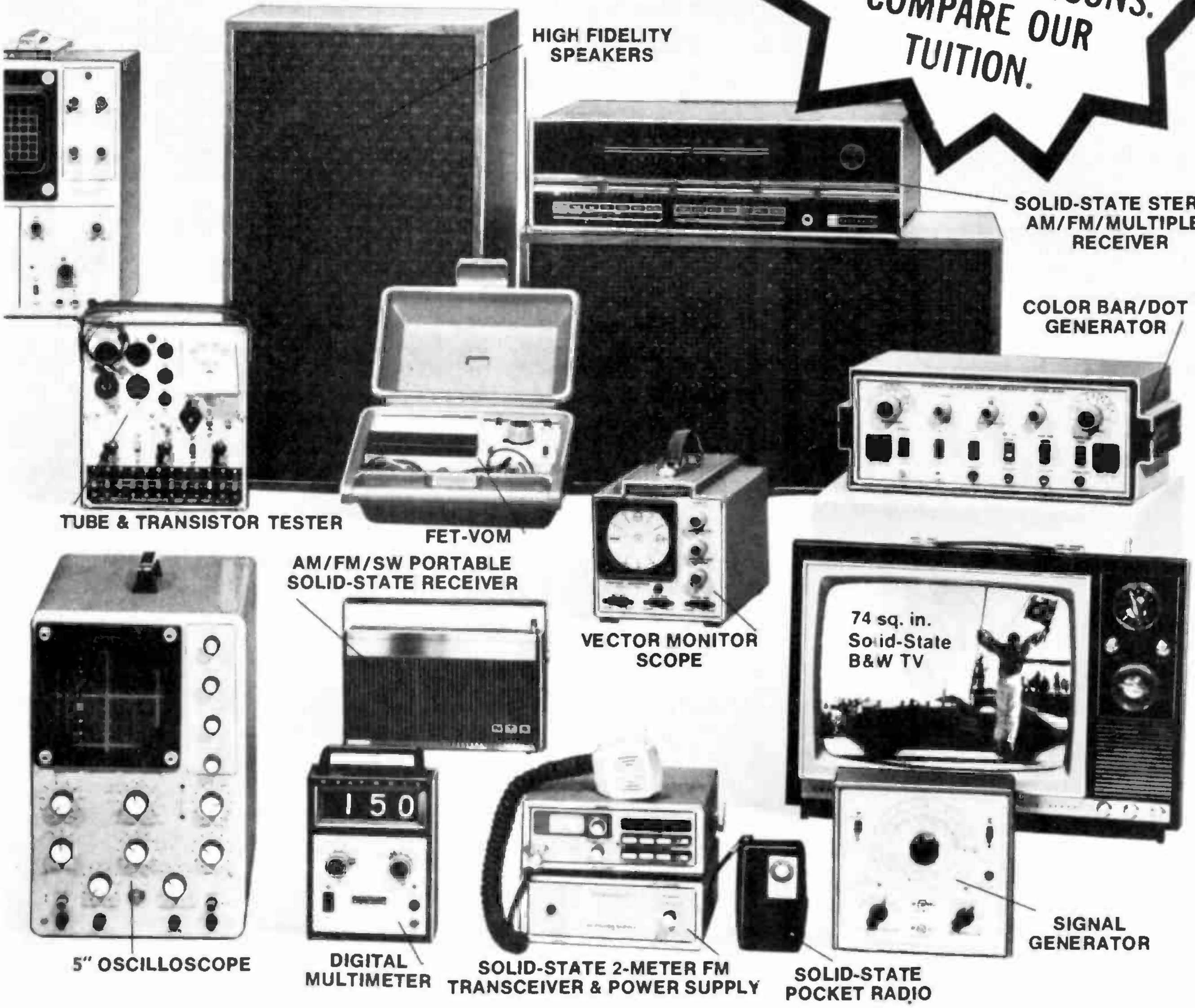

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BUILD FOR YOUR CAR

Anti–Theft Devices

PART I. Practical circuits you can build and connect to any vehicle with a 6- or 12-volt electrical system for protection against thieves

R. M. MARSTON

ONE OF THE MOST PERSISTENT DANGERS facing the modern automobile owner is that of having his vehicle stolen or burglarized. It is impossible to protect oneself 100% against that kind of danger. But the thoughtful owner can gain up to 99% protection by using a little common sense and by fitting his vehicle with fairly simple electrical or electronic anti-theft devices.

Anti-theft devices.

Vehicle anti-theft devices fit into two basic classes. The first is the "immobilizer" type, designed to simply reduce a thief's chances of starting or driving a target vehicle away. Immobilizers give no protection against the car *burglar*, who simply wishes to steal objects left inside the vehicle.

Most vehicles already have a built-in immobilizer—the ignition switch—but this device is easily bypassed by a skilled thief. Many modern vehicles are fitted with an additional immobilizer, the mechanical steering lock, which gives fairly good protection. Further protection can easily be gained by wiring a simple immobilizer switch into some part of the electrical section of the vehicle's power unit.

The second class of anti-theft device is the true burglar alarm that sounds an alarm (and perhaps also immobilizes the automobile's ignition system) if any unauthorized person tries to enter the vehicle. These alarms may be activated in any one of three basic ways. One of the most popular is via microswitches that operate when the car doors or hood or trunk are opened. Microswitch-activated alarms are relatively inexpensive, highly reliable, and can give excellent anti-theft protection.

Another method of activating an alarm is by detecting the small drop in the vehicle's battery voltage when a door, hood, or trunk courtesy light turns on, or when the ignition is turned on. These so-called "voltage sensing" alarms give the same degree of anti-theft protection as the microswitch alarm system, but are generally more expensive and far less reliable.

A third way of activating an alarm is by detecting the vibration or swaying that takes place when a vehicle is entered or moved. This type has a number of disadvantages. If its sensitivity is adjusted so that it activates when anyone enters or rocks the vehicle, the system will tend to go off in gusty winds or when a person leans on the automobile. This system, therefore, has a very low reliability rating. If the system is adjusted so that it activates only when the vehicle is actually moved or subjected to substantial "G" forces, it won't be sensitive enough to give effective anti-burglar protection.

Sometimes, thieves may deliberately activate the vibration sensitive alarm on a number of successive occasions, by rocking the vehicle, until the owner eventually disconnects the system in frustration. The thieves are then free to steal the unprotected vehicle. Thus, the protection given by the vibration sensitive alarm is inferior to that of the micro-switch-activated type.

Practical automobile anti-theft alarm systems may be turned on and off either from within the car, or from outside. Systems that are switched from within the vehicle have a number of disadvantages. To enable the owner to leave the vehicle without activating the alarm, the systems must incorporate a built-in "exit" delay of about 30 seconds, and to enable the owner to enter it again they must have an additional built-in "entry" delay of about 15 seconds.

Consequently, the circuits tend to be fairly complex and expensive, and to have a relatively poor reliability rating. More important, the systems give very poor anti-burglar protection, since the thief is allowed a full 15 seconds of entry time in which to steal any worthwhile goodies before the alarm sounds off.

By contrast, externally-switched alarm systems can be very simple, reliable, inexpensive and (since they can be made to sound off the instant a car door starts to open) can give excellent anti-

	SNATCH BURGLAR	CASSETTE THIEF	JOY RIDER	DRIVE-AWAY THIEF	TOW-AWAY THIEF
IMMOBILIZER	NIL	NIL	GOOD	GOOD	NIL
INTERNALLY-SWITCHED MICROSWITCH-ACTIVATED ALARM	NIL	GOOD	GOOD	GOOD	NIL
INTERNALLY-SWITCHED VOLTAGE-SENSING ALARM	NIL	GOOD	GOOD	GOOD	NIL
INTERNALLY-SWITCHED VIBRATION ALARM	NIL	POOR	GOOD	POOR	FAIR
EXTERNALLY-SWITCHED MICROSWITCH-ACTIVATED ALARM	GOOD	GOOD	GOOD	GOOD	NIL
EXTERNALLY-SWITCHED VOLTAGE-SENSING ALARM	GOOD	GOOD	GOOD	GOOD	NIL
EXTERNALLY-SWITCHED VIBRATION ALARM	POCR	POOR	GOOD	POOR	FAIR

TABLE 1—DEGREE OF PROTECTION provided by different types of alarm circuits.

burglar protection.

Thus, the best all-round kind of alarm system is the externally-switched microswitch-activated type. Later we'll show you some practical examples of this type of alarm. In the meantime, let's look at the different types of thieves who may try to steal or burglarize your vehicle.

Car thieves

Car thieves can be described as fitting into five basic classes:

Snatch burglars: These are the most common car thieves. They simply roam around looking to see if any theft-worthy goodies have been left lying around inside parked cars, or if vehicles' luggage compartments have been left unlocked. You can obtain a high degree of protection against this type of thief by fitting your vehicle with an externally-switched microswitch-activated or voltage-sensing alarm system that sounds off the instant a car door starts to open. But your best protection is common sense: Don't leave attractive goodies in sight in the car! Always lock the luggage compartment!

Cassette Thieves: This type of thief specializes in stealing radios or cassette players from vehicles. It takes the average thief several minutes to steal one of these units, so you can easily scare him off by fitting almost any type of burglar-alarm device that is activated by opening the car doors.

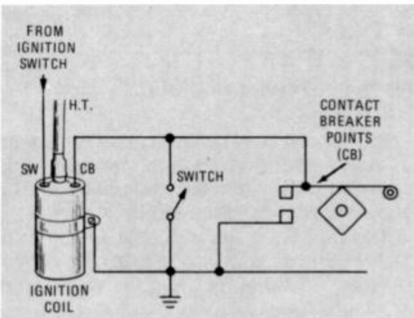


FIG. 1—IMMOBILIZER operates by shorting contact breaker points.

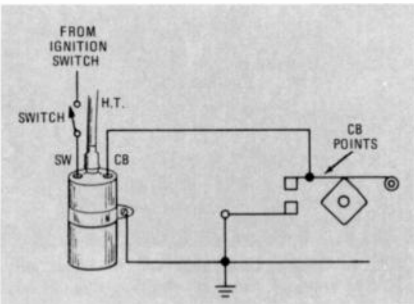


FIG. 2—IGNITION IMMOBILIZER operates by disabling vehicle's ignition circuit.

Joy Riders: These characters usually steal vehicles without premeditation. Most times, they simply look for an unlocked car, then short out its ignition switch and start the vehicle by briefly shorting out the starter switch. You should be able to beat this type of thief by fitting your vehicle with any type of immobilizer or anti-theft alarm, but the chances are that if you don't lock your car doors, you'll also be thoughtless enough to forget to switch on your anti-theft system. In this case, your best protection is lots of insurance.

Drive-Away Thief: This thief usually has enough skill to open locked car doors and bypass ignition switches, and then steal the vehicle by simply driving it away. You can often beat him by fitting your vehicle with a good immobilizer circuit or an anti-theft alarm.

Tow-Away Thief: This is the least common but most dangerous type of car thief. He specializes in stealing good quality and easily disposable vehicles. He steals them by either towing them away or by hoisting them onto the back of a tow-away vehicle. He selects vehicles very carefully before stealing them and often does his best to find out if a target vehicle is fitted with an anti-theft alarm before trying to steal it. In most cases, if he knows that the target vehicle is fitted with an alarm system, he will simply look for an alternative target. In extreme cases, however, he may go to almost any lengths to steal an exceptionally desirable vehicle.

The best defense against this type of thief is a vibration type alarm, but even it offers only limited protection. In most cases, the thief will try to persuade the owner to disconnect a vibration type alarm by repeatedly making it trigger falsely before finally stealing a target vehicle.

Table 1 shows the degree of protection offered by different types of anti-theft devices against different types of thief. As can be seen, immobilizers give good protection against joy riders and drive-away thieves but provide no protection against burglars or tow-away thieves. Externally-switched microswitch-activated and voltage-sensing alarms give good protection against all except tow-away thieves.

Having cleared up these points, let's look at some practical anti-theft circuits.

Immobilizer circuits.

These are used to reduce a thief's chances of starting or driving away a target vehicle. Most vehicles already have a built-in immobilizer—the ignition switch, but it is readily visible and can easily be bypassed by a skilled thief. So a simple additional concealed immobilizer circuit can give considerable extra anti-theft protection.

Simple immobilizers consist of a concealed switch wired into some part of the electrical section of the vehicles power unit. Figures 1 and 2 show how immobilizers can be wired into the vehicle's ignition system. In Fig. 1, the switch is wired between the chassis and the vehicle's contact breaker (CB) points. When this switch is open, the ignition operates normally. When it is closed, the points are shorted out and the engine is unable to operate. This circuit gives excellent protection, particularly if the wiring is carefully hidden at the CB points.

The circuit shown in Fig. 2 has the immobilizer switch wired in series with the vehicle's ignition switch, so that the engine can operate only when the switch is closed. The protection of this circuit is inferior to that of Fig. 1 since the thief can bypass the immobilizer and the ignition switch by simply hooking a wire from the battery to the SW terminal of the coil.

Figure 3 shows how an immobilizer switch can be wired into the vehicle's electric starter system so that the starter operates only when the switch is closed. This system gives better protection than Fig. 2, but is not as good as Fig. 1 since the starter solenoid can be operated manually on many vehicles and also because the starter and immobilizer switches can be bypassed by a single length of wire.

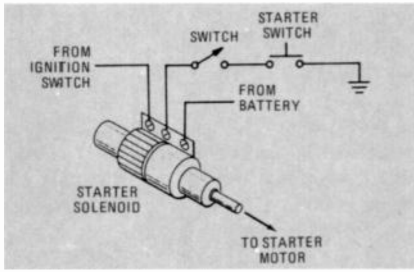


FIG. 3—STARTER IMMOBILIZER operates by opening starter-motor circuit.

Finally, Fig. 4 shows how an immobilizer switch can be wired in series with the electric fuel pump on suitable vehicles so that the pump operates only when this switch is closed. A feature of this system is that it permits a thief to start the engine and drive for several hundred yards on the fuel remaining in the carbureter before the lack of fuel immobilizes the vehicle.

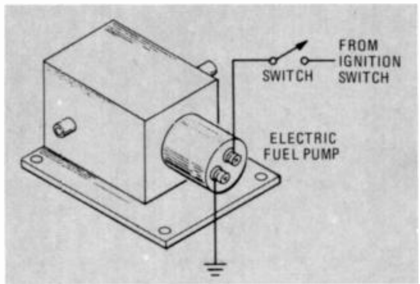


FIG. 4—FUEL-PUMP IMMOBILIZER operates by opening electric fuel-pump circuit.

A major weakness of the circuits shown in Figs. 1 to 4 is that they must all be turned on and off manually so they give protection only if the owner remembers to turn them on each time he leaves his car. Figure 5 shows an immobilizer circuit that turns on automatically each time an attempt is made to start the engine, but which can be turned off by briefly pressing a hidden pushbutton switch. A small "reminder" light turns on when the engine is disabled by the immobilizer. This circuit gives a high degree of protection since it does not depend on the memory of its owner.

How the immobilizer works

The relay coil RY1 is wired in series with 1,000 μF capacitor C1, and the combination is wired across the vehicle's ignition switch. Capacitor C1 is shunted by the series combination of normally-open relay contacts RY1-1 and normally-closed pushbutton switch S1. Relay contacts RY1-2 are wired across the vehicle's breaker points. An LED (light-emitting diode) is wired in series with current-limiting resistor R1 and the combination is wired across the coil of the relay.

Normally, C1 is fully discharged. When the ignition switch is first closed, a surge of current flows through the relay coil via C1 and the relay turns on. As the relay energizes, contacts RY1-1 close and lock the relay on via S1. Relay contacts RY1-2 close and short out the vehicle's breaker points, thus immobilizing the engine. Under this condition, current flows in the LED via R1.

The relay stays on until S1 is opened briefly, at this point the relay unlatches, C1 charges up rapidly via the relay coil, and the relay and the LED turn off. As the relay turns off, the short is removed from the vehicle's breaker points and the engine is able to operate normally.

The relay used in the Fig. 5 circuit

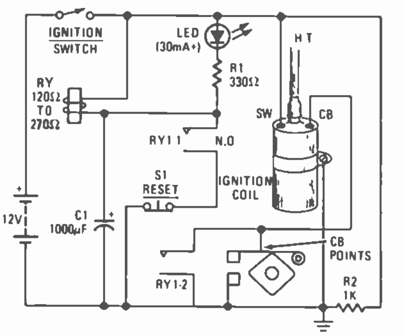


FIG. 5—SELF-ACTIVATING IMMOBILIZER circuit for vehicles with −V ground systems. For vehicles with +V grounded, reverse the polarities of C1 and the LED.

can be any 12-volt type with a coil resistance in the range of 120 to 270 ohms, and with two or more sets of normally-open contacts. The LED can be any type with a mean current rating greater than 30 mA or so. The circuit is shown as for use on vehicles with negative-ground electrical systems. On positive-ground vehicles, reverse the polarities of C1 and the LED.

Practical anti-theft alarms.

The most efficient and useful type of vehicle anti-theft alarms are externally-switched microswitch-activated or voltage-sensing types. These alarms are turned on and off via a concealed toggle switch or a key switch that is fitted to the outside of the vehicle. Figures 6 to 13 show a few practical examples of alarm systems of these types. All of these circuits also act as immobilizers, and operate the vehicle's horn and lights and immobilize the engine under the 'alarm' condition.

In the circuits shown in Figs. 7 to 11, microswitches are used to trip a self-latching relay when the car doors, hood or trunk are opened. This relay immobilizes the engine and operates the horn and headlights either directly or via additional circuitry. Two suitable front-door microswitches are built into most vehicles as standard fittings and are used to operate the courtesy or dome lights. Additional switches can easily be fitted to the rear doors. The hood and trunk can be protected by 'auxiliary' microswitches.

Microswitch-activated immobilizer

The operation of the circuit shown in Fig. 6 is very simple. Normally, the key switch is open and no voltage is fed to the relay network, so the alarm is off. Suppose, however, that the key switch is closed. If any of the door switches close, current flows in the relays via D1, or if

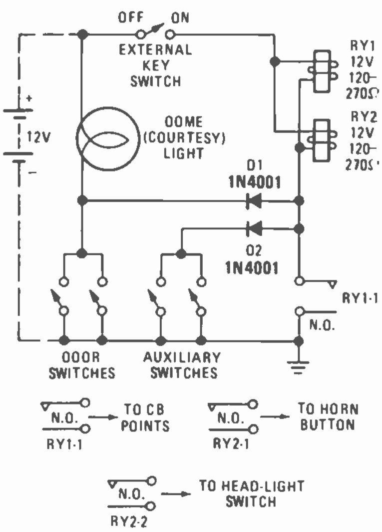


FIG. 6—MICROSWITCH-ACTIVATED alarm/immobilizer operates horn and lights until switched off, or until battery discharges. Circuit is for vehicles with −V ground electrical systems.

any of the auxiliary switches close, current flows via D2. In either case, both relays turn on. As RY1 energizes, contacts RY1-1 close and lock both relays on, and contacts RY1-2 close and short out the vehicles contact breaker (CB) points, thus immobilizing the vehicle.

Simultaneously, contacts RY2-1 close and switch on the car horn, thus giving an audible indication of the intrusion. Also, contacts RY2-2 close and switch on the headlights, thus giving a visual identification of the violated vehicle. The horn and lights remain on until the key switch is opened or until the vehicles battery runs down.

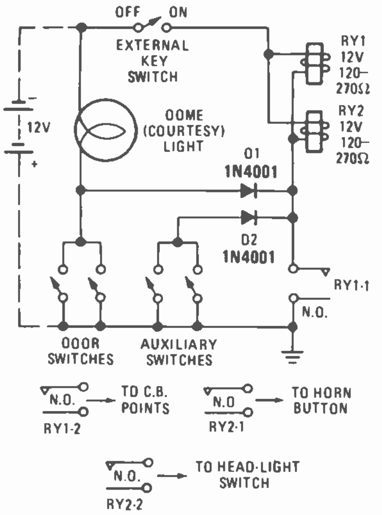


FIG. 7—MICROSWITCH-ACTIVATED alarm/immobilizer designed to operate on vehicles with +V ground electrical systems.

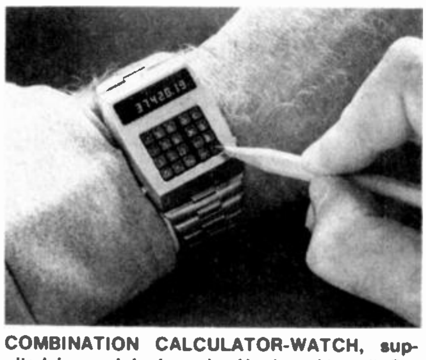
The circuit shown in Fig. 6 is for use on negative-ground vehicles. The circuit can be modified for use on positive ground vehicles by simply reversing the polarities of D1 and D2, as shown in Fig. 7.

to be continued.

Newest small calculator is also a wrist-watch

Hughes Aircraft Co. has just introduced a new electronic watch module that includes a nine-function calculator with a standard four-function digital watch.

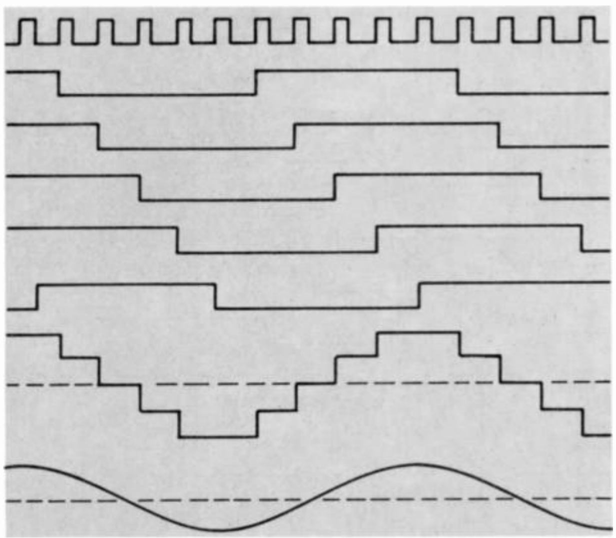
The module measures only 1.4 × 1.25 inches and it adds, subtracts, multiplies, divides, calculates percentages and



COMBINATION CALCULATOR-WATCH, supplied in module form by Hughes Aircraft Co. (Hughes does not market watches, but is a leading manufacturer of watch modules.)

squares, and has a memory and multiplication and division constant. The watch displays the standard four functions—hours, minutes, seconds and date.

The memory retains entries even when the unit is in non-display or time-display mode. Thus the user can interrupt a calculation to check the time, then return to his calculation without losing his figures. R-E



Create Sinewaves Using Digital IC's

Digital techniques can be used to synthesize sinewaves whose amplitude and frequency can be precisely and rapidly controlled and whose distortion is low

DON LANCASTER

EVERY ONCE IN A WHILE A REALLY GREAT IDEA gets buried deep in the technical literature. For instance, back in 1969, a very elegant and ultra-simple way to generate sinewaves digitally appeared. Then, apparently, it was nearly forgotten. Today we can use a $1.00 CMOS integrated circuit, three or four 5% resistors, and this "lost" method to build ultra-simple digital sinewave sources—sinewave sources whose amplitude and frequency we can precisely and rapidly control, and whose distortion is very low. We can use sinewaves like these in electronic music, lab function generators, sweepers, microprocessor and minicomputer analog I/O, digital cassette recorders and MODEMS. But, you're sure to find lots more places where you can use these simple, quick and sophisticated techniques.

The basic idea

Any method of generating sinewaves digitally is usually a two-step process. First, you generate a convenient waveform that consists of a fundamental and some harmonics. Then you get rid of the harmonics by filtering them out. The trick is to pick a convenient waveform that has as few harmonics as possible to start with. We also want the harmonics to be as small as possible, and we want them to be as high an order as possible. All these requirements simplify our filtering and let us change frequency over a reasonable range without necessarily changing our filtering.

Our search for a convenient waveform starts with a *symmetrical* one. This automatically gets rid of all the even harmonics. From here, we want to pick some waveform that inherently doesn't have as many of the odd harmonics as is possible. Ideally, we'd like to get rid of all the low-order odd harmonics. Directly using squarewaves doesn't look too promising because of a third harmonic only 10 decibels (1/3 amplitude) down from the fundamental that's staring you in the face. Similarly, most any relatively simple system based on binary counters will probably also have lots of strong, low-order odd harmonics.

The secret of digital sinewave generation is shown in Fig. 1. You use a circuit called a *walking-ring* or a *Johnson* counter to ultimately generate your sinewave. You make the counter as long as you have to. The longer the counter, the more parts, but the higher the odd harmonics you end up with and the weaker they are. A second part of the secret is that you combine outputs of the counter with resistors, into either a single small-value summing resistor, or into the summing input on an operational amplifier. *But you skip one counter stage in your summing.* This makes our sinewave waveform take twice as long automatically on the peaks and valleys. As we'll shortly see, the waveforms look rather strange and choppy before filtering, but *they have no low-order harmonics!*

You can make a walking-ring counter out of type-D flip-flops or out of many different types of shift registers. The CMOS 4018 is ideal for 6, 8, and 10-step sinewave synthesis, as we'll shortly see, and several 4018's can be cascaded for longer sequences. Our ten-step system takes only one 4018 (or five type-D flip-flops). Pick the resistors just right, and the first harmonic after the fundamental is the *ninth*, and it's almost 20 dB (one-tenth amplitude) down from the fundamental *before* you do any filtering. The only other low-order harmonics are the 11th, the 19th, 21st, 29th, 31st, and so on. All these are so low in amplitude and so high in frequency that if you get rid of the ninth by low-pass filtering, the rest will utterly disappear.

A type-D flip-flop or a register stage is a clocked logic block. When an input clock arrives, information on the D input is passed onto the Q output and its complement is passed onto the $\bar{Q}$ output. (If D is a "1", clocking puts a "1" on Q and a "0" on $\bar{Q}$. If D is a "0", clocking puts a "0" on Q and a "1" on $\bar{Q}$.)

To build a walking-ring counter, connect the Q output of one stage to the D input of the next stage and so on down the line. At the last stage use the complementary $\bar{Q}$ output to feed back to the D input of the first stage. If we use a five-stage register and start with

00000, one clocking gives us 10000 since the $\bar{Q}$ output of the last stage was a "1" and gets passed on to the first stage. More clockings give us 11000, 11100, 11110, and 11111. The $\bar{Q}$ output is now a 0, so the next clocking gives us 01111, 00111, 00011, 00001, and finally 00000, repeating the ten-step sequence as we close the series. The length of our sequence is ten or twice the number of stages.

The sequence length usually equals twice the number of stages in use. If we look at the five outputs A through E in Fig. 1, we see that we get a group of five *phase-shifted* squarewaves. We now sum *four of these five waveforms* with just the right "magic" resistor values, and we get a composite waveform that is a fundamental sinewave along with low-amplitude ninth, eleventh, and a few very small and very high-order remaining odd harmonics. For many uses you can use this sinewave pretty much as is, but it's a simple matter of filtering to get a sinewave of good purity.

Our clock frequency sets the output frequency. With a five-stage, ten-step system, the clock input is ten times the output frequency. As the clock frequency changes, so does the output on a nearly instantaneous basis, since there are no time constants or inductors in the circuit. Note also that a sudden change in clock frequency *coherently* changes the sinewave without any transients or jumps.

With CMOS and relatively light loading (20K or more) the output logic swing is equal to the supply voltage, so we can change the output amplitude either by changing the supply voltage or by changing the gain (digitally or otherwise) of any op-amp that's summing our phase-shifted squarewaves into the composite sinewave output.

Circuits

Figs. 2 and 3 show us two circuits using a single 4018 CMOS register that you can use for digital sinewave generators.

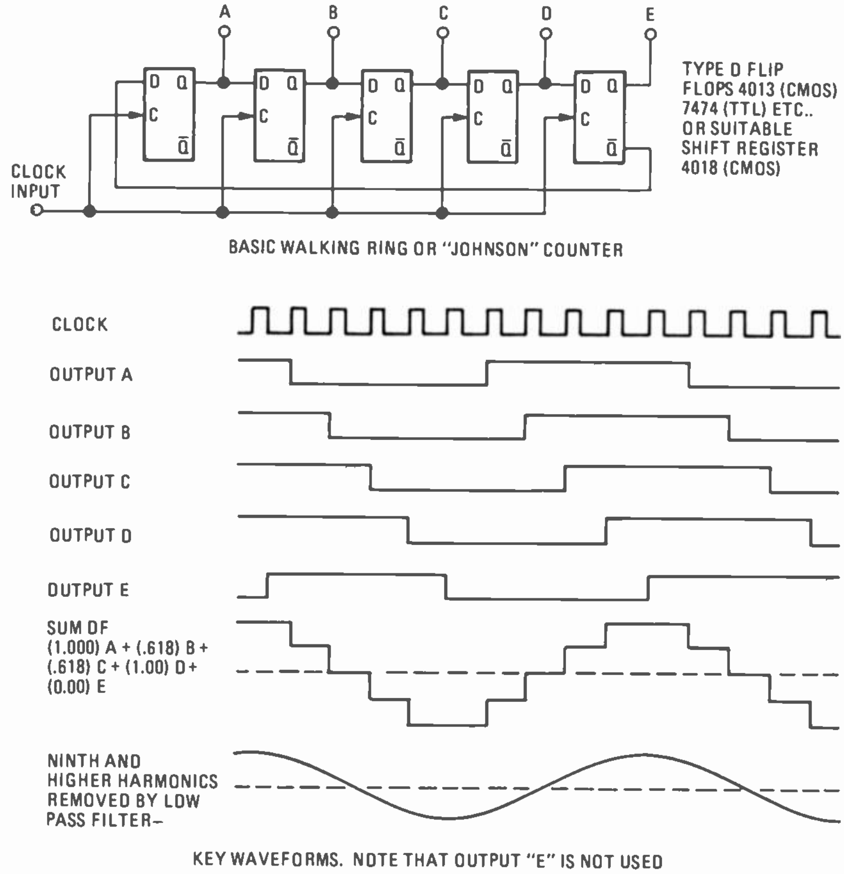
In Fig. 2, we've built a four-stage counter that gives us an eight-step output using one IC and three resistors. The output is summed across the 4.7K resistor and then actively filtered by the PNP emitter follower and the third-order Bessell active filter. This particular circuit is used in a digital cassette recording system, where a digital "1" is a 2400 hertz and a digital "0" is a 1200 hertz sinewave recorded on the tape. You can shift the cutoff frequency of the active filter by proportionately changing capacitors C1, C2, and C3. Doubling these capacitors reduces the cutoff frequency in half and so on. The input clock of this circuit is eight times the output frequency.

In Fig. 3, we have a five-stage counter and four resistors that sum into a type-741 operational amplifier. The op amp is filtered with a single capacitor. This particular circuit drives the transmitter speaker of a "103" style MODEM, outputting a 1070 hertz sinewave for a digital logic "0" and a 1270 hertz sinewave for a digital logic "1". This time the clock frequency is ten times these output values.

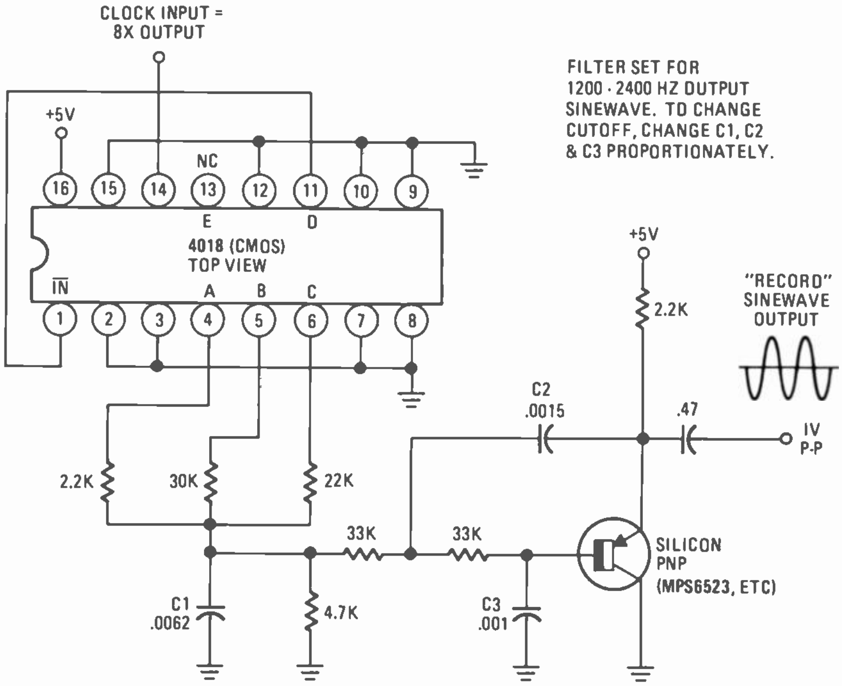
Magic numbers

Figures 4, 5 and 6 show us the magic resistor values, the circuits, and the waveforms for three, four and five-stage registers of length 6, 8, and 10. The value in parenthesis is the resistor ratio we want, while the

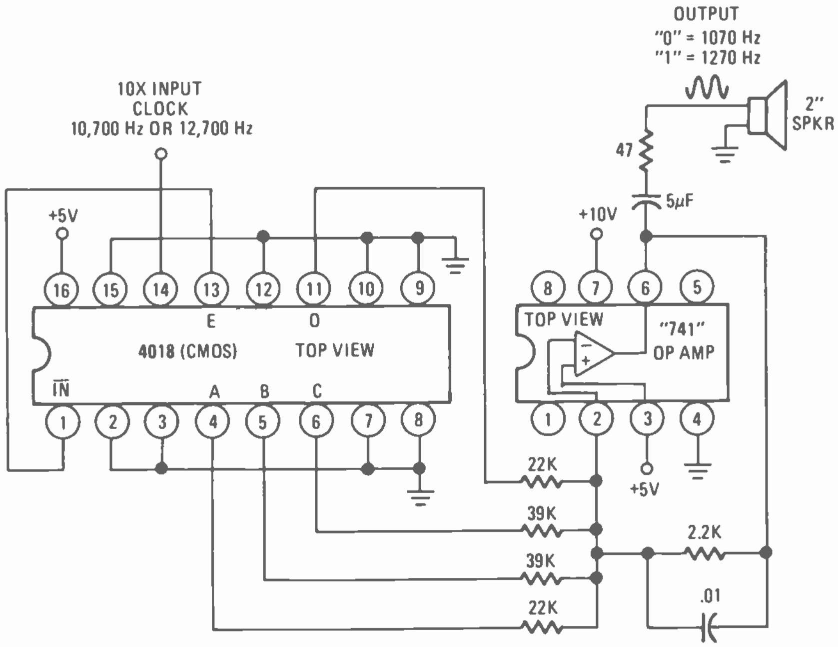
1. THE WALKING RING COUNTER and its waveforms, which combine to produce a good sinewave (after filtering).



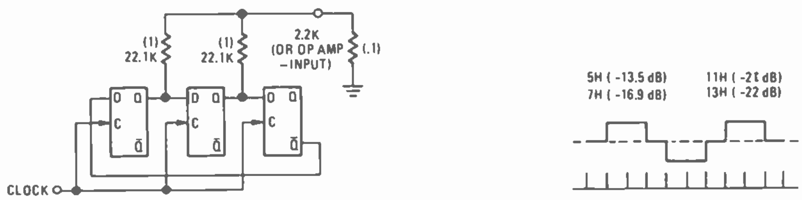
2. AN EIGHT-STEP GENERATOR, as used in a digital cassette recording system.



3. 10-STEP SINEWAVE GENERATOR drives the transmitter speaker of a MODEM.

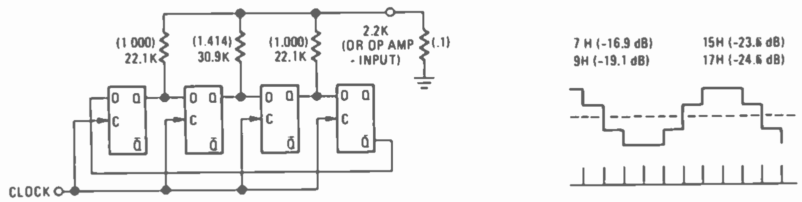


4. THREE-STAGE DIGITAL SINEWAVE GENERATOR. Resistance values are shown in ratios (parentheses) and ohms. The amplitude of the harmonics are also shown.



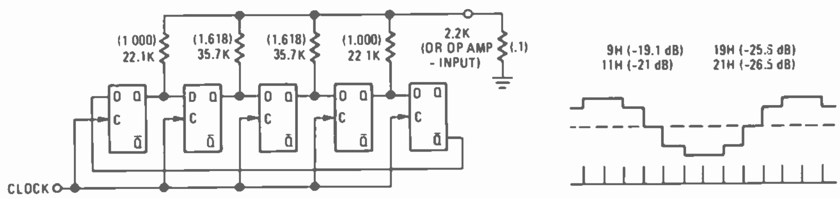
THREE-STAGE. CLOCK IS SIX TIMES OUTPUT FREQUENCY

5. FOUR-STAGE DIGITAL SINEWAVE GENERATOR.



FOUR-STAGE CLOCK IS EIGHT TIMES OUTPUT FREQUENCY

6. FIVE-STAGE DIGITAL SINEWAVE GENERATOR.



FIVE-STAGE. CLOCK IS TEN TIMES OUTPUT FREQUENCY

resistor value has been rounded off to a stock 1 percent value. Actually, 5 percent resistors are more than adequate for practically all sinewave generators, particularly for those of ten stages or less.

You'll get more performance by lengthening the registers and using more resistors. Values for any length are shown in Table I, along with the harmonics and their strengths that you can expect. Once again, the parenthesis values are exact ratios, while the resistor values are 1 percent based on 22.1 K being the smallest value used.

These longer lengths make filtering more easy since the odd harmonics you do get are higher in frequency and lower in amplitude as you add stages. Note that the input clock frequency goes up as you add stages. Two or more 4018's can be cascaded as needed for these longer lengths. Usually binary lengths of 8 and 16 or decimal lengths of 10 or 20 make for the easiest interface with the system timing in the rest of your circuit.

Note that with a longer register, you can have a fixed filter and still operate over a wide frequency range. For instance, with a 10-stage register and a 10:1 frequency change, the lowest harmonic of the lowest output frequency will still be 1.9 times the frequency of the highest output frequency and reasonably easy to get rid of with a sharp-cutoff filter.

Some loose ends

You may have to look into several details when generating your own digital sinewaves. These include the counter sequences, resistor tolerances, offsets, and the choice of filtering.

Walking-ring counters longer than two stages have *disallowed sequences* that make up the difference between the total possible counter states and the states you are actually using. For instance, a three-stage counter has the valid 000, 100, 110, 111, 011, 001 and back to 000 six-count state sequence. It also has a disallowed 101, 010, 101, 010 . . . . two-count rut it can get into. All walking-ring counters must be set up to eliminate the disallowed states.

This is done internally in the 4018 counters, and cascaded 4018's will probably eliminate most if not all the possible disallowed sequences. You can also use a reset button or signal to get your sequence off on the 000 state before you begin. Or you can add gating to force the internal stages to zero when the end stages are zero; or to all ones when the end stages are ones. (If you have only a common reset line for all stages, be sure to shorten the reset pulse so it doesn't permanently hang up the register.)

How accurate do the resistors have to be? For registers of ten stages or less, a tolerance of 5 percent is good enough, even though we've shown you 1 percent values. Resistors out of tolerance introduce lower-order odd harmonics, but for most 5 percent variations, these should be 40 decibels below the fundamental or lower.

Note that there will be a DC offset in the output sinewave that usually must be eliminated somehow. The simplest way is with a blocking capacitor as we did with the output capacitor in Figs. 2 and 3. With our CMOS outputs, we have a choice of summing to the positive supply voltage, to ground, or to an op amp's inverting input biased halfway between positive supply and ground. In Fig.

CIE has a terrific idea for a few people who know what they want.

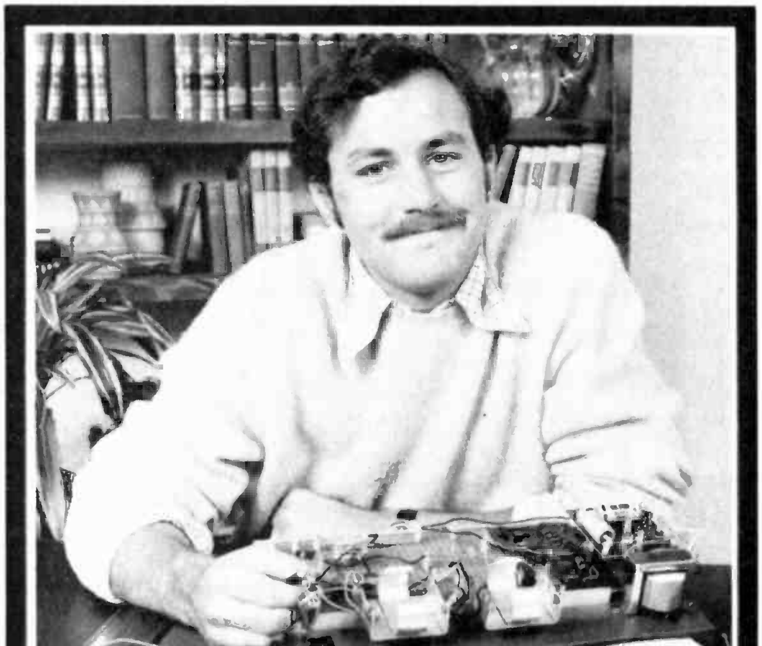


TABLE I—DESIGN INFORMATION FOR LONGER GENERATORS

STAGES	CLOCK	RESISTORS*	HARMONICS
6	12x	22.1K; 38.3K; 44.2K; 38.3K; 22.1K (1.000) (1.732) (2.000) (1.732) (1.000)	11H (−21 dB) 23H (−27 dB) 13H (−23 dB) 25H (−28 dB)
7	14x	22.1K; 40.2K; 49.9K; 49.9K; 40.2K; 22.1K (1.000) (1.803) (2.248) (2.248) (1.803) (1.000)	13H (−23 dB) 27H (−29 dB) 15H (−24 dB) 29H (−29 dB)
8	16x	22.1K; 41.2K; 53.6K; 57.6K; 53.6K; 41.2K; 22.1K (1.000) (1.849) (2.412) (2.613) (2.413) (1.849) (1.000)	15H (−24 dB) 29H (−29 dB) 17H (−25 dB) 31H (−30 dB)
9	18x	22.1K; 41.2K; 56.2K; 63.4K; 63.4K; 56.2K; 41.2K; 22.1K (1.000) (1.877) (2.532) (2.879) (2.879) (2.532) (1.877) (1.000)	17H (−25 dB) 35H (−31 dB) 19H (−26 dB) 37H (−31 dB)
10	20x	22.1K; 42.2K, 57.6K; 68.1K; 71.5K; 68.1K; 57.6K; 42.2K; 22.1K (1.000) (1.896) (2.618) (3.077) (3.236) (3.077) (2.618) (1.896) (1.000)	19H (−26 dB) 39H (−32 dB) 21H (−27 dB) 41H (−33 dB)
16	32x	22.1K; 43.2K; 63.4K; 80.6K; 93.1K; 105K; 110K; 113K; (1.000) (1.961) (2.847) (3.624) (4.262) (4.736) (5.027) (5.125) 110K; 105K; 93.1K; 80.6K; 63.4K; 43.2K; 22.1K (5.027) (4.736) (4.262) (3.624) (2.847) (1.96) (1.000)	31H (−30 dB) 63H (−36 dB) 33H (−31 dB) 65H (−36 dB)
n	2nx	$1; \frac{\sin\frac{2\pi}{n}}{\sin\frac{\pi}{n}}; \frac{\sin\frac{3\pi}{n}}{\sin\frac{\pi}{n}}; \frac{\sin\frac{4\pi}{n}}{\sin\frac{\pi}{n}}; \ldots \frac{\sin\frac{(n-1)\pi}{n}}{\sin\frac{\pi}{n}}$	$(2n-1)H$ $(\frac{1}{2}n-1)$ $(4n-1)H$ $(\frac{1}{4}n-1)$ $(2n+1)H$ $(\frac{1}{2}n+1)$ $(4n+1)H$ $(\frac{1}{4}n+1)$

*** The resistor values in parentheses are exact ratios; values in ohms are rounded off to stock 1 percent values.**

2, we've summed to ground so the emitter follower will have a reasonably constant emitter current and thus not distort the waveform. In Fig. 3 we sum to one-half the supply voltage to minimize the offset at the output even before capacitor coupling.

A final detail is filtering. Complete information on active filters appears in the *Active Filter Cookbook*. For some uses, the harmonics are high enough in frequency that they can simply be ignored. For others, a simple capacitor or two to introduce rolloff is all you need. For more critical uses, a better quality active filter is called for.

Sharp-cutoff low-pass filters using Butterworth or Chebyshev response curves have the advantages of producing very clean sinewaves with a minimum of circuitry. But these sharp filters have one possible drawback—if the input sinewave is changing or jumping between several frequencies, the filters will introduce *group-delay distortion*, or simple smearing that will generally mess up any sudden input frequency changes. Where you are suddenly or often changing input frequencies, use the higher-order "more gentle" Bessell active filters since Bessell filters are designed to absolutely minimize this form of distortion.

These circuits actually make digital sinewaves easier and simpler and cheaper than analog ones, so there should be all sorts of things you can do with them. Let us know what uses you come up with. **R-E**

FOR MORE READING:

Generating digital sinewaves—
"Digital Generation of Low Frequency Sinewaves," Anthony C. Davies, *IEEE Transactions on Instrumentation and Measurement*, IM18, No. 2, June 1969 PP 97-105.

Active filters—
The Active Filter Cookbook No. 21168, Howard W Sams, Indianapolis, IN, 46206.

ELECTRONIC LANDMARK GONE

THE "GOLF BALL" 160-FOOT RADOME of the radar system built by RCA in southern New Jersey in 1959, is now a thing of the past. The Air Force reports that it has become unnecessary; its functions are now being performed at other radar sites.

Designed as a prototype for the Air Force's Early Warning system in the North, the 84-foot dome was constructed to withstand the 150-mph winds of the Arctic. It was made with nearly 1,650 interlocking hexagonal pieces, and one pentagonal piece at the top.

The "Golf Ball" was considered the most powerful radar in the world when it was designed. It could track a three-foot object 3,000 miles away. It has been used to track spacecraft, study eclipses, and take precise measurements of objects in space. Among its feats was a more precise determination of the value of the Astronomical Unit, the mean distance between the earth and the sun. This measurement has been valuable to scientists in determining orbital data on satellites and other planets more accurately.

FCC gets petition to permit stereophonic AM broadcasting

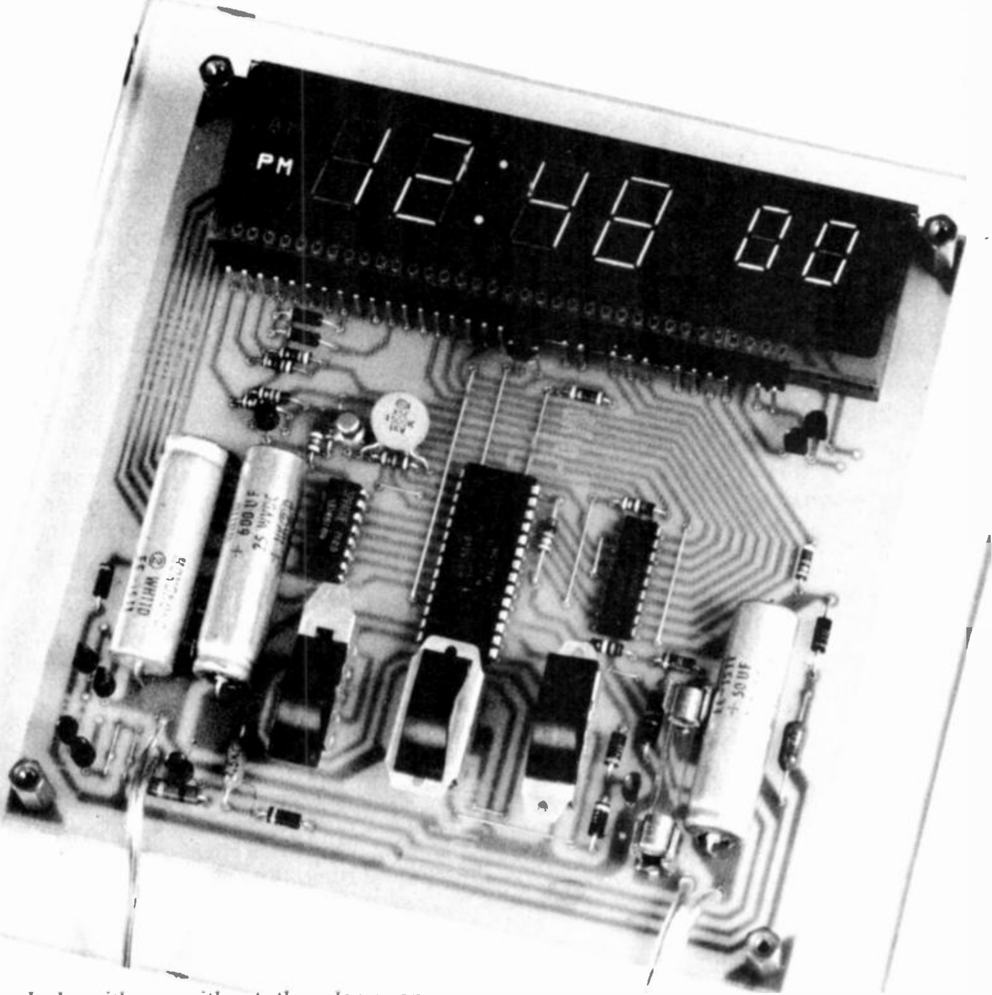
Kahn Communications, Inc., of Freeport, NY, has filed a petition asking that the Federal Communications Commission institute rule-making proceedings looking toward regulations that would allow AM broadcasters to operate sterephonically. The petition states that the Kahn AM stereo broadcasting system is completely compatible with standard AM broadcasting and does not degrade present broadcast service; and that it will allow AM broadcast listeners to enjoy stereophonic reception with little or no additional investment in receiving equipment.

The system has been demonstrated several times in on-the-air experiments, notably over WFBR, Baltimore, and was in use by station XETRA, Tiajuana, Mexico, for more than three years.

The Kahn system is a type of compatible single-sideband that can be received with two ordinary broadcast receivers, one tuned slightly below and the other slightly above the carrier frequency. A receiver designed to receive this type of AM stereo might have two IF's, one tuned slightly higher in frequency than the other.

An ordinary receiver tuned to the carrier receives both channels with the same results as if the station were using conventional modulation. **R-E**

Gas-Discharge Alarm Clock



A digital clock with a gas-discharge display that uses neon gas to produce a pleasing orange glow. The alarm feature is optional and the clock is powered from a 115-volt AC line

PAUL EMERALD*

THE ELDER STATESMAN AMONG ELECTRONIC displays is the gas-discharge display panel; its ancestry lies in the ubiquitous neon lamp, and later in the Nixie tube pioneered by Burroughs in the 1950's. Newer gas-discharge displays are planar, multi-digit, seven-segment types such as the Burroughs Panaplex series. These displays are evident in a wide variety of display applications, particularly desk-top calculators. Rather than the single formed-wire characters found in the Nixie tubes, the planar displays usually operate in a multiplexed seven-segment format while emitting the same pleasing orange glow.

The gas-discharge panel used in this full-feature clock has six digits and is easily read from 25 feet. The hours and minutes digits are 0.7-in. high while the seconds are 0.5-in. high. This display is coupled with two state-of-the-art IC drivers from Sprague Electric and a Mostek PMOS alarm clock IC to form the many featured electronic clock that is described. The clock can be readily turned into a wall, mantel or bookcase clock—with or without the alarm option.

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Display

The Panaplex display requires a minimum ionization voltage of 180 volts for operation, and it's a thin/thick film circuit sandwich with a neon gas mixture between the anode (+) and cathode (−). An orange glow is visable when the neon mixture is ionized by the application of appropriate voltage and current.

The segment (cathode) side of the sandwich is thick-film technology on either a ceramic or, more recently, a glass substrate. All like segments are internally connected (Digit 1a to Digit 2a, D1b to D2b to D3b, etc.) for multiplexed operation. This technique minimizes display connections, MOS IC pins, board wiring, interface electronics, etc. Segments in the display are switched to a negative supply potential, in this case −95 volts. Figure 1 shows the internal segments and bussed connections between like segments (cathodes) in an exploded view.

The digit (anode) half of the display panel is glass with a thin film conductor such as tin oxide. The anode is switched to a positive potential, in this case +95 volts. The digit (anode) is fundamentally the same as the wire-screen anode of the Nixie tube, or the common terminal (anode or cathode depending upon type) in LED's, etc. Figure 2 shows the connections for the display.

Clock IC

The clock IC is Mostek's MK 50250—a PMOS, multiplexed 28-pin DIP with several available features. The MK 50250 can operate as either a 12-hour 60-Hz clock, or a 24-hour 50-Hz clock. For this clock, the 12-hour 60-Hz option is used. The MK 50250 has several features—alarm (24 hour period), snooze

(10 minute interval). three intensity levels (pulse modulated outputs) and AM/PM capability. Also. with a brown-out or momentary power failure. the clock will alternately flash the AM and PM numerals to indicate that the displayed time is incorrect.

Of the available features. only the AM/PM feature requires any appreciable number of components. Its level of complexity is due to the incompatibility of the MOS chip and the display configuration itself. The schematic diagram (see Fig. 3) shows the interface to the separate AM/PM indicators in the display. This interface consists of transistors Q2 and Q3 and the associated components.

The MK 50250 is actually a 24-hour clock. even though the display never indicates other than a 12-hour cycle. However. the AM/PM is important when incorporating the alarm. The alarm will not go off at 6:30 PM if it is set for 6:30 AM. Hence the need to know if the clock is set to an AM or PM state—a feature not available in electromechanical clocks.

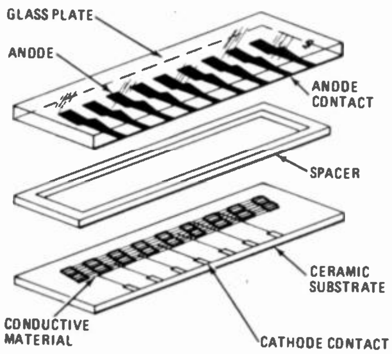


FIG. 1—CONSTRUCTION of the gas-discharge planar display. Like segments of each digit are connected together for multiplexed operation.

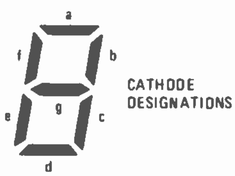
SETTING CLOCK TIME

Begin:	TIME SET switch in RUN position, FUNCTION switch in COUNT INHIBIT position.
Set Minutes:	Push TIME SET switch to SET MINS position. Increment minutes to correct setting.
Set 10 Minutes:	Quickly slide TIME SET switch to next lowest position when minutes have been set.
Set Hours:	Quickly slide TIME SET switch to next lowest position where it then will increment to proper hour setting. Note: With AM/PM operation it is a full 24-hour cycle.
Run:	As proper hour and AM/PM indication is set, push slide switch to bottom position for clock operation.
Count Inhibit:	Although it is not necessary to start with the FUNCTION switch in this position, it allows the synchronization of the clock with an appropriate time reference.
	Note: This clock will operate effectively with a 60-Hz input frequency and an input voltage range from 95 VAC to 115 VAC. Do *not* exceed 115 VAC since damage to the power supply may result.

Another feature is the three-level display intensity—bright. medium. and dim. The digit and segment outputs are pulse-width modulated to provide three distinct intensity levels to correspond to ambient light conditions. High ambient light gives the brightest display. while low ambient light produces a low duty-cycle strobing of the display and results in a readout that does not glare harshly in a dim or dark room.

The automatic intensity feature is easily accomplished by using only a cadmium-sulphide photocell (R2) and a single resistor (R3). The MK 50250 IC has a three-level intensity control input (pin 11). When this input is pulled toward the V_{SS} potential (V_{SS} = 16 volts). the outputs are multiplexed with the maximum duty cycle (approx. 14.29%) resulting in a bright display. With the intensity input at a level close to the V_{DD} potential (ground) the outputs are pulse modulated to the minimum duty cycle (approx. 2.60%) resulting in a dim display.

The photocell and fixed resistor operate in a manner similar to having a potentiometer connected to the resistor. the resistance of the photocell varies with the ambient light. Minimum resistance (high ambient light) pulls IC2 pin-11 well toward V_{SS}. while low light levels produce a high resistance and the input voltage is close to V_{DD}. The medium level is when the fixed resistor and photocell are approximately equal. The duty cycle of the intermediate intensity level is approximately 7.20%. The



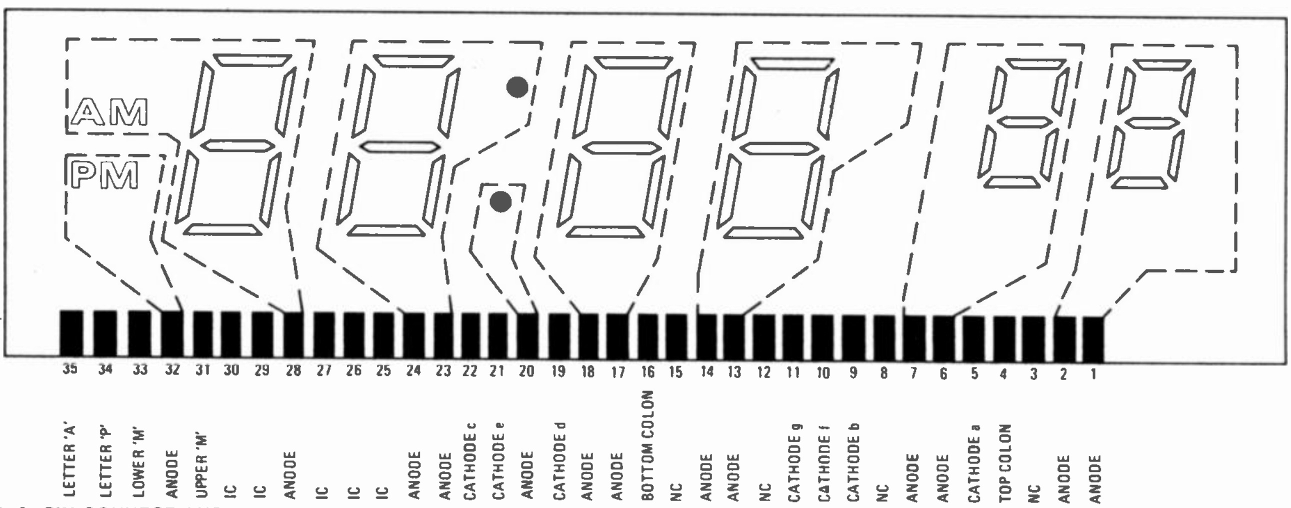


FIG. 2—PIN CONNECTIONS of the gas-discharge planar display.

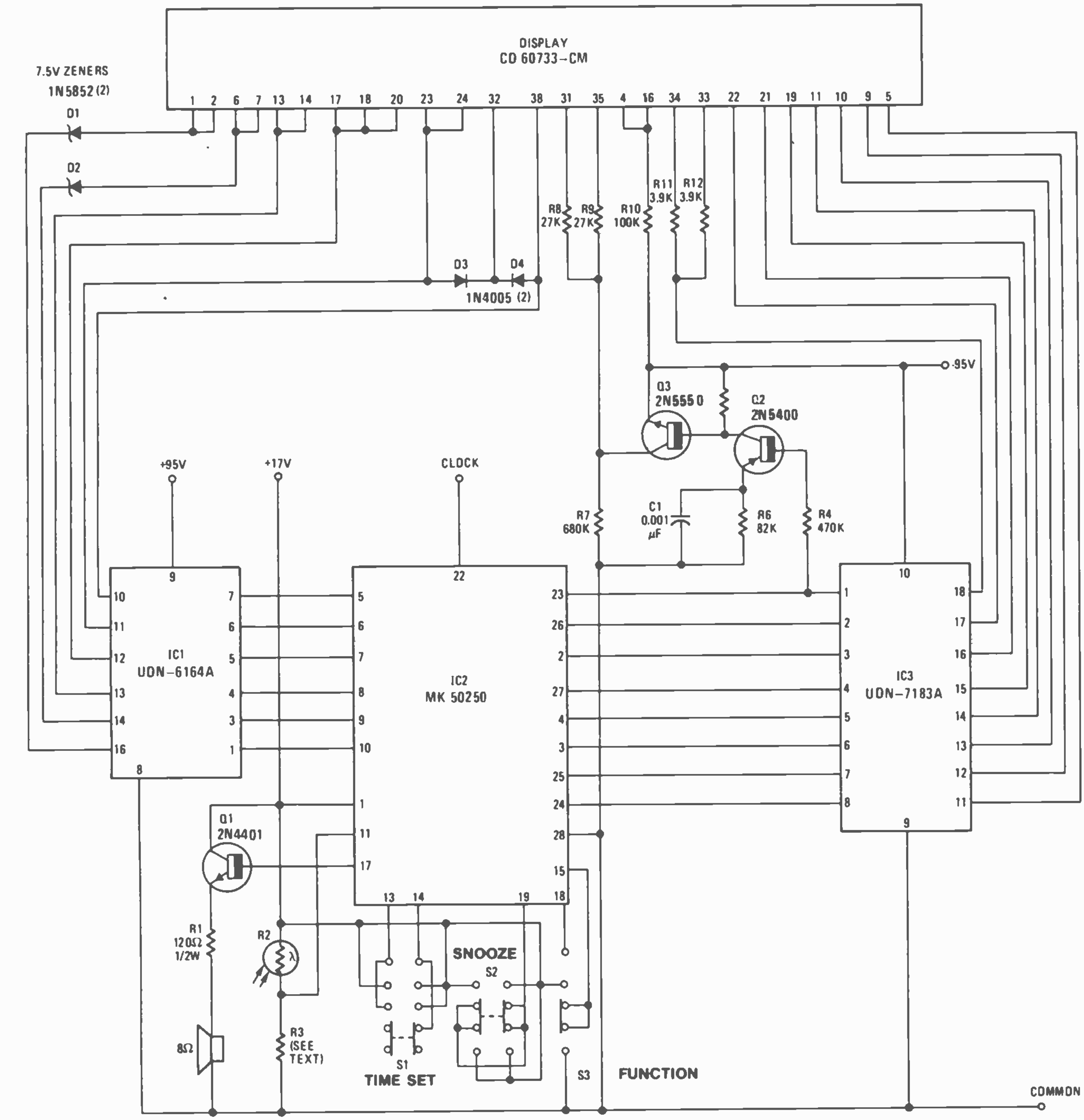


FIG. 3—CLOCK CIRCUIT is built around a MOS IC and has an optional alarm circuit.

All resistors are ¼-watt, 10%, unless noted.

R1—120 ohms, ½ watt (required for optional alarm)
R2—CdS photocell, 3.3K at 2 foot-candles, 220K minimum dark resistance, 125 mW at 25°C maximum power (Clairex CL7P5L, Vactec VT801, or equal.)
R3—See text
R4—470,000 ohms
R5, R15—22,000 ohms
R6—82,000 ohms
R7—680,000 ohms
R8, R9—27,000 ohms
R10—100,000 ohms
R11, R12—3900 ohms
R13—180,000 ohms
R14—2000 ohms, 3 watts (1500 ohms, 5 watts with optional alarm)
R16—2000 ohms, 3 watts
R17, R18—68,000 ohms, ½ watt
C1—.001 μF, 100V disc
C2—.01 μF, 125VAC disc (Sprague 125L-S10 or equal.)
C3—600 μF, 25V electrolytic
C4, C5—50 μF, 150V electrolytic
D1, D2—7.5-volt Zener (1N5852 or equal.)
D3-D7, D9, D14, D15—600-volt, 1A diode (1N4005 or equal.)
D8—16-volt, 10% Zener (1N5862 or equal.)
D10-D13—47-volt, 1-watt, 5% Zener (1N4756 or equal.)
Q1—2N4401 transistor (or equal.)
Q2—2N5400 transistor (or equal.)
Q3—2N5550 transistor (or equal.)
IC1—UDN-6164A (Sprague)
IC2—MK50250 (Mostek)
IC3—UDN-7183A (Sprague)
S1—2 pole, 4-position slide switch
S2—2p, 3p, spring return
S3—1 pole, 4-position slide switch
Misc: PC board, display (Burroughs CD60733-CM or Cherry Electric W06-0001), display connector, ¼-ampere fuse, fuse clips, wire, solder, etc.

The following parts are available from AVTEK Electronics, P.O. Box 457, Andover, MA 01810: A complete kit of parts that includes a PC board and all other electronic components—$59.50; and a partial kit that includes a PC board, three IC's, three switches, photocell, display and connector—$39.50. A case consisting of plastic front and back covers plus hardware is also available for $7.50.

current in each segment is the same at any intensity level, but the reduced duty cycle results in a reduction of average light emitted. The value of the fixed resistor R3 can vary widely and depends on the type of enclosure used. If the photocell is exposed directly to ambient light, then R3 will be between 4K and 5K ohms. If a colored filter covers the photocell, then R3 will be between 27K and 30K ohms. The correct value should be determined by experimentation.

Another simple feature is the COUNT INHIBIT position of the function switch. Switching to this inhibit position allows "locking up" the clock time and setting the clock in synchronization with a time standard such as WWV. From that point on, the clock is at the mercy of the power company for short-term accuracy, but corrections are made by the power company to provide long-term accuracy.

Another optional feature is the alarm. The alarm provides a 400–600 Hz "beep-off-beep" alternating tone. The clock IC requires only a buffer transistor (2N4401 or equiv.), a 100-ohm ½-watt resistor to limit current and the necessary transducer (speaker). Additionally, you may also wish to add the SNOOZE switch. Depressing the SNOOZE switch while the alarm is operating deactivates the alarm for a period of ten minutes, after which the alarm will go off again.

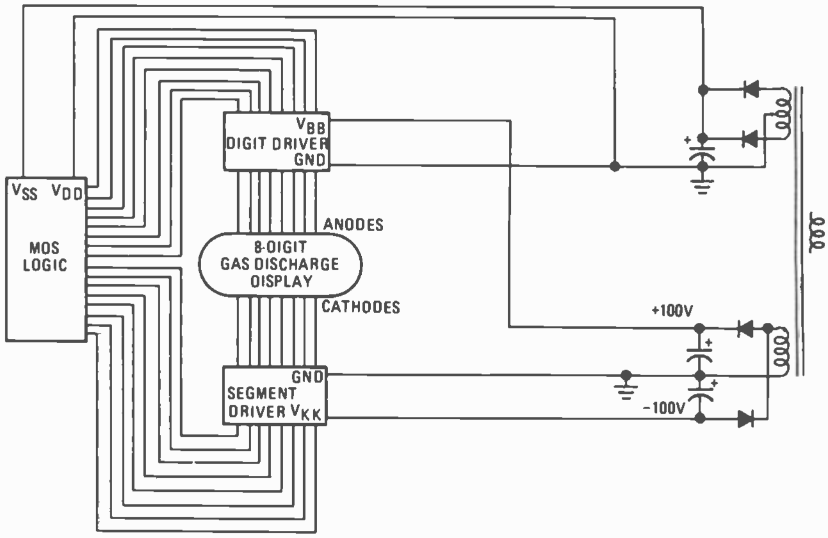


FIG. 4—SIMPLIFIED SCHEMATIC of the split power-supply used to drive the gas-discharge display.

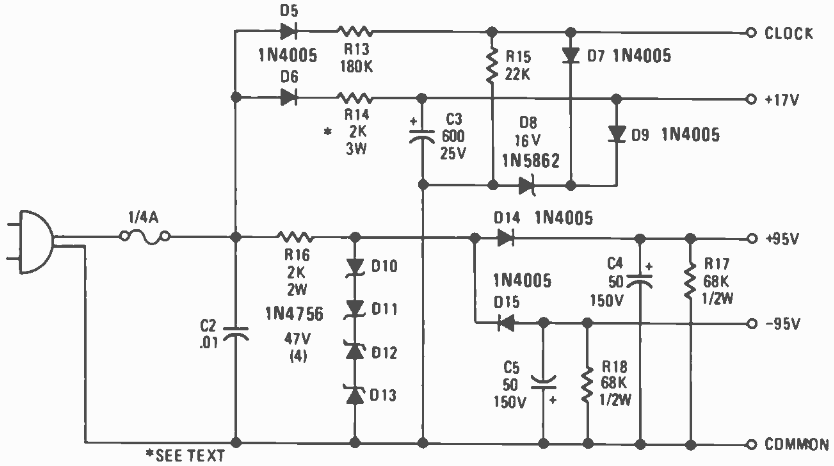


FIG. 5—POWER SUPPLY has split high-voltage supply to drive display and low-voltage source for IC's. Timebase is derived from low-voltage supply.

Interface circuits

The interface circuits to convert low-level logic to the high-voltages necessary to drive gas-discharge displays has been a difficult problem for the IC industry for several years, but a new family of Sprague display drivers has dramatically simplified this situation. Previous schemes of either discrete components or discrete components coupled with IC's have almost always required large numbers of components or were expensive due to the rather exotic process technologies. A joint Sprague/Burroughs effort has resulted in a much simpler, less expensive interface to these high-voltage displays. This new IC series is employed in this clock to minimize components and simplify the clock circuitry.

A detailed explanation of the anode (digit) and cathode (segment) circuit interface is rather lengthy and will not be presented. However, any one interested may easily obtain applications information by requesting MAR75-1 from their Sprague dealer.

Fundamentally, the digit and segment IC's employ high-voltage bipolar processing and the use of thin-film resistor technology on the surface of the IC chip to accommodate all the functions necessary in gas-discharge interface schemes. The level shifting from the low level (low voltage) logic to the display panel is done by high-voltage transistors (PNP's in 7100 series segment circuits and NPN's in 6100 series digit circuits). Necessary input current limiting, segment current limiting, pull-up or pull-down resistors are included via chrome silicon resistors added to the IC. Also, the appropriate reference voltages are internally generated.

As the result of this circuit breakthrough, this display may be used with only two IC's—one digit circuit and one segment IC—while previous discrete approaches might have resulted in 50–75 components to perform the same function. Figure 4 shows the basic interface from the clock IC to the display. Level shifting to a positive supply (approx. +100V) is done on the digit side, while the DC level shifting on the segment side to a negative voltage (approx. −100V) provides a total of approximately 200V (+100V and −100V). This split supply technique allows the use of high-voltage bipolar processing using PN diode isolated circuitry rather than more expensive solutions such as dielectric isolation. Formerly, supplies for gas-discharge panels were single-ended (either +200V or −200V etc.) rather than the use of a split technique to provide the necessary ionization voltage.

Power supply

The schematic diagram of the split power-supply is shown in Fig. 5. The high-voltage split power-supply uses Zener diodes D10-D13 to limit the AC peaks to ±95 volts. This voltage is then half-wave rectified by diodes D14 and D15 and filtered to provide the +95V and −95V source for the display.

The low-voltage supply for the alarm circuit and clock IC is derived from the AC line voltage. The line voltage is half-wave rectified by diode D6 and filtered by R14 and C3. Zener diode D8 and diode D9 regulates the output of the filter to produce the +17V source. R14 is a 2000-ohm 3-watt resistor. The resistance of R14 should be reduced to 1500-ohms when the alarm option is used. This prevents the alarm circuit from

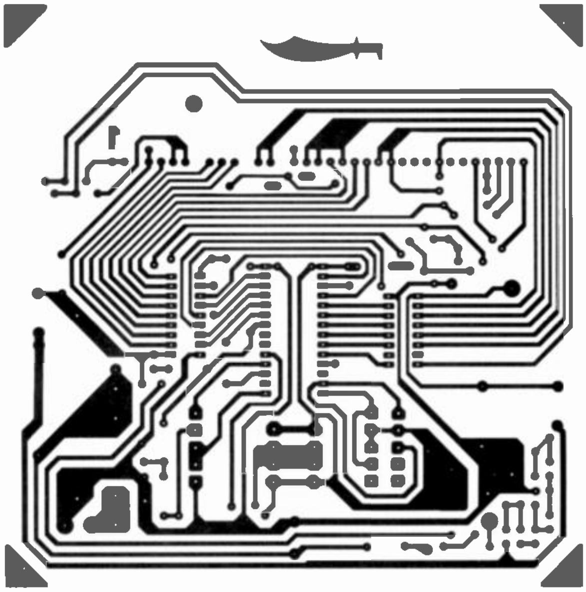


FIG. 6—FOIL PATTERN of PC board shown half-size.

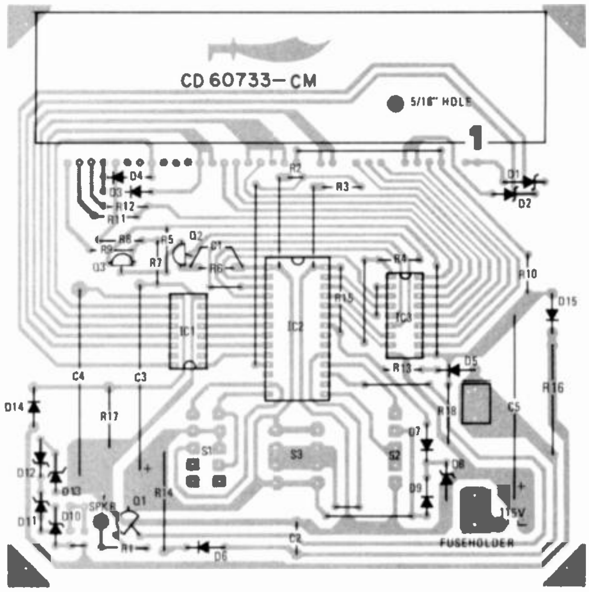


FIG. 7—COMPONENT PLACEMENT diagram shown from component-side of board.

overloading the 17V source and prevents the clock IC from issuing a power-interrupt indication (AM/PM indicators flash) when the alarm sounds.

The 60-Hz timebase for the clock IC is derived from the AC line voltage. Diode D7 clamps this signal to the 16-volt drop developed across Zener diode D8.

Construction

Assembling the clock is rather easy, and begins with installing the eleven jumper wires. The foil pattern for the single-sided PC board is shown in Fig. 6, while the component placement diagram is shown in Fig. 7. A word to those concerned with neatness: use the trick employed by any fussy technician—stretch the jumper wire to straighten it before cutting to length (stretch 12″ to 15″ lengths). Push the leads through the board and bend them slightly to retain the jumper until soldering.

Mount the components on the PC board as shown in Fig. 7 and solder. Note: conservative use of 30 and 33V Zeners in the power supply requires 6 Zeners, but two may be omitted (substitute a jumper) if 1-watt 47-volt types are employed (board will take these also) as shown.

Slide switches may be mounted toward front or rear. A wall clock would normally omit the SNOOZE switch and have switches soldered on the foil side of PC board. If switches are to be out of sight (rear) they must be spaced off the board to allow soldering. Figure 8 shows the functions of the three slide switches.

Slowly insert the display into connector from one end—proper position is with the small, center contact tab of connector facing upward or against the front (anode) position. These slip-in connectors are rather fragile and care must be taken to prevent bending contacts, etc. After mating display and connector, use either double-sided adhesive tape or other adhesive to mount display to $\frac{1}{16}$″ spacer for raising display to proper height. Begin at one end of display leads and slip them into proper holes in PC board. Four leads have *no* holes; bend them away initially—after display is fully mounted and soldered they can be cut off.

Display leads must be bent 90°. With connector fully inserted between display anode and cathode plates, bend the leads at the point where they exit the connector. When the leads have been properly bent, remove paper from double-sided tape (or use alternate adhesive) to secure the display unit to the PC board. Solder all leads after checking to be certain that all are properly lined up to appropriate holes. Trim all leads again. Solder in line cord and insert fuse (¼ A).

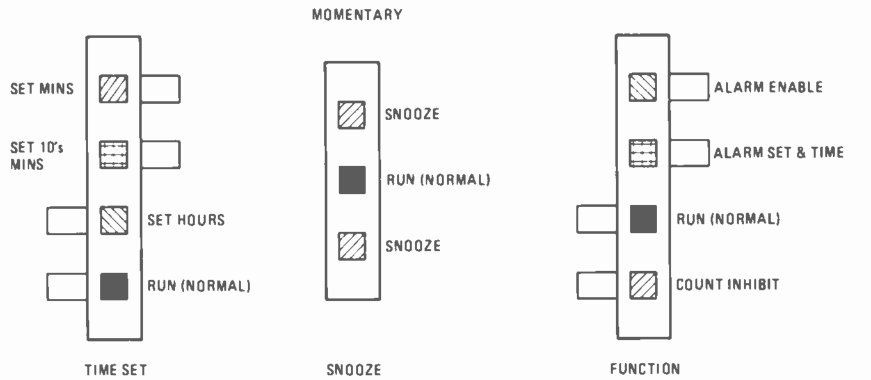


FIG. 8—SWITCH FUNCTIONS of the three slide switches.

Prior to inserting the three IC's, it is desirable to measure three supply-voltages to prevent possible damage to the IC's from faulty or improperly oriented components. Use *caution*! The PC board connects to one side of the 115 VAC line for its ground; use an isolation transformer if available. Use a VOM and be certain to rest the PC board on an insulated surface when measuring voltages.

Connect the meter ground-lead to the junction of C4 and R17 and measure +95V ±1.7V across C4; and measure +17V ±0.2V at the junction of C3 and R14.

Reverse the meter connections prior to making the measurement at the junction of C5 and R18; this should measure −95V ±1.7V. If all three voltages are correct, then the IC's may be soldered into the board. If the voltages are not correct, then check diode and capacitor polarities, etc. Be certain that IC1, IC2 and IC3 are oriented correctly as shown in Fig. 7.

Check the operation of the clock. Plug it into a 115-volt 60-Hz AC line and, if available, use an isolation transformer. The display should ionize and indicate "AM 12:00:00." The display will hold in this state until the time is set. For setting to the exact time, use the count inhibit function and lock the clock to a reference standard such as WWV. From that point the accuracy is maintained by the local power company. **R-E**

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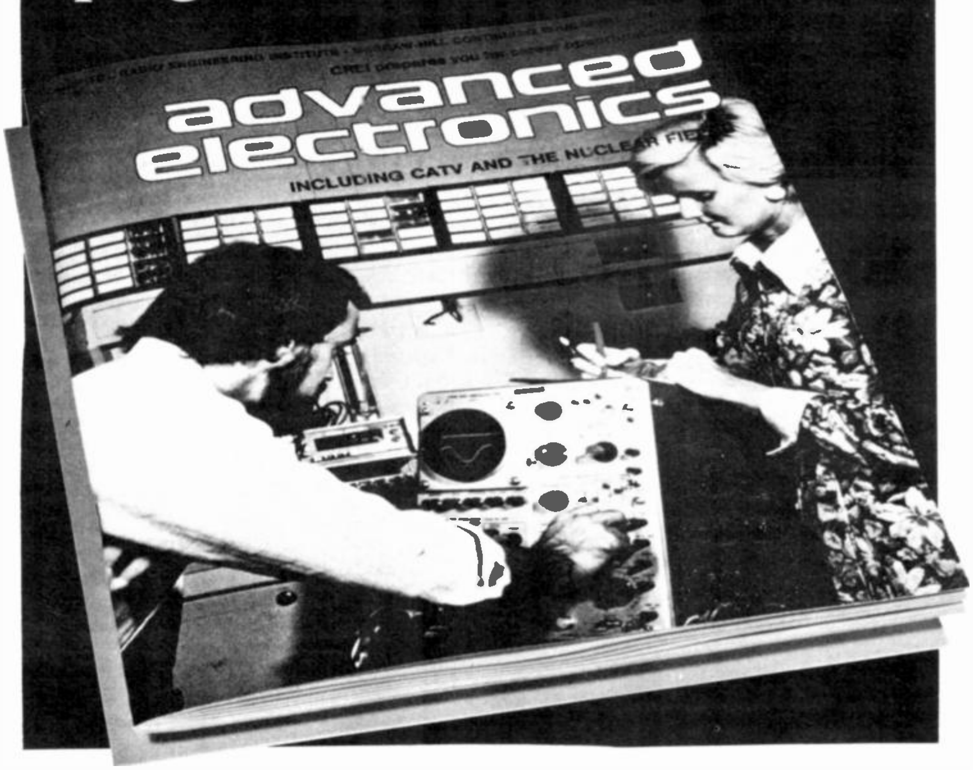

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Improved Noise-Reduction for Tapes

Super-ANRS—developed by JVC and incorporated in several of their newly introduced stereo cassette decks—provides improved noise-reduction and increased dynamic-range capability

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

AS JUST ABOUT EVERY CASSETTE DECK OWNer knows by now, noise-reduction systems such as Dolby and ANRS (the *A*utomatic *N*oise *R*eduction *S*ystem developed by Japan Victor Company) increase the dynamic range capability of the cassette recording format by lowering the noise threshold, above which the softest recorded sounds can be heard. Both of these systems increase the recording level of high-frequency sounds when those sounds are part of a soft passage of music. The amount of high-frequency pre-emphasis during the record process is dependent upon the average signal level being recorded and varies continuously. Loud passages, for example, undergo no pre-emphasis whatever, while softest passages undergo the greatest amount of pre-emphasis during the record process.

During playback, voltage-controlled frequency-sensitive amplifiers reverse the process, attenuating high-frequency playback by the amount required to restore flat frequency-response at all loudness levels. Typically, this process improves the signal-to-noise ratio above about 5 kHz (where tape hiss is most audible) by approximately 10 dB. While most people think of this action in terms of noise reduction, the process can also be thought of as increasing the dynamic-range capability. The boundaries of dynamic range in tape recordings consist of the low residual tape noise-level at one extreme and the tape saturation level at the other extreme. If we think of the recorded program as a ship passing under a bridge, taller ships can be accommodated either by "lowering the water or raising the bridge." Noise reduction systems, in this analogy, "lower the water."

Upward dynamic expansion

In an attempt to "raise the bridge," JVC has now come up with a modified version of their original ANRS system that they call Super-ANRS. In order to understand how it works, it is necessary to review some of the principles of tape recording. During the recording process, input signals are equalized so that high-frequency signals are boosted by a prescribed amount. This is done so that the playback response will be reasonably flat beyond the point at which the playback-head response begins to fall off. The principle of record equalization is illustrated in the graph of Fig. 1.

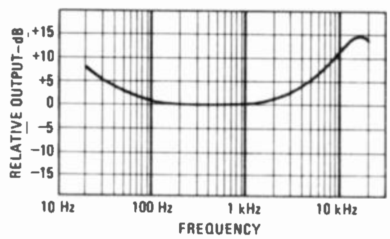


FIG. 1—TYPICAL RECORD EQUALIZATION applied to cassette systems to compensate for head and tape characteristics.

Because cassette recorders operate at the slow speed of 1⅞ IPS and use a narrow tape, the record equalization used in cassette decks pre-emphasize high frequencies much more than does the equalization appled to faster operating open-reel decks. As a result, tape saturation at high frequencies occurs more readily. Figure 2 illustrates this effect. At low recording levels, playback output level is linear with respect to record input level for both the 1 kHz and 10 kHz signals. But, at higher recording levels, the 10-kHz signal saturates the tape at a level that is nearly 15 dB lower than the saturation point for the 1 kHz signal. If the music you try to record contains a high percentage of higher frequencies (music dominated by cymbals, piccolo or even guitar sounds that have high-frequency transients), the

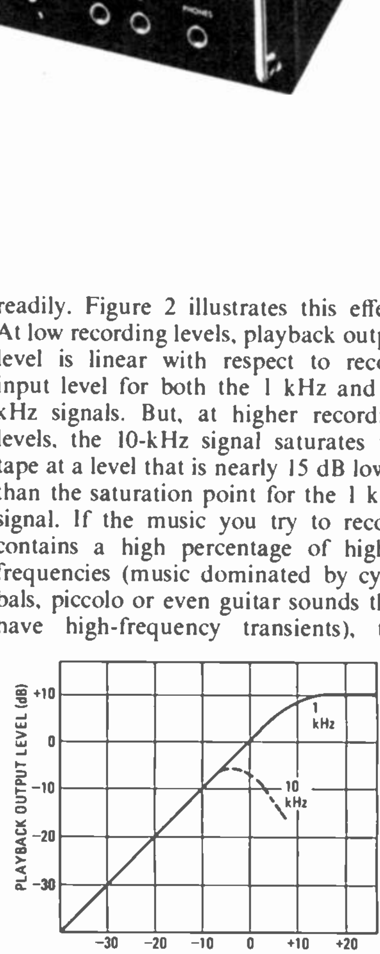


FIG. 2—CASSETTE TAPE saturates more readily at high-frequencies, as this linearity curve shows.

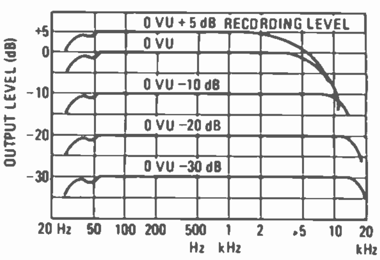


FIG. 3—RECORD/PLAYBACK frequency response of cassette tape.

dynamic range of the tape is exceeded and when the recording is played back, sounds are distorted.

This point is further illustrated in the curves of Fig. 3. If you try to measure the response (record/playback) of a cassette deck using a record level of 0 dB (as indicated on the record level meters) or even +5 dB, high-frequency response rolls-off above about 5 kHz (for 0 dB recording level) or at an even lower frequency for the +5-dB record level. It is for this reason that most manufacturers quote the record/playback frequency response of their products on the basis of a −20 dB or even a −30 dB recording level. At this lower recording level, the overall response is improved because the high frequencies are not saturating the tape, even with record equalization added. But, there are moments in musical recording when high-frequency musical peaks do occur and often they occur too rapidly to be observed on the record-level meters.

How super-ANRS works

Figure 4 is a simplified block diagram of the Super-ANRS principle developed by JVC. Basically, the circuit consists of a variable impedance circuit that determines the amount of high-frequency boost of the regular ANRS (noise reduction) filter circuit at the left plus a second Super-ANRS filter circuit. The super-ANRS filter circuit shares the common variable impedance elements of the regular ANRS circuit. At low signal levels, the variable impedance

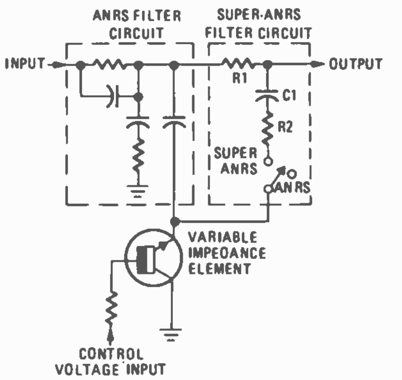


FIG. 4—SUPER-ANRS CIRCUIT is added to basic ANRS circuit and is controlled by a variable impedance.

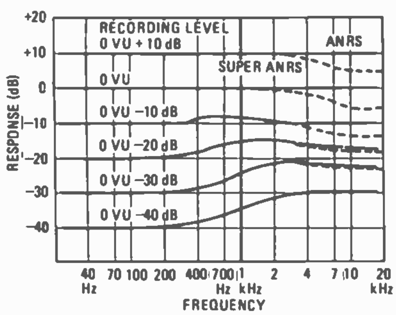


FIG. 5—RECORDING CHARACTERISTICS of the ANRS and Super-ANRS circuits.

rises in value (determined by the control voltage) and the record response at various input levels is made to vary in accordance with the solid lines of Fig. 5. When the selector switch is thrown to Super-ANRS, an additional high-cut filter element formed by R1, C1 and R2 is introduced. This additional high-cut filter *compresses* or attenuates high-level high-frequency signals in the recording process as indicated by the dotted lines of Fig. 5. Low level operation of the regular ANRS filters remains the same. The extra Super-ANRS circuit selectively compresses the signals with up to 6 dB for a +10 dB (as indicated on the meter) signal at 10 kHz.

During playback, exactly the reverse process takes place, as shown in Fig. 6. Low-level high-frequency signals are

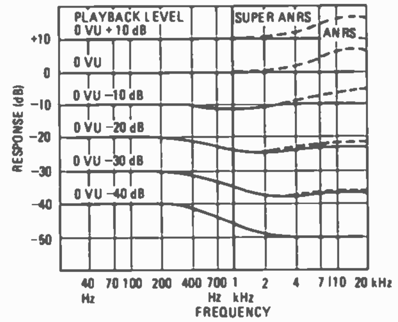


FIG. 6—PLAYBACK CHARACTERISTICS of the ANRS and Super-ANRS circuits.

correspondingly attenuated by the action of the regular ANRS circuit (restoring the flat frequency-response at moments of low-level reproduced music) while high-level high-frequency signals that had been compressed in the Super-ANRS recording process are now expanded during playback (shown by the dotted lines in Fig. 6). The 10-kHz signal that was compressed by 6-dB in recording (at a 10-dB level) is now expanded by precisely the same 6 dB and is therefore reproduced at exactly the same level as when applied to the input of the tape deck.

The use of ANRS together with Super-ANRS therefore provides a double benefit. ANRS extends the dynamic-range downwards as it reduces tape noise-level, while Super-ANRS also extends the dynamic-range capability upwards. An illustration of the overall effect of both circuits is shown in Fig. 7. The double process reduces high-level sounds and boosts low-level sounds during recording. The sounds are processed in such a way that loud sounds (which might exceed the tape saturation level) and soft sounds (which might be obscured by tape hiss) can now be recorded within the available dynamic-range boundaries of the tape. In playback, the system restores the original levels with tape hiss significantly reduced and the effective saturation level raised.

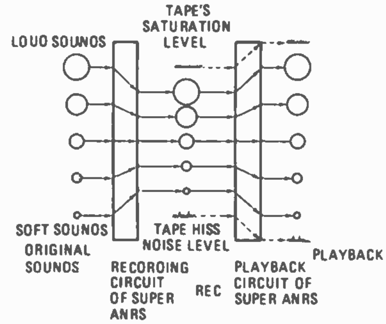


FIG. 7—COMPRESSION/EXPANSION characteristic of Super-ANRS circuit. The size of the circles are proportional to the signal levels.

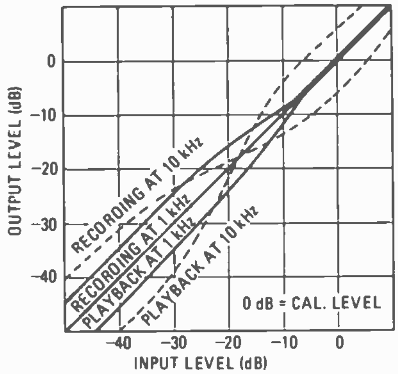


FIG. 8—INPUT/OUTPUT characteristics of the Super-ANRS circuit.

Figure 8 illustrates the action of Super-ANRS in terms of input/output characteristics. Note that for a 10-kHz signal, the system actually switches over from an expand-compress process (below levels of about −20 dB) to a compress-expand system (at levels above −20 dB).

Figure 9 compares the record/playback linearity characteristics of normal tape for a 10-kHz signal with and without the Super-ANRS circuit acti-

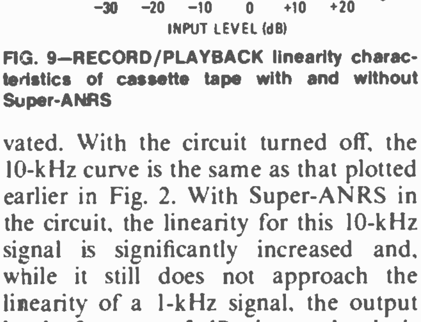


FIG. 9—RECORD/PLAYBACK linearity characteristics of cassette tape with and without Super-ANRS

vated. With the circuit turned off, the 10-kHz curve is the same as that plotted earlier in Fig. 2. With Super-ANRS in the circuit, the linearity for this 10-kHz signal is significantly increased and, while it still does not approach the linearity of a 1-kHz signal, the output level for a +5-dB input level is increased by approximately 12 dB. The lower two curves of Fig. 9 show distortion versus input level. For a 10-kHz signal at 0-dB record level, distortion

continued on page 104

Radio-Electronics Tests Crown IC-150A Preamplifier

1

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

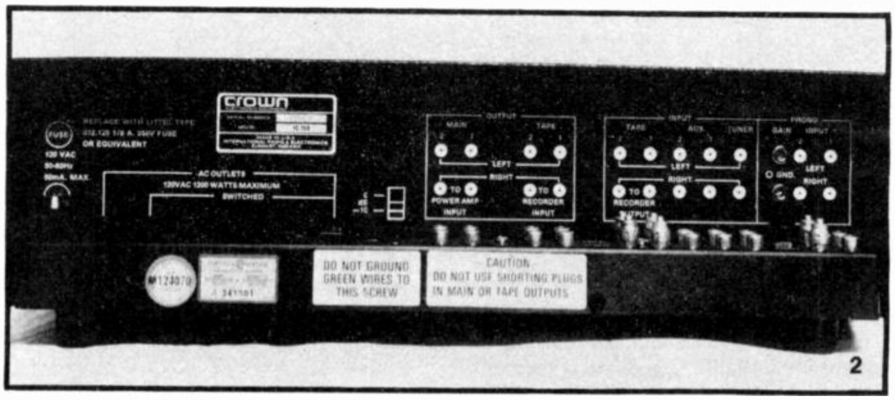
ANYONE FAMILIAR WITH CROWN'S EARLIER model IC-150 will immediately realize that the new IC-150A is a totally redesigned unit, both in terms of front-panel arrangement and internal circuitry. The newer preamplifier-control unit, shown in Fig. 1, is supplied with a vinyl-clad black wrap and can be operated free-standing. Additionally, it can be mounted in an optionally available wood cabinet, custom mounted in a cabinet panel of your choice, or rack-panel mounted by means of angle brackets and hardware supplied with each unit. When rack-mounted, the unit is light enough so that no support shelf is required.

Major controls along the upper section of the panel include a SELECTOR switch (with two PHONO settings, a TUNER position and three AUX positions plus two TAPE positions), BALANCE control, dual-concentric BASS and TREBLE controls, a unique continuously variable PANORAMA control (that makes a smooth transition from stereo, to mono, to reverse stereo) and a precision switch-type VOLUME control calibrated in 2-dB steps from 0 dB to −58 dB. A pushbutton located between the VOLUME and SELECTOR switches activates the loudness control circuitry, while a similar pushbutton between the BASS and TREBLE controls serves to bypass the tone control circuitry completely for absolutely flat response. Five pushbuttons centered along the lower, black section of the panel take care of two tape monitor circuits, low and high filters and the power on/off function. At the lower left are a pair of single-circuit phone jacks for front panel connection to the AUX 3 inputs, while at the extreme lower right is a stereo (two-circuit) phone jack for monitor output.

The rear panel is shown in Fig. 2. No less than six convenience AC outlets are provided, five of which can handle a combined AC drain of 25 amperes. Input and output jacks are all mounted on a horizontal surface, but descriptive legends corresponding to these jacks are screened on the rear vertical surface for legibility. Near the pairs of PHONO inputs are screwdriver adjustment controls that permit you to vary the gain of the phono preamp section over a 20-dB range, with maximum sensitivity being 0.7 mV for rated output. In all of our subsequent tests, these controls were set to provide rated output (2.5 volts) from the main outputs with a phono input level of 2.5 mV. A slide-switch changes the gain by a fixed 10 dB.

Circuit description

The number and type of equipment that can be connected to the IC-150A is extremely diverse. As illustrated in the connection diagram of Fig. 3, as many as four different tape decks could be used with the system, along with two turntables and a tuner. Only two decks could be monitored however if they are of the three-headed variety. Note, too, that since there are two pairs of main output jacks, signals could be fed to two separate stereo power amplifiers, if desired, or to a power amplifier and a headphone amplifier as shown in the connection diagram.



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A signal-flow block diagram of the IC-150A is shown in Fig. 4. The electronics of the IC-150A are built around five integrated circuits that provide the equivalent of 89 transistors, 25 FET's, 3 Zener diodes and 12 diodes. In addition, 7 bipolar transistors, 1 FET, 1 Zener and ten diodes are used in discrete form. The output of the IC-150A is muted for several seconds after turn-on to protect speakers against "pops". The phono-preamplifier section employs a low-noise complementary design, using an LM301AN operational amplifier IC. Tone control and voltage amplifiers are LF356H FET op-amp IC's: one per channel.

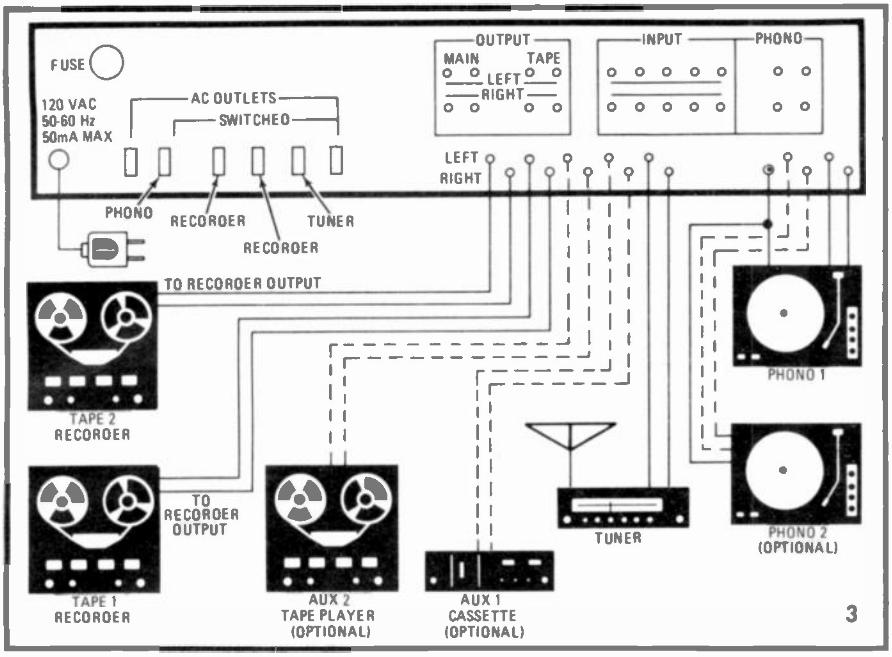
Two major circuit boards are used in the construction of the IC-150A: one containing the phono-preamp circuitry, the other for high-level amplification, tone control circuits and power-supply parts. The regulated power-supply delivers plus and minus 18 volts. The master VOLUME control is positioned directly following the high-level input circuits, followed by the BALANCE and PANORAMA controls that precede the tone control amplifier stages. The 10-dB output attenuator is in the form of a precision voltage-divider arrangement just preceding the actual output terminals. Muting relay contacts (that delay audio turn-on) follow all the active signal-handling elements of the circuit.

Laboratory measurements

A summary of our test measurements is shown in Table I and can be readily compared with manufacturer's claims. At

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

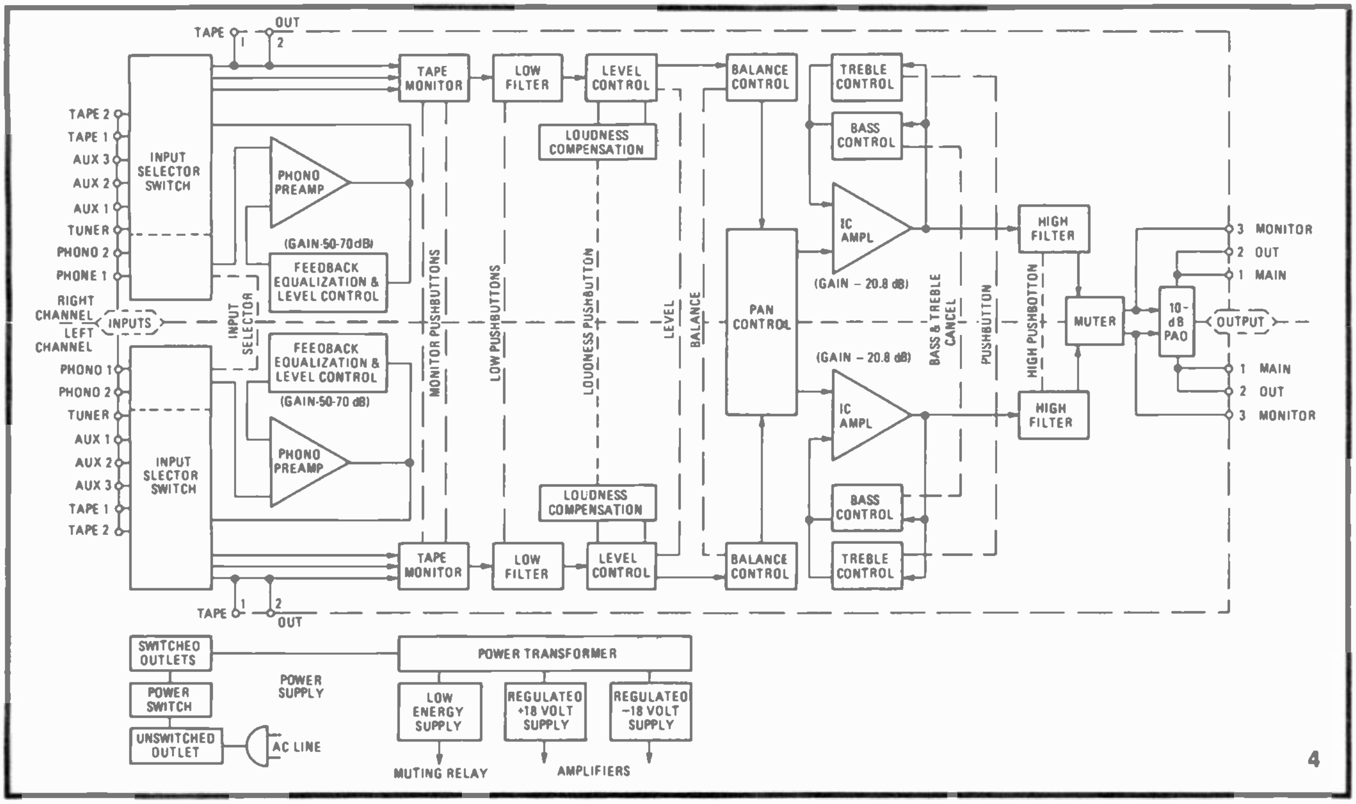
Frequency Response: High Level: ±0.6 dB from 3 Hz to 100 kHz; Phono (RIAA): ±0.5 dB. **Phase Response:** High Level: +1° to −12°, 20 Hz to 20 kHz; Phono: ±5°, 20 Hz to 20 kHz. **Hum and Noise:** Phono: 85-dB below 10 mV input; High Level: 95-dB below rated output. **THD:** Less than 0.0005% at rated output with 1-kHz input; 0.05% from 20 Hz to 20 kHz. **IM Distortion:** Less than 0.002%. **Input Gain:** Phono: adjustable from 30 to 50 dB; High Level: 20.8 dB ±0.2 dB. **Phono Overload:** 33 to 330 mV, depending upon gain setting of input. **Output Level:** 12-volts maximum before overload; 2.5 volts, rated. **Tone Control Range:** ±15 dB at 30 Hz (bass) and 15 kHz (treble). **Filters:** Rumble: −3 dB @ 24 Hz, 6 dB/octave; Scratch: −3 dB @ 5 kHz, 12 dB/octave. **Power Requirements:** 2 watts @ 120V or 240V, 50-400 Hz. **Dimensions:** 19-inches standard rack mount; 17 × 5¼ × 8⅛-inches behind panel. **Weight:** 10 lbs (20 lbs in optional walnut-finish cabinet).



maximum deviation occurring at the extreme low end of the audio spectrum. Our phono hum measurement of 72 dB is referred to an input sensitivity of 2.5 mV. Translated to a 10 mV input (as specified by Crown), the number becomes 84 dB, or within a hair's breath of the 85 dB claimed. Both Crown's claim and our measurements were made without any weighting network applied. Frequency response for the high-level inputs was within 1-dB from 4 Hz to 37 kHz, and hum-and-noise for these inputs was exactly 95-dB below rated output as claimed.

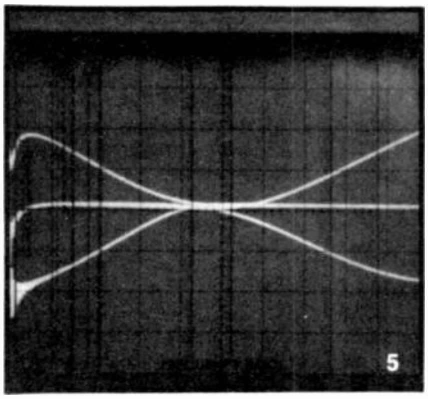
As stated earlier, all of our phono performance measurements were made with respect to a 2.5-mV input for an output of 2.5-volts (a total system gain of 60 dB), but we did check the range of the gain adjustments for phono and determined that overall gain could be varied from 70 dB to 50 dB so that the phono input-signals ranging from 0.79 mV to 8.0 mV could be adjusted to produce the rated output.

The range of the BASS and TREBLE controls are shown in the composite scope photo of Fig. 5, with a flat-response trace superim-



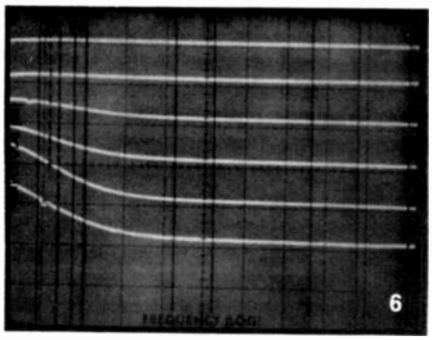
mid-frequencies, the maximum output obtained before overload exactly equalled the 12.0-volts claimed. The harmonic distortion observed for rated output (2.5 volts) is undoubtedly produced by our signal source, which is known to contain around 0.002% THD. Thus, we cannot substantiate Crown's claim of 0.0005% for this specification. Obviously, at these distortion levels, the readings become a bit academic anyway since no one is likely to hear this level of distortion under actual listening conditions. Note, however, that there is a tendency for THD to increase, however slightly, at the high-frequency end of the spectrum where we did measure 0.047% for rated output.

The phono equalization was accurate to within 0.4 dB of the RIAA curve, with



posed for reference. High and low filter response corresponds exactly to manufacturer's claims, with the rumble filter exhibiting a 6 dB-per-octave slope and the high-cut filter attenuating frequencies above about 5 kHz at a rate of 12 dB-per-octave.

Figure 6 serves to illustrate two important features of the IC-150A. First, of course, we see the loudness control compensation at 10 dB intervals. This loudness compensation differs somewhat from the so-called Fletcher-Munson curves that have been traditionally used as a basis for loudness compensation at low listening-levels. These new curves are based upon more recent work by Robinson and Dadson (1956) which has been adopted by the International Standards Organization. Note, in particular, that no high-frequency emphasis is introduced at low levels, since very little of such emphasis was found to be needed for most listeners in the more recent investigations. In order to use this loudness control most effectively, it is necessary to calibrate your master VOLUME control on the IC-150A so that its maximum clockwise position corresponds to a listening level of around 100 dB SPL. Allowing for the many variables such as power amplifier gain, speaker efficiency and room size, this requires that all input program source levels be normalized in level to deliver that final sound pressure level. This is easily done with respect to phono program sources (thanks to the gain controls included for this circuit), but unless the amplifier used with the IC-150A has input level controls as well and unless your tuner and tape decks are equipped with output level controls, all the effort and precision built into this loudness compensation control may be for naught.



The second purpose served by the scope photo of Fig. 6 is to illustrate the precise calibration of the VOLUME control of the IC-150A. We did not reduce this control by observing successive 10-dB reductions in output, but simply by reading the numbers on the front panel that surround the knob: 0 dB, −10 dB, −20 dB, −30 dB, −40 dB and −50 dB. Since each vertical division on our spectrum analyzer corresponds to an amplitude difference of exactly 10 dB, you can see how extremely precise that master VOLUME control really is.

Using the IC-150A

Our overall comments concerning the performance of Crown's IC-150A will be found along with an overall product analysis in Table II. Control action is smooth and positive, though we did run into a bit of trouble with the tone defeat switch on our sample, which seemed to exhibit an intermittency during its first few pushes. This problem cleared up by itself and may have been caused by a bit of dirt or dust that had gotten into the contacts during shipment and/or packing. While the front panel (and our description of it) seems devoid of any indicator lights, there is, in fact, a camouflaged red spot of light that seems to shine right through the lower section of the panel when power is applied. In general, the IC-150A gives one a feeling of a total control over one's music without imposing redundancy of controls, switches, and what have you. Such front panel simplicity and flexibility denotes a good sense of human engineering on the part of the designers of the IC-150A who are to be commended for improving upon their own earlier IC-150 which was a very fine preamplifier-control unit to begin with. **R-E**

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Crown International** Model: **IC-150A**

PREAMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
OUTPUT VOLTAGE MEASUREMENTS		
Rated output (volts) (per mfr.)	2.5	
Maximum output before overload (V)	12.0	Excellent
DISTORTION MEASUREMENTS		
Harmonic distortion, rated output, 1 kHz (%)	0.0025	Superb
Harmonic distortion, rated output, 20 Hz (%)	0.0035	Superb
Harmonic distortion, rated output 20 kHz (%)	0.047	Excellent
IM distortion, rated output (%)	0.0025	Superb
IM distortion, 10-volt output (%)	0.001	Superb
Harmonic distortion, 10-volt output (1 kHz)	0.0017	Superb
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± ___ dB)	0.4	Good
Maximum input before overload (mV)	150	Very good
Hum/noise referred to full output (dB) (at rated input sensitivity)	72	Excellent
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± ___ dB)	4-37, 1.0	Excellent
Hum/noise referred to full output (dB)	95	Excellent
Residual hum/noise (minimum volume) (dB)	95	Very good
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 6	Good
Action of low frequency filter(s)	See Fig. 7	Very Good
Action of high frequency filter(s)	See Fig. 7	Very good
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.5 / 2.5	See Text (Variable)
Input sensitivity, auxiliary input(s) (mV)	230	
Input sensitivity, tape input(s) (mV)	230	
Output level, tape output(s) (mV)	230	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		Very good
Adequacy of input facilities		Excellent
Arrangement of controls (panel layout)		Very good
Action of controls and switches		Good
Design and construction		Excellent
Ease of servicing		Good
OVERALL PREAMPLIFIER PERFORMANCE RATING		Excellent

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Crown International** Model: **IC-150A**

OVERALL PRODUCT ANALYSIS

Retail price	**$399.00**
Price category	**Medium**
Price/performance ratio	**Very Good**
Styling and appearance	**Good**
Sound quality	**Superb**
Mechanical performance	**Very good**

Comments: In our opinion, this excellent preamplifier-control unit from Crown should probably have been assigned a completely new model number, instead of the "A" which has been added on to the old IC-150 that has been around for several years. The IC-150A is completely redesigned and, in many ways, runs rings around the older unit, which is no small accomplishment since the original IC-150 was a very fine preamp for its time. Hum-and-noise of the IC-150A is a good 5-dB lower than on the earlier unit, and distortion has been reduced by another order of magnitude, so that even our latest lab test equipment limits factual readings. We particularly liked the new step-calibrated master volume control with its 2-dB steps all the way down to −58 dB. The new loudness compensation circuitry is also an improvement, though we would have liked to see a few input level controls on the back panel so that it could be used more effectively. Welcome, too, are the high-current convenience outlets. Many preamps supply enough outlets for other equipment, but they usually cannot handle the power requirements of a basic amplifier that is likely to be used with a preamplifier of this high quality

While it is difficult to discuss the "sound" of a preamplifier when it is being used with a basic power-amplifier (Who is to determine which of these components is ultimately responsible for what we end up hearing?), in our tests, using a Lux M-4000 to power a pair of Dahlquist DQ-10 speakers, sound was exceptionally transparent, devoid of coloration and totally free of audible hum-and-noise. We are familiar with Crown's excellent amplifier, model DC-300A that is similar to their earlier DC-300 but with minor modifications incorporated to increase stability under unusual load conditions. The IC-150A, while representing a more major redesign effort, should make a perfect companion to that amplifier or to any other high-quality top-grade basic amplifier.

AKG Model P8E Cartridge

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

AKG, BASED IN VIENNA, IS PERHAPS BEST KNOWN for its expertise in microphone technology. Its products are distributed in this country through North American Philips Corporation. Recently, the company announced availability of a new line of phonograph cartridges, five in all, ranging in price from around $40 to $135. We tested the next-to-the-top *model P8E*, packaged as shown in Fig. 1 and carrying a suggested list price of $100.

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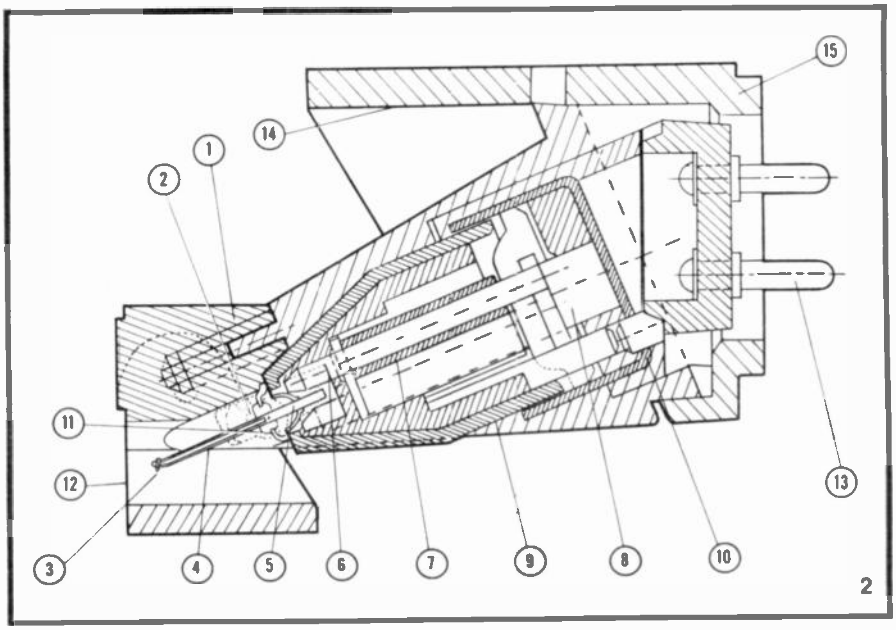
The new line features what AKG calls a Transversal Suspension System in which a single "knife-edge" suspension element in the form of a rubber diaphragm provides both the spring (suspension and restoring force) and frictional (damping) functions. Tracking force of the cartridge is transferred to the stylus tip through torque forces created at the suspension element. The design of the pivot point concentrates all forces at essentially one point so that no restrictive tie or support wires are required.

A cross-sectional view of the cartridge construction (basic configuration of all models is essentially the same, with primary differences arising from the differences in stylus assemblies) is shown in Fig. 2. Numbered items are identified as follows: (1) stylus assembly that is user replaceable, (2) tranverse suspension system, (3) "nude" diamond tip, (4) aluminum stylus cantilever, (5) thin-wall tubular moving iron, (6) four-pole-pieces, (7) four pickup-coils, (8) crystal oriented permanent magnet, (9) soft-iron housing, (10) soft-iron back plate, (11) suspension plate, (12) hinged stylus-guard, (13) connecting terminals, (14) mounting bracket, (15) cartridge body.

The replaceable stylus assembly, identified by the model number *X8E* when purchased separately at a suggested price of $55.00, has two tiny protrusions in its housing that insure accurate mating with the cartridge body. Basically, the cartridge principle is the "induced magnet" type in which the permanent magnet is not part of the moving stylus assembly and therefore does not contribute to the effective mass of the stylus. Connection terminals are color coded and lettered for



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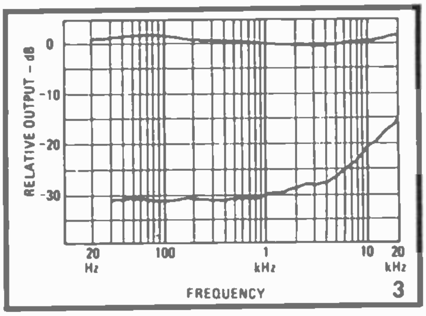
channel and phase identification in accordance with internationally adopted standards. Standard ½-inch mounting centers and a variety of mounting screws are provided, together with a spacing wedge that may be required for mounting the cartridge in some pickup-arm shells. Open, semi-circular shapes in the body of the cartridge make installation extremely simple, since mounting screws can be turned part-ways into the shell before the cartridge is tucked under them and tightened in place after final correct orientation and positioning of the entire cartridge body. Installation of the cartridge should be done with the stylus assembly dismounted to prevent accidental damage to the stylus itself. Care should be exercised when mounting the stylus.

Laboratory measurements

We tested the AKG *P8E* cartridge by mounting it in the pickup arm of a new Empire *model 698* turntable. We were able to align the stylus tip for proper overhang with no difficulty or dimensional interference. Downward tracking force and anti-skating were adjusted for a 1 gram setting—the optimum force recommended by AKG for this particular model. A frequency response check was made for both channels which turned out to be identical within 0.5 dB over the frequency range from 20 Hz to 20 kHz (the limits of our CBS test record, Series



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STR-130). Nominal output measured at 1 kHz was 3.0 millivolts for a stylus velocity of 3.54 cm-per-second. This corresponds quite closely to the 4.0 mV claimed by AKG for a velocity of 5.0 cm-per-second.

We measured trackability using a Shure TTR-103 test record after first increasing downward tracking force to the maximum recommended 1.25 grams. For mid frequencies, the stylus was able to track velocities of 31.5 cm-per-second before audible breakup was perceived. At high frequencies, a velocity of 30 cm-per-second was successfully tracked. These figures are quite good compared with those obtained with other competitively

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Frequency Response: 10 Hz to 23,000 Hz. **Output Voltage:** 4.0 mV at 5 cm-per-s. **Effective Stylus Mass:** 0.45 milligrams. **Tracking Force Range:** 0.75 to 1.25 grams. **Stylus Tip Radius:** 0.0002 × 0.0007-inch elliptical. **Compliance:** 35 × 10^{-6} cm-per-dyne. **Channel Separation:** 30 dB at 1 kHz; 20 dB at 10 kHz. **Channel Balance:** within 2 dB. **DC Resistance:** 860 ohms. **Inductance:** 280 mH. **Optimum Load Resistance:** 47,000 ohms. **Optimum Load Capacitance:** 470 pF. **Weight:** 5.86 grams.

priced cartridges we have checked. Table I lists our measurement results.

Frequency response obtained with the 1-gram tracking force setting, as well as channel separation, are shown in Fig. 3. Channel separation at 1 kHz was an impressive 30 dB, exactly as claimed. At 10 kHz, separation decreased to 22 dB, somewhat better than claimed. Results were virtually identical for both channels so only the right channel is shown for frequency response and the left channel was measured for separation. It should be noted that to obtain this extremely smooth response it was necessary to add capacitance to the cartridge loading circuitry so that the total (including internal pick-up wires) added up to the recommended 470 pF. During an earlier trial test, we noted a rising characteristic at the high-frequency end of the spectrum, amounting to around +3 dB. Since this did not correspond with the manufacturer's stated results (an individual response curve and separation curve is supplied with each model of the *P8E* cartridge), we checked the cables we had been using only to discover that our previous testing with this turntable had involved a discrete 4-channel pickup that required a very low (100 pF) capacitance cable. Our Empire turntable had been fitted with low capacitance cable for the purpose of those earlier tests and once we reconnected the standard cable (that measured 350 pF for its 4-foot length) we were able to obtain the curves shown, which corresponded almost precisely with the manufacturer's included graphs.

Use and listening tests

As with all transducers (speakers, headphones and phono pickups), measurements alone do not tell a complete story. We used the AKG *P8E* cartridge for several days for both casual and serious musical listening and came to appreciate its accurate tracking capability as well as its ability to pick up and reproduce difficult transients contained in some especially demanding musical test records. Our summary comments will be found together with our overall product analysis in Table II. From tests of this relatively high priced cartridge, we can only conclude that AKG has managed to impart the same high level of technological achievement in the *P8E* (we cannot, of course, speak for lower priced models in the new line) as they have done in their highly regarded line of professional microphones—and that level is considerable. **R-E**

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **AKG (Philips)** — Model: **P8E**

PHONOGRAPH CARTRIDGE MEASUREMENTS

	R-E Measurements	R-E Evaluation
FREQUENCY RESPONSE (Hz-kHz, ±__dB)	20-20, 2 See Fig. 3	Excellent
STEREO SEPARATION		
Separation, 1 kHz (dB)	28	Very good
Separation, 10 kHz (dB)	22	Excellent
Separation, 30 kHz (dB)	N/A	
CHANNEL BALANCE, 1 kHz (dB)	0.5	Excellent
TRACKABILITY MEASUREMENTS		
Stylus velocity at 1 kHz (cm/s)	31.5	Very good
Stylus velocity at 10 kHz (cm/s)	30.0	Very good
COMPONENT MATCHING CHARACTERISTICS		
Output level, 1 kHz, 3.54 cm/s (mV)	3.0	
Optimum load impedance (ohms)	47,000	
Tracking force range (__ to __ grams)	0.75 to 1.25	
Cartridge weight (grams)	5.86 grams	
OVERALL PHONO CARTRIDGE RATING		Excellent

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **AKG (Philips)** — Model: **P8E**

OVERALL PRODUCT ANALYSIS

Retail price	**$100.00**
Price category	**High**
Price/performance ratio	**Very good**
Styling and appearance	**Excellent**
Sound quality	**Excellent**
Mechanical performance	**Very good**

Comments: Aside from the measurement of frequency response, trackability and required tracking force for best tracking results, the evaluation of any phono cartridge becomes a highly subjective matter. Most of the cartridges of the pre-quadriphonic era exhibited a high-end resonance that gave them a characteristic "brightness" that many listeners came to regard as "natural" and desirable. It was only when the demands of the CD-4 disc forced manufacturers to "push" pickup resonance to beyond audibility that listeners began to realize that they had been listening to high-frequency response that was anything but "flat". Properly loaded, the AKG *model P8E* cartridge has no peak in response to beyond 20 kHz and this gives it a smooth, natural sounding quality that may take some getting used to. In our opinion, it is a highly desireable trait and one which will come to be appreciated the more one listens to this excellent pickup. Orientation of the cartridge seemed to be less critical than with most, and stereo imaging and positioning of instruments is extremely stable and well defined. With tracking forces of only 1 gram, the cartridge was able to reproduce music from our most demanding test discs with no evidence of mis-tracking and very good transient reproduction. The use of this model should be limited to installation in pickup arms that have extremely low pivotal friction such as those found in better single-play manual or semi-automatic turntable systems and a very few multiple-play high quality systems.

New Sony anti-dubbing device to foil video tape pirates

The Sony Corp. is now marketing in Japan a dub-proof tape recording system, CSX-100, designed for the Betamax cassette video-tape recording system.

The new system is used at copy-producing centers that mass-produce Betamax video-tape cassettes. It produces special electrical signals to make the tape uncopiable by any other Betamax VTR. When an illegal operator tries to reproduce a tape the result is a tape with images so scrambled as to be unsuitable for commercial sale.

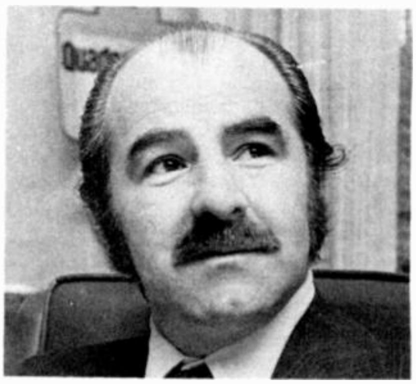
Sony spokesmen stated that the new device might solve the pirating problem for computer software producers as well as for the entertainment tape producer.

The system was being marketed in Japan early last summer for about $3,300.

Bernie Mitchell now president of Institute of High Fidelity

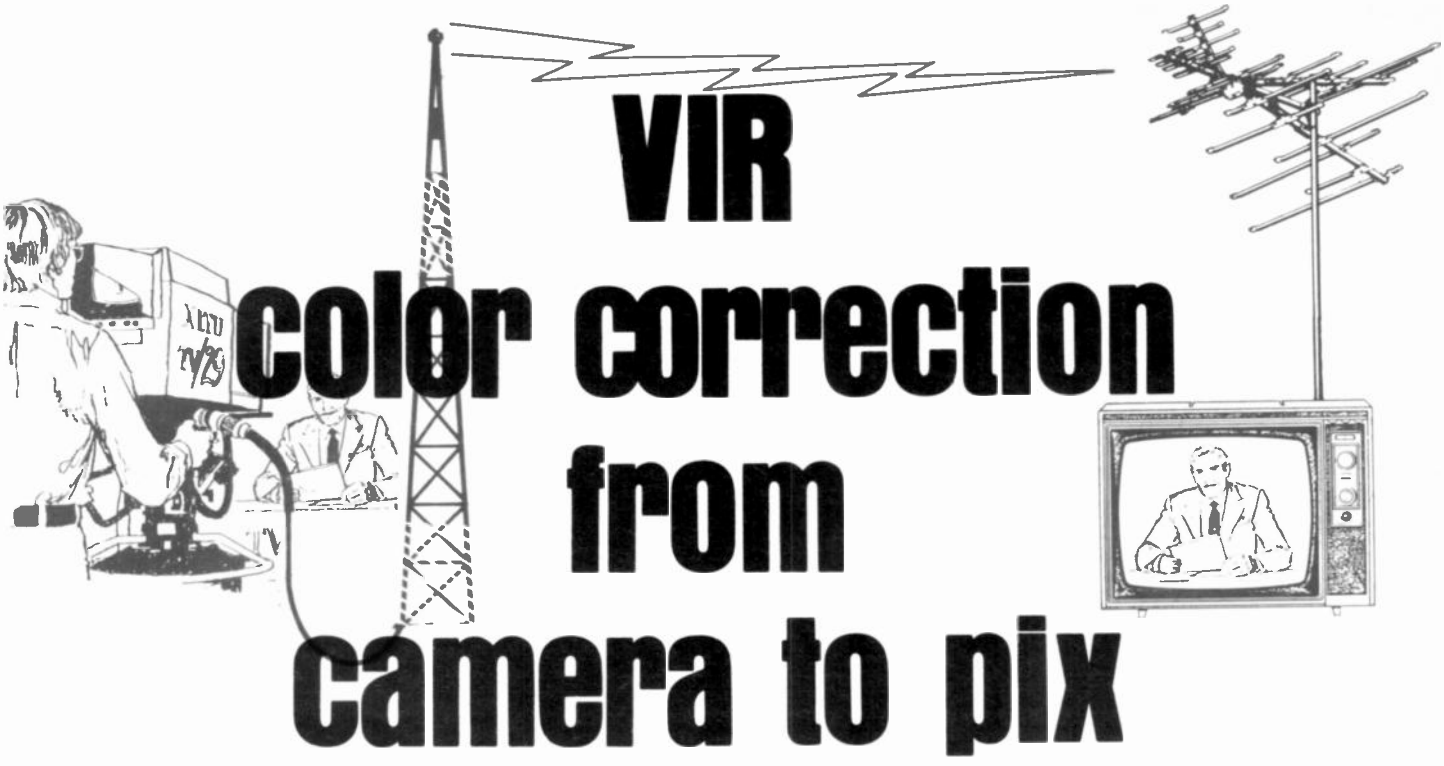
The Institute of High Fidelity elected Bernie Mitchell, head of U.S. Pioneer Electronics Corp., president of the Institute at its 1976 general meeting in New York. He succeeds George De Rado, president of TEAC Corp. of America, who was elected vice president at the same meeting. Richard Ekstract, of *Audio Times*, was elected secretary and Walter Stanton, of Stanton Magnetics, treasurer.

The Board of Directors includes Victor Amador of Audio Dynamics; Arthur Gasman, British Industries; Ed Hopper, Ziff-Davis; Jerry Kalov, Jensen Sound Labs, and Jay Schaub, United Audio, together with the four officers.



BERNIE MITCHELL

Mrs. Gertrude Nelson Murphy continues as Executive Director. **R-E**



VIR color correction from camera to pix

A new system that automatically adjusts the color from the camera all the way to the picture on the TV screen in your home

ROGER KENFIELD

TURNING ON YOUR FIRST COLOR SET brought the exhilaration of a jump in TV viewing enjoyment. Unfortunately, after the initial novelty wore off, the system faults rose to the surface somewhat diluting your enthusiasm. High on the list of complaints were the annoying inconsistencies in tint and color level.

Changes in hue, color saturation and brightness levels were not only noticeable from channel to channel but from one program to the next, and especially between entertainment and commercial segments. Hue and saturation levels simply did not stay within reasonable limits. Constant adjustment was necessary, or the viewer gave up and watched a generally poor facsimile of the original studio image.

Much has been done to vastly improve the consistency of color television pictures. The VIR (*V*ertical *I*nterval *R*eference) concept is capable of helping to produce pictures of excellent consistency *by tying together the total state-of-the-art transmission technology.* It is responsible for most of the improvements you have noticed over the last year or two.

There are many points between the studio where the program originates and your home receiver where color problems crop up. The underlying problem is the place where the color reference burst is inserted. The back porch of the horizontal sync pulse is a very vulnerable position where small amounts of video signal compression affects the burst amplitude and phase. Deviations from the original burst characteristics cause corresponding errors in the reproduced picture since the burst ultimately is used by the receiver demodulators to reproduce the picture color information. These signal imperfections show up at virtually any point in the signal processing chain. Video tape recorders, stabilizing amplifiers and the transmitter itself are typical trouble spots.

VIT signal

In response to these problems, the Broadcast Television System Committee of the Electronic Industries Association did something about the sad situation in 1969. There already existed the VIT (*V*ertical *I*nterval *T*est) signals that included such things as sine-squared pulses and multiburst signals. These were designed to give diagnostic information of the equipment in the broadcast link. VIT signals may be inserted and measured at any point in the transmit signal chain and in general, do not follow the signal from studio to transmitter. Finding and improving individual equipment characteristics may help, but does not lead to an electrically transparent transmission path. (A transmission system that does not alter the original information.)

VIR signal

It became apparent that a new type of signal was needed and it was decided to experiment with VIR (*V*ertical *I*nterval *R*eference). The vertical blanking interval is a nice place to put new signals since this is a relatively long period of 21 horizontal lines that is blanked from the viewer's eye. It is the popular place where most facsimile schemes have been known to hide their signals.

As a reference signal, VIR is created and "certified" as close to the camera as possible. Once the technician adjusting the equipment decides that the picture on his monitor is correct, the reference is encoded in such a way that allows readjustment to the video signal further down the line without artistic judgements. The logical point for this readjustment is at the furthest point just before electromagnetic radiation, namely at the transmitter.

In contrast to VIT, VIR is not meant to be a measure of system performance; it is designed so that deviations in signals can be easily corrected for.

The VIR system has been extensively field tested by the television networks and manufacturers to detect any problems unforeseen at its conception. Originally on line 20, the signal has now been assigned exclusive rights to line 19 on both fields of the interlaced picture by the FCC. The relative positions of the VIT and VIR signals in the vertical blanking-interval are shown in Fig. 1.

While line 19 has been reserved for this purpose, the transmission of VIR *is not mandatory*! So VIR is really still experimental and its full benefits are yet to be realized.

Figure 2 shows the relative amplitudes of the VIR signal segments. The waveform is shown as it appears on a the bottom swing of the subcarrier reference. An uncalibrated waveform check will quickly show a signal disparity. The 7.5 IRE luminance reference has been chosen above the blanking level so that clipping at the blanking level will not affect the reference EIA's *Television System Bulletin No. 1* gives suggestions

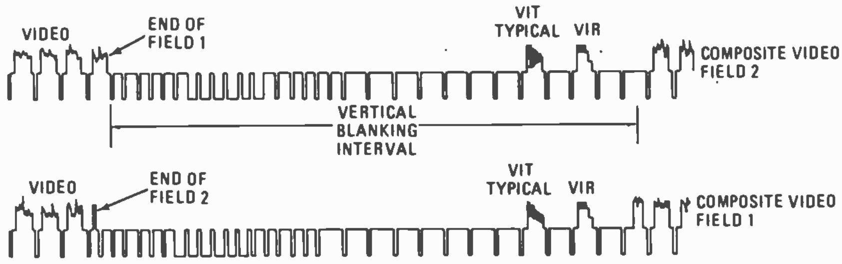


FIG. 1—RELATIVE POSITION OF VIR SIGNAL in the composite video signal.

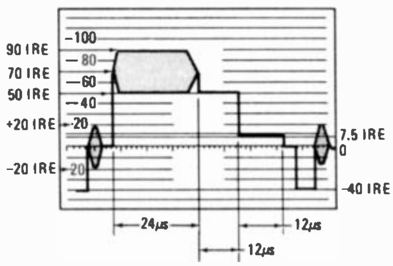


FIG. 2—VIR signal shown between two horizontal sync pulses.

waveform monitor calibrated in IRE units (140 IRE units equals 1 volt peak-to-peak). Zero is the blanking level. The signal starts out with 24 microseconds of color subcarrier reference. Similar to the subcarrier burst on the rear porch of the video sync, the subcarrier VIR reference contains both the phase and amplitude information. The phase of the signal is exactly the same as the burst. The important difference lies in its amplitude and average level. Sitting on a pedestal of 70 IRE units, the signal swings with a peak-to-peak amplitude of 40 IRE units. Sometimes you will see 286 millivolts associated with the 3.58 MHz reference. When the 140-IRE unit video signal is adjusted for its standard 1 volt P-P level, 40 IRE units corresponds to 0.2857 volt. The chroma reference extends to neither the white or black signal extremes. Signal compression common to the sync pulses will not affect this reference. The 70 IRE unit pedestal and the 40 IRE unit amplitude is about the level of flesh tones, so if the chroma reference frequency is shifted in phase differently from the other video frequencies, at least the flesh tones can be corrected close to their right values.

The first of two luminance reference levels follows directly after the subcarrier reference—12 microseconds of a constant 50 IRE unit level. Next is the second luminance reference that is also 12 µs in duration but at 7.5 IRE units.

The first 50 IRE unit luminance reference has been selected to line up with

for monitoring the VIR signal with a waveform monitor and vectorscope.

Using VIR

The most obvious way of using the VIR signal is an open-loop method in which an operator sits in front of a waveform monitor and vectorscope, observes discrepancies in the waveform and readjusts the signal to correct the VIR. Tektronix has a number of instruments that are ideal for this purpose. One type of waveform monitor can be adjusted to give a two-field display and the sweep magnifier used to examine the VIR waveform in detail. Some other models such as the *model 529* Waveform Monitor include selectors that pick out the individual lines of a TV picture.

Manual adjustment of the video signal at the TV studio proceeds by first setting the luminance gain so that the 50 and 7.5 IRE unit reference levels are correct. Then the blanking level and sync amplitude are set. Chrominance gain is adjusted next so that the reference signal is 40 IRE units in amplitude. Finally the color burst is corrected so that its phase is the same as the VIR reference. Note that the first three adjustments are made on the total video signal using the VIR as the reference, and the fourth burst phase setup was made only on the color burst.

The Tektronix *model 1441* VIR Signal Deleter/Inserter will remove the signal appearing on the chosen vertical blanking interval line and replace it with an internally generated VIR signal. Another mode of operation inserts the VIR signal only if none is present on the input. Special effects such as fades require manual control. The original VIR may have to be removed during the effect.

All this leads up to the Tektronix *model 1440* Automatic Video Corrector that makes all the necessary video corrections based on the VIR signal. Six parameters are automatically corrected: master gain, setup, chroma gain, burst phase, burst gain, and sync gain.

Master gain, or video amplification, is corrected so that the 50 IRE unit luminance reference is in the right signal proportion. Setup sets the black level using the 7.5 IRE reference. The 40 IRE unit chrominance signal is used by the *model 1440* to adjust chrominance amplitude. Burst gain is set on the basis of the VIR chrominance amplitude. This adjustment is important for those receivers that have color saturation levels proportional to the burst level. Burst phase is aligned with the VIR chrominance phase. The sync gain corrections are important for the sync tip clamping used throughout the transmission link as well as the TV sets that clamp on sync tips.

An additional feature of the *model 1440* is an output voltage that drives a monitoring device such as a strip recorder to give a record of the variations in the incoming signal. The instrument does other useful functions such as clamping to remove 60-Hz hum and field-time tilt on the video. Signal bounce common to microwave links is removed.

Distortion in the transmitter is a source of color problems that cannot be open-loop corrected at any point up to

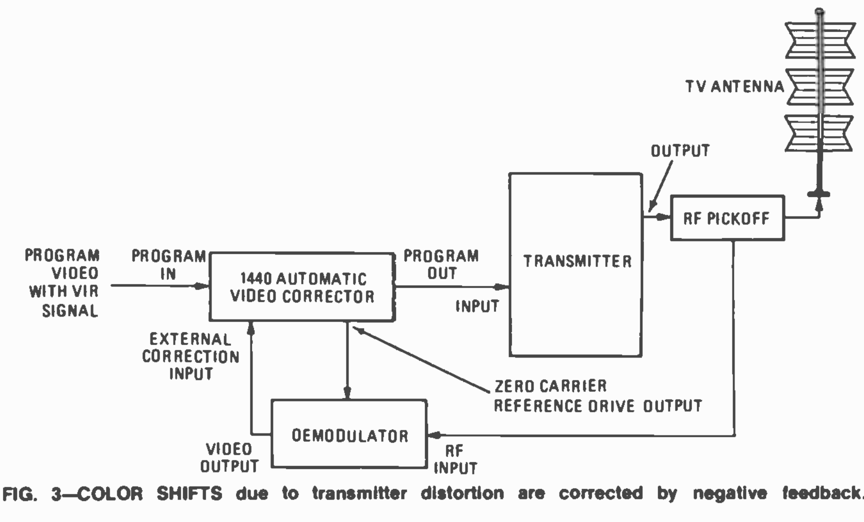


FIG. 3—COLOR SHIFTS due to transmitter distortion are corrected by negative feedback.

the video input to the modulator. Figure 3 shows an innovative solution to this dilemma. A closed loop is formed around the transmitter by detecting the RF output after modulation! Here the *model 1440* is used as a precorrector. The signal at the input to the transmitter is predistorted so that the RF output is distortion-free. The effect is analagous to a feedback amplifier. The sum of the input and feedback signals in the input amplifier stage produces error signal. The negative feedback signal distorts the input in such a way that the output distortion is reduced. Vestigial sideband demodulation must be done with something other than an inaccurate diode detector. The demodulator must be a precision device since its faithful detection is vital to producing the corrected output.

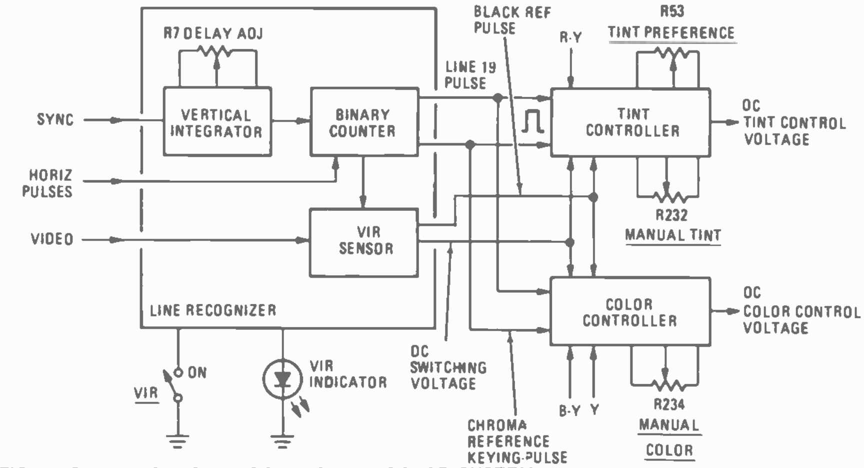


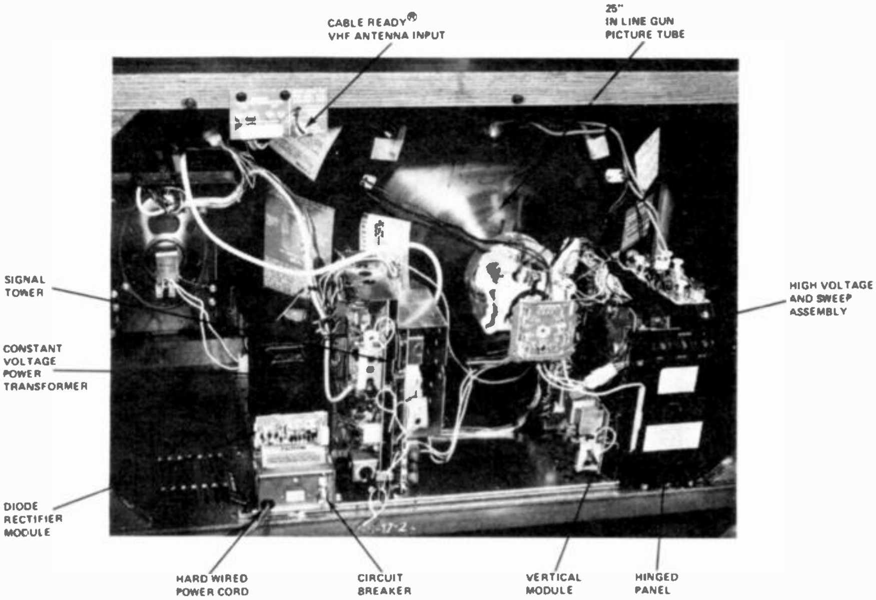
FIG. 4—G-E's BROADCAST CONTROLLED COLOR SYSTEM.

VIR and the consumer

Although the VIR system was originally envisioned to be used by the broadcasters, G-E has gone a step further and actually built a VIR recognition system right into their 1977 TV receiver line. The G-E VIR Broadcast Controlled Color System used in their YM 25-inch and some of their YC-2 19-inch models make the final corrections right in your home. Any problems such as differential phase caused by a non-ideal antenna system are corrected for with this system.

The viewer knows this set is different than the others because of the presence of a VIR switch and an LED indicator. When the switch is flipped to the ON position and a VIR signal is being received, the indicator lights. The automatic circuitry takes over the color functions and the COLOR and TINT controls on the front-panel of the television receiver become inoperative.

A separate VIR module performs the functions of the block diagram in Fig. 4. The module has 5 IC's and 30 transistors and can be completely removed for servicing. First the module detects the 19th horizontal-line of each video field and determines whether a VIR signal is present. DC voltages are then developed for color amplitude and phase correction.



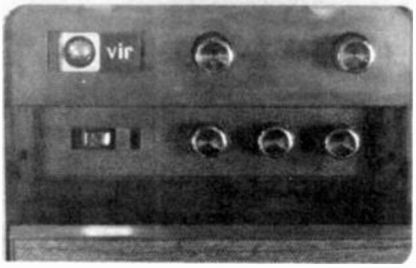
REAR VIEW of G-E's new television receiver containing the VIR module.

Because of the half-line variation in the phase of the two vertical fields, an intermediate point between the 4th and 5th line is located as a timing reference. The trigger point is sensed on an integrated vertical-sync waveform. Factory adjusted potentiometer R7 (DELAY ADJ) sets the exact instant of the timing pulse. Fifteen more horizontal pulses must be counted to get to line 19. A 7493 TTL 4-stage binary counter counts from 0000 to a full count of 1111 (15 counts) that is detected by a decoder.

The VIR sensor circuitry then examines line 19 to see if the signal is there. The *tint controller* and *color controller* circuits is enabled by the line recognizer circuit.

Some algebraic manipulation shows that when the chrominance reference level and black reference level have the same amplitude at the output of the R-Y detector, the chroma-burst phase is the same as the VIR reference.

Based on this principle, the *tint controller* circuit compares the chroma detector output and the black reference and generates a DC error voltage. As in any closed-loop control system, the voltage is fed back to control one of the signals being compared, in this case the chroma phase. Control R53 gives the set owner a small range of tint control that he can use for his own preference.



VIR INDICATOR on front-panel of G-E's new television receiver.

Operation of the *color controller* circuit is very similar. The theory says that when the chrominance reference level and black level reference are equal in amplitude to the blue drive, the chroma level is correct. So a similar closed loop is constructed using a comparator to feed the DC chroma gain control circuits. Blue drive is simulated from the B-Y demodulator output and a signal from the luminance, or Y, video amplifier.

Both the *color controller* and *tint controller* circuits are switched with diodes in response to the output of the VIR sensor. The DC control inputs to the chroma amplitude and tint circuits are switched between the tint control and tint controller, and the color control and color controller. **R-E**

R-E's Service Clinic

More bits and pieces

Series strung heaters

JACK DARR
SERVICE EDITOR

THE CLINIC COLUMN ABOUT "BITS AND pieces" (**Radio-Electronics**, Feb. 1976) proved to be quite popular. Some readers asked for more. So, have some more! Let's look at some peculiarities that you can run into in sets using series-heater circuits. There are quite a lot of these around, including a lot of the hybrid color TV's. If one tube goes dead, they all go out. Or, is this always true? Let's see.

For one, there's the set with several tubes in the string, say 8 or 9. Only 5 of these are dead, the remaining 4 are burning far too brightly. The basic series heater circuit uses tubes with a *total* heater voltage adding up to the applied line voltage. When a short to ground develops somewhere in the string, the full line voltage is applied across only a few tubes. The heaters of these tubes are running at a higher than normal temperature.

We turn the set off and start hunting for the short with an ohmmeter. We don't find one. Now what? A little reasoning will tell you what's going on. The heater string should go to common only at the "far end". How can it get to common in the middle? Through an element in each tube that *does* go to common—the cathode. One of the tubes on either side of the point where they stop lighting has a heater-to-cathode short. Now, which one? See Fig. 1.

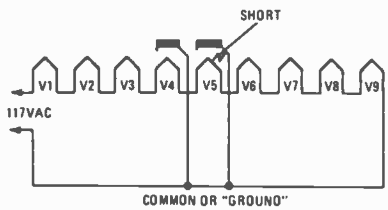


FIG. 1

Let's say that V1 through V4 are lit. We can pin this down to one of two tubes—V4 or V5. One of these has a *hot-short* between the heater and cathode. It doesn't show up until the heater gets warm and expands. The *location* of this short, on the heater, causes the different symptoms. If the output side of the heater is shorted, V4 would be the culprit. If the input side of V5's heater is the villain, that's it. Quick-check: Turn the set on and pull V5. If the others go out, this is the bad one. If they stay lit, then V4 is it. Naturally this kind of trouble can be intermittent to add to the joy of the occasion.

If this isn't really a dead short, heater-cathode *leakage* can cause some dandy problems, too. This shows up as bending, ripple or a hum-bar in the picture. When you see this, you usually check the filter capacitors. They cause most of this kind of trouble and should be checked first. Also, they're easy to check: just bridge a good one across each one. Alternate test, scope the DC power supply lines and look for excessive ripple or signals. You can also scope the signal path looking for the point where the ripple first shows up. If the signal is clean before this point, all tubes between here and the tuner can be eliminated.

The characteristics of the hum-bar can help in many cases. If the set has a full-wave DC power supply, the hum-bars will be 120 Hz (two bars visible at once.) Heater-cathode leakage produces only one hum-bar or a 60-Hz ripple. If the set has a half-wave rectifier, this will also produce only one hum-bar, of course.

There is one key point to remember. The stage you're looking for *must* have a *cathode resistor.* If the cathode goes directly to common, there will be no resistance for the leakage current to develop a hum-voltage across! Since the cathode circuit is a part of the *plate* circuit, any hum voltage appearing here will modulate the signal at the plate. You'll have hum in the signal from this point all the way to the picture tube. A scope check on the cathodes of all suspected tubes will catch it. On a properly bypassed cathode, there should be no signals of any kind, including hum.

The dropping rectifier.

The original series-heater circuit sometimes used a dropping resistor in series to take care of any excess voltage. Many of them still do. However, there is one peculiar thing that you'll run into now and then and this can cause some weird problems. This is the "dropping diode"—a diode in series with the heater string. This makes the heater current flow in only one direction (pulsating DC instead of a true AC.) This can give you some extremely odd voltage readings along the heater string! More on this in a moment. If this diode develops leakage, or shorts, the full AC line

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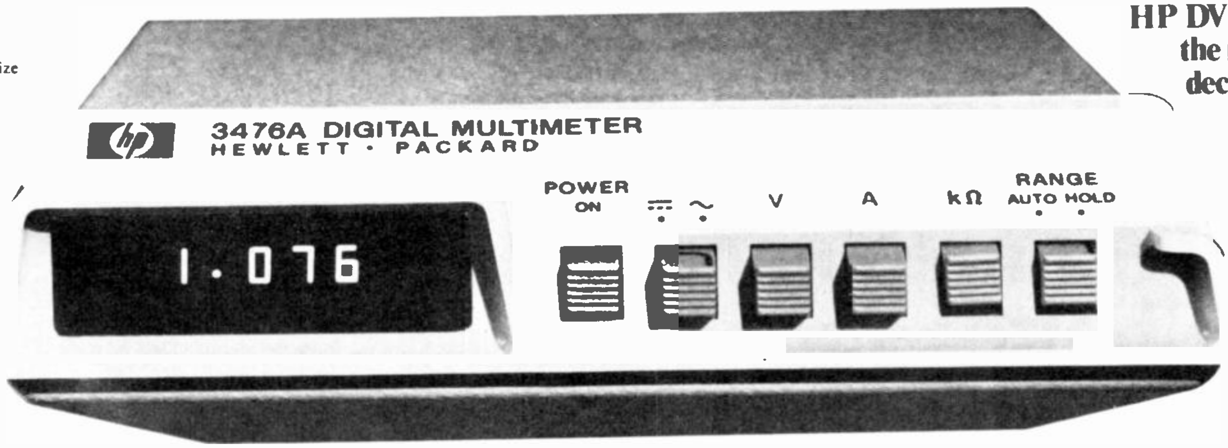

HP DVM's– the right decision

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SERVICE CLINIC

continued from page 86

voltage is applied to the heater string. This overloads the tubes and usually blows at least one. Several of the makers who used this circuit now recommend modifying it by using a dropping resistor in place of the diode. However, there are still a few floating around.

One example of a complex circuit like this is the Sears 564.41102100 chassis, Sams 1317-2, shown in Fig. 2. This is an

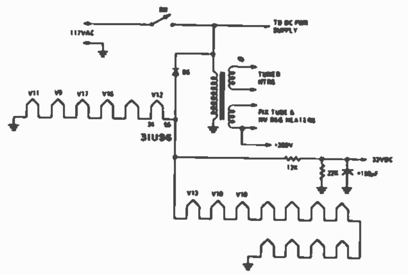


FIG. 2

all-tube set. Note the heater circuits. There are two of them in parallel, both of which are fed through diode D6. The heater voltage is given as –55 volts, so it is evidently read on a DC voltmeter! A standard AC voltmeter would probably give you a very weird reading since it's calibrated for sinewaves.

Now we come to the first curious thing. If you add up the heater voltages of the tubes in the upper string, (two 8's, a 6, a 21 and a 31) you get 74 volts! The voltage drop across V12 is shown as 55–34 volts or 21 volts. This tube is a *31*JS6. The two-winding transformer shown there feeds the tubes in the tuner from the top winding and the picture tube and the high-voltage regulator from the lower winding. The DC protective voltage is applied to this one from the +300 volt DC source. All of the other tubes are in the lower string with the same 55 volts shown across it.

A novel circuit is used here. Note that they have added a series resistor, shunt resistor and a filter capacitor to the 55 volt half-wave rectified DC output. This is used to develop a –33 volt DC source that is used in the AGC and AFT circuit and one other place I never did find.

One odd problem reported by Max Zimmerman of Fairborn, OH, in this chassis was that it had a habit of eating 12AZ7 tubes. This was V19, in the R-Y/B-Y amplifier stage. After much checking, he found that the diode X6 showed a normal scope pattern at first (half-wave humps) but that as it warmed up, it began to show a full sinewave output! Neither of us have any idea as to why V19 was the tube that blew, but it did. Replacing diode X6 cleared up the problem.

So, if you run into odd symptoms in series-heater-string sets, look for any or all of these troubles. Don't be fooled by the AC voltage readings you get on your voltmeter. It will *not* read this voltage correctly. I keep forgetting to check for this, but I suspect that a DC voltmeter won't read it correctly either! However, if the thing works, then the voltages must be nearly right no matter what the instruments say. This can really be confusing. I get a lot of mail about it. If you know it's there and what it does, it won't bother you! Good luck! **R-E**

reader questions

SUBSTITUTE FOR UNKNOWN TRANSISTOR

I need a replacement transistor for a transistor mike. Can't find any data on it, but the original has the numbers C828(S).—C.C., Centreville, VA.

In quite a few of the import transistors, the first two digits of a JEIA type number are left off. So, this could be a "2SC828(S)". RCA shows a 2SC828S as an SK-3122. This is an NPN audio-transistor in a TO-220 (flat-pack) case. If this should be too large, an SK-3122 is almost the same characteristics and is in a TO-92 case, much smaller.

CORRECTION

The inventor of the famous Darr Portable Full-Floating Decimal Point has struck again! In the June 1976 issue, page 64, the yoke-return capacitor in the Magnavox T979 chassis should have been a 1.0 μF., not a 0.1 μF. It should also be a special type, Magnavox Part No. 250653-2. This must be a special RF high-current carrying type, with polycarbonate dielectric.

Thanks to Gene McLin, Magnavox Service Training Manager, and George Crouch CET of Ace TV-Electronics, Concord, CA, for telling me about this. Gene also notes that if this capacitor fails, the horizontal-centering control and resistor R29 may also be damaged; check them. Both suggested replacing the *D* panel with Part No. 703505-11, which has the new rated parts in it.

NO RASTER

I have plenty of high-voltage and the picture tube bias voltages are OK, but I have no raster. This is a Zenith 20BC50. Resistor R166, 47K 3W, is burning up. I have changed tubes, etc., but no help. 6LB6 cathode current around 275-300 mA I'm missing something, but what?—B.T., Delta, IA.

I think that what you're missing is the *focus voltage*. Without focus voltage the raster will not come on. R166 is the one feeding the drive pulse to the focus rectifier. I would definitely suspect something in this area if it is getting hot. Most likely suspect would be a shorted focus rectifier.

HIGH-VOLTAGE PROBLEMS

I have too much cathode current on the 6KD6 in this Admiral 3K16. High voltage is quite low and the focus jumps in and out. When I turn the brightness up, the focus goes completely out and the high voltage drops to about 10 kV.—L.P., Oscola, IA.

From all of these symptoms, plus the reaction of the controls, I'd be inclined to suspect that the focus bleeder resistor is defective. Try this; disconnect the high-voltage lead to this bleeder and see if the high-voltage jumps back up and the current drops to normal. If so, try a new bleeder resistor. This one has probably broken down internally. (Remember that without any focus voltage, you will *not* see a raster! So, don't be alarmed at that.

VOLUME CONTROL PROBLEM

There is an odd problem in this Magnavox 1FM053 radio. I can't turn the volume down enough. In fact, it hardly works at all. I've replaced the control and it does the same thing.—V.S., Dalton, PA.

Simple; the bottom end of the volume control is not grounded. A control like this is just a variable signal-voltage divider. If the bottom (low end) is not grounded, the control will have no effect.

Incidentally, this does not have to be a DC ground. The bottom of the control may be open but grounded for audio signals through a capacitor. Trace the circuit.

(Feedback: Found it. Open electrolytic capacitor!)

WHY USE THE SCOPE?

In response to a question in the June, 1976 issue, you stressed the importance of using an oscilloscope. Can you tell me why?—V.F., Hickory, NC.

You use a scope in TV servicing because it is the ONLY instrument that will SHOW you the signal at a given point in a circuit. Other instruments will tell you only that there is a certain voltage (AC or DC) or resistance there. What you need to know is whether this point has a NORMAL waveform on it. This works both ways. In all DC power supply circuits, the normal "signal" is no signal at all, just a nice straight green line. Any kind of signal means trouble due to feedback.

GATE CONTROL SWITCH

Please recommend a replacement for a gate-turn-off switch used in the horizontal output stage of an Emerson 11P04. I found a couple listed but they were all small ones. This is in a TO-3 case.—E.M., Washington, DC.

I fell over this same thing quite a while back. Ordered one from the factory. They sent me a big TO-3, power transistor! I thought that a clerk had made a mistake, but then it dawned on me that a power transistor *was* a gate turn-off switch! Put it in and it worked beautifully.

Try SK-3115, HEP-740 or any transistor with similar characteristics.

SUBSTITUTE FOR 7687 TUBE

I need a couple of 7687 tubes for an old Sylvania stereo. I've checked with the maker and these tubes are no longer available. I can't find anything on the characteristics either. Can you give me a practical substitute? Need help.—R.W., Schenectady, NY.

I thought at first this was going to be one of those screw-ball-base types, but it isn't.

7687 is a triode-pentode with a 6.3-volt 0.5-amp heater and transconductances of 2500/6800 on a 9AE base. Similar tubes with this base would be 6CG8, 6LX8, 6FG7, 6EA8 or 6GH8. All of these are in the ballpark as far as the transconductance is concerned. Plug-in replacements.

HOT ELECTROLYTIC CAPACITORS

There are four big can-type electrolytic capacitors in this Philco TV. I happened

to discover that three of them are running very warm, almost hot. The other is cold. Could this have anything to do with some of the symptoms I have? That is, bad sync and a wide floating bar up and down the picture. Found a couple of resistors that were running very warm and discolored.—F.K., Chicago, IL.

I'd say so, yes! Any electrolytic capacitor that runs definitely warm or hot to the touch is pretty sure to have excessive leakage. However, make *sure* that this is definitely due to internally generated heat and not heat radiated from a very hot tube close to the capacitor. (Test by putting a piece of aluminum foil between the tube and the capacitor for a heat shield and running the set for about 20-30 minutes.)

HORIZONTAL LINE WITH WIGGLES?

I replaced a blown fuse on this Magnavox T941 portable. Turned it on and got sound, high voltage, etc. Looked at the screen and all I had was a horizontal line with little pulses on it! Something like a video signal on a scope. Everything in the vertical output section seems to be OK. What the heck?—J.A., Pensacola, FL.

Check the schematic of the vertical output circuit. You'll find a component that looks like a vertical output transformer. It isn't; it's a vertical output coil or choke. The vertical winding of the deflection yoke is also connected to the collector of the output transistor. The *return* of this winding is back to the +12-volt source *through* a 500 μF electrolytic capacitor. I believe you'll find this capacitor is open. This would leave you with a sawtooth signal on the collector but no vertical deflection. Check the yoke plug and socket too, just for luck!

ONE MORE MARKER

I'd like to have a 44.0-MHz marker on my Heath IG-57A sweep generator for the center of the IF passband. Can you tell me how to get it?—H.M., Bristol, TN.

If you insist! You can take one of the markers you aren't using, for example the 39.75-MHz crystal, out and install a 44.0-MHz crystal in place of it. The tuning coils used for all of the IF marker oscillators are the same, so this one should tune up to 44.0 MHz. Follow the directions in the manual for setting the amplitude of this marker.

WHY THE NARROW EYE?

I've been checking some capacitors scrounged from junk TV's with a Heath IT-28 capacitor checker. I note that on some, the eye-tube won't open all the way. On others, it hardly opens at all. Capacitance always checks close to the rated value. I checked some capacitors

from stock which had been around for some years. Same kind of thing. Can you explain this?—A.G., Hyattsville, MD.

From my experience with bridge capacitor testers, a "squint" of the eye-tube usually means that this capacitor has some insulation resistance leakage. The wider the eye opening, the better the insulation resistance. This may be several megohms, or even tens of megohms.

In some uses, such as bypassing, this may not hurt. I wouldn't use a capacitor with a narrow eye for a coupling capacitor in audio stages, though. Possible that just enough DC voltage could leak through to upset the grid bias on the next stage.

ALL DC VOLTAGES LOW

The vertical size and linearity weren't too good on this CTC-25. Had other problems, too. Finally discovered that all of the DC voltages were quite a bit low. Changed the diodes in the bridge, and the input filter capacitor. Voltages came up to normal, stayed there for half an hour and then down again! I'm on the wrong track somewhere!—R.Z., Lincoln, NE.

I wouldn't say that you've been eliminating the most likely causes! You just haven't gone far enough along that track. From an experience with the same kind of thing not long ago, I would suggest checking that thermistor in the degaussing circuit, and the coil. If this thermistor has gone up in hot-resistance and the coil is unplugged or open, you can get just this kind of problem. Quick-check; just hook a short clip-lead across the thermistor. If the voltages come up, replace thermistor.

BIAS PROBLEM?

The 6CZ5 output tubes in this 1960 Knight amplifier glow red, and burn out. I changed the 250-ohm bias resistor in the cathodes; same problem. Finally had to use a 1000-ohm bias resistor. This works at low volume, but there is bad distortion if I turn it up. What's the problem?—P.G., Charles City, IA.

Well, you were in the right place; in the bias. It sounds a little obvious to say it, but if a tube is red hot, it's drawing too much current. If there are no shorts in the output, the problem has to be incorrect bias. A 6CZ5 tube with +250 volts on plate and screen grid should have a net bias of – 14 volts on the grid, and draw about 45 mA per tube.

One other good possibility. This could cause both problems; heat and distortion. Check for leaky coupling capacitors. This will put too much positive voltage on the 6CZ5 control grids. To check quickly, pull the 6CZ5's, turn power on and read voltage on grids with your VTVM: should be zero.

continued on page 103

DIGITAL MULTIMETERS

continued from page 47

inputs should drift (commonly this changes with temperature), the voltage measured by the single-slope converter changes. With the dual-slope converter, drift in the comparator trip point does not cause a problem unless it happens between the time of the up ramp and the down ramp of a conversion cycle.

The reference signal for both the single and the dual-slope converters must be stable. To ensure good stability with time and temperature, the voltage (or current) reference source is commonly derived from a temperature-compensated Zener diode that may have been selected for aging characteristics. This Zener diode normally has a constant load impedance, and may be driven by a constant-current source.

The dual-slope converter also has some inherent noise rejection capabilities. The most common noise problem, apparent when making DC measurements, is generated by line-frequency signals riding on the DC voltage to be measured. Considering the single-slope converter, it is possible that noise on the input line causes the comparator to trip on the sum of the noise and the DC input signal or on the difference between them. For example, a 0.5-volt DC signal having 0.25 volt of AC peak noise could cause a measurement as high as 0.75 volt, or one as low as 0.25 volt.

The input to a dual-slope converter is applied to an integrator. The output voltage of the integrator at the end of the ramp-up cycle is the average value of the DC signal plus any noise which might have been present during the integration period. The length of the integration cycle is determined by the number of counts required to fill and overrange the counter and by the frequency of the clock.

The length of this integration is of course constant from conversion to conversion within the stability of the clock. The average value of a sinewave is zero after both the positive and negative halves of a cycle are complete. The oscillator frequency of most dual-slope converters is adjusted to make the unknown integration cycle a whole number of line frequency cycles. Typically, the integration time is chosen to be an even multiple of the period of one cycle of the line frequency (for example, 100 milliseconds which is the time required for six cycles at 60 Hz or five cycles at 50 Hz).

Integrating six cycles of the interfering signal simply improves the technique of averaging sinusodial noise to zero, even with slight discrepancies in the integration period. This technique, of making the integration time equal to an integral number of line frequency cycles, gives the dual-slope converter a good immunity to line frequency related noise. The rejection of such signals is called "line frequency normal mode rejection".

Obviously this simple converter needs some extra supporting circuitry to create a full-fledged voltmeter. The overrange circuits are usually sophisticated enough so they are not only able to handle the two overranges (indicated in the previous explanations) but also to handle a third overrange, permitting the normal range of the voltmeter to be 0 to 1999.

This means a first overrange when the

unknown signal is being measured, a second overrange when the reference voltage cannot reduce the integrator to zero in the same time allowed the unknown voltage, and a third overrange if the reference voltage requires twice as long to reduce the integrator to zero as as did the unknown voltage to charge the integrator.

A third overrange with a simultaneous detection of zero output from the integrator would indicate an unknown voltage twice the reference voltage. Some models of voltmeter have provisions permitting even greater overrange capability. Display ranges of 2999 or 3999 are available. Such voltmeters simply make a trade-off between the voltage swing of the integrator for 0 to 1,000 inputs and the overrange voltage swing which must be permitted if the integrator is to have extensive overrange capability.

The previously described dual and single-slope converters have been monopolar—the converter only works with unknown signals of a single polarity. Most digital voltmeters either indicate the necessity for reversing the polarity of the unknown signal to display a proper reading, or they reverse polarity automatically and indicate the proper polarity of the unknown signal with a ± indicator. Single-slope converters and some dual-slope converters simply employ an additional comparator on the input (or at the output of the integrator) which detects an improper polarity input and indicates it on a display. Automatic polarity selection with the dual-slope converter is usually made by changing the polarity of the reference voltage. Signals directing the polarity reference source of the converter are generated by comparators at the output of the integrator.

To measure unknown signals at or close to zero volts effectively, an offset voltage is added to the converter. For example, a 1-volt full-scale converter might actually measure signals from 0.1 volts to 1.1 volts at the converter. Thus the dual-slope integrator would never have to integrate an input signal of less than 0.1 volts. Some dual-slope converters have been developed with an additional cycle in the measurement scheme. This additional cycle is completed with zero input. As the input during this cycle is known to be zero, any reading present at the completion of the cycle can be used to correct zero-offset circuits. Such an additional cycle ensures a true zero condition.

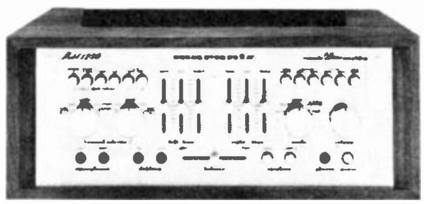
There are many other variations on the dual-slope converter. One of the first efforts was to remove the switch from the input signal entirely, as switches in the input line present a design problem. Mechanical ones, such as reed relays, have a definite short life span, and long-life semiconductor switches have serious temperature problems, in addition to causing variations when used in circuits where voltage and impedance levels are not carefully controlled.

to be continued

new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Free Information Card following page 106.

INTEGRATED AMPLIFIER, *model 1250*, delivers 125 watts minimum continuous power per channel with both channels driven, covering a power bandwidth of 20 Hz to 120 kHz. It is rated at no more than 0.1% total harmonic distortion with an 8-ohm load.



The *model 1250* features a separate record mode selector for 2 tape recorders. This enables the user to select a different source for each tape recording, even while listening to a third program source. Special circuitry enables the user to monitor the quality of those recordings. In addition, the front panel contains detented slide-graphic controls for bass, midrange and treble. This provides the user with selectable frequency turnover points.

The *model 1250* is equipped with inputs for stereo microphones, two turntables, a tuner, and two auxiliary stereo sources.—**Marantz Co., Inc.**, 8150 Vineland Ave., Sun Valley, CA 91352.

CIRCLE 90 ON FREE INFORMATION CARD

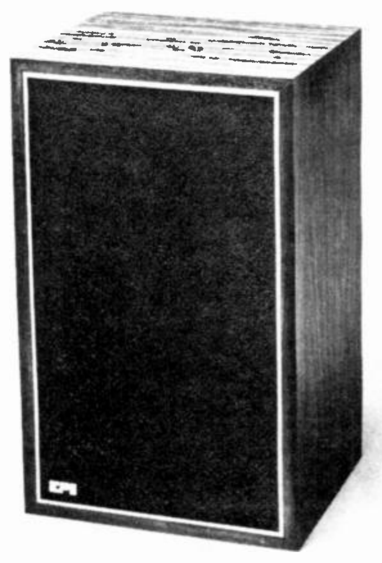
FREQUENCY COUNTER, *model FM-7*, is a miniature battery-powered test instrument. The unit measures only 1.9 × 2.7 × 4 inches and will monitor frequencies from 10 Hz to 60 MHz and display that frequency to seven digits using 0.25-inch high LED's. Input sensitivity is 30 millivolts RMS from 50 Hz to 30 MHz, and 100 millivolts RMS from 10 Hz to 60 MHz with a 1-megohm input impedance. It has an input signal overload capability of up to 250 volts RMS at 500 kHz.

Resolution is 1-Hz below 10 MHz and 10-Hz from 10 MHz to 60 MHz. The internal timebase has an aging rate of less than 10 PPM from 0°C to +40°C. The unit operates on self-contained type-AA NiCad rechargeable batteries. The batteries and charger unit are furnished with the frequency meter. The meter can be operated continuously for two hours on a fourteen-hour recharge. Options include a panel-mount flange, a tilt stand and a leather case. Price: $195.00—**Non Linear Systems, Inc.**, P.O. Box N, Del Mar, CA 92014.

CIRCLE 91 ON FREE INFORMATION CARD

SPEAKER SYSTEMS, *model EPI 70* and *EPI 120*, features 1-inch air-spring tweeters with a crossover frequency of 1800 Hz.

The *model EPI 70* is a bookshelf model using a long-traverse 6-inch woofer, plus tweeter. The frequency response is 60 to 20,000 Hz with a recommended RMS power range of 10 to 80 watts. Measures 16 × 10½ × 7½ inches and weighs 17½ pounds.



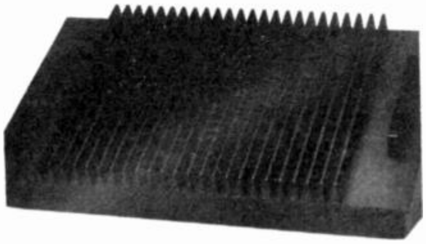
The *model EPI 120* is a floor/bookshelf model featuring a 10-inch woofer plus tweeter. Frequency response is 38 to 20,000 Hz, ± 3 dB, with a recommended RMS power range of 25 to 80 watts. Measures 25 × 15 × 12½ inches and weighs 47 pounds.

Both models are finished in wood-grain vinyl with bronze trim, and have acoustically transparent matte-black foam grilles. The *model EPI 70* is priced at $139.90 per matched pair and the *EPI 120* sells for $139.95 each.—**Epicure Products, Inc.**, 1 Charles Street, Newburyport, MA 01950.

CIRCLE 92 ON FREE INFORMATION CARD

POWER AMPLIFIER, *model 620*, features a radically new circuit refered to as a "Tetra-Linear Differential Amplifier". It is a pure Class-B design that virtually eliminates crossover and switching distortions found in all popular class

A-B power amplifiers. This results in a barely measureable total harmonic and intermodulation distortion figures that are an entire order of magnitude lower than those of most high-quality preamplifiers at all power levels right up to and beyond its rated maximum output of 100-watts-per-channel.



The new circuit design also increases temperature stability and efficiency. The idling current of the *model 620* is 1/25 that of other power amplifiers of comparable output ratings. The amplifier is reportedly stable into all types of loads, including reactive loads. Protection of the output transistors and loudspeakers is accomplished without the use of relays or current-limiting devices. Short-circuiting the outputs will not cause any damage.

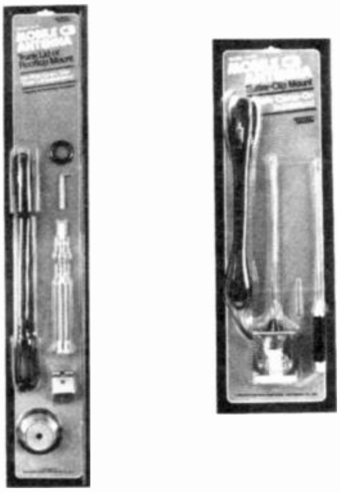
Specifications include: power output at less than 0.01% THD of 100 watts-per-channel from 5 Hz to 20,000 Hz, both channels driven into 8 ohm loads; damping factor of greater than 100 at 1-kHz into an 8-ohm load, total harmonic distortion is less than 0.002% at any frequency up to 1 kHz and less than 0.005% at any frequency up to 10 kHz; intermodulation distortion is less than 0.002% into an 8-ohm load with a 100-watt output; frequency response is 5 Hz to 100,000-Hz +0-dB, −1-dB; input impedance is 10,000 ohms and input sensitivity is 1 volt. The residual noise ratio is better than 117-dB with A-weighting.

The front-panel features peak-indicating lamps that are integrated into the heat-sink fins. These lamps may be programmed with rear panel switches to light green at 1, 5, or 25 watts and red at 25, 50 watts or clipping. The lamps indicate the true preset peak value at any frequency.

The *model 620*, measures $15^3/_4 \times 6^3/_4 \times 9^3/_8$-inches and weighs 27.6 pounds. Price: $600.00—**Nakamichi Research (U.S.A.), Inc.**, 220 Westbury Ave., Carle Place, NY 11514.

CIRCLE 93 ON FREE INFORMATION CARD

MOBILE CB ANTENNAS, *model CA-10* and *CA-20*. The Trunk-Lid *model CA-10* is a base-loaded



unit that attaches to the trunk-lid without the need for screws or drilling. It features a neutralgrey coil housing that will blend with the color of any vehicle and has a chromed base and spring that seats on a rubber base cushion. The overall length is 45 inches and the unit is equipped with 15 feet of coaxial-cable terminated in a standard PL-259 connector.

The Gutter-Clip *model CA-20* features a center-loaded whip that attaches directly to the rain gutter of any car, truck or recreational vehicle without the need for drilling or screws. The antenna is only 21-inches high and features a tunable stainless steel whip, a 9-foot coaxial cable terminated with a PL-259 standard coaxial connector.

The *model CA-20* is priced at $19.95 and the *model CA-10* at $24.95.—**EICO Electronic Instrument Co., Inc.**, 283 Malta St., Brooklyn, NY 11207.

CIRCLE 94 ON FREE INFORMATION CARD

CB ANTENNA, *Long Gainer*, is a tunable base-loaded stainless-steel antenna that can be easily adjusted to cover all channels across the band. A frequency adjustment screw is provided that brings in the desired channel clearly. It also has the capability of tuning in all the new channels as they become available.

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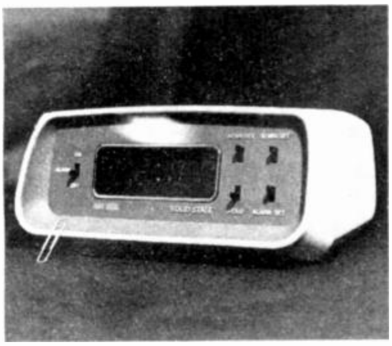

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CIRCLE 39 ON FREE INFORMATION CARD

. The *Long Gainer* has a long lasting stainless-steel whip and deluxe mount with high-quality coaxial cable designed for easy snap-on installation. No drilling is required because it mounts easily to the trunk lip. A PL-259 coaxial

connector is also provided. Maximum height of the antenna is 60-inches and the tuning range is 26.9 to 27.5 megahertz.—**Anixter Bros., Inc.**, 4711 Golf Road, One Concourse Plaza, Skokie, IL 60076.

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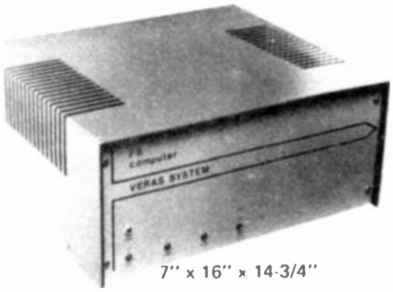

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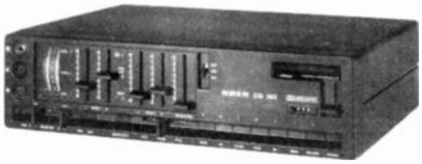
CIRCLE 66 ON FREE INFORMATION CARD

CASSETTE DECK, *model CG-362*, is front loading and has three motors and full digital IC logic controls. Also featured is a digital tape counter, auto-stop, tape-flow control, remote control possibilities, input mixing and three position replay program selector.

The *model CG-362* incorporates Dolby noise reduction and DNL. There's a switchable multiplex filter that's important when dubbing from FM Stereo and disconnectable when dubbing from records. Automatic bias and EQ is available and there is a 3-position switch for setting three types of tape—ferric oxide or ferrichrome. RCA-type input and output connectors are included as well as DIN connectors.



Frequency response is 20 Hz to 18,000 Hz, wow-and-flutter is less than 0.15% RMS and the signal-to-noise ratio is better than 68 dB with chrome tape and Dolby.

The output of the *model CG-362* is 0.5 watts 4-ohms and is ideal for driving Philips' type motional feedback speakers.—**Uher Of America,** 621, S. Hindry Ave., Inglewood, CA 90301.

CIRCLE 98 ON FREE INFORMATION CARD

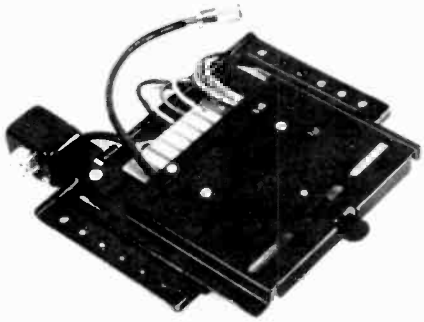
VHF SCANNER, *model SBE-11SM*, is a super-sensitive, ultra-compact VHF scanner monitor with exceptionally low current-drain. The scanner receiver is called the Pocket Sentinel because it fits neatly inside a shirt pocket.

The unit delivers a full 100-mW audio output with only 0 08-amps power consumption. Sensitivity is 0.7μV for 12-dB SINAB. Adjacent channel rejection is −55 dB.

The *model SB-11SM* offers both low- and high-band VHF coverage from 30 MHz to 50 MHz and from 148 MHz to 174 MHz. It provides four-channel coverage and features LED channel indicator lights. Also featured are separate volume and squelch controls, switch for channel lockouts, a switch for manual scan of all four channels, an earphone jack and a built-in charger jack for use with an optional *SBE-5AC* charger for nicad batteries. The unit measures 6.5 high × 2.75 wide × 1.38-inches deep and weighs 12.5 ounces with batteries.—**SBE, Inc.**, Department P, 220 Airport Blvd., Watsonville, CA 95076.

CIRCLE 99 ON FREE INFORMATION CARD

CB MOUNTING BRACKET, *model 14T170*, provides quick removal and reinstallation of CB transceivers to prevent theft or unauthorized use of such equipment during the operator's absence. The adaptor permits quick-release brackets to be mounted either under-the-dash-board of the automobile or on the vehicle's floor. Connections between the transceiver and the power source are made with spring-loaded brass contacts. The antenna circuit includes a shielded connector for coaxial cable.



A separate dash-mount section—*model 14T171*—is also available for installation of a single transceiver unit in a second vehicle, providing a convenient transfer from one operating location to another—**RCA, Distributor and Special Products Division,** Cherry Hill Offices, Camden, NJ 08101.

CIRCLE 101 ON FREE INFORMATION CARD

new lit

More information on new lit is available from the manufacturers of items identified by a Reader Service number. Use the Free Information Card following page 106.

TOOL CATALOG, *No. 20,* contains a comprehensive selection of hand tools and accessories for production and maintenance work in the electronics and electro-mechanical oriented industries. Product lines range from vapor degreasers to parts-holding boxes.

This edition introduces a self-contained catalog of tool kits for practically every service and installation. The 25 kits shown in the catalog range from security kits for alarm installers to computer installation units. Also included is a Design-A-Kit program to enable you to design, select and price a kit to your own specific requirements.—**Techni-Tool, Inc.**, 5 Apollo Road, Plymouth Meeting, PA 19462.

CIRCLE 102 ON FREE INFORMATION CARD

COMPONENT CATALOG, *No. 514,* 56 pages of electronic components, test equipment, tools and production aids that are stocked for immediate delivery. Included are cabinets, alligator clips, speakers, battery holders, capacitors, fuses & holders, hardware, knobs, lamps, meters, plugs & jacks, potentiometers, relays, resistors, semiconductors, switches, test equipment, soldering equipment, tools, transformers and wire. Prices are included.—**Mouser Electronics**, 11511 Woodside Ave., Lakeside, CA 92040

CIRCLE 103 ON FREE INFORMATION CARD

SOLDERING EQUIPMENT CATALOG, *No. 76*, features a full line of soldering and desoldering equipment for electronic service, industrial, craft and military users. Included are soldering irons, desoldering irons, kits and a desoldering head that converts a soldering iron into a desoldering iron. Also shown are tips, desoldering bulbs, and soldering-tool stands.

All irons feature a safety light that tells when it's on; a cool, unbreakable polycarbonate handle; and a flexible, burn-resistant Neoprene cord set. Soldering irons provide two heats—40W and 20W—to handle a wider range of work. Desoldering irons operate at 40W; idle at 20W for longer tip life. An exclusive bracket insures alignment and prevents damage. Prices are included.—**Enterprise Development Corp.**, 5137 East 65th Street, Indianapolis, IN 46220

CIRCLE 104 ON FREE INFORMATION CARD

IGNITION SYSTEMS. Four-color illustrated booklet describes a full line of electronic ignition systems. The systems are designed to improve engine performance for the broad variety of people who have yet to purchase 1975-76 model cars.

Among the benefits claimed by the *Mark 10* systems are the elimination of 3-out-of-4 regular engine tune-ups, up to 20% improvement in gas mileage, better acceleration and quicker starts. The systems (some of which are available in kit form), install easily in a matter of minutes.—**Delta Products, Inc.**, P.O. Box 1147, Grand Junction, CO 81501.

CIRCLE 105 ON FREE INFORMATION CARD

next month

DECEMBER 1976

■ Projection TV Is Here Now

See the systems, the prices, how they work. You may have been looking to buy one, but did you know that there are more than 25 to choose from?

■ TV Games

Bad programming may give way to game boards on the TV screen as a new and growing competitor. Radio-Electronics looks at all the games you can buy and use now.

■ Installing A CB Rig

It isn't difficult if you have a guide. This story shows you how to do the job, in step-by-step detail, to help you do it right.

■ Noise Measurements In Audio

Careful testing is a must in this land of almost unmeasurables. Len Feldman shows how it's done and what to look for.

■ Expand A Calculator

We show how to take a common Novus calculator and add extra buttons and functions to the unit. Upgrade your calculator in December.

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Reader Questions and Solutions

continued from page 91

SINGLE CHANNEL ATTENUATION

I need a filter that will attenuate a single TV channel without affecting adjacent channels. Channel 3 is a very strong signal in my area and it laps over into Channel 2 and Channel 4. Is there such a filter?—W.M., Janesville, WI.

Yes. Jerrold, Blonder-Tongue, J.W. Miller and others make single-channel traps that tune sharply from 40 to 80 MHz. This would cover Channel 3, which is 60 to 66 MHz.

You might try the little RCA trap which is just a 4.5-inch length of 300 ohm twin-lead. Short one end and tie a ceramic trimmer capacitor (3–15 pF) across the other. Tape this tightly to your lead-in as close to the antenna terminals as possible. Now, tune for least interference on either Channel 2 or 4. If one of these helps but doesn't cure it, make up another one and try it as close to the first as possible.

CRITICAL SYNC

This is a tough dog! This Truetone MIC-4219A-27 has very critical sync, but it's not a sync problem! The video waveform at the detector doesn't have much sync on it. I can inject a video signal here and it works. Run this through the crystal-ball and see what shows up, please!—D.D., Apalachicola, FL.

It's a sync problem but it isn't the sync? (It's going to be one of *those* days.) OK: crystal-ball says this could be a "feedback cancellation of sync" due to open capacitor somewhere. Scope the DC power supply and the AGC line, etc., looking for any sign of signals.

(Feedback; reader says "Bless you and your crystal ball! I scoped the AGC line first and there it was; a 0.25-volt positive going spike at horizontal rate. Replaced the 1.0-μF non-polarized AGC filter and Bingo. Thanks.") **R-E**

NOISE REDUCTION

continued from page 77

with Super-ANRS is approximately half of what it would be without this circuit addition.

Finally, Fig. 10 illustrates the effect of Super-ANRS on overall record/playback frequency response for a recording made at the 0-dB record level. Without Super-ANRS, the response is down 3 dB

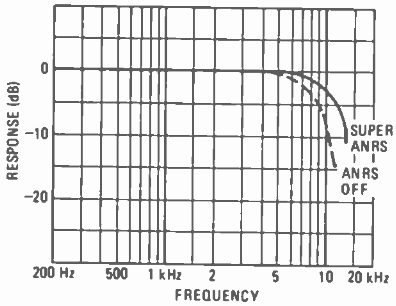
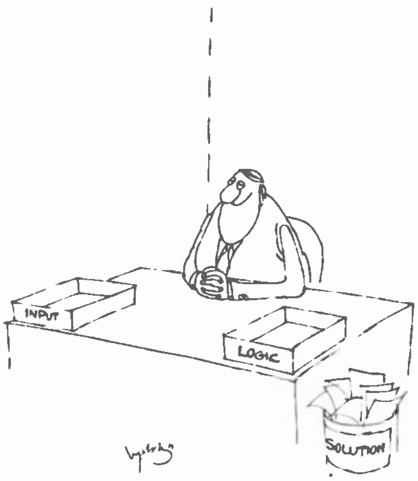


FIG. 10—RECORD/PLAYBACK frequency response with and without Super-ANRS.

at around 8 kHz while with Super-ANRS in the circuit, the 3 dB roll-off point extends to beyond 10 kHz. At lower recording levels, the improvement will, of course, be even more significant.

JVC has incorporated this new dynamic range expanding feature in several of their newly introduced stereo cassette decks. One of these units, the model CD-1636, can be battery operated for use in live, field recording work.

The incorporation of Super-ANRS in such a deck is especially useful since in live microphone recording work, sudden transients are more likely to occur than when re-recording FM programs or phono discs in which a fair amount of signal compression has already been "built in" to and is inherent in the program source. **R-E**



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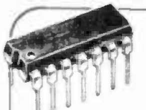

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7407	.25	7485	.89	74184	2.19	4011	.23	4514	2.80
7408	.21	7486	.28	74185	2.19	4012	.23	4515	2.80
7409	.21	7489	2.19	74188	3.50	4013	.40	4516	1.23
7410	.21	7490	.44	74189	3.50	4014	.96	4518	1.14
7411	.21	7491	.70	74190	1.23	4015	.96	4520	1.14
7412	.21	7492	.44	74191	1.23	4016	.40	4527	1.68
7413	.25	7493	.44	74192	.88	4017	1.05	4528	.88
7414	.89	7494	.70	74193	.88	4018	1.05	4585	1.23
7416	.25	7495	.70	74194	.88	4019	.23	LM309K	1.80
7417	.25	7496	.70	74195	.88	4020	1.14	LM324N	1.28
7420	.21	74100	1.28	74196	.88	4021	1.14	LM340T-5	1.25
7421	.25	74107	.30	74197	.88	4022	.96	LM340T-6	1.25
7423	.35	74109	.33	74198	1.39	4023	.23	LM340T-8	1.25
7425	.35	74121	.35	74199	1.49	4024	.84	LM340T-12	1.25
7426	.25	74122	.44	74251	1.09	4025	.23	LM340T-15	1.25
7427	.33	74123	.61	74279	.58	4026	1.68	LM340T-18	1.25
7428	.28	74125	.40	74365	.67	4027	.40	LM340T-24	1.25
7430	.21	74126	.40	74366	.67	4028	.89	LM3900N	.88
7432	.25	74132	.70	74367	.67	4029	1.14	NE536T	3.24
7433	.30	74141	.88	74368	.67	4030	.23	NE540L	2.04
7437	.25	74145	.70	75150	1.31	4033	1.51	NE555V	.48
7438	.25	74147	1.63	75450	.88	4034	3.50	NE556A	.88
7440	.21	74148	1.30	75451	.61	4035	1.14	NE560B	3.83
7441	.88	74150	1.16	75452	.61	4040	1.14	NE561B	3.83
7442	.53	74151	.70	75453	.61	4041	.79	NE562B	3.83
7443	.63	74153	.65	75454	.61	4042	.79	NE565A	1.25
7444	.63	74154	1.03	75491	.81	4043	.70	NE566V	1.28
7445	.70	74155	.70	75492	.84	4044	.70	NE567V	1.36
7446	.70	74156	.70	75493	1.09	4046	1.86	uA709CV	.44
7447	.70	74157	.70	75494	1.19	4049	.40	uA710CA	.44
7448	.70	74160	.88	8093	.40	4050	.40	uA711CA	.53
7450	.21	74161	.88	8094	.40	4051	1.26	uA723CA	.60
7453	.21	74162	.88	8095	.67	4052	1.26	uA741CV	.44
7454	.21	74163	.88	8096	.67	4053	1.26	uA747CA	.70
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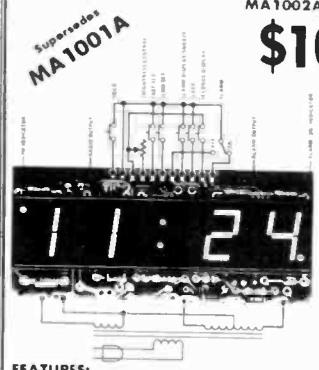

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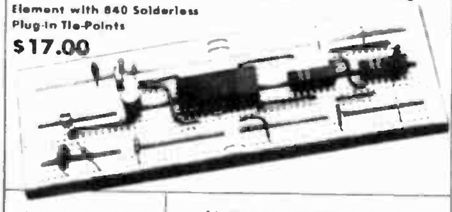

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4-40 ¼ Screw	.55/C	3.60/M
4-40 ½ Screw	.60/C	4.05/M
6-32 ¼ Screw	.65/C	4.40/M
6-32 ½ Screw	.75/C	4.85/M
8-32 3/8 Screw	.90/C	5.85/M
2-56 Hex Nut	.55/C	3.60/M
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1N5231B	5.1v	.15	$11/C	1N5241B	11v	.15	$11/C
1N5232B	5.6v	.15	$11/C	1N5242B	12v	.15	$11/C
1N5233B	6.0v	.15	$11/C	1N5243B	13v	.15	$11/C
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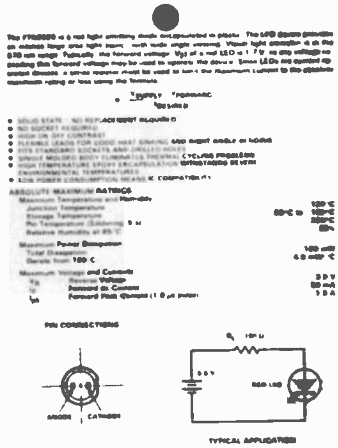
FTK0020



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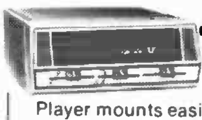
Locks player in place. Slides in & out. 6 x 13/16 x 7". 6 or 12 VDC. Shipping weight 2 lbs.

Standard Dial DESK PHONE

PH-117 **7.99** Reg. $13

Factory reconditioned. Comes with base, dial & coil. Less bell. Styles may vary. Wt. 8 lbs.

Auto Stereo 8-Track Tape Player



AU-428 **19.99** Reg. $24

Player mounts easily under dash. Slide controls. 7½ x 5½ x 2½". 12 VDC. neg. grd. Styles may vary. 4 lbs.

Police Converter Kit

Model EC-2900. Use AM radio & tune in the 152-174 MHz band for police, etc. 2 lbs.

KB-380 **7.99** Reg. $13

Pencil-Tip Soldering Iron

TL-448 **1.99** Reg. $3.29

Tip reaches temperature to 250°. Is 9¼" long. 117 VAC. ¼ lb.

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4 Digit Mechanical Counter	XM-367	1.49	.59
5 Digit Mechanical Counter	XM-543	3.00	1.29
2 watt Solid-State Phono Amp.	AM-529	16.00	11.00
5 Digit 117 volt AC Counter	XM-533	2.00	.99
12 Hour Timer, 117 V. AC	SW-777	4.00	1.79
6 Digit 117 V. AC Counter	XM-481	2.29	1.39
L.E.D. Pkg. of 5 Small Red 2V. 5 MA	PL-234	1.19	.60
L.E.D. Pkg. of 5 Large Green 2 V. 5 MA	PL-235	1.19	.60
L.E.D. Pkg. of 5 Small Green 2 V. 5 MA	PL-236	1.19	.60
L.E.D. Pkg. of 5 Large Yellow 2V. 5 MA	PL-237	1.19	.60
L.E.D. Pkg. of 5 Small Yellow 2 V. 5 MA	PL-238	1.19	.60
L.E.D. Pkg. of 5 Large Orange 2 V. 5 MA	PL-249	1.19	.60
L.E.D. Pkg. of 5 Large Clear 2 V. 5 MA	PL-274	1.19	.60
7 Seg. L.E.D. Readout. 3" Com. K Reel	XM-414	2.00	1.29
LM-309K 5 V. IC Regulator TO-3	TR-511	1.60	1.19
3 Amp. 50 PIV Diodes Pkg. of 2	DI-055	.70	.59
3 Amp. 400 PIV Diodes Pkg. of 2	DI-056	1.20	.79
1 Amp. 200 PIV 50 Piece Kit	DI-051	1.69	.69
P Channel FET 2N5460	TR-430	1.19	.59
18 Amp. 200 PIV Diode IN3493R	DI-054	1.49	.59
Medium Power Transistor 2SB474	TR-147	3.79	1.29
Cadmium Photo Cells. 500 Ohm. Pkg. 2	TR-512	.90	.59
N Channel FET 2N3819	TR-429	1.00	.49
40 Watt NPN Transistor. Pkg. of 4	TR-440	1.29	.59
709 IC Hi-Gain OP-Amp	RE-131	1.49	.69
PC Board Kit — Make Your Own	XM-393	6.59	3.99
PC Wire Kit, 150 Ft.	WW-575	1.69	.99
Magnet Wire, 28 Ga. 375 Ft.	WR-281	.89	.69
4PDT Plug-In Relay, 117 V. AC Coil	SW-543	2.69	1.79
16 Step Relay, 110 Ohm Coil, 450 Ohm Reset	SW-842	5.79	3.79
SPDT 5A. Plug-In Relay 117 V. AC	SW-417	1.19	.79
DPST Power Relay 25A. Cont. 117 V. Coil	SW-646	2.69	1.69
Heavy Duty Solenoid, 117 V. AC	SW-839	1.79	.79
Miniature Solenoid, ½" Trav. 117 V. AC	SW-840	2.00	.89
Reed Switch with Mag. Pkg. 10	SW-632	2.69	.79
SPDT Key Switch 3A. Contacts	SW-808	1.20	.79

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HOW MANY	STOCK NUMBER	DESCRIPTION	PRICE EACH	TOTAL

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Poly Pak's EXCLUSIVE BARREL KITS

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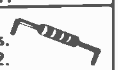

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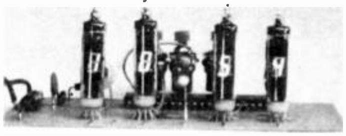

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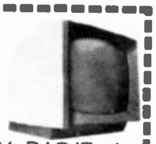

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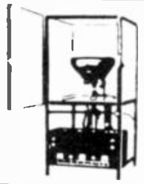

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2SA679	3.75	2SB471	1.75	2SC627	1.75	2SC1098	1.15	2SD201	1.95
2SA682	.85	2SB474	1.50	2SC642	3.50	2SC1115	2.75	2SD218	4.75
2SA699	1.30	2SB476	1.25	2SC643	3.75	2SC1166	.70	2SD300	2.50
2SA699A	1.75	2SB481	2.10	2SC644	.70	2SC1170	4.00	2SD313	1.10
2SA705	.55	2SB492	1.25	2SC681	2.50	2SC1172B	4.25	2SD315	.75
2SA815	.85	2SB495	.95	2SC684	2.10	2SC1209	.55	2SD318	.95
2SA816	.85	2SB507	.90	2SC687	2.50	2SC1213	.75	2SD341	.95
		2SB511	.70	2SC696	2.35	2SC1226	1.25	2SD350	3.25
2SB22	.65			2SC712	.70	2SC1243	1.50	2SD352	.80
2SB54	.70	2SC206	1.00	2SC713	.70	2SC1293	.85	2SD380	5.70
2SB56	.70	2SC240	1.10	2SC732	.70	2SC1308	4.75	2SD389	.90
2SB77	.70	2SC261	.65	2SC733	.70	2SC1347	.80	2SD-390	.75
2SB128	2.25	2SC291	.65	2SC739	.70	2SC1383	.75	2SD437	5.50
2SB135	.95	2SC320	2.00	2SC715	1.75	2SC1409	1.25		
2SB152	4.50	2SC352	.75	2SC762	1.90	2SC1410	1.25	MPS-U31	4.00
2SB173	.55	2SC353	.75	2SC783	1.00	2SC1447	1.25	MPS8000	1.25
2SB175	.55	2SC371	.70	2SC784	.70	2SC1448	1.25		
2SB178	1.00	2SC372	.70	2SC785	1.00	2SC1507	1.25		
2SB186	.60	2SC394	.70	2SC793	2.50	2SC1509	1.25		

POWER-TRANSISTORS HIGH-VOLT. TV. TYPE

BU204	1300V	3.90	BU207	1300V	5.40	2SC1172B	1100V	4.25
BU205	1500V	4.70	BU208	1500V	6.25	2SC1308	1100V	4.95
BU206	1700V	5.90	2SC1170	1100V	4.00	2SC1325	1100V	4.95

OEM SPECIALS

1N270	.10	2N960	.55	2N2219A	.30	2N2913	.75	2N3740	1.00	2N4401	.20
1N914	.10	2N962	.40	2N2221	.25	2N2914	1.20	2N3771	1.75	2N4402	.20
		2N967	.50	2N2221A	.30	2N2916A	3.65	2N3772	1.90	2N4403	.20
2N173	1.75	2N1136	1.35	2N2222	.25	2N3019	.50	2N3773	3.00	2N4409	.20
2N178	.90	2N1142	2.25	2N2222A	.30	2N3053	.30	2N3819	.32	2N4410	.25
2N327A	1.15	2N1302	.25	2N2270	.40	2N3054	.70	2N3823	.70	2N4416	.75
2N334	1.20	2N1305	.30	2N2322	1.00	2N3055	.75	2N3856	.20	2N4441	.85
2N336	.90	2N1377	.75	2N2323	1.00	2N3227	1.00	2N3866	.85	2N4442	.90
2N338A	1.05	2N1420	.20	2N2324	1.35	2N3247	3.40	2N3903	.20	2N4443	1.20
2N398B	.90	2N1483	.95	2N2325	2.00	2N3250	.50	2N3904	.20	2N4852	.55
2N404	.30	2N1540	.90	2N2326	2.85	2N3375	6.50	2N3905	.20	2N5061	.30
2N443	1.75	2N1543	2.70	2N2327	3.80	2N3393	.20	2N3906	.25	2N5064	.50
2N456	1.10	2N1544	.80	2N2328	4.20	2N3394	.17	2N3925	3.75	2N5130	.20
2N501A	3.00	2N1549	1.25	2N2329	4.75	2N3414	.17	2N3954	3.50	2N5133	.15
2N508A	.45	2N1551	2.50	2N2368	.25	2N3415	.18	2N3954A	3.75	2N5138	.15
2N555	.45	2N1552	3.25	2N2369	.25	2N3416	.19	2N3955	2.45	2N5198	3.75
2N652A	.85	2N1554	1.25	2N2484	.32	2N3417	.20	2N3957	1.25	2N5294	.50
2N677C	6.00	2N1557	1.15	2N2712	.18	2N3442	1.85	2N3958	1.20	2N5296	.50
2N706	.25	2N1560	2.80	2N2894	.40	2N3553	1.50	2N4037	.60	2N5306	.20
2N706B	.40	2N1605	.35	2N2903	3.30	2N3563	.20	2N4093	.85	2N5354	.20
2N711	.50	2N1613	.30	2N2904	.25	2N3565	.20	2N4124	.20	2N5369	.20
2N711B	.60	2N1711	.30	2N2904A	.30	2N3638	.20	2N4126	.20	2N5400	.40
2N718	.25	2N1907	4.10	2N2905	.25	2N3642	.20	2N4141	.20	2N5401	.50
2N718A	.30	2N2060	1.85	2N2905A	.30	2N3643	.15	2N4142	.20	2N5457	.35
2N720A	.50	2N2102	.40	2N2906	.25	2N3645	.15	2N4143	.20	2N5458	.30
2N918	.35	2N2218	.25	2N2906A	.30	2N3646	.14	2N4220A	.45	C103y	.25
2N930	.25	2N2218A	.30	2N2907	.25	2N3730	1.50	2N4234	.95	C103d	.40
2N956	.30	2N2219	.25	2N2907A	.30	2N3731	2.75	2N4400	.20	C106b1	.50
										C106di	.75

SILICON UNIJUNCTIONS

2N2646	.50	2N4871	.50
2N2647	.60	2N4891	.50
2N6027	.55	2N4892	.50
2N6028	.70	2N4893	.50
D5E37	.25	2N4894	.50
2N2160	.65	MU10	.40
2N4870	.50		

INTEGRATED CIRC.

UA703C	.40
709C OP. AMP.	.25
741C OP. AMP.	.25
7400	.15
TA7061P	3.50
TA7205P	8.00
UPC1001h2	6.00
Ne555	1.25

RECTIFIERS

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IN4001	.60	5.00
IN4002	.70	6.00
IN4003	.80	7.00
IN4004	.90	8.00
IN4005	1.00	9.00
IN4006	1.10	10.00
IN4007	1.20	11.00

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MADE FOR HOTEL ROOM SERVICE WAKE UP SERVICE
Here's a parts list- All new not used, just installed in the board.
1-LM309K, heat sink, 2-2N5137, 5-2N3904, 2-7400, 7402, 1-7403, 3-7410, 1-7413, 2-7430, 9-7474, 1-7486, 1-74151, 1-74154, 1-4001, 2-741CT, 5-TIP29 & 30, 1-LM380 AN(14), 3-MDA942-1 Bridges, 1-555 Timer, 1-OnOff 10K Vol Con
1-Fuse Block with 1 A SloBlo
1-4" Speaker 3.2 Ohm 1 Watt,
1-Transformer 16V Pri 5V-12V
1-Thumbwheel Switch 2 Digit
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P. A. or Music Outlet
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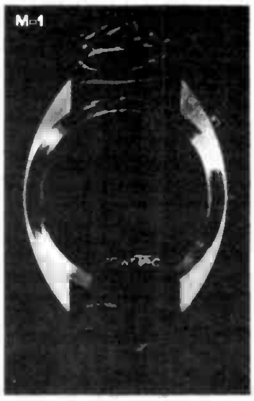
CrownTec L.E.D. watches



6-Function, 1-Button Solid State. Hours, Minutes, Seconds, Day of Week, Month & Day. The Crowntec L.E.D. watch contains the finest custom designed quartz crystal to assure accuracy of 3 min. per year. Guaranteed 1 yr. from date of purchase (battery excepted).

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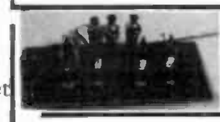


CLOCK KIT $12.95

MM5316, pc bd., display tubes switches, etc, instructions.

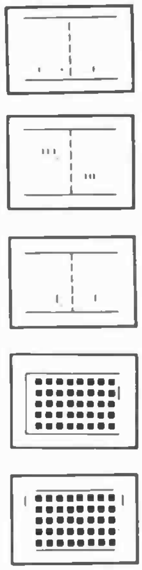
CLOCK CHIPS

MM5375, CT7001, MM5316
Your choice $4.95

VIDEO GAME KIT

5IVE Games To Play

A CHALLENGE TO BUILD,
A CHALLENGE TO PLAY.



Features:

1. Basic Tennis games in three variations.
2. Plus 2 variations of Wipe Out the squares. A fascinating game for 1 or 2 players. Not available in most games sold.
3. All 5 games in one kit.
4. Curve Button for added excitement.
5. On screen scoring between plays.
6. Sound.
7. Basic TTL circuitry except for VK-6 proms.
8. Requires 5V DC + at 2 A.

VK-1	PC Board Only Includes parts list & wiring Diagram requires VK-6	25.00
VK-2	PC Board with parts Includes PC Board, 78 IC's (those necessary are pre-programed) resistors & capacitors to stuff the board.	125.00
VK-3	Hardware Kit Controls, switches, wire Does not include Housing.	17.50
VK-4	RF Module Kit To convert video signal to TV receiver signal. Eliminates internal "wire in" on TV set.	22.50
VK-4-A	Antenna-Game Switch Allows outside antenna to remain connected while game is in use.	9.50
VK-5	Power Supply Kit For VK-1 or VK-2 PC Board ONLY.	12.50
VK-6	PROM Set 3 Programmed DM8574N with 2 DM8130N for VK-1 (If you have plenty of TTL).	50.00

TTL IC'S

7400	.18	7441	.75	7496	.65	74160	.86
7401	.20	7442	.44	7497	2.00	74161	.62
7402	.20	7443	1.20	74100	1.25	74162	1.35
7403	.20	7445	.89	74107	.26	74163	.76
7404	.20	7446	.87	74109	.35	74164	.80
7405	.20	7447	.69	74110	.50	74165	.90
7406	.39	7448	.81	74116	2.00	74166	1.00
7407	.39	7450	.20	74120	1.25	74167	3.00
7408	.20	7451	.20	74121	.34	74170	2.00
7409	.24	7453	.20	74122	.39	74172	9.72
7410	.20	7454	.20	74123	.50	74173	1.25
7411	.20	7460	.20	74125	.45	74174	.85
7412	.24	7470	.20	74126	.45	74175	.75
7413	.35	7472	.23	74128	.65	74176	.85
7414	.70	7473	.26	74132	.95	74177	.85
7416	.33	7474	.29	74136	.50	74180	.75
7417	.33	7475	.39	74141	.80	74181	2.00
7420	.20	7476	.31	74142	4.00	74182	.90
7422	.50	7479	2.40	74143	4.00	74184	1.65
7423	.28	7480	.69	74144	4.00	74185	1.30
7425	.24	7482	.72	74145	.70	74190	1.00
7426	.24	7483	.75	74147	2.50	74191	.65
7427	.24	7485	.90	74148	1.75	74192	.85
7428	.40	7486	.25	74150	1.00	74193	.85
7429	.40	7488	3.50	74151	.70	74194	1.20
7430	.20	7489	1.50	74153	.70	74195	.55
7432	.28	7490	.39	74154	.90	74196	.80
7433	.34	7491	.65	74155	.70	74197	.83
7437	.28	7492	.39	74156	.90	74198	1.50
7438	.28	7493	.39	74157	.70	74199	1.75
7439	.36	7494	.70	74158	1.75	74200	3.50
7440	.20	7495	.50	74159	2.25	74279	1.75

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8080	Improved 8008	24.95
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	DYNAMIC RAMS	
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1103	1024x1	2.50
2107B-4	4096x1	8.00
8225B	16x4	1.50
93407	16x1	4.85
	STATIC RAMS	
1101	256x1	1.75
2102	1024x1	2.00
2501B	256x1	1.75
3107	256x1	4.00
7489	64 Bit R/W	2.00
74200	256 Bit R/W	5.75
	PROMS	
1702A	256x8 Eras	12.00
1702AL	256x8 low pow	12.00
8223B	32x8	3.50
74S287N	256x4	6.95
	SHIFT REGISTERS	
MM5058	1024x1 Static	4.75
TMS3002LR	Dual 50	4.00
TMS3132NC	Dual 144	3.00

COMPARES TO

2107B4	TMS4060
2102	AMD9102, ISL7552-1, TMS4033
MM5058	AMD2533, FSC3355, TMS3133
TMS3002	SIG2509
TMS3132	MM4060, FSC3346

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FEATURES:
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CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

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22 Pin dual Read Out .156	2.25
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MAN4	0.187 ChHt	2/1.00

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CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
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MM5739	8 Digit, 4 Function, Floating Decimal	2.95
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This 0-2 VDC .05 per cent digital voltmeter features the Motorola 3½ digit DVM chip set. It has a .4" LED display and operates from a single +5V power supply. The unit is provided complete with an injection molded black plastic case complete with Bezel. An optional power supply is available which fits into the same case as the 0-2V DVM allowing 117 VAC operation.

A. 0-2V DVM with Case **$49.95**
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SPECIAL

Vector Wiring Pencil P173 consists of a hand held featherweight (under one ounce) tool which is used to guide and wrap insulated wire, fed off a self-contained replaceable bobbin, onto component leads or terminals installed on pre-punched "P" Pattern Vectorbord". Connections between the wrapped wire and component leads, pads or terminals are made by soldering. Complete with 250 FT of red wire. **$7.95**

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	0.1 Hole Spacing Part No.	P-Pattern	W	Price 1	2-Up
PHENOLIC	64P44 062 XXXP	1 50	6 50	[illegible]	1 54
	169P44 062 XXXP	1 50	17 00	3 69	3 32
EPOXY GLASS	64P44 062	1 50	6 50	2 07	1 86
	84P44 062	1 50	8 50	2 56	2 31
	169P44 062	1 50	17 00	5 04	4 53
	169P84 062	8 50	17 00	9 23	8 26
EPOXY GLASS COPPER CLAD	169P44 062C1	4 50	17 00	6 80	6 12

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205-CB	Beryllium Copper Heat Sink with Black Finish for TO-5	.25
291-36H	Aluminum Heat Sink for TO-220 Transistors & Regulators	.25
680-.75A	Black Anodized Aluminum Heat Sink for TO-3	1.60

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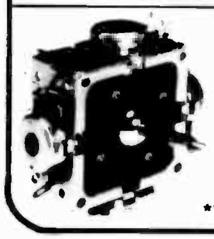
HD0165 16 LINE TO FOUR BIT PARALLEL KEYBOARD ENCODER $7.95

JOYSTICK



These joysticks feature four potentiometers, that vary resistance proportional to the angle of the stick. Sturdy metal construction with plastics components only at the movable joint. Perfect for electronic games and instrumentation.

*5K Pots $6.95
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8080	Super 8008	24.95
8080A	Super 8008	34.95
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2519	Hex 40 BIT	4.00
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ROM'S		
2513	Char. Gen.	$9.95
2516	Char. Gen.	10.95
74S387	1024-Bit Programmable	1.95

RAM'S			
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1103	1024 × 1	Dynamic	2 for 1.00
2101	256 × 1	Static	5.95
2102	1024 × 1	Static	1.75
2107	4096 × 1	Dynamic	9.95
2111	256 × 4	Static	6.95
7010	1024 × 1	MNOS	29.95
7489	16 × 4	Static	2.49
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8111	256 × 4	Static	6.95
8599	16 × 4	Static	3.49
91L02	1024 × 1	Static	2.25
74200	256 × 1	Static	6.95
93421	256 × 1	Static	2.95
MM5262	2K × 1	Dynamic	.99
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82S23	32 × 8	Open C	5.00
82S123	32 × 8	Tristate	[illegible]
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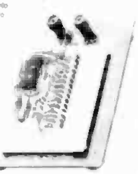
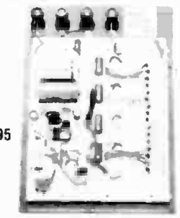


THE MINI-BREADBOARD BUDGET KIT

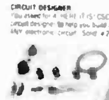


Proto Board 101 ... 29.95
Proto Board 102 ... 39.95
Proto Board 104 ... 79.95
Proto Board 103 ... 59.95

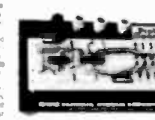
COMPLETE KIT

DESIGN MATE 1

CIRCUIT DESIGNER



PROTO BOARD 6



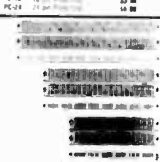
Proto Board 6 $15.95

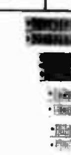
SPECIAL!

LOGIC MONITOR

Simultaneously displays static and dynamic logic states of DTL, TTL, HTL or CMOS DIP ICs. Pocket size. $84.95

QT Proto Strips





QT type	# holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.00

DIGITAL WATCHES

Ladies Watch
- 6 Function
- Bracelet Styling
- 1 Year Guarantee
- Model 900
- Specify Gold or Chrome

$69.95

EXELAR Mens Watch
- 5 Function
- Quartz Crystal
- Black Leather Band
- Manufacturer Guarantee
- Specify Gold or Chrome

$29.95

DIGITAL QUARTZ CAR CLOCK

Complete kit from mounting bracket of the injection molded case down to the three conductor power cord and all components including MM5314 clock chip. Features quartz accuracy of .01%, six digit, .35" high LED display, and P.C. Boards. Works on any 12 volt system — motorcycles, boats, vans, motorhomes, autos, and trucks.

DIMENSIONS: 4½" × 4" × 2" — 12 OR 24 HOUR MODE.

Kit: $29.95 — Assembled: $39.95

DIGITAL CLOCK KIT — 3½ INCH DIGITS

This clock features big 3½" high digits for viewing in offices, auditoriums, etc. Each digit is formed by 31 bright 0.2" LED's. The clock operates from 117 VAC, has either 12 or 24 hr. operation. The 6 digit version is 27" × 1½" × 1½", and the 4 digit is 18" × 3½" × 1½". Kits come complete with all components, case and transformer.
Specify 12 Or 24 Hr. When Ordering

4 DIGIT KIT $49.95 — 4 DIGIT ASSEMBLED $59.95
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23-Channel Synthesized CB Transceiver
SIZE: 6⅝ (W) x 2" (H) x 8¼
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POWER OUTPUT: 4 Watts RMS

MOBILE CB ANTENNA $24.95
BASE LOAD - FIBERGLASS WHIP — KA-2401
Mounts on Hood or Trunk Lid

AMTEX 8 TRACK AM/FM STEREO

FEATURES **$69.95**

- 8 track stereo player
- AM/FM mpx radio
- Advanced IC construction
- Dial on door and slide-bar switch type
- Compact — only 1-25/32" (45mm) high, 4-13/16" (122mm) deep, 6-11/16" (170mm) wide and 5 position adjustable shaft distance
- Complete in-dash type design
- Easily adjustable antenna trimmer for best performance

KRACO CAR SPEAKERS $14.95
Flush Mount 10 Oz. Mag./8 ohm — Model SST-101F

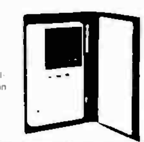
5 FUNCTION ELECTRONIC CALCULATOR RADOFIN MODEL 8P

$8.95

FEATURES:
- 8 Digit Display
- 5 Functions consists of addition, subtraction, multiplication, division, percentage, with constant on all functions, with full floating decimal point
- Power source is 1 piece 9V DC Battery 006P, jack for AC adapter
- Black superfine grained finish plastic cabinet

5 FUNCTION ELECTRONIC CALCULATOR WITH WALLET-NOTEBOOK AND POCKET CHECKBOOK RADOFIN MODEL 1710

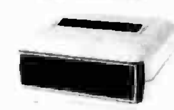
$19.95



FEATURES:
- 8 Digit Display
- 5 Functions consists of addition, subtraction, multiplication, division, percentage, with constant on all functions, with full floating decimal point
- Power source is 6 AAA cells 9 V DC
- Wallet is 2 tone texon cabinet is black plastic

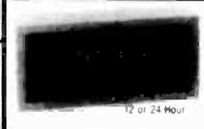
DIGITAL ALARM CLOCK — Novus

This 4 digit Novus Alarm Clock is a very reliable and smartly styled unit. It provides such features as an alarm settable to any minute of the day, a 7 minutes snooze alarm, a power failure indicator, and even an A.M., P.M. indicator.



$17.95 — NOT A KIT

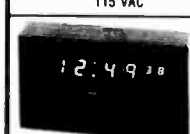
JE700 CLOCK



12 or 24 Hour — 115 VAC

The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" × 2½" × 1". It utilizes a MAN72 high brightness readout and the MM5314 clock chip.

$17.95

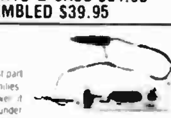


This large digit clock (.6" hours & minutes, .3" seconds) features the MM5314 clock chip. It operates from 117 VAC, and will operate in either a 12 or 24 hour mode. The clock is complete with a walnut grain case, and has fast set, slow set, and hold time set features.

KIT - ALL COMPONENTS & CASE $34.95
WIRED & ASSEMBLED $39.95

JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (HI) - 1 (LOW) - 0 (PULSE) - P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.



$9.95 Per Kit
printed circuit board

T²L 5V 1A Supply

This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **$9.95 Per Kit**

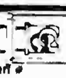
± 5 VOLT POWER SUPPLY

$39.95

Completely Assembled
- +5 Volts @ 6 Amps Regulated Output
- −5 Volts @ 6 Amps Regulated Input
- 6.3Volts @ 5 Amps Unregulated Output

Length 8⅝" x Width 6½" x Height 4"

Limited Supply



CIRCLE 45 ON FREE INFORMATION CARD

7400N TTL

Type	Price	Type	Price	Type	Price
SN7400N*	.16	SN7459A	.25		
SN7401N	.16	SN7460N	.22	SN74154N*	1.00
SN7402N	.21	SN7470N	.45	SN74155N	.99
SN7403N	.16	SN7472N	.39	SN74156N	.99
SN7404N*	.18	SN7473N*	.37	SN74157N	.99
SN7405N	.24	SN7474N*	.32	SN74160N	1.25
SN7406N	.20	SN7475N*	.50	SN74161N	.99
SN7407N	.28	SN7476N*	.32	SN74163N*	.99
SN7408N	.25	SN7479N*	5.00	SN74164N	1.10
SN7409N	.25	SN7480N	.50	SN74165N	1.10
SN7410N*	.18	SN7482N	.98	SN74166N	1.25
SN7411N	.30	SN7483N	.70	SN74167N	5.50
SN7412N	.33	SN7485N	.89	SN74170N	2.10
SN7413N	.45	SN7486N	.39	SN74172N	8.95
SN7414N	.70	SN7488N	3.50	SN74173N	1.50
SN7416N	.35	SN7489N	2.25	SN74174N	1.25
SN7417N	.35	SN7490N*	.45	SN74175N	.99
SN7420N	.21	SN7491N	.75	SN74176N	.90
SN7421N	.33	SN7492N	.49	SN74177N	.90
SN7422N*	.49	SN7493N*	.49	SN74180N	.99
SN7423N	.37	SN7494N	.79	SN74181N	2.49
SN7425N	.29	SN7495N	.79	SN74182N	.95
SN7426N	.29	SN7496N	.89	SN74184N	1.95
SN7427N	.37	SN7497N*	4.00	SN74185N	2.20
SN7429N	.42	SN74100N*	1.00	SN74186N*	5.00
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SN7437N	.27	SN74122N	.39	SN74190N	1.19
SN7438N	.27	SN74123N*	.70	SN74191N	1.25
SN7439N	.25	SN74125N	.60	SN74192N*	.89
SN7440N	.15	SN74126N	.60	SN74193N*	.89
SN7441N	.89	SN74132N	1.09	SN74194N	1.25
SN7442N	.59	SN74136N	.95	SN74195N	.75
SN7443N	.75	SN74141N	1.15	SN74196N	1.25
SN7444N	.75	SN74142N*	4.00	SN74197N	.75
SN7445N	.75	SN74143N*	4.50	SN74198N	1.75
SN7446N	.81	SN74144N*	4.50	SN74199N	1.75
SN7447N*	.69	SN74145N	1.15	SN74200N	5.59
SN7448N	.79	SN74147N	2.35	SN74279N*	.90
SN7450N	.26	SN74148N	2.00	SN74251N	1.79
SN7451N	.27	SN74150N	1.00	SN74284N	6.00
SN7453N	.27	SN74151N	.79	SN74285N	6.00
SN7454N	.20	SN74153N	.89	SN74367N	.75

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20% Discount for 100 Combined 7400's

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Type	Price	Type	Price	Type	Price
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CD4001	.25			74C10N	.65
CD4002	.25	CD4035	1.85	74C20N	.65
CD4006	2.50	CD4040	2.45	74C30N	.65
CD4007	.25	CD4042	1.90	74C42N	2.15
CD4009	.59	CD4044	1.50	74C73N	1.50
CD4010	.59	CD4046	2.51	74C74	1.15
CD4011	.25	CD4047	2.75	74C90N	3.00
CD4012	.25	CD4049	.79	74C95N	2.00
CD4013	.47	CD4050	.79	74C107N	1.25
CD4016	.56	CD4051	2.95	74C151	2.90
CD4017	1.35	CD4053	2.95	74C154	4.00
CD4019	.55	CD4060	3.25	74C157	2.15
CD4020	1.49	CD4066	1.75	74C160	3.25
CD4022	1.25	CD4069	.45	74C161	3.25
CD4023	.25	CD4071	.45	74C163	3.00
CD4024	1.50	CD4081	.45	74C164	3.25
CD4025	.25	CD4511	2.50	74C173	2.60
CD4027	.69	CD4518	2.50	74C193	2.75
CD4028	1.65	CD4566	3.00	74C195	2.75
CD4029	2.90	74C00N	.39	MC4044*	4.50
CD4030	.65	74C02N	.55	MC14016*	.56

LINEAR

Type	Price	Type	Price	Type	Price
LM300H	.80			LM1310N	2.95
LM301H	.35			LM1351N	1.65
LM301CN	.35			LM1414N	1.75
LM302H	.75			LM1458C	.65
LM304H	1.00	LM370N	1.15	LM1496N	.95
LM305H	.95	LM373N	3.25	LM1556V	1.85
LM307CN	.35	LM377N	4.00	LM2111N	1.95
LM308H	1.00	LM380N	1.39	LM2901N	2.00
LM308CN	1.00	LM380CN	1.05	LM3065N	.69
LM309H	1.10	LM381N	1.79	LM3900N	.55
LM309K	.99	LM382N	1.79	LM3905N	.60
LM310CN	1.15	NE501K	8.00	LM3909*	1.25
LM311H	.90	NE510A	6.00	LM5556N	1.85
LM311N	.90	NE531H	3.00	MC5558V	1.00
LM318CN	1.50	NE536T	6.00	LM7525N	.90
LM319N	1.30	NE540L	6.00	LM7535N	1.25
LM320K-5	1.35	NE550N	.79	8038B*	4.95
LM320K-5.2	1.35	NE555V*	.45	LM75450	.49
LM320K-12	1.35	NE560B*	5.00	75451CN	.39
LM320K-15	1.35	NE561B*	5.00	75452CN	.39
LM320T-5*	1.75	NE562B*	5.00	75453CN	.39
LM320T-5.2	1.75	NE565H*	1.25	75454CN	.39
LM320T-8*	1.75	NE565N*	1.25	75491CN	.79
LM320T-12*	1.75	NE566CN*	1.25	75492CN	.89
LM320T-15	1.75	NE567H*	1.95	75494CN	.89
LM320T-18*	1.75	NE567V*	1.50	RCA LINEAR	
LM320T-24	1.75	LM703CN	.45	CA3013	2.15
LM323K-5*	9.95	LM709H	.29	CA3023	2.56
LM324N	1.80	LM709N	.29	CA3035	2.48
LM339N	1.70	LM710N	.79	CA3039	1.35
LM340K-5	1.95	LM711N	.39	CA3046	1.30
LM340K-6	1.95	LM723H	.55	CA3059	3.25
LM340K-8	1.95	LM723N	.55	CA3060	3.25
LM340K-12	1.95	LM733N	1.00	CA3080	.85
LM340K-15	1.95	LM739N	1.00	CA3081	2.00
LM340K-18	1.95	LM741CH	.35	CA3082	2.00
LM340K-24	1.95	LM741CN	.35	CA3083	1.60
LM340T-5	1.75	LM74114N	.39	CA3086	.85
LM340T-6	1.75	LM747H	.79	CA3089	3.75
LM340T-8*	1.75	LM747N	.79	CA3091	10.20
LM340T-12	1.75	LM748H	.39	CA3123	2.15
LM340T-15	1.75	LM748N	.39	CA3130	1.39
LM340T-18*	1.75	LM1303N	.90	CA3140	1.25
LM340T-24	1.75	LM1304N	1.19	CA3600	1.75
LM350N	1.00	LM1305N	1.40	RC4194	5.95
LM351CN	.65	LM1307N	.85	RC4195	3.25

74LS00 TTL

Type	Price	Type	Price	Type	Price
74LS00	.39			74LS139	1.95
74LS02	.39			74LS151	1.55
74LS03	.39	74LS74	.65	74LS153	1.89
74LS04	.45	74LS75	.79	74LS157	1.55
74LS05	.45	74LS76	.65	74LS162	2.25
74LS08	.39	74LS83	2.19	74LS163	2.25
74LS10	.39	74LS85	2.49	74LS164	2.25
74LS13	.79	74LS86	.65	74LS175	1.95
74LS14	2.19	74LS90	1.25	74LS181	3.69
74LS20	.39	74LS92	1.25	74LS190	2.85
74LS26	.49	74LS93	1.25	74LS191	2.85
74LS27	.45	74LS95	2.19	74LS192	2.85
74LS28	.49	74LS96	1.89	74LS193	2.85
74LS30	.39	74LS107	.65	74LS194	2.25
74LS32	.45	74LS109	.65	74LS195	2.25
74LS40	.49	74LS112	.65	74LS257	1.89
74LS51	.39	74LS132	1.55	74LS260	.55
74LS55	.39	74LS136	.65	74LS279	.79
74LS73	.65	74LS138	1.89	74LS670	5.95

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FEATURES OF PONG AND SUPER PONG
- Incremental speed on volleys increases excitement.
- Playing field adjusts to any size screen.
- Game appears in color or in black & white, depending on television set.
- Unmistakable "PONG" sound accompanies each volley.
- Digital scoring flashes on the screen between each point.
- 2 player challenge or Solitaire.
- Hooks up simply to any model television set: the screen actually becomes the playing field.
- English and other techniques can be used to make any member of the family a Pong champion.
- Battery operated by 4 size "D" flashlight batteries included with the Unit.

AC Adaptor (Eliminates Batteries) $9.95

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.125" dia.
XC209Red 10/$1
XC209Green 4/$1
XC209Yellow 4/$1
XC209Orange 4/$1

.190" dia.
XC111Red 10/$1
XC111Green 4/$1
XC111Yellow 4/$1
XC111Orange 4/$1

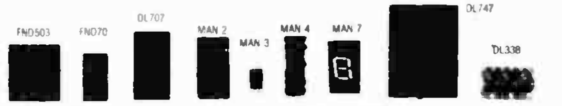
.200" dia.
XC22Red 10/$1
XC22Green 4/$1
XC22Yellow 4/$1
XC22Orange 4/$1
SSL-22RT 4/$1

.185" dia.
XC526Red 10/$1
XC526Green 4/$1
XC526Yellow 4/$1
XC526Orange 4/$1
XC526Clear 4/$1

.200" dia.
XC556Red 10/$1
XC556Green 7/$1
XC556Yellow 7/$1
XC556Orange 7/$1
XC556Clear 7/$1

.085" dia.
MV50
.085" dia. Micro red LED
6/$1

DISPLAY LEDS



TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	Common Anode	.270	2.95	MAN 3620	Common Anode-orange	.300	1.75
MAN 2	5 x 7 Dot Matrix	.300	4.95	MAN 3640	Common Cathode-orange	.300	1.75
MAN 3	Common Cathode	.125	.39	MAN 4710	Common Anode-Red	.400	1.95
MAN 4	Common Cathode	.187	1.95	DL701	Common Anode-red	.300	1.85
MAN 7	Common Anode	.300	1.25	DL707	Common Anode	.300	1.50
MAN 7G	Common Anode-green	.300	1.95	DL 728	Common Cathode	.500	2.95
MAN 7Y	Common Anode-yellow	.300	1.95	DL 747	Common Anode	.600	2.25
MAN 52	Common Anode-green	.300	1.75	DL 750	Common Cathode	.600	2.49
MAN 64	Common Anode-red	.400	1.75	DL 338	Common Cathode	.110	.99
MAN 72	Common Anode	.300	1.25	FND70	Common Cathode	.250	.75
MAN 74	Common Cathode	.300	1.50	FND503	Common Cathode	.500	1.29
MAN 82	Common Anode-yellow	.300	1.75	FND507	Common Anode	.500	1.29
MAN 84	Common Cathode-yellow	.300	1.75				

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	.16	.15	24 pin	$.38	.37	.36
14 pin	.20	.19	.18	28 pin	.45	.44	.43
16 pin	.22	.21	.20	36 pin	.60	.59	.58
18 pin	.29	.28	.27	40 pin	.63	.62	.61
22 pin	.37	.36	.35				

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin	$.27	.25	.24	28 pin	$.99	.90	.81
16 pin	.30	.27	.25	36 pin	1.39	1.26	1.15
18 pin	.35	.32	.30	40 pin	1.59	1.45	1.30
24 pin	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.30	.27	.24	24 pin	$.70	.63	.57
14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
16 pin	.38	.35	.32	36 pin	1.75	1.40	1.26
18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
10 pin	$.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea.	10 OHM, 12 OHM, 15 OHM, 18 OHM, 22 OHM	27 OHM, 33 OHM, 39 OHM, 47 OHM, 56 OHM	1/4 WATT 5% = 50 PCS.
ASST. 2	5 ea.	68 OHM, 82 OHM, 100 OHM, 120 OHM, 150 OHM	180 OHM, 220 OHM, 270 OHM, 330 OHM, 390 OHM	1/4 WATT 5% = 50 PCS.
ASST. 3	5 ea.	470 OHM, 560 OHM, 680 OHM, 820 OHM, 1K	1.2K, 1.5K, 1.8K, 2.2K, 2.7K	1/4 WATT 5% = 50 PCS.
ASST. 4	5 ea.	3.3K, 3.9K, 4.7K, 5.6K, 6.8K	8.2K, 10K, 12K, 15K, 18K	1/4 WATT 5% = 50 PCS.
ASST. 5	5 ea.	22K, 27K, 33K, 39K, 47K	56K, 68K, 82K, 100K, 120K	1/4 WATT 5% = 50 PCS.
ASST. 6	5 ea.	150K, 180K, 220K, 270K, 330K	390K, 470K, 560K, 680K, 820K	1/4 WATT 5% = 50 PCS.
ASST. 7	5 ea.	1M, 1.2M, 1.5M, 1.8M, 2.2M	2.7M, 3.3M, 3.9M, 4.7M, 5.6M	1/4 WATT 5% = 50 PCS.
ASST. 8R		All Seven Resistor Assortment		$10.95 ea.

5-25 PCS .05 ea 30-95 PCS .04 ea 100-495 PCS .03 ea 500-995 .0275 ea

SINGLE TURN 3/4" CERMET POTENTIOMETER

- Resistance Tolerance ± 20%
- High Power — 0.5 Watt at 70°C
- Wide Operating Temp. Range −55°C to +125°C

$.89

STANDARD RESISTANCE VALUES
50Ω 100Ω 500Ω 1K 2K 5K 10K 20K 50K 100K 200K 500K 1 MEG

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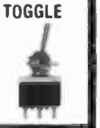
MINIATURE TOGGLE



					1	2-9	10-20	20-50
SPDT	ON	OFF	ON	221	2.95	2.55	1.87	1.70
	ON	NONE	ON	223	2.95	2.15	1.58	1.43
DPDT	ON	OFF	ON	121	2.35	1.95	1.43	1.30
	ON	NONE	ON	122	2.08	1.85	1.21	1.10

PUSH BUTTON

SPDT — SERIES PB. PB1

PB-123 $1.75
PB-126 $1.75

5 AMP RATINGS

THUMBWHEEL SWITCHES

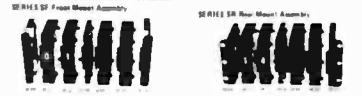
THUMBWHEEL SWITCH ONLY

Single Pole 10 Position Decimal
10 Position BCD only

Ordering: Order desired switch or switches and add necessary accessories for your particular application.

SF = Front Mount SR = Rear Mount

SERIES SF Front Mount Assembly — SERIES SR Rear Mount Assembly



ACCESSORIES: End Plate (pair), Divider Plate (each), Blank Body (each), Half Body (each)

DIP SWITCH

These switches feature seven SPST slide switches in a molded dip. They are ideally suited for microprocessor applications.

$1.95

CLIPLITE !! 4/$1.00

NEW LED MOUNTING SYSTEM

- CLIPLITE mounts from the front of the Panel in a .250 hole on 3/8" centers. Panel thickness from 1/16" to 1/8".
- CLIPLITE equalizes and increases the brightness of commonly used wide beam LEDS.
- CLIPLITE is to be used with XC556 LEDS.
- Specify colors—red, green, amber, or yellow when ordering.

ZENERS—DIODES—RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005*	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006*	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007*	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25M	20/1.00
1N5232	5.6	500m	.28	1N4734	5.6	1w	.28
1N5234	6.2	500m	.28	1N4735	6.2	1w	.28
1N5235	6.8	500m	.28	1N4736	6.8	1w	.28
1N5236	7.5	500m	.28	1N4738	8.2	1w	.28
1N456	25	40m	6/1.00	1N4742	12	1w	.28
1N458	150	7m	6/1.00	1N4744	15	1w	.28
1N485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.70
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	25A @ 50V	FW BRIDGE REC	1.95
MDA 980-3	25A @ 200V	FW BRIDGE REC	1.95

TRANSISTORS

Type	Price	Type	Price	Type	Price
MPS A05	5/$1.00			PN4249	4/$1.00
MPS A06	5/$1.00			PN4250	4/$1.00
2N2219A	3/$1.00	PN3567	3/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	PN3568	4/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	PN3569	4/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3704	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3705	5/$1.00	2N4409	5/$1.00
PN2415	5/$1.00	2N3706	5/$1.00	2N5086	4/$1.00
2N2484	4/$1.00	2N3707	5/$1.00	2N5087	4/$1.00
2N2906A	4/$1.00	2N3711	5/$1.00	2N5088	4/$1.00
2N2907A	5/$1.00	2N3724	$.65	2N5089	4/$1.00
2N2925	5/$1.00	2N3725	$1.00	2N5129	5/$1.00
2N3053	2/$1.00	2N3903	5/$1.00	2N5138	5/$1.00
2N3055	$.89	2N3904	4/$1.00	2N5139	5/$1.00
MJE3055	$1.00	2N3905	4/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N3906	4/$1.00	2N5951	5/$1.00
2N3392	5/$1.00	2N4013	3/$1.00	C106B1SCR	2/$1.00
2N3398	5/$1.00	2N4014	3/$1.00	2N5432	$2.00
		2N4123	10/$1.00	40673	1.75ea.

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001μF	.05	.04	.035
22 pf	.05	.04	.03	.0047μF	.05	.04	.035
47 pf	.05	.04	.03	.01μF	.05	.04	.035
100 pf	.05	.04	.03	.022μF	.06	.05	.04
220 pf	.05	.04	.03	.047μF	.06	.05	.04
470 pf	.05	.04	.035	.1μF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead	1-9	10-49	50-100	Radial Lead	1-9	10-49	50-100
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.15	.13	.10	1.0/16V	.15	.13	.10
4.7/25V	.16	.14	.12	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

JAPANESE transistors. All transistors original factory made. Free catalog. **WEST PACIFIC ELECTRONICS,** P. O. Box 25837, W. Los Angeles, CA 90025

IN-circuit transistor tester. Tone indicates good transistor. Plans $2.00. **ZACH SCIENTIFIC**, 39 Bayberry Lane, Levittown, NY 11756

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(Not A Kit)

Only $22.50

ON SALE $17.50 ea.

NEW CLOCK KITS!

MODEL OC1032

JUMBO DIGITS ALARM CLOCK
1.2" Bright Yellow Color Readouts

Features. 12/24 Hour Display, 24 Hour Alarm Set, 10 Min Snooze Switch, AM/PM Indicator
Kit Includes: Woodlike Color Plastic Case, 4 Digit 1.2" Neon Display with AM/PM. TMS 3834 Alarm Chip, 2 pcs. double sided PC Boards, 16 transistors, all other components, Transformer and speaker

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Features: 12/24 Hour Displays, 24 Hour Alarm Set, 10 Min Snooze Switch, AM/PM Display.
Kit Includes. Orange Color Plastic Case, 0.5" LD8132 Green Color Readouts PC boards with transformer, all electronic parts with speaker.

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THE MOST POPULAR MM5314 KIT

WITH A NEW CASE!!
Features. 12/24 Hour Display 50/60 HZ Input 6 Digits Readout
Kit Includes: Grey Color Plastic Case MM5314 Clock Chip PC Boards and Transformer, 6 Green Color 0.3" Tube Readouts, All other transistor Drivers and other Components.

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Drive 6 Fairchild FND 0.5" Red LED with MONTH & DATE 50/60HZ and ALARM

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CASE ONLY $6.00 EACH

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Standard Teletype Keyboards with gold plated contact switches. All switches are independent and allow you to connect into any form of output. **Only $22.50**

ASCII KEYBOARD ENCODER CHIP

G1 AY-5-3600

40 pin DIP package, 4 level, 10 BITS per level, encoding for up to 90 keys. Latched data outputs and control signal output, TTL compatibility for all controls.

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COMPLETE ASCII DECODED KEYBOARD KIT
(Using the above 64 key keyboard and the AY-5 encoder chip.) Kit includes keyboard, PC board, encoder LSI chip, TTLIC, LED, all electronic components and the instructions.
ONLY $54.50

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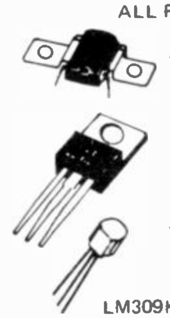

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MINI SIZE REGULATOR
in TO-92 package
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3 AMP POWER SUPPLY

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Output 5V and 12V
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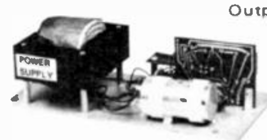
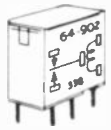


only $19.50

*Postage for this item $2.50



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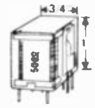
SPDT 4 amp
$1.25 ea.



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6V 6AMPH YUASA
Wet Rechargeable Battery
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NI-CD FAST CHARGE

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BATTERIES
BY SANYO
ALL BRAND NEW
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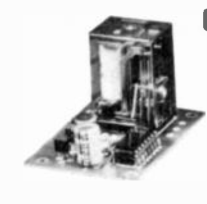
The Crimelighter Auto Alarm is an electronic, self controlled auto protection system normally mounted within the glove box of an automobile. Two minutes after turning off the ignition the alarm automatically turns itself "on." When the auto is re-entered, the horn will sound after a 10-45 second entry delay. The automobile owner, by inserting the ignition key, will activate the alarm. Once activated the alarm will sound for two minutes before automatically turning off. The alarm then resets and is ready to again protect the vehicle from unwanted entry.

FEATURES: Simple installation 5 wires, Automatically turns on when auto is parked. Adjustable entry time, Extended exit time to allow for unrushed exit from vehicle, Numerous applications include protection of boats, campers, trailers, motorcycles, trucks. Cannot be deactivated by "hot wiring" an auto, Cannot be turned off without ignition key. Negative ground only.

ONLY $10.00 per kit Completed Unit $16.00

ELECTRONIC SWITCH KIT



CONDENSER TYPE
Touch on Touch Off
use 7473 I.C.
and 12V relay
$5.50 each

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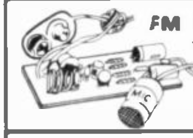

Transmit range up to 500ft.
Easy to assemble
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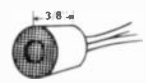
Sub-Mini Size
Condenser Microphone
$2.50 each



5W AUDIO AMP KIT

USE 2 LM380
with Volume Control
POWER SUPPLY 6VDC

only $5.00 ea.

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Fairchild FSC 8000
0.8 Red LED 3½ Digits
with AM-PM
Direct Drive by MM 5316 or Fairchild 3817
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JUMBO LED

Fairchild
FND 800
0.8 Common Cathode
Red Color
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DL 747	RZ D	$2.50
DL 727	Double Digit	$2.50
DL 707	0.3 Red	$1.30
FND 70	0.25 Red	$0.60
FND 503	0.5" Red	$1.60
FLV 50	Submini Red	$0.15 ea
FLV 209	Mini Red	$0.15 ea
	Jumbo Red	$0.15 ea
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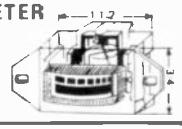
50 UA PANEL METER

Size 2¼" x 2½"

First designed for metal Finder Scaled from 0 10 but can be erased and your own scale put on top. Brand new in box. Only $3.80 ea.

150UA METER

only $1.50 ea.

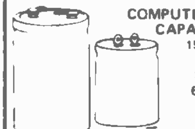


QUAD VOLUME CONTROL

(JOY STICK)

4 100K Volume pot in one unit very resistence proportional to the angle of the stick. Perfect for electronic games or model remote control

only $5.60



COMPUTER GRADE CAPACITOR
15500 MFD
75V DC
$5.95 ea
6000 MFD
75V DC
$4.00 ea
Postage for above items $.50 ea

SAE DIP SWITCHES

Part No 1004 692 4×SPST SW
1008 692 8×SPST SW

4 Toggle SPST Switches on a Mini DIP (8 pins) Only $1.50 ea
8 Toggle SPST Switches on a DIP (16 pins) Only $2.60 ea

SUBMINIATURES TOGGLE SWITCHES

SPDT On None On $1.30ea
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EECO BCD THUMBWHEEL SWITCHES

8 positions	$1.25 ea
10 positions	$2.15 ea
12 positions	$2.50 ea

COLORFUL SUB MINI PUSH BUTTON SWITCH
Nor Open Contact
Color Red, Green, Yellow Black
4 for $1.00

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1MHZ Computer Crystals $4.25 ea
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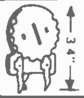
Use with Nation MM 5369 to make a perfect time base for clock

NATIONAL MM 5369 17-STAGE PROGRAMMABLE OSC/DIVIDER generate A 60 Hz reference Frequency with a 3.58 MHZ Color TV X'TAL in Mini DIP Package

ONLY $2.25 each

COMPLETE 60HZ DC TIME BASE KIT
Kit includes MM5369, X'TAL, capacitor, resistor and PC board
SPECIAL PRICE ONLY $5.25 each

THUMBWHEEL TRIM POTS



VALVE 300Ω, 2K, 2.5K, 5K, 10K, 12K, 50K, 1M

Special Offer 5 for $1.00

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INTEL C8008 CPU	$9.95 ea
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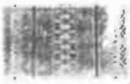

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7474	.23	309K	.99	1702	8.95	MAN5	1.59
7486	.33	311	.79	2102	1.49	MAN8	1.69
7490	.39	340T-5V	.99	5203	8.95	LED's	
74107	.29	723	.39	5260	.95	JUMBO CLEAR	.13
74123	.59	741	.25	5261	.95	JUMBO ORANGE	.15
9602	.59	1414	1.69	F93410	1.39	MV50	10/$1.00

TTL

7400	.13	7451	.17	74153	.89
7401	.16	7453	.17	74154	1.20
7402	.15	7454	.17	74155	.97
7403	.15	7460		74156	.97
7404	.16	7464	.35	74157	.99
7405	.19	7465	.35	74158	1.79
7406	.20	7470	.30	74160	1.23
7407	.28	7472	.30	74161	.97
7408	.18	7473	.35	74162	1.39
7409	.19	7474	.28	74163	1.09
7410	.16	7475	.49	74164	.99
7411	.25	7476	.30	74165	.99
7413	.43	7483	.68	74166	1.25
7414	.65	7485	.88	74170	2.10
7416	.35	7486	.40	74173	1.49
7417	.35	7489	2.25	74174	1.23
7420	.16	7490	.43	74175	.97
7422	.30	7491	.75	74176	.89
7423	.29	7492	.48	74171	.84
7425	.27	7493	.48	74180	.90
7426	.26	7494	.78	74181	2.45
7427	.29	7495	.79	74182	.79
7430	.20	7496	.79	74184	1.90
7432	.23	74100	.98	74185	2.20
7437	.25	74105	.64	74187	5.75
7438	.25	74107	.37	74190	1.15
7440	.15	74121	.38	74191	1.25
7441	.89	74122	.38	74192	.95
7442	.59	74123	.65	74193	.85
7443	.73	74125	.54	74194	1.25
7444	.73	74126	.58	74195	.74
7445	.73	74132	.89	74196	1.25
7446	.81	74141	1.04	74197	.73
7447	.79	74145	1.04	74198	1.73
7448	.79	74150	.97	74199	1.69
7450	.17	74151	.79	74200	5.45

LOW POWER

74L00	.29	74L51	.29	74L90	1.40
74L02	.29	74L55	.29	74L91	1.20
74L03	.23	74L71	.29	74L93	1.50
74L04	.29	74L72	.45	74L95	1.50
74L06	.29	74L73	.56	74L98	2.25
74L10	.29	74L74	.56	74L164	2.25
74L20	.29	74L78	.75	74L165	2.30
74L30	.29	74L85	1.09		
74L42	1.39	74L86	.65		

LOW POWER SCHOTTKY

74LS00	.36	74LS32	.38	74LS95	2.09
74LS02	.36	74LS40	.45	74LS107	.59
74LS04	.36	74LS42	1.40	74LS164	2.20
74LS08	.38	74LS74	.59	74LS193	2.20
74LS10	.36	74LS90	1.30	74LS197	2.20
74LS20	.36	74LS93	1.30		

HIGH SPEED

74H00	.25	74H22	.25	74H61	.25
74H01	.25	74H30	.25	74H62	.25
74H04	.25	74H40	.25	74H74	.39
74H08	.25	74H50	.25	74H101	.58
74H10	.25	74H52	.25	74H102	.58
74H11	.25	74H53	.25	74H103	.60
74H20	.25	74H55	.25	74H106	.72
74H21	.25	74H60	.25	74H108	.72

SCHOTTKY

74S00	.38	74S08	.52	74S22	.38
74S02	.45	74S10	.38	74S32	.52
74S03	.38	74S20	.38	74S74	.38
74S04	.45				

8000 (NATIONAL)

8091	.61	8220	1.49	8811	.65
8092	.61	8230	2.19	8812	1.02
8095	1.25	8288	1.49	8822	2.19
8121	.80	8520	1.16	8830	2.19
8123	1.43	8552	2.19	8831	2.19
8200	2.33	8563	.62	8836	.29
8214	1.49	8810	.70	8880	1.19

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8263	5.79	8267	2.59

9000

9002	.40	9309	.79	9601	.61
9301	1.03	9312	.79	9602	.79

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Solder Tail - low profile

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16 pin	.22	40 pin	.69
18 pin	.29		

WIRE WRAP - gold plate
14 pin .49

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4000A	.26	4018A	1.39	4066A	.89
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4002A	.25	4021A	1.18	4069A	.44
4006A	1.35	4022A	.94	4071A	.26
4007A	.26	4023A	.25	4072A	.35
4008A	1.52	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
4010A	.54	4027A	.59	4078A	.39
4011A	.29	4028A	.98	4082A	.35
4012A	.25	4030A	.44	4518A	1.56
4013A	.45	4035A	1.27	4528A	1.56
4014A	1.27	4040A	1.39	4585A	2.10
4015A	1.27	4042A	1.47		
4016A	.48	4049A	.59		
4017A	1.01	4050A	.59		
74C00	.19	74C74	1.04	74C162	2.49
74C02	.26	74C76	1.34	74C163	2.66
74C04	.44	74C107	1.13	74C164	2.66
74C08	.68	74C151	2.62	74C173	2.22
74C10	.35	74C154	3.15	74C195	2.26
74C20	.35	74C157	1.76	80C95	1.15
74C42	1.61	74C160	2.48	80C97	.96
74C73	1.04	74C161	2.49		

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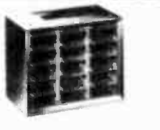

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3.3	5	1.0K	20	68K	10
6.8	5	1.5K	10	100K	20
10	10	2.2K	20	150K	10
15	5	2.7K	10	220K	10
22	5	3.3K	10	270K	5
33	5	3.9K	10	330K	10
47	10	4.7K	20	470K	10
68	5	6.8K	10	680K	10
100	10	10K	20	1.0M	20
150	10	15K	10	1.5M	5
220	10	22K	10	2.2M	5
270	5	27K	10	3.3M	5
330	10	33K	20	4.7M	5
470	20	39K	10		

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4.7 ufd 16V 6.8 ufd 6V 10 ufd 25V 15 ufd 20V
22 ufd 16V 33 ufd 10V 47 ufd 6V 56 ufd 6V

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2102	1024 bit RAM static 16 pin	1.95
5203	2048 bit PROM static electrically programmable UV erasable 24 pin	10.95
5260	1024 bit RAM MOS dynamic 16 pin	1.95
5261	1024 bit RAM MOS dynamic 16 pin	1.95
7489	64 bit ROM TTL 16 pin	2.25
82S23	256 PROM-SCHOTTKY 16 pin	3.69
F93410	256 bit RAM bi-polar 16 pin	1.95
74187	1024 bit ROM TTL 16 pin	5.75
74200	256 bit RAM tri-state 16 pin	5.45

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1 mfd	35V	.25	15 mfd	10V	.40
2.2 mfd	20V	.25	15 mfd	20V	.45
2.2 mfd	35V	.30	22 mfd	16V	.45
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4.7 mfd	16V	.30	47 mfd	6V	.40
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6.8 mfd	50V	.40	150 mfd	15V	.50

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2 PC Boards Clock & Display
All Transistors, Resistors
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MAN2	3.95	MV50	.12
MAN3A	.19	NSL100	.12
MAN5	2.25	NSL101	.12
MAN6	2.49	NSL102	.15
MAN7	1.49		
MAN8	2.25	MV5020	
MAN66	2.25	RED	.15
DL10A	2.19	GREEN	.15
FND500	1.89	AMBER	.15
NS71L	1.39	CLEAR	.15

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SP-425-09	9 digit .25 gas disch.	1.79

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MCD2	Opto isolator diode	1.09
MCT2	Opto isolator transistor	.70

LINEAR CIRCUITS

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305	Pos V Reg TO-5	.71
307	Op AMP (super 741) mDIP TO-5	.26
308	Micro Pwr Op Amp mDIP TO-5	.89
309K	5V 1A regulator TO-3	1.35
310	V Follower Op Amp mDIP	1.07
311	Hi perf V Comp mDIP TO-5	.95
319	Hi Speed Dual Comp DIP	1.13
320T	Neg Reg 5, 12, TO-220	1.39
320K	Neg Reg 5.2, 12 TO-3	1.39
322	Precision Timer DIP	1.70
324	Quad Op Amp DIP	1.52
339	Quad Comparator DIP	1.58
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340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-220	1.49
370	AGC/Squelch AMPL DIP	1.20
372	AF-IF Strip detector DIP	2.93
373	AM FM/SSB Strip TO-5	2.42
376	Pos V Reg mDIP	.68
380	2w Audio Amp DIP	1.30
380-8	.6w Audio Amp mDIP	1.25
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382	Lo Noise Dual preamp DIP	1.75
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556A	Dual 555 Timer DIP	1.19
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562	Phase Locked Loop DIP	3.39
565	Phase Locked Loop DIP TO-5	1.18
566	Function Gen mDIP TO-5	1.95
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709	Operational AMP TO-5 or DIP	.26
710	Hi Speed Volt Comp DIP	.35
711	Dual Difference Compar DIP	.26
723	V Reg DIP	.62
733	Diff. video AMPL TO-5	1.02
739	Dual Hi Perf Op Amp DIP	1.07
741	Comp Op Amp mDIP TO-5	.32
747	741 Dual Op Amp DIP or TO-5	.71
748	Freq Adj 741 mDIP	.35
1304	FM Mulps Stereo Demod DIP	1.07
1307	FM Mulps Stereo Demod DIP	.74
1456	Op Amp mDIP	1.83
1458	Dual Comp Op Amp mDIP	.62
1800	Stereo multiplexer DIP	2.48
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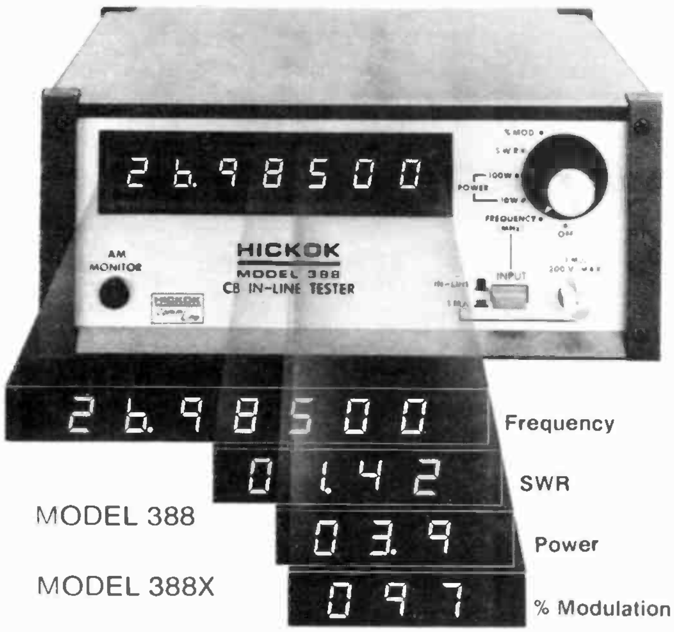

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4001–	.25	4018–	1.40	4047–	2.60
4002–	.25	4019–	.60	4049–	.70
4006–	1.60	4022–	1.20	4050–	.70
4007–	.25	4023–	.25	4055–	1.20
4009–	.60	4024–	1.25	4066–	1.20
4010–	.60	4025–	.25	4071–	.30
4011–	.25	4027–	.65	4077–	.70
4012–	.25	4028–	1.50	4081–	.35
4013–	.50	4029–	1.75	4076–	1.20
4015–	1.40	4030–	.90		

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100	.06	.14	.30	.80	3.70
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400	.09	.25	.50	1.40	6.50
600	.11	.30	.70	1.80	8.50
800	.15	.35	.90	2.30	10.50
1000	.20	.45	1.10	2.75	12.50

SILICON SOLAR CELLS

2¼" diameter
.5V at 500 ma. . . . . $5.00 ea., 6/$27.50

REGULATED MODULAR POWER SUPPLIES

+– 15 VDC AT 100ma 115VAC INPUT	$27.95
5VDC AT 1A, 115VAC INPUT	$24.95
12 VDC AT .5 AMP	$24.95
IN 4148 (IN914)	15/$1.00

TANTULUM CAPACITORS

.22UF 35V	5/$1.00	6.8UF 35V	3/$1.00
.47UF 35V	5/$1.00	22UF 35V	$ .40
.68UF 35V	5/$1.00	33UF 35V	$ .40
1UF 35V	5/$1.00	30UF 6V	5/$1.00
3.3UF 35V	4/$1.00	100UF 35V	$ .50
4.7UF 35V	4/$1.00	150UF 15V	$ .40

M7001 ALARM CLOCK CHIP . . . $6.00

NATIONAL MOS DEVICES

MM1402–	1.75	MM5057–	2.25
MM1403–	1.75	MM5058–	2.75
MM1404–	1.75	MM5060–	2.75
MM5013–	2.50	MM5061–	2.50
MM5016–	2.50	MM5555–	4.75
MM5017–	2.70	MM5556–	4.75
MM5055–	2.25	MM5210–	1.95
MM5056–	2.25		

TTL IC SERIES

74L00–	.25	7441–	.85	74126–	.60
7400–	.16	7442–	.55	74150–	1.00
7401–	.18	7445–	.75	74151–	.80
7402–	.18	7446–	.80	74153–	.79
7403–	.22	7447–	.69	74154–	1.05
7404–	.22	7448–	.77	74155–	1.00
7405–	.22	7472–	.40	74157–	.75
7406–	.35	7473–	.40	74161–	1.00
7407–	.33	7474–	.40	74164–	1.05
7408–	.25	7475–	.50	74165–	1.05
7409–	.25	7476–	.40	74173–	.95
7410–	.16	7480–	.48	74174–	1.20
7411–	.25	7483–	.80	74175–	.95
7412–	.40	7485–	.88	74177–	1.00
7413–	.45	7486–	.45	74180–	1.00
7414–	1.00	7489–	2.00	74181–	2.40
7416–	.33	7490–	.48	74190–	1.15
7417–	.33	7491–	.75	74191–	1.10
7420–	.18	7492–	.49	74192–	.80
7425–	.30	7493–	.49	74193–	.90
7426–	.35	7494–	.80	74194–	1.25
7427–	.28	7495–	.80	74195–	.74
7430–	.16	7496–	.73	74196–	1.10
7432–	.30	74107–	.40	75324–	1.75
7437–	.30	74121–	.39	75491–	.60
7438–	.30	74123–	.75	75492–	.60
7440–	.18	74125–	.60		

MINIATURE DIP SWITCHES
CTS-206-4 Four SPST switches in one minidip package . . . $1.50
CTS-206-8 Eight SPST switches in a 16 pin DIP package . . . $2.55

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ALCO MINIATURE TOGGLE SWITCHES
MTA 106 SPDT . . . $1.20
MTA 206 DPDT . . . $1.70

Full Wave Bridges

PRV	2A	6A	25A
200	.95	1.25	2.00
400	1.15	1.50	3.00
600	1.35	1.75	4.00

SANKEN AUDIO POWER AMPS

Si 1010 G 10 WATTS	$ 6.90
Si 1020 G 20 WATTS	$13.95
Si 1050 G 50 WATTS	$24.95

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CCD 201 100 x 100 CHARGE COUPLED DEVICE . . . $135.00

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LM 309K 5V 1A REGULATOR	$1.16
723 – 40 + 40VV REGULATOR	$ .50
301/748-Hi Per. Op. Amp.	$ .31
320T 5, 12, 15, OR 24V NEGATIVE REG.	$1.50
709C – Op. Amp.	$ .31
741A or 741C OP AMP.	$ .31
710 COMPARATOR	$ .35
CA 3047 Hi Pef. Op. Amp.	$ .95
340T 5, 6, 8, 12, 15, 18, 24V POS REG. TO-220	$1.50
101 OPER. AMP. HI PERFORM.	$ 75
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747 – DUAL 741	$ .65
556 – DUAL TIMER	$1.00
537 – PRECISION OP. AMP.	$1 70
LM 3900 – QUAD OP. AMP	$ .49
LM 324 – OUAD 741	$1.50
560 – PHASE LOCK LOOP	$2.00
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566 FUNCTION GEN.	$1.65
567 – TONE DECODER	$1.50
LM 1310N FM STEREO DEMOD.	$2.75
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555 – 2µs – 2 HR. TIMER.	$ .45
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1458 DUAL OP AMP.	$ .60
LM 380 – 2W AUDIO AMP.	$ .95
LM 377 – 2W Stereo Audio Amp.	$2.50
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LM 382 – DUAL AUDIO PREAMP	$1.50
LM 311 – HI PER. COMPARATOR	$ .90
LM 319 – Dual Hi Speed Comp.	$1.25
LM 339 – OUAD COMPARATOR	$1.50

TRIACS / SCR'S

PRV	TRIACS 1A	TRIACS 10A	TRIACS 25A	SCR'S 1.5A	SCR'S 6A	SCR'S 35A
100	.40	.70	1.30	.40	.50	1.20
200	.70	1.10	1.75	.80	.70	1.60
400	1.10	1.60	2.60	1.00	1.20	2.20
600	1.70	2.30	3.60		1.50	3.00

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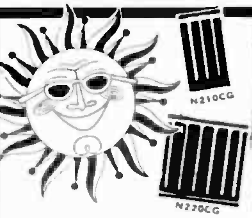
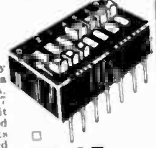


IMAGINE! 7 SWITCHES ON A DIP!

- *Tease Resistant Over-Center Switching Action!*
- *Positive Detent For Tactile Feel!*
- *Dust Resistant Construction!* **Cat. No. 11R2677**
- *Low Profile--0.3" Max. Height Above P.C*

Poly Paks exclusive DIP SWITCHES. Provides highly reliable, low-cost means of manually programming a variety of mico-miniature electrical-electronic circuits. Each device rocker actuated. SPST. High reliability. 7 different circuits on a DIP IC type housing makes it ECONOMICAL. Housing of heat-resistant glass-filled nylon material. Fits into 14-pin IC socket, or its phosphor bronze gold-plated connections for PC board use tool Each switch rated at (non-switching) 50 VDC @ 100 ma. Meets MIL specs Size ¾ x ⅜ x ⅜".



☐ **$1.95**

ECONOMIZE WITH Solar Energy Chips

- 10 Times more potent than cad cells in 10 times less space!
- From space projects to hobby!
- Fraction of original cost!
- Rectangular shapes save space!

Cat. No.	Type	Size	MA	MW	Sale	3 for
11R3229	N210CG	2 x 1	50	21	$1.49	$3.00
11R3230	N220CG	2 x 2	100	42	1.98	5.00
11R3232	N120S	2 x 2	100	†	2.49	5.50
11R3231A	N240CG*	2 x 4	200	85	3.50	8.00
11R3231B	N420CG*	4 x 2	200	85	3.50	8.00

† Two 1 x 2's shingled together; equals 1 volt
* State 1st and 2nd grid choices. 1 oz

A "sold out" is now back! POLY PAKS is in the SOLAR ENERGY business. We were first in many fields and once again we have "SHONE" them all! These blue energy chips were used by the National Aeronautical Space Agency (NASA) for SPACE & TELEPHONIC COMMUNICATION SATELLITES! Forced to unload due to the economy pinch; factory & POLY PAKS now give you these nifty chips to stimulate all energy-economy-thinking hobbyists. **Converts Solar to Electrical Energy!**

We are stocking 4 sizes: measured in centimeters 1 x 2, 2 x 2, 2 x 4, 1 x 2 linked together. Silicon "thin plate" forms the basis of the cell. It's a Space Saver! Each cell (chip) generates 0.5 volts, but at different current capabilities. Solder edges for easy "multiple chip building". Each cell has blue-reflective-coated-surface and with transparent protection.

HONEST ABE PENNY SALE BACK BY POPULAR DEMAND

Type	Sale	2 for	Type	Sale	2 for
☐ SN7400	.22	.23	☐ SN7494	.82	.83
☐ SN7401	.22	.23	☐ SN7495	.86	.87
☐ SN7402	.22	.23	☐ SN7496	.86	.87
☐ SN7403	.22	.23	☐ SN74125	1.29	1.30
☐ SN7404	.24	.25	☐ SN74126	1.29	1.30
☐ SN7406	.36	.37	☐ SN74132	1.95	1.96
☐ SN7407	.46	.47	☐ SN74141	1.12	1.13
☐ SN7408	.22	.23	☐ SN74145	1.69	1.70
☐ SN7409	.52	.53	☐ SN74148	3.25	3.26
☐ SN7410	.22	.23	☐ SN74150	1.12	1.13
☐ SN7411	.27	.28	☐ SN74153	1.10	1.11
☐ SN7417	.62	.63	☐ SN74154	1.53	1.54
☐ SN7420	.22	.23	☐ SN74157	1.09	1.10
☐ SN7421	.55	.56	☐ SN74158	1.55	1.56
☐ SN7423	.47	.48	☐ SN74160	1.59	1.60
☐ SN7425	.37	.38	☐ SN74163	1.50	1.51
☐ SN7430	.22	.23	☐ SN74164	1.79	1.80
☐ SN7432	.36	.37	☐ SN74165	1.79	1.80
☐ SN7440	.22	.23	☐ SN74173	1.69	1.70
☐ SN7442	.97	.98	☐ SN74174	1.42	1.43
☐ SN7445	.97	.98	☐ SN74175	1.45	1.46
☐ SN7446	1.10	1.11	☐ SN74176	1.59	1.60
☐ SN7447	1.10	1.11	☐ SN74177	1.59	1.60
☐ SN7448	1.10	1.11	☐ SN74181	3.75	3.76
☐ SN7450	.22	.23	☐ SN74184	2.19	2.20
☐ SN7451	.27	.28	☐ SN74190	2.75	2.76
☐ SN7473	.44	.45	☐ SN74191	2.75	2.76
☐ SN7475	1.00	1.01	☐ SN74193	1.29	1.30
☐ SN7483	.99	1.00	☐ SN74195	.89	.90
☐ SN7485	1.41	1.42	☐ SN74196	2.19	2.20
☐ SN7486	.47	.48	☐ SN74198	2.25	2.26
☐ SN7489	2.25	2.26	☐ SN74199	2.25	2.26
☐ SN7490	1.00	1.01			
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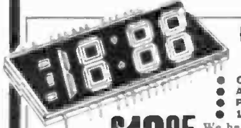

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• 1.2" HIGH, 4-DIGIT, 7-SEGMENT

- Orange, gas discharge!
- AM-PM indicators!
- Pulsating seconds!
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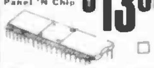
Interfaces directly to MM5316 chip which we are offering FREE! Cat.No.11R3248

Panel 'N Chip **$13.95** ☐



FREE! FREE! Each Clock panel purchase we give MM5316 chip—no charge.

We have never seen a digital clock panel with characters so high, orange color so bright. It's by far the finest panel we've sold. The substrate is "sandwiched" between ⅛" thick panels of glass. Each of the printed circuit pins is lettered or numbered to correspond pin-for-pin interfacing with the famous MM5316 clock chip, which WE GIVE FREE! Power requirements 170 volts for anode, 1½ mils per segment. Includes colon tool Size 4¼ x 1-9/16". Makes a nifty looking digital clock for home, office, ham or radio station, lab, etc. Wt. 8 oz.

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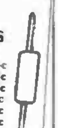
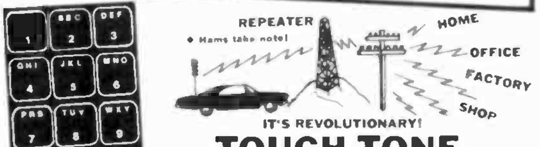
☐ 1N4003	200	10 for 65¢
☐ 1N4004	400	10 for 75¢
☐ 1N4005	600	10 for 85¢
☐ 1N4006	800	10 for 99¢
☐ 1N4007	1000	10 for 1.29





IT'S REVOLUTIONARY!

TOUCH TONE ENCODER KIT*

1.25M, 2-meter and 6-meter amateur radio operators. If your rig is mobile, convert it easily to a mobile telephone station and contact your home, shop, school, factory TTE-100 touch tone encoder kit. Kit includes: Chomerics touch tone pad, Motorola MC14410 chip, trimpot, resistors, zener, diagram, and G-10 pc board. Electrical specs: 12-16 volts, 5 mils (max), 4 volts PP output. * Less 1-MC crystal. Cat. No. 11R3385

$18.88 ☐

Cat. No.	Description	Sale
11R3149	Touch Tone Pad	$4.50
11R3382	MC14410 Chip	10.50

BUY 'EM SEPARATELY: 11R3383 P.C. Board 2.95

These small magnetic proximity reed switches are ideal for all types of burglar alarms. One case contains an Alnico magnet, which actuates a Normally Open reed switch in the other case within a distance of 1". Mount on windows & doors, on back of valuable equipment, etc. Protect your home, car, and shop. Cat.No.11R3163

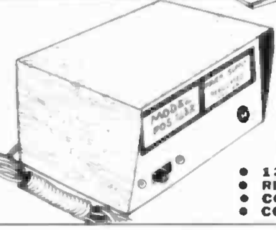
PROXIMITY REED SWITCHES FOR BURGLAR ALARMS

$1.50 pair ☐

FULL WAVE EPOXY SILICON BRIDGE RECTIFIERS

PIV	2 Amp	6 Amp	10 AMP
50	☐ $ .69	☐ $ .88	☐ $1.49
100	.79 ☐	.99 ☐	1.69
200	.95 ☐	1.25 ☐	1.89
400	1.19 ☐	1.50 ☐	2.09
600	1.35 ☐	1.75	
800	1.59 ☐	1.95	
1000	1.79 ☐	2.25	

6 Amp 1/2 x 1/2 x 3/16 sq.
Code: 2 amp TO-5 case



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- CONVERTS CB, HAM RIGS TO HOME
- COMPLETELY WIRED

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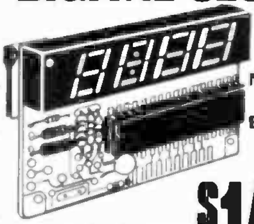
Cat. No. 11R3411



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$14.95 ☐

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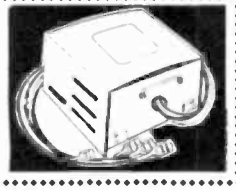

$8.88 ☐

- 3-5-6 Bladers!
- 115 VAC!
- Compact!
- Lightweight!
- Only 4-11/16" sq. x 1½" deep!

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Cat. No.
11R3108 "Muffin" 3-blade
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Shpg. wt. 1½ lbs.

KEYBOARD & ENCODER KIT

- Double sided PC board

Outputs — standard ASCII 7 bits plus strobe

$69.95 WIRED ☐

$59.95 ☐ **KIT**

Lowest price Keyboard and Encoder kit we've seen. General purpose ASCII keyboard for data terminal applications. Could be used for TV, RTTY, Code Transmission, Altair and other Mini Computers, etc. Utilizes 2-key rollover MOS memory allowing encoded outputs to be strobed out as each key is depressed. Uses double side pc board. Electronic shift lock, not mechanical on keyboard. Keyswitches, one integral assembly not individual keys. Keyboard: 63 keys (49 encoded keys). 4 mode: normal, shift and control, 3 internal function keys: shift (each side of board, shift lock and control. 3 functions: Key Break, Here Is, Repeat. 7 additional functions (can be assigned by user).

Electrical specs: voltage requirements plus 5 volts and minus 12 volts, 200mw, negative or positive logic output, jumper selectable. Output connector. On the PC board we have A NEW KEYBOARD TEST FEATURE . . . 7 LEDS! These LEDs display visually the ASCII code for the depressed key. TTL compatible. Kit includes: 63 key keyboard, pc board, ROM, 7 LEDs, resistors, capacitors, TTL IC's and SOCKETS. We include diagram and wiring instructions, ROM code. Wt. 7 lbs. Size overall: 13 x 5½ x 2".

Cat. No. 11R3208	Keyboard & Encoder Kit	$59.95
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YOUR CHOICE **$1** ☐

- 1-AMP RATING
- TO-220 or TO-3 CASES
- POSITIVE OR NEGATIVE

Volts: ☐ 5 ☐ 6 ☐ 8 ☐ 12 ☐ 15 ☐ 18 ☐ 24

3 for $2.75
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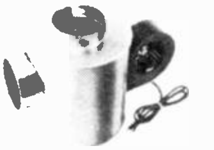
No. 1976EH . . . (LESS THAN 1¼ OZ.!)........................ $14.95 Ppd.

FUEL MISER RECLAIMS HEAT



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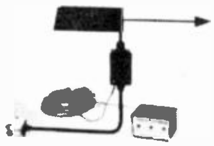

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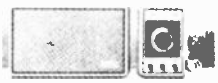

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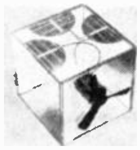

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