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Radio-Electronics

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Now there's a new breed of Beckman hand-held DMMs tough enough to withstand accidental drops, input overloads and destructive environments.

The new HD100 and HD110 DMMs are drop-proof, packed with overload protection and sealed against contamination. You won't find more rugged meters than the Beckman HDs. Inside or out.

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Contamination Proof

The HD series meters are designed to keep working even around dirt, heavy grime, water and oil. The special o-ring seals, ultrasonically-welded display window and sealed input jacks protect the internal electronics of the HD meters. The oops-proof meters are sealed so tightly, they even float in water.

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The 0.25% basic dc volt accuracy HD meters serve you with 7 functions and 27 ranges. The HD 110 also gives you 10 AMPS ac and dc. With one simple turn of the single selector switch, you can go directly to the function and range you need. There's less chance of error.

Also available is the electrical service kit. It includes the meter of your choice, a current clamp, deluxe test leads and a heavy-duty case designed to carry both meter and accessories, conveniently.

Feature for feature you can't find a more dependable meter with prices starting at just $169 (U.S. only).

To locate your nearest distributor, write Beckman Instruments, Inc., Instrumentation Products, 2500 Harbor Blvd., Fullerton, CA 92634 or call (714) 993-8803.

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THE BACK CHAIR
The Back Chair allows you to sit comfortably with your spine & back muscles in perfect alignment.

ONLY $89.95

Computer desk designed by Island Computer Desks, Santa Barbara, CA

THE FIRST INTELLIGENT CHAIR

Consider the alternative – THE BACK CHAIR, the new chair designed with one goal in mind, the care of your back, spine, health & well-being.

REDUCE THE EFFECT OF GRAVITY ON YOUR BACK

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Sitting on the BACK CHAIR relieves your back from supporting the total weight of your body by distributing the weight between your lower back and legs. The BACK CHAIR design is nothing more than simple common sense. Your legs support you when standing, your lower back supports you when sitting – combine them both in a comfortable sitting posture and you relieve the unnecessary stress on your back. When sitting on the BACK CHAIR you'll surprisingly feel much more relaxed, you'll sit up absolutely and comfortably straight; and with the pressure off your lower back you'll breathe deeper with less effort. **At home or especially at work** the BACK CHAIR will help you in improving your posture and enhance your fitness and exercise program throughout the day. Made of multiple layers of hardwood with a final layer of oak, the BACK CHAIR assembles in 15 minutes with a screwdriver. Enjoy one for two weeks as our guest and see how intelligent chair design can soothe your aching back and greatly improve your sense of wellbeing throughout the day.

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ITEM NO.	QUAN.	ITEM	PRICE EA.	SHIPPING	TOTAL
825		BACK CHAIR	$89.95		

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Radio-Electronics

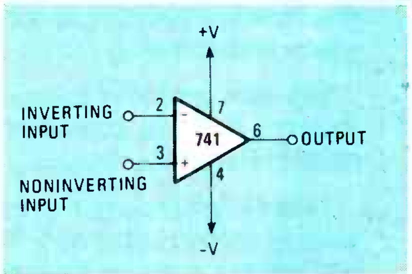
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

APRIL 1984 Vol. 55 No. 4

ON THE COVER

Owners of personal computers know that one of the natural uses for those devices is as a controller for the appliances, lights, or what have you in your home. But if you use it for that, your computer can not be used for any other task at the same time. This month we show you a way around that problem—a computer that you can build that's specifically for use as a controller. The story begins on page 47.



KNOWING ABOUT LINEAR IC's and how to use them in your designs can greatly improve your enjoyment of electronics. But if you missed out on learning about those devices, where can you get the information you need to use them successfully? One place is in our new back-to-school series on designing with linear IC's. It all begins on page 89.

COMING NEXT MONTH
On Sale April 19

- **Automotive Exhaust Analyzer.** A unique device to help get your car ready for those tough emissions tests.
- **3-D TV.** A look at what's coming in 3-D television.
- **Home Control Computer.** Part 2 of our build-it-yourself computer.
- **And lots more!**

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PUBLISHER'S LETTER

About "Your Own Computer"®

"Your Own Computer" has appeared as a special section in **Radio-Electronics,** twice a year, for the past several years. It has ranged from as small a section as 16 pages to as large a section as 101 pages.

We know from the mail that our editors received that there is great reader interest in personal computers and we intend to continue our coverage of the subject.

However, instead of occasional, large-space sections, we will report on a regular, consistent basis with 16-page units in every issue of **Radio-Electronics.**

I want to emphasize that this will be an expansion of our editorial content; a bonus to **Radio-Electronics** readers over and above the regular features to which they are accustomed on every facet of the fast-moving world of electronics—video, computers, stereo, MRO, servicing, and technology.

So, starting next month, in the May issue of **Radio-Electronics,** you will find a special 16-page tear-out section titled, "ComputerDigest". It is a complete magazine within a magazine.

It's entirely possible that continued reader response may encourage us to convert this section into a separate magazine rather than an insert within the covers of **Radio-Electronics.**

So watch for Volume I Number I of "ComputerDigest". We think you'll like it!

And this month, enjoy "Your Own Computer".

Larry Steckler

LARRY STECKLER
Publisher

Radio-Electronics

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Tek's best-selling 60 MHz scopes: Now 25 ways better for not a penny more!

Now Tek has improved its 2213/2215 scopes with brighter displays. Greater accuracy. And more sensitive triggering. At no increase in price.

The 60 MHz 2213 and dual time base 2215 have been the most popular scopes in Tektronix history. Now, Tek introduces an "A" Series update with more than 25 specification and feature enhancements— things you have asked for such as single sweep—all included at no added cost.

A brighter display and new vertical amplifier design provides sharp, crisp traces. That makes the 2213A/2215A a prime candidate for tasks like TV troubleshooting and testing, where fast sweeps are typical.

New features include 10 MHz bandwidth limit switch, separate A/B dual intensity controls (2215A only), and power-on light: additions customers have suggested for giving these scopes the final measure of convenience.

Triggering, sweep accuracy, CMRR and many more major specifications are better than ever. Check the performance chart: not bad for scopes already considered the leaders in their class!

The price: still $1200* for the 2213A, $1450* for the 2215A. Or, step up to the 100 MHz 2235 for just $1650*! You can order, obtain literature, or get expert technical advice, through Tek's National Marketing Center. Direct orders include operator manuals, two 10X probes, 15-day return policy, world-wide service backup and comprehensive 3-year warranty.

Specification enhancement	2213/2215 "A" Series	2213/2215
CRT brightness	14 kv accel. potential	10 kv accel. potential
Vertical accuracy	3%, 0° to 50°C	3%, +20° to 30°C
Chop rate	500 kHz	250 kHz
Input capacitance	20 pF	30 pF
CMRR	10 to 1 at 25 MHz	10 to 1 at 10 MHz
Channel isolation	100:1 at 25 MHz	Not specified
A Trigger sensitivity (int)	0.3 div at 5 MHz	0.4 div at 2 MHz
TV triggering	1.0 div compos. sync	2.0 div compos. sync
Sweep accuracy (in 10X)	4%, 15° to 35°C	5%, 20° to 30°C
Delay jitter	20,000 to 1 (2215A) 10,000 to 1 (2213A)	10,000 to 1 (2215) 5,000 to 1 (2213)
Holdoff Range	10:1	4:1

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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

DIGITAL TV DELAY?

The planned introduction of digital television sets in the United States this year could stretch out into 1985. ITT Semiconductors is said to be behind schedule in delivering the VLSI IC's. At least some of the delay is attributed to the fact that American manufacturers wanted such special features as automatic tint-correction and comb filter as part of the special NTSC-system IC. The two manufacturers known to be planning to field digital sets—General Electric and Zenith—say there's still hope they'll introduce the sets late this year, but full-scale deliveries may not start until 1985.

GERMAN TVs—MADE IN U.S.

The newest American TV brand name is an old familiar German one—Grundig. An American-owned firm, Display Devices, Inc., has purchased a former TV-cabinet plant in Monticello, IN from RCA and will assemble color-TV sets from modular kits produced in Germany by Grundig, one of Europe's largest television manufacturers. The company will specialize in deluxe sets, priced in the same range as those from Sony, JVC, and Mitsubishi. It plans to have a capacity of 120,000 sets a year to start. Grundig will be the 13th foreign brand to have assembly operations in the U.S.—all of the others are Japanese, Korean, or Taiwanese.

"NEW LOOK" FOR TV

RCA has revealed a two-step plan to change the appearance of the television set in the United States. Though the Japanese were first to announce the FST (*F*latter *S*quarer *T*ube), a tube with a flatter faceplate and squared-off corners, RCA has outlined the American approach to the new look—and it will make the transition in two steps. The first step will be squaring off the corners without flattening the faceplates, with new versions of the 25-, 19- and 13-inch tubes in completely rectangular shapes—measured diagonally as 26, 20, and 14 inches. These FS (for *F*ull *S*quare) tubes will be followed by two new tubes to be called SP (*S*quare *P*lanar). The SP tubes are computer-designed and have a surface that appears flat, but actually is in the shape of a plateau when viewed in profile. RCA will make SP tubes available in 27- and 20-inch sizes.

The FS tubes, whose faceplates have the same curvature as today's tubes, will start appearing in TV sets this summer. RCA thinks that the introduction of the new tube sizes means the end of the line for the 25-inch tube in 1986 or 1987, while the 19-inch will last a little longer because it will fill a need in the more price-competitive smaller-screen area.

VHS vs. BETA

Although Sony claims that the Beta format is increasing its share of the market thanks to the new Beta Hi-Fi sound system, the VHS format appears to be gaining new adherents in the VCR-format race. The two developers of the competing Video-2000 format in Europe—Philips and Grundig—both will be introducing VHS recorders there this year. Sanyo, a pioneer Beta follower, already is producing VHS recorders through its subsidiary, Tokyo Sanyo, which is making them for sale under the Fisher label. Zenith, which has been marketing Sony-made Beta VCR's, is expected to add VHS recorders this year. Toshiba, a pioneer in the Beta group, will make VHS recorders in Europe for sale there. And another Beta proponent, NEC, probably will add VHS soon. Sony, the inventor of Beta, says it will not succumb to VHS fever and will continue to field Beta recorders only, although it manufactures cassettes for both Beta and VHS formats. VHS recorder sales outnumber Beta by at least three to one.

DBS GETS STARTED

The first direct-to-home satellite broadcasting system, owned by United Satellite Communications Inc. (USCI), is now transmitting to homes in the East and Midwest. The initial transmissions are on three channels, to be increased to five, on a monthly subscription basis. Radio Shack is the exclusive sales agent for the receiving equipment, which it sells for $750 installed (including a four-foot dish) if the buyer subscribes for at least one year's service at $29.95 monthly. Radio Shack will also lease the receiving systems at $300 for installation plus $39.95 monthly for one year (reception service included). RCA Service Co. is handling installation and service.

R-E

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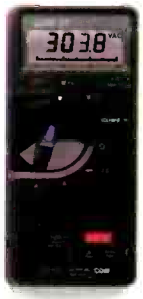

Fluke 73	Fluke 75	Fluke 77
$85*	$99*	$129*
Analog/digital display	Analog/digital display	Analog/digital display
Volts, ohms, 10A, diode test	Volts, ohms, 10A, mA, diode test	Volts, ohms, 10A, mA, diode test
Autorange	Audible continuity	Audible continuity
0.7% basic dc accuracy	Autorange/range hold	"Touch Hold" function
2000+ hour battery life	0.5% basic dc accuracy	Autorange/range hold
3-year warranty	2000+ hour battery life	0.3% basic dc accuracy
	3-year warranty	2000+ hour battery life
		3-year warranty
		Multipurpose holster

* Suggested U.S. list price, effective October 1, 1983.

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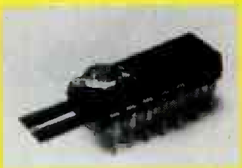
APRIL 1 WHAT'S NEWS

SYMBOL	CODE (h)	OFFICIALLY DESIGNATED MEANING
☺	60	HAVE A NICE DAY



COOL IC'S

A major advance in semiconductor cooling techniques was announced last month by YoYodyne of Los Angeles. The encapsulating material of the semiconductor is cast with a series of channels buried inside it. All the channels are interconnecting and join a pair of common input and exhaust fittings at one end of the IC (see above). A small gate valve is incorporated in the device and it controls the flow of coolant being pumped through the IC by a compressor located on the circuit board. YoYodyne claims that one compressor can adequately cool up to twelve standard 7400 series IC's and that power requirements are minimal, although the special compressor used in the new technique requires a separate three-phase, 440-volt line.

The actual coolant can be as simple as distilled water, but a special fitting is needed if a pressurized refrigerant such as freon is used. Preliminary literature from YoYodyne indicates that the results of supercooling have produced dramatic results. A standard 78-series regulator didn't fail until over three hundred amperes were drawn from it. That was accomplished by using liquid nitrogen as a coolant, and YoYodyne was quick to point out that the techniques involved were still "in the early experimental stages."

CALLING DICK TRACY

Rumors that have been flying around the computer industry for months were confirmed at last November's Comdex show in Las Vegas. A new breakthrough in ULSI (*U*ltra *L*arge *S*cale *I*ntegration) fabrication techniques has produced a new computer. All the circuitry needed for the device is contained on one chip that is housed in a package that measures less then ¼-inch square. The display is an improved version of the LCD's currently being used in miniature TV sets. The increased efficiency of the new LCD's, however, has made possible resolution fine enough to feature an 80 × 24 character display, with each character being formed by an impressive 18 × 26 matrix. The keyboard for the new computer is similar to the ones found on the calculator watches, and features 56 keys for input of a complete ASCII character set including upper- and lower-case letters. Because of the single IC design, the computer measures only 1 × 2 inches. It is powered by body heat, with a silver-oxide battery for memory backup. Dubbed the *Wrist Computer*, it is available with either a stainless steel or brushed gold finish. An executive, deluxe model is planned that will have all of the above features as well as a numeric keypad and ten user-definable keys.

NICE DAY

The American National Standards Institution has announced the introduction of a new symbol to be incorporated in the standard ASCII character set (see above). The code will be 96 decimal or $60h. A spokesman said that this was only the beginning of a new series of characters to be introduced over the next year or so.

QUICK NOTES

Sosy Corporation has announced a working prototype of the long expected "TV on a chip." At the present time the prototype IC measures 2 × 3 feet, and is 6 inches thick.

The FCC is considering standards for stereo CB-transmission.

BCB has introduced a new series of fast-recovery diodes designated the FR4000 series. Those are special application parts that feature two paralleled inverted diodes on the same substrate. As a result they will pass current in either direction and BCB engineers claim that new doping techniques make the voltage drop across the diode less than one microvolt in either direction

Ball Labs has announced the discovery of a new atomic particle, the anti-neutrino. According to the report issued by the researchers, the particle has all the characteristics of the neutrino but is opposite in charge.

R-E

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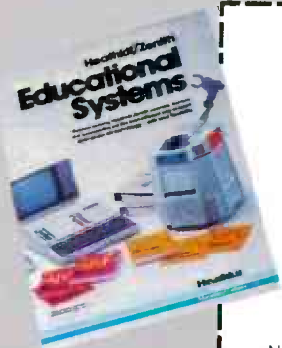

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SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

AROUND THE SATELLITE CIRCUIT

Scientific-Atlanta has introduced a dual-beam prime-focus feed assembly designed to receive simultaneous signals from two adjacent C-band satellites spaced 3° or 4° apart. The new dual-beam device, which can be used with 4.6- and 5-meter earth stations, allows single-dish reception from Satcom IIIR and Galaxy I, the major cable programming birds.

Paradigm Manufacturing has incorporated an innovative hub design and rib configuration in its new 3.8-meter aluminum-mesh antenna. The new design is said to improve structural integrity and reduce weight. A redesigned LNA tube support increases rigidity and reduces noise temperature and side lobes for the polar-mounted, eight-rib unit. (Paradigm Manufacturing, 6911 Eastside Road, Redding, CA 96001).

National Microtech has introduced the *Apollo Elite* receiver/dish-rotator system. The receiver and the rotator-control units feature individual microprocessors and an infrared remote-control unit with a 25-foot range (see photo). All remote command functions can be sent to either the receiver or rotator control units. Thus, you can mount one unit at each of two TV's and use your remote control at either location to change the channel, volume, antenna, or audio fine tuning. The system can be programmed for up to 100 satellite locations. (National Microtech, PO Drawer E, Grenada, MS 38901)

Ka-BAND BIRD

Hughes Communications has asked the FCC for permission to build and launch two Galaxy satellites using the Ka-band (30 GHz), a virtually unused part of the spectrum that could handle several times the capacity of current birds. The $450 million Hughes system has a 1988 timetable and will mainly be used for teleconferencing, data transmission, and paging/signalling services. The medium-powered satellites would send signals to two-meter dishes via "spot beams" aimed at 150-mile radius areas around 16 major cities.

SATELLITE-PHONE

"Personal Satellite Phone," a five-pound cordless communicator, has been proposed as a system to take advantage of two electronic rages: portable phones and satellite transmission. Skylink Corp., a Colorado firm, is seeking FCC authorization to develop the service that will use a high-powered satellite to relay voice and data signals from Personal Satellite Phones into the conventional phone system. Skylink sees the system as one which will let people talk from vehicles as well as from remote areas. The Skylink system could be launched by 1987. (Skylink, 3000 Pearl St., Boulder, CO 80301).

VIDEO RETRIEVAL SYSTEM

Warner Electronic Home Services hopes to launch a video-on-demand retrieval system in Pittsburgh by mid-1984. The service, a spin-off of Warner Amex Cable's QUBE interactive technology, would offer text as well as full video images that could be requested by viewers using a hybrid arrangement involving phone lines and cable-TV circuits. Videodisc players at the cable-TV offices would feed short programs—including music-video clips, teleshopping demonstrations and oher material—directly into customers' homes. R-E

LETTERS

Address your comments to: Letters, **Radio-Electronics,**
200 Park Avenue South, New York, NY 10003

OOOOOPS!

For those of you who want to order a kit of parts for the MHD generator that we described in our February issue, the correct address is: Images Co., PO Box 313, South Richmond Hill Station, Jamaica, NY 11419. (The address given in the Parts List had the box number omitted.)

Readers: don't forget to let us know about your results with MHD generators!—*Editor*

SHORT PROGRAM

Radio-Electronics, my favorite hobby magazine, has given me so many usable ideas that I would like to pass on an item that may be of help to those who, like me, are still learning how to write good programs for the Sinclair *ZX81* and the Timex/Sinclair *1000*.

Although those computers provide a total of 24 lines on the screen, the lower two are reserved for inputs and reports, unlike several other home or hobby computers. The 22 remaining lines are often just one or two lines short of what a programmer would like the computer to display.

The short program below will result in screen printing on the bottom two lines, lines 22 and 23 in the Sinclair line-numbering method, which numbers the top line as "0". The first two statements provide the text input for lines 22 and 23 respectively. Warning: neither text can exceed 32 characters in length.

```
9000 LET A$ = "(INSERT TEXT FOR
     LINE 22)"
9001 LET B$ = "(INSERT TEXT FOR
     LINE 23)"
9002 FOR N = 0 TO LEN A$-1
9003 POKE (727+N+PEEK 16396+
     256*PEEK 16397), CODE A$
     (N+1)
9004 NEXT N
9005 FOR N = 00TO LEN B$-1
9006 POKE (760+N+PEEK 16396
     +256*PEEK 16397), CODE B$
     (N+1)
9007 NEXT N
```

If the display on line 22 only is wanted, delete statements 9001, 9005, 9006 and 9007. If line 23 only is wanted, delete statements 9000, 9002,9003, and 9004.

The computer will probably crash if either line of text exceeds 32 characters, or if any character is used that takes up more than one space. Thus, characters like " ", the quote image, and **, the exponent operator, cannot be used.

This method of obtaining screen printing on the bottom two lines is much simpler than poking the print-position system variable, 16398, 16399, as hinted at by the *ZX81* manual. Note that this program does not POKE

the D_FILE system variable, an action that the manual warns against, but finds the D_FILE start address and then pokes the desired character codes into the addresses of the display file proper.

Any report from the computer will overwrite the first several characters of line 23, which is only occasionally a problem when a program is run. If the program here is typed in for a test by itself, a program line such as PAUSE 4E4 can be added. Then pressing any key except SHIFT will "unlock" the computer and display the overwriting report.

If printout on lines 22 and 23 is used several times in a program, it might be best to use statements 9002 through 9007 as a subroutine. Don't forget to add the RETURN statement. The main program would then need only statements 9000 and 9001. If one or the other, only, of the two lines is wanted at a particular place in the program, the empty string can be the text for the unwanted line.
H. E. FELLHAUER
Mabank, TX

NEED FULFILLED

Congratulations to you and your publication for remaining a magazine dedicated to the electronics enthusiast and not going the way of all the other electronics publications (into computers).

This is the first time that I have ever written to a publication in this way, and I will say that if your publication changes over to computer articles, or leans heavily toward computer circuitry and accessories, then I will cancel my subscription.

Computers have a place in our society, but let the others in the electronics field go that way—as most of them have done.

This country needs a publication like yours, so that the younger generation has a place to learn and experiment with the many projects that your magazine has published in the past and, I hope, will continue to print.

I have enjoyed the many articles printed over the years, so please continue that way and thanks for a job well done.
RONALD STORCK
Dallas, PA

TRANSIENT SUPPRESSOR

In reference to the "Transient Suppressor" article in **Radio-Electronics**, September 1983: That item sounds like a good thing to have; however, I would like to discuss a *safety problem*. The article shows the line neutral, the white wire, being switched by the relay. That is an extremely unhealthy practice. The hot side of the line, the black wire, remains unswitched as shown in the article. Even though the device has its current path interrupted by the relay, whatever is plugged into the receptacle still has full line voltage from the *hot* (black wire) side of the line. An accidental ground path through a person who believes that the device is off can occur even when relay RY 1 is unlatched. The suggestion of adding an ON/OFF switch in the article further increases the chance of an electric shock.

I would suggest that both sides of the line be switched by RY 1 using a similar relay, but having an extra set of contacts. The ground wire, of course, should be carried through the suppressor uninterrupted.

If you do not want to change the relay type, then at a minimum the builder should be very careful to keep the *hot* (black wire) side of the line and the *neutral* (white wire) side of the line functions consistent with standard wiring practices—that is, *not* switching the *neutral*. Good wiring practices in dwellings, and electric codes, should be thought about when distributing line current around places where we work and live. Safety first, etc.
STUART MARCINIAK
San Francisco, CA

AUDIO TAPES

In reference to "Audio Tapes—How Different Are They?" in the November 1983 **Radio-Electronics**, that article is very misleading. The main difference in cassette tapes is not the tape, but the mechanics of the cassette—the little wheels that start to squeak. Take a look at the tape-head pressure mechanics. Will it fall apart or wear out? Those are the big differences.

One of the companies mentioned in your article will just disappear if you try to get replacements for bad junk.
GUS OSITIS
Orinda, CA

THE 55-MILE-PER-HOUR SPEED LIMIT

In reading the letter from Mr. Raymond Kostanty ("Letters," **Radio-Electronics**, November 1983), I find myself a bit miffed at an over-simplistic view of the 55-mile-per-hour speed limit and its "minimal" benefits. I feel that this department would be far better serving to your readers if the content were kept to matters concerning the industries and

continued on page 20

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LETTERS

continued from page 14

trends that your publication serves so well. But if highway safety is a viable topic, I would like to make a response to several remarks that I found to be somewhat flawed.

The 55-mile-per-hour speed limit was enacted by Congress, not by local state or local law-enforcement agencies, for several reasons (faulty or otherwise). It is therefore unfair to attribute the speed limit to a tactic or means for traffic officers to keep up to their quotas. The principal duties of a highway patrolman or traffic officer is the enforcement of highway regulations that are duly enacted into law by elected officials. Investigating murders, robberies, and drug dealing are matters assigned to officers who specialize in criminal activities.

I feel, personally, that 10,000 lives saved each year is a significant figure. That reflects a 20% reduction in highway fatalities. It's quite a significant number, especially when we consider the increase in the number of licensed vehicles and drivers during the ten years that the law has been in effect.

But the bottom line remains this: Driving over 55 miles per hour is *illegal*. The only way to change that fact is to convince our federal legislators that there is a valid reason for increasing the legal speed limit. I doubt that belittling highway officers, or stating that 10,000 lives annually is not in perspective, will get much favorable attention from any of our congressmen.

You have a fine magazine, but I still feel that there are more appropriate places to deal with issues on highway regulation than **Radio-Electronics**. *(Does that include issues on radar detectors?—Ed)* I am one of your most devoted readers and will continue to be so.
HULBERT F. SATTERFIELD
Memphis, TN

AUTO-ALARM SYSTEM

Just a short note to tell you about the "Auto Alarm System" by Ed Loxterkamp in the May 1983 issue of **Radio-Electronics**. I built it; I installed it—and it works *great!*

I have also incorporated a motion detector into the system, which works off the hood and trunk switches. It's an excellent system and I am well pleased. Keep up the great job you're doing with "do-it-yourself" projects.
J. JOSEPH HLASNEY
Whitehall, PA

NO RECORDS

In the November 1983 **Radio-Electronics**, the writeup on Heathkit's Electronics Course EE-3104 ("Equipment Reports") states that the course includes instructional records. That *isn't* so.

My course arrived without any records. Checking back on their catalog for the past six months, I find that Heath does not include records with their course.
BILL TOMPKINS
Oakland, CA

Author's Reply: *Our review copy of EE-3104 was received some time ago and, did, indeed, include instructional records. Apparently, Heathkit has decided to make those instructional aids optional. Our copy of the latest catalog confirms that: and while you can do the course without them, they do help personalize things. So we'd suggest buying them.*

THE 7805

I suppose that by now you must have received many letters supporting the circuit in National Semiconductor's *Voltage Regulator Handbook* that was mentioned in the letter from Mr. Lawrence J. Jones, appearing in the January 1984 **Radio-Electronics.** That book explains how to use their regulators, and how to hook up the circuit indicated. I myself find National Semiconductor's arguments persuasive.

The 7805 is a hard-to-damage IC. When the output of the IC is held to ground (shorted), the chip will supply current until it overheats. When the IC overheats, it will supply reduced current so as to prevent its being damaged. If you really want to burn out a 7805, you must supply it with excessive voltages—either inputs or outputs. The circuit described in Mr. Jones's letter cannot damage the 7805. The only danger is that the transistor, or some other discrete components, will be damaged. Believe me; the circuit works.

PIANOMATIC PROBLEMS

Two errors crept into the parts-placement diagrams for the Pianomatic project. In Fig. 12 (page 67 of the October 1983 **Radio-Electronics**), IC4 is shown upside down. It must be turned around, with pin 1 pointing toward the top left of the diagram, for the project to work correctly. Also, in Fig. 14, C22 is actually C16.—*Robert Grossblatt.*

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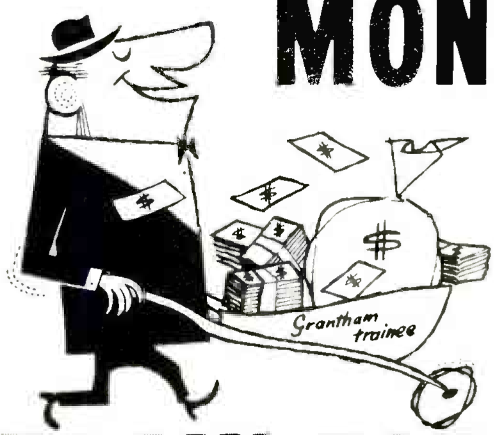

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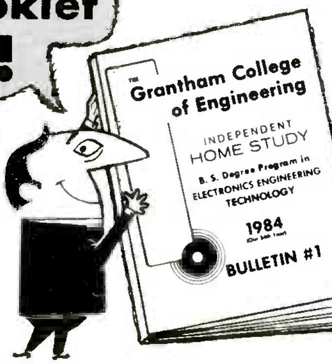

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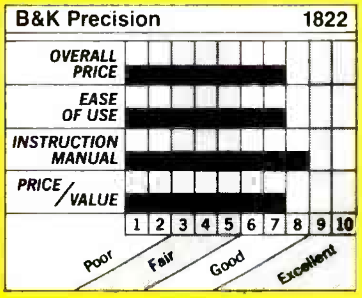

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WHETHER YOU'RE INVOLVED WITH THE design or repair of electronic equipment—be it analog or digital—at some point you're sure to need a frequency counter. We recently had the opportunity to examine a counter that can be used for more than just measuring frequency. (Thus it is called a "universal counter.") So if you've ever needed to make duty-cycle measurements of, say, a power supply, or if you ever had to measure the frequency ratio of two signals, or the length of time between two once-only events, then the following should interest you.

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continued on page 28

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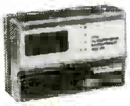

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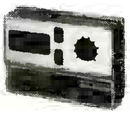

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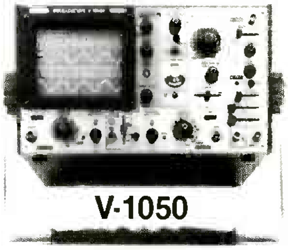

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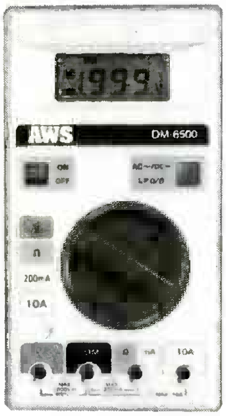

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DC Volts

RANGE	ACCURACY
200mV	±(0.5% rdg + 4d)
2V 20V 200V	±(0.7% rdg + 4d)
1000V	±(1% rdg + 4d)

AC Volts

RANGE	ACCURACY 40-500 Hz
2V 20V 200V	±(1% rdg + 8d)
600V	±(1.2% rdg + 8d)

DC Current

RANGE	ACCURACY
200mA	±(1.5% rdg + 4d)
10A	±(1.7% rdg + 4d)

AC Current

RANGE	ACCURACY 40-500 Hz
200mA	±(2% rdg + 8d)
10A	±(2.2% rdg + 8d)

Resistance

RANGE	ACCURACY	SHORT CIRCUIT CURRENT (approx.)	
200		Hi 1.5mA	Lo —
2K	±(0.8% rdg + 5d) Hi	300μA	150μA
20K	±(1% rdg + 10d) Lo	30μA	15μA
200K		3μA	1.5μA
2000K	±(2% rdg + 10d)	0.3μA	0.15μA

DM-6590

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RANGES

DC VOLTS

RANGE	ACCURACY
2V	±0.5% rdg ±4 dgt
20V 200V	±0.7% rdg ±4 dgt
500V	±1.0% rdg ±4 dgt

AC VOLTS

RANGE	ACCURACY
2V 20V 200V 500V	±1.0% rdg ±8 dgt

RESISTANCE

RANGE	ACCURACY
2KΩ 20KΩ 200KΩ	±0.7% rdg ±4 dgt
2000KΩ	±1.2% rdg ±4 dgt

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Bandwidth	DC to 15MHz, −3dB (at 4 div) DC to 7MHz, −3dB (at 4 div) (When using x5 amplifier)
Rise Time	24ns, (for x5) 70ns typ
Signal Delay Line	—
Max. Input Voltage	600Vp-p or 300V (DC + AC peak, at 1kHz)
Input Coupling	AC, GND, DC
Input Impedance	Direct 1M ohm, approx. 30pF
Operating Modes	Single-trace
X-Y Operation	External trigger Input: X axis, Vertical Input: Y axis
Sensitivity	X axis: approx. 200mV/div Y axis: same as Vertical input
Phase Difference	DC to 10kHz within 3°
X Bandwidth	DC to 500kHz, −3dB
Dynamic Range	4 div or more
Vertical Output	
Output Voltage	20mV/div or more (terminated into 50Ω)
Bandwidth	50Hz to 5MHz, −3dB
Output Impedance	Approx. 50Ω
Horizontal Deflection	
Trigger Modes	AUTO, NORM, TV (+), TV (−)
Trigger Source	LINE, EXT
Trigger Coupling	AC
TV Sync	TV sync-separation circuit
Internal	1 div or more (V sync-signal)
External	1Vp-p or more (V sync-signal)
Trigger Sensitivity	Frequency / Internal / External: 20Hz to 2MHz / 0.5div / 200mV 2 to 15MHz / 1.5div / 800mV
AUTO Low Bandwidth	30Hz
Trigger Slope	±
External Trigger Input	Input impedance, approx. 1M ohm, 30pF or less Max. input voltage: 100V (DC + AC peak at 1kHz)
Sweep Time	0.2μs/div to 0.2s/div, ±5% 19 calibrated steps Uncalibrated continuous control between steps 1 : < 2.5 (provided with click-positioning function)
Sweep Time Magnifier	10 times (±7%)
Max. Sweep Time	100ns/div (20ns/div and 50ns/div, not calibrated)
Amplitude Calibrator	
Waveform	Approx. 1kHz ±10% (typ), square wave
Voltage	0.5V ±5%
Power Requirements	100/120/220/240V ±10% 50 to 60Hz approx. 40W
Dimensions	Approx. 275(W) x 190(H) x 400(D) mm
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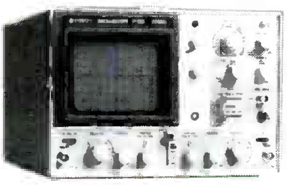

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continued from page 22

channels, a time-interval mode, and a frequency-ratio mode, just to name a few. We'll look a little more closely at some of its capabilities in a moment; but first, let's look at its outward appearance.

The model *1822* is housed in a 3.5 × 9.5 × 12.6-inch aluminum cabinet with a bail mounted at its sides. The bail can be locked in any one of several positions for easy reading on a bench and it doubles as a carrying handle. The unit has an eight-digit 0.43-inch LED display at the top of the front panel. There are also MHZ, KHZ, MS, μS, and GATE annunciator LED's to the right of the display. Decimal-point placement is automatic.

Below the display is a row of thirteen pushbutton switches. Going from left to right, the first seven switches are used to power-up the unit and select its various functions (frequency, period, ratio, time-interval, totalize, and the self-test function). The unit has four decades of resolution (in each operating mode) that are selected using the next four switches. There is a handy chart printed on the panel (directly over those switches) that shows you which one you're using. The next switch in that line is used to select either kHz/μs or MHz/ms. The right-most switch is for the display-hold function. Just above the HOLD switch is the RESET button that's used to clear the stored count.

To the far right of the front-panel are five more pushbutton switches and a rotary control. That rotary control selects the trigger level (for channel A only). The top pushbutton switch is used to select the degree of attenuation of the A input (either ×10 or ×1). The next switch, labeled −SL, is used to select the slope of the trigger signal so that the measurement can start on either the positive or negative edge of the input signal. The third switch, labeled LPF, is used to engage the low-pass filter. (That filter has a 10-MHz 3-dB corner frequency.) The last two switches are the attenuator and slope-selection switches for the B channel.

We mentioned that the *1822* has two input channels. Let's look at their charisteristics and how each is used. Each channel has an input impedance of 1 megohm in parallel with 40 pF and uses a standard BNC connector. Those characteristics make it possible to use standard oscilloscope probes. The A channel has a bandwidth of 5 Hz–175 MHz and its sensitivity ranges from 20 to 100 mV RMS over its full frequency range. (Note: Although the instrument's front panel claims that the *1822* is a 150-MHz frequency counter, an addendum to the service manual says that the unit operates well beyond 150 MHz at slightly reduced sensitivity. Operation is extended to at least 175 MHz at a sensitivity of 100 mV rms. That takes care of any possible problems that might arise when using the unit in the 150-174 MHz public-service band application.) The B channel has an input bandwidth of 5 Hz–2 MHz with a sensitivity of 30 mV RMS. The A channel is used when measuring frequency, period, or for totalizing events. The B channel is used along with the A channel when ratio and time-interval measurements are made.

Operating modes

The first operating mode we'll look at is the frequency mode. In that mode, the unit measures signal frequencies from 5 Hz to 175 MHz in two ranges. In the frequency mode, its resolution is .1 Hz to 1 kHz (depending on the scale chosen), with a rated accuracy of ± 1 count, ± the timebase error. The basic unit comes with a crystal timebase that's stable to ± 1 ppm-per-year.

The *1822* can also measure the period of input signals from 5 Hz to 2 MHz and display the result in either milliseconds or microseconds. Accuracy in this mode is rated at ± 1 count, ± timebase error, ± trigger error. The trigger error is typically ± 0.3% of the reading, divided by the average number of cycles for signals with a better than 40-dB signal-to-noise ratio and an amplitude greater than 100 mV. The period mode is useful because you can more accurately determine the frequency of low-frequency signals by first measuring the period and then converting that value to its equivalent frequency.

Besides simply measuring the frequency and period of an input signal (as most frequency counters do), the *1822* can work in other modes. In the frequency-ratio mode, the unit compares the frequencies of two input signals and displays their ratio. That's useful, for example, when you want to calibrate a timebase against a frequency standard.

The time-interval mode can be used to read the elapsed time (in microseconds) between two once-only events. The counter can also be used in that mode to make duty-cycle measurements. (Duty cycle is defined as the ratio of ON time to idle or OFF time expressed as a decimal or percentage.) To make that measurement, both probes are conncted to the same signal source. Using the SLOPE switches, one channel is set to trigger on the leading or positive-going edge of the signal and the other on the negative edge. The counter measures the time between those two events and displays to ON time. Now, reverse the triggering so that the first channel triggers on the negative edge and the other channel triggers on the positive edge. The counter now measures the OFF time.

Another useful feature of that counter is its totalize mode. Using the switch labeled TOTAL the unit will count events and display their total. The counting process can be gated either by using the front-panel HOLD and RESET switches, or by using an external gating pulse fed through a jack on the rear panel.

The HOLD switch can be used to freeze (store) the displayed value. That value can be cleared from the display and storage by simply pressing the RESET button. When that button is pressed, the counter is ready to start a new measurement. A self-test function is also provided. When the SELF-TEST button is pressed, the frequency of the internal clock, a 10 MHz crystal-controlled oscillator, is displayed. That clock's stability is rated at 10 ppm (parts-per-million) over a temperature range of from 0°C to 50°C.

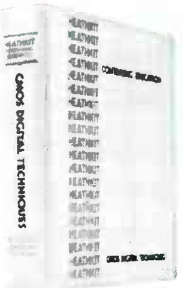
The unit is provided with a clearly written instruction manual that contains all the information needed to run the counter in any range or operating mode. The manual also provides full maintenance and calibration instructions, along with circuit descriptions and parts-placement diagram. There are some extremely handy tables for frequency and period measurements and B&K has also included some time-interval examples and handy circuits for contact debouncing.

There are three available accessories: the PR-45- × 10 probe priced at $52.20, the PR-37- × 10 direct probe at $44.75, and the optional TCXO (temperature-compensated crystal-oscillator), available through the manufacture's service department, at $130. That TCXO has a temperature stability that's rated at better than .0001% variation (± 1ppm) from 0°C to 50°C ambient.

All in all, the model *1822* frequency counter (priced at $450) is quite a handful of test equipment. It should give good service for a long time to come. **R-E**

Heath EE-3202 Digital CMOS Techniques Course

IF THERE'S ONE THING CERTAIN ABOUT electronics it is that you never outgrow



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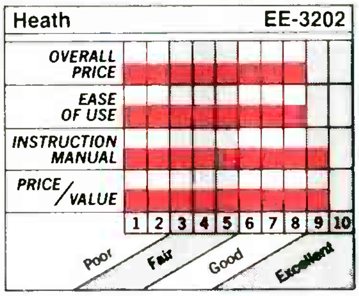

your need for knowledge. That's true whether you are a hobbyist or an advanced electronics professional. Things are changing so fast that the knowledge you have today can easily be outmoded by the developments of tomorrow.

Look at the changes of the last 15 years and you'll see what we mean. Back then, much of the circuitry we worked with was discrete, consisting of the usual variety of transistors, resistors, capacitors, diodes, and other components. But that has changed drastically. With the advent of large-scale integrated-circuitry techniques, those discrete components have been replaced by a variety of IC's, all handling the same functions and more. Even such things as simple transistor switching circuits are now available in IC form.

One of the most exciting developments of this period has been the introduction of CMOS (Complementary *M*etal-*O*xide-Semiconductor) technology. That low-power-consumption logic family allows you to do things that just can't be done with other types of IC logic. Its flexibility allows you to build devices that incorporate analog switching, oscillators, pulse shapers, phase-locked loops, and more. But, what's even better, its low power consumption and its virtual immunity to noise make its use very attractive in a wide range of applications.

But there is a drawback with CMOS. Because of its sensitivity to high voltages, including static electricity, it requires some special handling.

All that leads us to one question: How does one learn more about CMOS technology and how to use it? One excellent way is through another of the excellent Heath (Benton Harbor, MI 49022) Educational Systems Courses. This one is their $79.95 CMOS Digital Techniques Course (*EE-3202*), and it is a good one. As usual, this course is complete in itself, but it does fit neatly into the overall Heath Educational Systems series of continuing-education courses. Heath does, however, urge anyone considering the course to be sure they have a knowledge of the material covered by their Digital Techniques course (*EE-3201*) first.

The key to this course is learning-by-doing. While we were completing it, we found many hands-on experiments dealing with CMOS technology, and, in truth, we found the hands-on portions more instructive than the well-written course material. In fact, much of the written material seems to act only as a backup to the hands-on portion.

As usual, Heath provides you with all the components you will need to complete the varied experiments in the course, including many 74C00 series CMOS devices, as well as all the capacitors, resistors and other devices needed.

What's covered

As to the course material itself, just about every aspect of CMOS digital technology that you might need to know is covered in seven units. For instance, Unit One discusses CMOS basics and summarizes them. It then moves on through CMOS logic gates and how the devices are packaged. It also discusses CMOS characteristics including such things as input protection, propagation delay, and power-supply requirements.

Unit Two takes that basic knowledge, which is also tested during the chapter by two programmed review tests, and applies it to interfacing considerations, such as logic levels, output drive, and fan-out. Interfacing techniques for various types of logic systems, including TTL and ECL, as well as such devices as operational amplifiers, LED's, and optocouplers are discussed.

Taking that knowledge even further, Unit Three goes into CMOS logic, including basic logic gates, and discusses logic-gate topics including state definitions, the one-input logic gate, the two-input logic gate, and the use of logic gates as switches. It then goes through the various types of gates—AND, NAND, OR, NOR, EXCLUSIVE OR and EXCLUSIVE NOR as well as other two-input gates and then discusses gates with more than two inputs. From there it goes on to DeMorgan's equivalence, transmission-gate logic, and three-state logic. The unit concludes with a discussion of advanced logic techniques including data-selector logic, read-only memories, programmable logic arrays, and microprocessors.

Unit Four takes the knowledge you have acquired in the previous three units and applies them to CMOS multivibrators. It discusses direct-logic circuits, bistable circuits, astable circuits, crystal oscillators, voltage-controlled oscillators, monostable circuits, and duty-cycle integrators. It also presents some application guidelines and then moves through clocked-logic circuits and master-slave flip-flop applications.

Building on that knowledge, Unit Five discusses counters and registers, including CMOS counters, counter applications, and shift registers.

Unit Six discusses some practical applications of CMOS analog devices and includes a discussion of operational amplifiers and their uses, as well as their limitations. Also covered is using CMOS analog-switches in such applications as sample-and-hold circuits, tracking filters, microprocessor data-entry, and as video combiners. It also discusses the CMOS phase-locked loop and how it can be used as a low-frequency counter, digital tachometer, or a frequency synthesizer.

All the knowledge you accumulate in the previous units is applied to advanced CMOS applications in Unit Seven. That unit goes into using CMOS information processing circuits, such as analog-to-digital and digital-to-analog, sample-and-hold, and peak-detector circuits; frequency modulation and demodulation, and multiplexing and demultiplexing. It also discusses commutating filters and then moves onto various CMOS projects, including a code-practice radio transmitter, a camera shutter delayed-release timer, a capacitance meter, a multichannel adapter for single-trace oscilloscopes, and a CMOS electronic watch circuit.

One thing you must note about the course is that you need certain items to complete it successfully, including the *ET-3200B* breadboard/trainer, an oscilloscope, and a digital multimeter. Now, if you have a well-equipped bench available, it should be no problem. But if you are just equipping yourself for this course, you will find the cost of the course rising significantly above the $79.95 price. The breadboard/trainer alone costs $99.95 and a good, inexpensive oscilloscope can cost $300, or more. Still, those items are things that any workbench should have, and once they are purchased they are yours to use for many years to come. **R-E**

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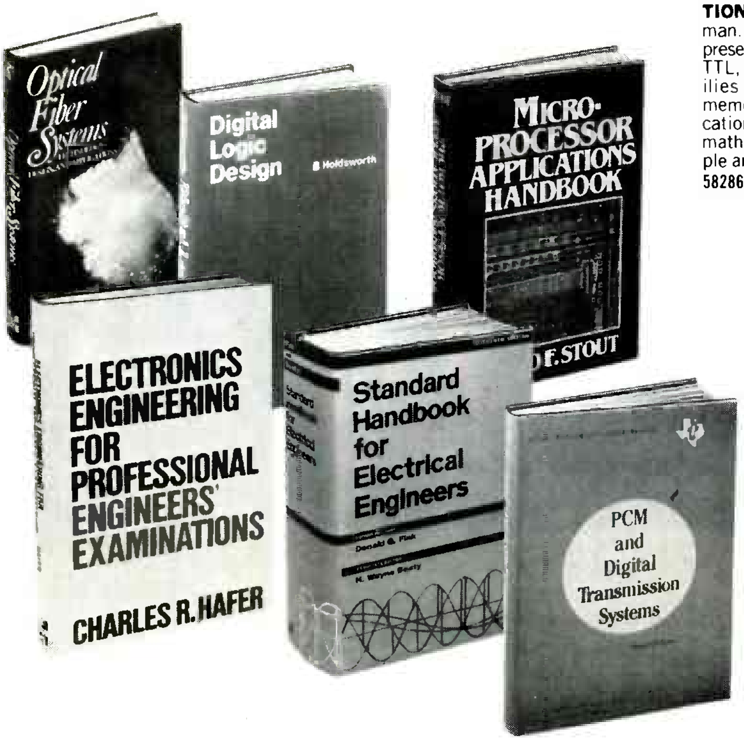

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NEW IDEAS

Light-sensitive timing circuit

MANY LIGHTS AROUND THE HOUSE ARE turned on at sunset and kept on for say three or four hours, and then turned off. Because the same routine is followed almost every day, the lights can be automatically controlled by a light-sensitive circuit combined with a timer. The circuit could be used to turn on not only lamps or security lights; it could also turn on an electric blanket or any other electrical device when the light level falls to a predetermined point. Then, the timer could keep that device turned on for a pre-set time period before it shut it off. Figure 1 shows such a circuit.

How it works

The circuit is powered by a single-ended 12-volt DC supply (not shown) consisting of a 12.6-volt transformer and a 7812 voltage regulator. Though a regulated supply isn't really necessary, it does improve the timer's accuracy. The 741 op-amp is used to form a comparator with *hysteresis* that monitors the outside light level using a photoresistor. That means that the comparator's output goes high only after the input to pin 3 crosses a certain DC value (determined by R2). The feedback applied to pin 3 of the comparator causes the output to remain high until a negative voltage of sufficient quantity to overcome the feedback is applied. Only then will the output change states. Note that there are two switching voltages. In the *dead zone* (the area between the two switching voltages), the output will remain in the same state that it was previously set to. In other words, if the output is high, it will remain so as long as the input is in the dead zone.

Resistor R1 and photoresistor SR1 form a voltage divider. R1 should be selected to have the same resistance as SR1 at the light level at which the lamp is to be turned on. The photoresistor should be mounted near a window and shielded from the lamp that it is to control; or it can be mounted in the same enclosure as the other components if the device is to be mounted near a window. As the light level drops, the photoresistor increases in resistance. That increased resistance causes a greater voltage drop across the photoresistor; an equal voltage is applied to the non-inverting input to the comparator through the 120-kilohm resistor. When the voltage at the non-inverting input reaches a level that's about equal to the voltage at the inverting input of the op-amp, its output goes from low to high. The level at which that change occurs is controlled by R2.

When the comparator's output goes high, a pulse is generated through capacitor C1 that triggers the 2240 timer. The timer stays on for a set period that is determined by capacitor C_t (10 μF) and resistor R_t (8.2 megohm). With the component values shown, the timer period is about 3 hours with switch S3 open and about twice as long with it closed.

The timer's output is sent to the inverter, transistor Q1. The output of that transistor, taken from the collector, is used to turn transistor Q2 on and off. When Q2 is turned on it completes a path to ground through the MOC3010 optocoupler for an internal LED. That LED triggers a triac driver or diac and that, in turn, triggers the triac in the lamp circuit. When the triac is turned on current flows to the lamp.

The LED in series with the optocoupler serves as a pilot light. The LED lights to indicate that the circuit is in operation.

Switch S1 is used to manually start the timer by applying a high input to the timer at pin 11; while, S2 is used to stop its operation by applying a high to the timer's reset at pin 10. Any or all of the switches can be eliminated if the functions they control are not needed. The optocoupler and triac can be replaced by a relay if desired.—*John A. Wert* **R-E**

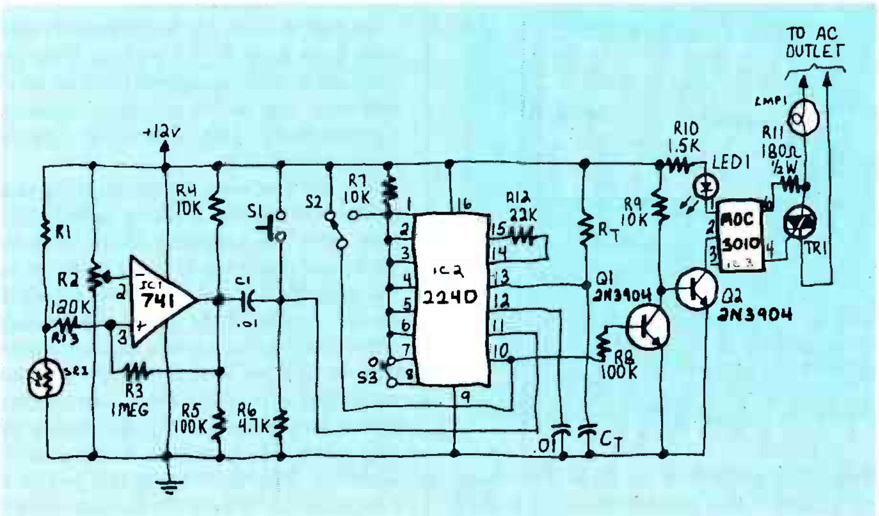

FIG. 1

THE DRAWING BOARD

Generating sinewaves with the 4018

ROBERT GROSSBLATT

BY THIS TIME WE SHOULD ALL BE FAMILiar with the unbreakable first rule of electronic design: *Brainwork before board work.* If you can't get it down clearly on paper, you can't design it, much less build it. (I believe that there's some sort of natural law that governs the relationship between the weight of the finished product and the paperwork it generates. If anyone knows what it is, please let us know!) Paperwork always chops mind-boggling design problems down to a manageable size and also lets you concentrate all your energy on specific design problems.

Last month we spent a little time breaking down the problem of using the 4018 to generate sinewaves. Although that's certainly not the most complex problem you'll ever see, it is important to remember that the design approach that you take is as important as the design itself. As a matter of fact, the initial approach will more often than not shape the final product.

Generating sinewaves

Take a look at the output waveforms of the 4018 shown in Fig. 1. It puts the procedure to follow (and the problem it causes) in black and white for us to look at. And it should give you some idea as to how to go about using that IC. As you can see, the 4018 provides phase-shifted outputs that are delayed by exactly one incoming clock pulse. Not only that, but we've already seen that the output duty cycle is nice and square. If we sum the outputs together properly, we can produce a digital waveform that can be filtered to any degree of smoothness desired by the circuitry that's tied to it's output.

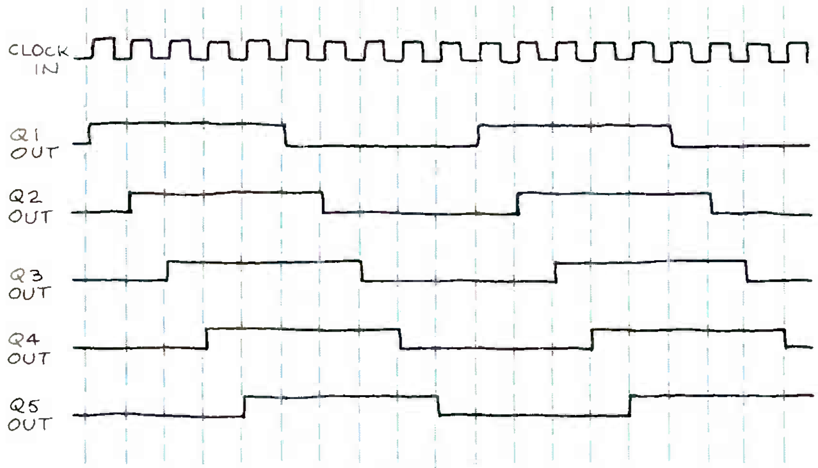

FIG. 1

If the outputs (Q_1 through Q_5) of the 4018 are added together using equal value resistors, we're going to wind up with the very familiar and entirely predictable waveform shown in Fig. 2-a. If you squint your eyes and imagine the waveform to be all smoothed out you'll see that the best that we can hope to get from the circuit in Fig. 2-b is a triangular wave. Obviously, our approach is on the right track but the problem is a little more complex than it first appeared. While, it is evident that we have to add the IC's outputs together, it should also be evident that we have to give more thought to how we do it. The shape of the wave that's generated by the 4018 depends on the values chosen for the summing resistors. Determining the values of those resistors, however, is something else. There's no way to avoid doing some math: but let's see if there's some way to at least cut the required calculations down to a slightly less formidable size. Once again we have some paperwork to do.

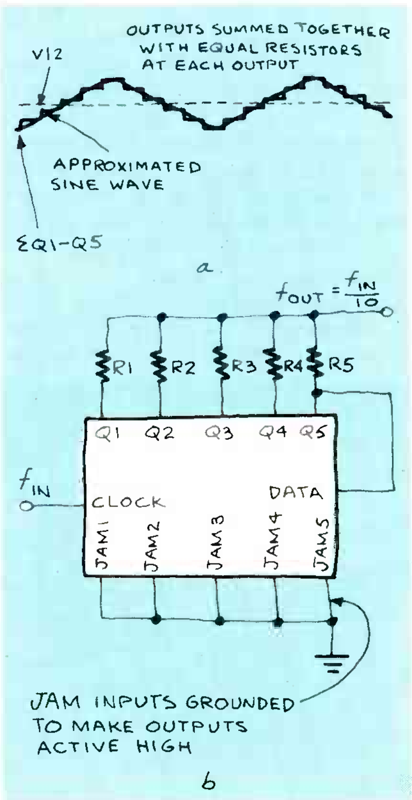

FIG. 2

Now, as everybody knows, there are lots of different ways to go about solving a problem. Which one you pick depends on the problem, but remember that the idea behind all of them is to cut down the amount of work you have to do. Let's attack our problem with the most basic approach—common sense!

In Fig. 2-a we see a composite output waveform from Fig. 1 and we have also overlaid it with an approximation of the sinewave that we're trying to generate. Certain things should become clear almost immediately.

As the sinewave approaches its maximum positive and negative values it flattens out. The staircase shape that was generated using equal value resistors has sharp peaks at those points and therefore, doesn't really fit the curve. That simple observation leads us to a sledgehammer-type fix. All we have to do now is to lose the output of the 4018 that's causing those peaks. In practical terms that means getting rid of the Q_5 output. As you can see from Fig. 2-b, we're using that output for two purposes: It's one of the data outputs

continued on page 113

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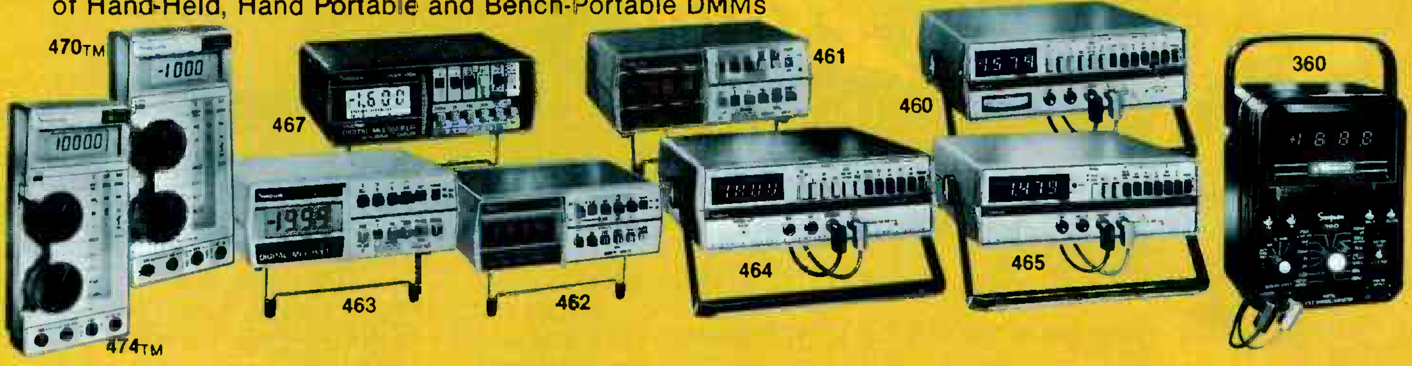

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WIRE-WRAPPER, model *BJW-3*, is a battery-powered version of the *Just Wrap* tool. A bit compresses insulated wire against the wrap post in such a way that the post edge cuts through the insulation and makes contact with the wire conductor. That allows the user to wrap directly from a wire reel or spool without precutting or prestripping, and makes it possible to wire continuous strings across any number of points with a single, continuous insulated wire. The string may be ended at any point with a built-in cutting mechanism.

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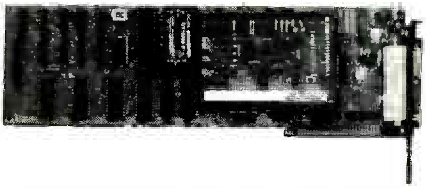
The model *BJW-3* is operated by two rechargeable nickel-cadium batteries (not included). It comes with a bit and sleeve, and a 100-foot spool of 30 AWG wire. Refill spools are available in 100-foot lengths and in four colors: blue, red, white, and yellow.

The model *BJW-3* is priced at $59.95.—**OK Industries, Inc.,** 3455 Conner Street, Bronx, NY 10475.

DATA-ACQUISITION SYSTEM, model *DT2818*, is a simultaneous sample-and-hold data-acquisition system for the IBM personal computer. It provides simultaneous analog-input and analog-output capabilities, as well as digital I/O and clock functions. With an analog input throughput rate of up to 27,500 samples per second, the model *DT2818* is useful for physiological and speech research, as well as multiparameter materials testing and applications requiring auto- and cross-correlation techniques.

The model *DT2818* combines the utility of multi-channel signal freezing with the flexibility and low cost of personal-computer-controlled data acquisition. Using a 12-bit simultaneous sample and hold analog-to-digital converter system, the user is allowed to take a snapshot of up to four high-level analog-input channels, freezing their values instantaneously (within ±5 nanoseconds).



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Subsequent analog-to-digital conversions can occur at up to 27,500 samples per second.

An accessory available for use with the model *DT2818* is the model *DT707* screw terminal panel with integral cable. The model *DT707* provides an easy connection scheme, via screw terminals, for all analog and digital signals.

The single unit price for the model *DT2818* is $1585.00. The model *DT707* is priced at $149.00. The model *DT2818* is shipped complete with a comprehensive user manual, which includes example BASIC programs.—**Data Translation,** 100 Locke Drive, Marlboro, MA 01752.

RECHARGEABLE SPRAY CAN, the *Jenni Can* can be pressurized to about 50 psi with a bicycle pump, footpump, or service station airline. It is useful in the garage, workshop and in engineering jobs, delivering lubricants, rust inhibitors, cleaning solvents, penetrating oil, and de-icer. In electronics, it is useful to

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apply contact cleaner, light lubricants, and for dust blowing. The *Jenni Can* is priced at $19.50—**Scandex, Inc.,** 87 Crescent Road, Needham, MA 02194.

MARINE DEPTH INDICATOR, the Polaris *DI480*, has an alarm which sounds if the

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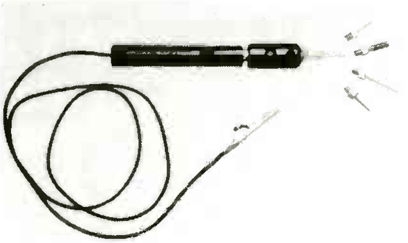
depth varies above or below any range the user specifies. The unit can read depth up to 480 feet. It also features a backlit liquid-crystal display that shows normal depth and shallow- or deep-alarm depth settings. The display can be set to read out in either feet or fathoms in tenths. Variable controls are used to set the shallow- and deep-alarm functions. Additional features include an external buzzer jack, a mounting bracket, and power cord. The Polaris *D1480* is priced at $329.00 — **Regency Electronics,** 7707 Records St., Indianapolis, IN 46226.

AUDIBLE CONTINUITY TESTER, model *137*, comes complete with an adaptable probe end that allows it to accept any probe in Desco's catalog. The standard probe, which is shipped with the unit, will meet most common testing needs. The model *137* gives a combination audible and visual response to a complete circuit, and is capable of polarity



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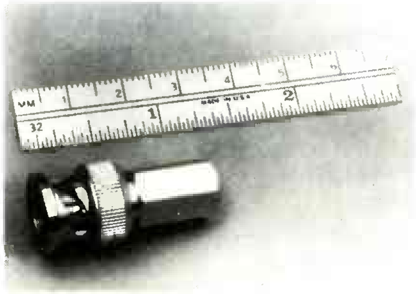
testing. Input impedance is 150 ohms. The model *137* comes complete with two 1.5-volt AA batteries, operates at 3 volts, and draws 5 mA current. It is priced at $22.50 — **Desco Industries, Inc.,** 761 Penarth Avenue, Walnut, CA 91789.

TWIST-ON BNC CONNECTOR, model *203040*, has a body length of only 1.23 inches, for applications where space is limited. No solder or special tools are required for installation. The model *203040* is in one piece and there are no loose parts. It is designed for operation in the 0-4 GHz frequency range at



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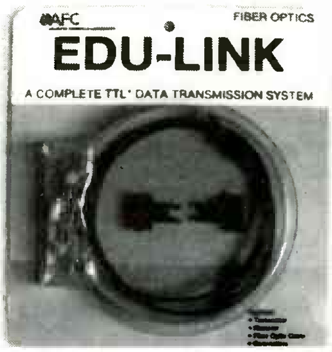
500 volts, has an impedance rating of 50 ohms nominal, and is for installation on RG-59 or RG-62 cable. The model *203040* twist-on BNC connector is priced at $2.29 — **Ava Electronics Corp.,** 4000 Bridge Street, Drexel Hill, PA 19026.

FIBER-OPTIC LINK SYSTEM, the *EDU-LINK*, is a TTL data-transmission system, designed specifically as an educational tool. The *EDU-LINK* package includes a transmitter, receiver, and a 1-meter length of preterminated fiber-optic cable. The kit, sold in unassembled form, demonstrates the principles of fiber-optic transmitter and receiver design. It comes with instructions, theory of operation, and tutorial information. The *EDU-*



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LINK is priced at under $20.00 — **Advanced Fiberoptics Corp.,** 637 S. Hayden Road, Tempe, AZ 85281.

CONTACT ENHANCER, *Tweek*, is a fluid designed to reduce contact resistance in low-power circuits. The better the contact, the cleaner the signal. Connections treated with *Tweek* act as if either the conductivity of the contacting metal surfaces has increased or the contact surface area has been multiplied by a significant factor.

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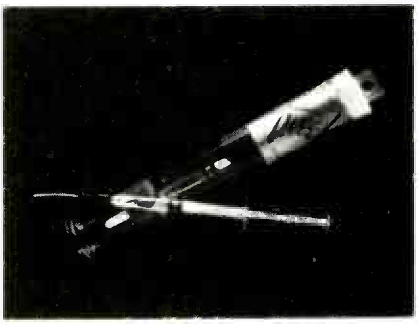

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faces and decreases contact resistance. Among its applications are audio and video interconnects, phono cartridge and head-shell pins, antenna connections, computer connections, and battery terminals. It is sold in 0.5-cc applicator tubes, and the suggested list price is $15.00 — **Umiko,** PO Box 5046, Berkeley, CA 94705. **R-E**

DESIGNER'S NOTEBOOK

Low-voltage amplifier circuits

ROBERT GROSSBLATT

DIGITAL AND ANALOG CIRCUITS EACH have their own unique set of design problems. Very often what is a major consideration in one field doesn't even appear in the other. There is, however, one problem that is common to both analog and digital circuits: the problem of tailoring real world signals so that they can be handled by whatever circuitry that is being designed to follow them.

The output of many real-world sensors (from microphones to keyboards to transducers) need a certain amount of conditioning before they can be reliably processed by either analog or digital circuitry. One of the most frequent problems that turns up is that the voltage level coming out of the input device is just too low to be used by the following circuitry. Because of that, those signals must be amplified to a usable level. This month we'll look at two general-purpose amplifier circuits. The first uses a single transistor and the other a CMOS IC. Either one can really come in handy when you're faced with the problem of low-voltage input signals. We'll look at the transistor amplifier first.

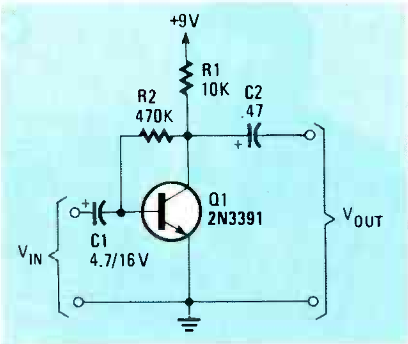

FIG. 1

Transistor amplifier

Figure 1 shows a simple single-transistor amplifier that can be used anytime you need a boost for a signal that's in the microvolt range. That circuit can be assembled from the sort of spare parts that fall into the cracks of your parts box. Not only that, but the it uses so few parts that it takes up less space on a PC-board than an IC. In addition, the circuit has a flat frequency response across the audio spectrum and a gain of about 100 with the component values shown. None of the component values are particularly critical, therefore a wide range of substitutions can be made without seriously affecting the performance of the circuit.

The gain of the circuit can be lowered by dropping the value of feedback resistor R2. And the capacitor values shown can be changed if you don't happen to have those values on hand. Transistor Q1 is a small-signal high-gain NPN transistor; substitutions can be made here as well. A 2N2222 transistor can be used but it will give you a lower gain than the 2N3391 shown; again it's a matter of trial and error on one hand, and how much gain you need on the other.

The circuit can be used anytime that a really low input signal needs to be boosted to a workable level. Anyone who has ever had to deal with the output level of a dynamic microphone (in the microvolt range) will find that little amplifier really handy because it will boost the mike's output signal level enough so that it can be fed into a standard line input. The other low-voltage amplifier circuit that we will look at uses CMOS inverters rather than a single transistor.

CMOS amplifier

The second amplifier circuit is shown in Fig. 2. It uses three sections of a CMOS 4049 hex inverter IC (but any CMOS inverter can be used). It features a high input impedance. It also features all the good things we've come to expect from CMOS: a wide power-supply range, high noise-immunity, an output that swings from ground to just about the supply rail, and so on. The response of the circuit can be easily tailored to satisfy a wide range of circuit conditions.

The gain of that circuit is determined solely by the ratio of the feedback resistor (R2) to the input resistor (R1). And the frequency response is a function of the input capacitor. Keep this circuit in mind, it can make life a lot easier when the output signal for the circuit you're designing needs a bit of amplification. Just round up three spare inverters and your problem is solved. The only thing to remember is that the output voltage won't be at ground potential when you remove the input signal. Since we're using the inverters in a linear mode, the output voltage will always return to V/2 (where V is the supply voltage). If that presents a problem you can always take care of it with a capacitor or some other scheme at the output. **R-E**

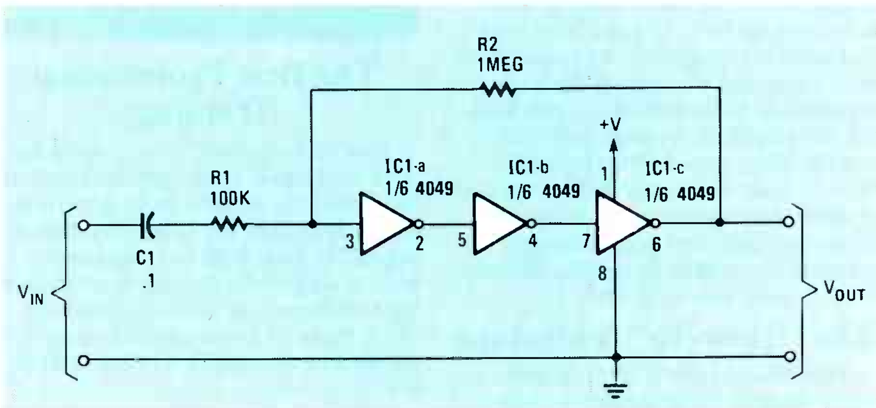

FIG. 2

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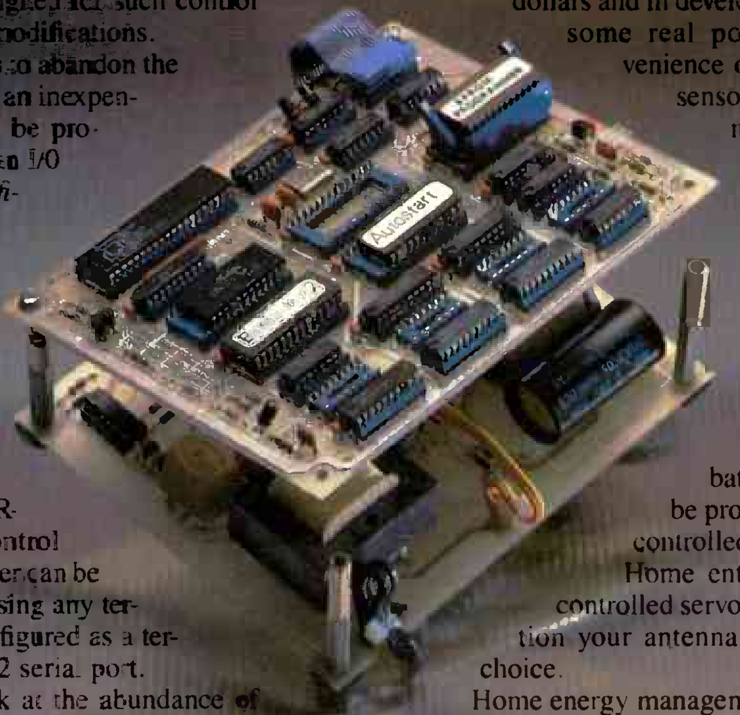
STEVEN E. SARNS

HOW OFTEN HAVE YOU THOUGHT: "IF ONLY I COULD hook my computer up to that furnace (or model train, coffee pot, security system, etc.), then I could really get it to do what I want"? You probably gave up the idea for one of two reasons. First, your computer is too expensive to be relegated to turning on a coffee pot 15 minutes before you wake up (especially when you can buy inexpensive timers to do the same thing). Second, your computer is not designed for such control tasks and requires some modifications.

Those are good reasons to abandon the idea. But what if you had an inexpensive computer that could be programmed easily and had an I/O structure designed *specifically* for control applications? Then you could put some of your ideas into action. This control computer that you can build has—along with its many other I/O cababilities—the ability to control BSR-type wireless remote-control modules. And the computer can be programmed in BASIC using any terminal (or a computer configured as a terminal) that has an RS-232 serial port.



Let's take a quick look at the abundance of applications for a control computer that surround you—some of which you've probably considered and, perhaps, some you've never even thought of. We won't go into detail on how to use the controller for the following applications. Keep in mind that your programming capabilities may limit what you want to do. (You need to know at least BASIC programming to use the controller.) But we will explain how to use the control computer in enough detail so that you'll be able to tailor it to your own applications.

Security systems: A "smart" security system could arm itself in your absence. And the alarm could be dependent on the type or source of breach. For example, with external circuitry, the system could be interfaced to the telephone to alert the police if it sensed a break-in, or it could phone the fire department if it sensed a fire.

Robotics: Even the most drole robot requires some amount of "smarts." Now you can afford—both in dollars and in development time—to give him some real power. Imagine the convenience of independent drive- and sensory-systems. Imagine how much faster your development would be with a complete computer system for each function.

Model control: Imagine the complexity that you could build into a computer-controlled model-train layout, or the acrobatic maneuvers that could be programmed into your radio-controlled model airplane.

Home entertainment: A computer-controlled servo tracking system can position your antenna on the satellite of your choice.

Home energy management: (This is what the author's prototype was designed for.) The living-room thermostat could be the first target—it could automatically set back when you are at work and warm up before you return (but not on weekends). If you have electric heat, and if your electric company has peak and off-peak rates, your electric bills could be cut in half by averaging your power requirements instead of turning everything on at once. Remember—any equipment you purchase for energy management or control might be a tax credit for you. You'll have to check your own state's laws. If you're lucky, you might effectively cut the cost of your project in half!

Features of the controller

The underlying design goal for this controller was a small, inexpensive, yet powerful control computer with its own development system. That design had to achieve a successful balance: We wanted the board size and the cost to be kept down, yet we still wanted to include as many features as we could. However, if we tried to give the board too many bells and whistles, the resulting high cost would limit its practical (economical) applications. On the other hand, a cost-conservative approach would result in a board with only limited applications. Of course, we searched for a happy medium.

The result was a rather small board (about 5½ × 6½ inches) that has enough power to do its job at a competitive cost—take a look at the controller's features:

- A total of 46 inputs and outputs: Seven high-current, individually addressable outputs; 7 individually addressable inputs; 2 eight-bit input ports, and 2 eight-bit output ports.
- An RS-232 serial port: a terminal can be used for program entry.
- An eight-channel, 8-bit analog-to-digital converter with provisions for digital-to-analog conversion.
- A choice of two operating systems: BASIC or Forth. The high-level language will cut your programming time by 90%.
- An on board EPROM programmer makes a permanent copy of your RAM-based program.
- A real-time clock for time-of-day functions.
- Auto start of ROM-based programs.
- BSR-type remote controller is on a companion power-supply board. That system communicates to readily available receiver modules that you simply plug into the AC lines. All of the hassles of stringing wires from the controller to the control point are eliminated.

A closer look

Now that we have an idea of the basic features of the controller, let's discuss some of the theory behind it. Unfortunately, we won't be able to cover all of the points that we just mentioned this month—they will be discussed in upcoming installments of this article.

We'll start by describing the microprocessor and the support circuitry required to test, debug and program the basic system. The design will be discussed in enough detail so that even those who are not familiar with microprocessor design techniques will be able to get an overview of the process. The control computer's schematic is shown in Fig. 1.

The microprocessor selected for this project is the Intel 8088—the 16-bit microprocessor that forms the heart of IBM's personal computer. (Anyone who owns an IBM PC has a complete set of development tools for this board.) The 8088 can be thought of as being made up of two units. The first is the BIU or *B*us *I*nterface *U*nit, which prefetches instructions while the rest of microprocessor (the EU—*E*xecution *U*nit) is working on the current instruction. Besides speeding execution, that has an even more fortunate (economical) effect: Memory IC's with access times as slow as 400 ns will work on the board.

The bus structure

The microprocessor is connected to the memory and I/O through the *data bus*, the *address bus* and the *control bus*. Those busses are shown in the computer's schematic in Fig. 1.

The data bus is the group of eight lines (D0–D7) over which data can be transferred between the microprocessor and any memory or I/O (*I*nput/*O*utput) device.

The address bus is made up of 20 lines, some of which are time multiplexed. Don't worry about now—we'll get to it shortly. You should know, however, that the microprocessor uses the address bus to select the desired memory address or I/O device to send data to or receive data from. That address is represented by the unique combination of address-line states.

We will be concerned with three lines of the control bus. The $\overline{\text{READ}}$ ($\overline{\text{RD}}$) and $\overline{\text{WRITE}}$ ($\overline{\text{WR}}$) lines determine whether the data is to be transferred to (read by) or from (written by) the microprocessor on the bi-directional data lines. The third line, IO/$\overline{\text{M}}$, is used to distinguish between a memory access or an I/O access.

The 8088 can address 1 megabyte (2^{20}) of memory with its 20 address lines. If we use only the lower 16 lines, we can address 64K. The 8088 combines the data bus and the lower eight address lines into what is called a time-multiplexed bus. That was done so that the 8088's package could be kept to 40 pins. The first design question is to decide whether to demultiplex the data and address bus or use it as is. Intel (and others) supports the multiplexed bus with an extensive range of products. Leaving the bus multiplexed will result in a smaller board that is easy to lay out. (That is one of our design goals.) However, because of the popularity of the non-multiplexed bus, peripheral IC's designed for it are more available and are less expensive. Because another of our design goals is to design a low-cost board, we must stick to popular components—or at least ones that we expect to become popular. Fortunately, demultiplexing the bus is an easy matter; it requires only a set of latches. A 74LS373 octal latch (IC15) is used. It is enabled by the ALE (*A*ddress *L*atch *E*nable) pin of the microprocessor (pin 25). Now we have 8 high-order address lines, A15–A8, (IC18 pins 39, 2–8), and 8 low-order address lines coming from the latch outputs, A7–A0, (IC15 pins 7, 12, 6, 15, 5, 16, 2, 19). We also have 8 bi-directional data lines, AD7–AD0) from the input side of the latch (IC18 pins 9–16). Note that the data lines still contain the multiplexed address-information. They will contain data at the time the appropriate control line ($\overline{\text{RD}}$ or $\overline{\text{WR}}$) is active.

The memory field must be divided into appropriate banks (or peripheral IC's). We must make sure that only a single peripheral IC can be active at any one time. If more than one device attempts to place data on the bi-directional data bus simultaneously, a condition known as *bus contention* rises. The result of bus contention is an undefined bus state and, consequently, undefined operation. Thus the output of our memory decoder will be a one-of-N type—only one output will be active at any one time. Each of those outputs will be connected to the chip-enable ($\overline{\text{CE}}$) input of a peripheral IC.

The selection of the size and type of memory is heavily influenced by our need to convert our finished program into ROM. If we can simply remove a RAM IC and replace it with a pin-compatible ROM, we will have a compact yet flexible board. The 2016 2K×8 RAM and the 2716 2K×8 EPROM are pin-compatible, so they will be used. We also need memory space for ROM-ed development tools that can be used during the program testing, and an empty socket for the blank EPROM to be programmed.

Throughout the remaining description of the board, the highest order address lines (A19–A16) will be ignored. The address lines A15–A8 will be called the high-order address lines. The most significant high order address line (A15) can be used to chip-select the system ROM. Address lines A11 and A12 are used as the inputs to a 74LS139 one-of-4 decoder (IC16), which will be used to chip-select the other memory IC's. We have mapped our system ROM and 4 memory sockets uniquely into the 64K address space. Table 1 shows a memory map of our system. Note that A15 is inverted by IC19 to select the system ROM and that the one-of-4 decoder (IC16) is qualified by IC17-d: when A15 and the IO/$\overline{\text{M}}$ lines are low, a memory-field operation is indicated.

TABLE 1—MEMORY MAP

Address (hex)	IC/Function
0000–07FF	IC12/RAM
0800–0FFF	IC10/RAM
1000–17FF	IC13/ROM
1800–1FFF	IC14/ROM and EPROM programming socket
8000–FFFF	IC9/System ROM

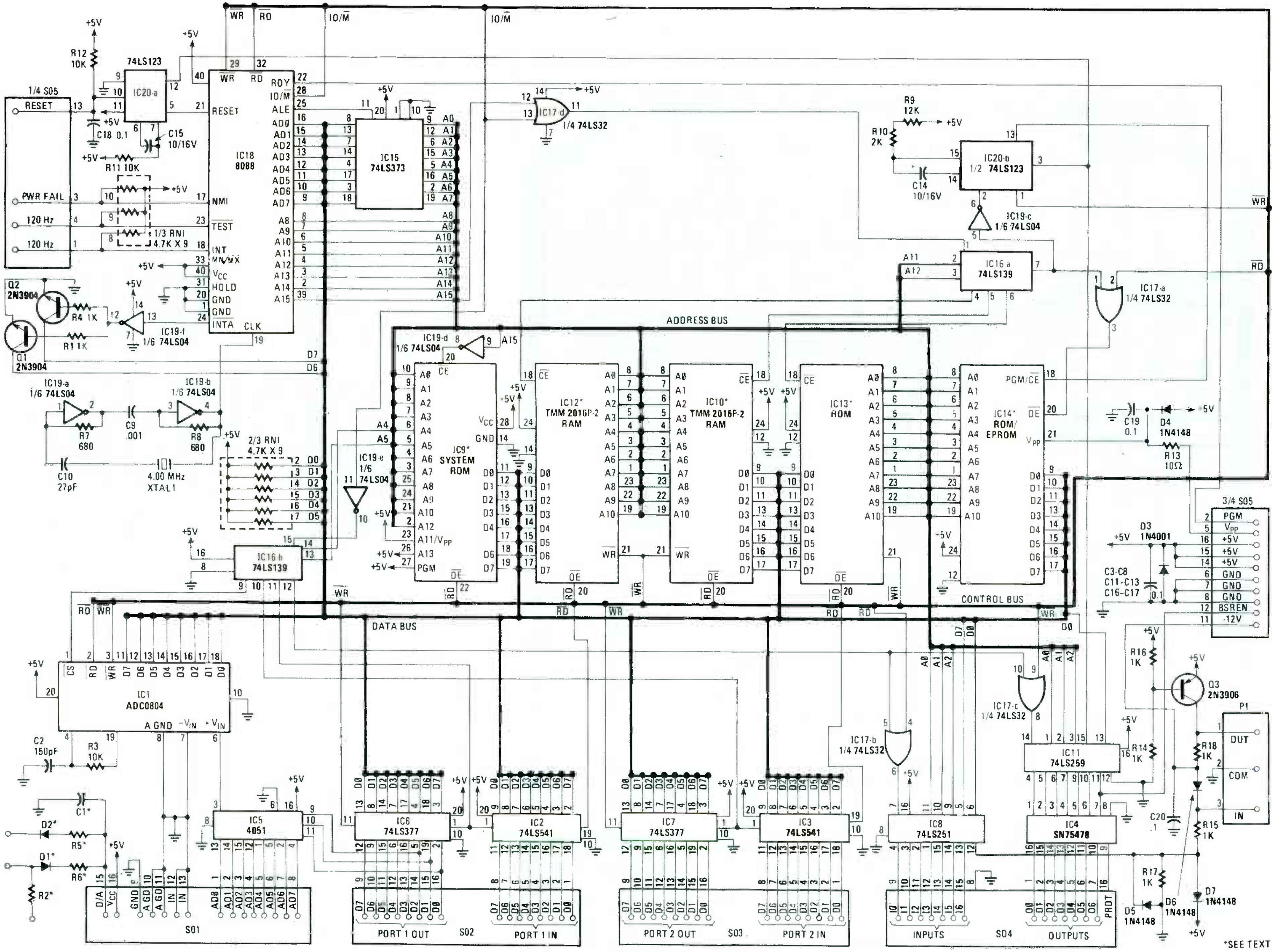
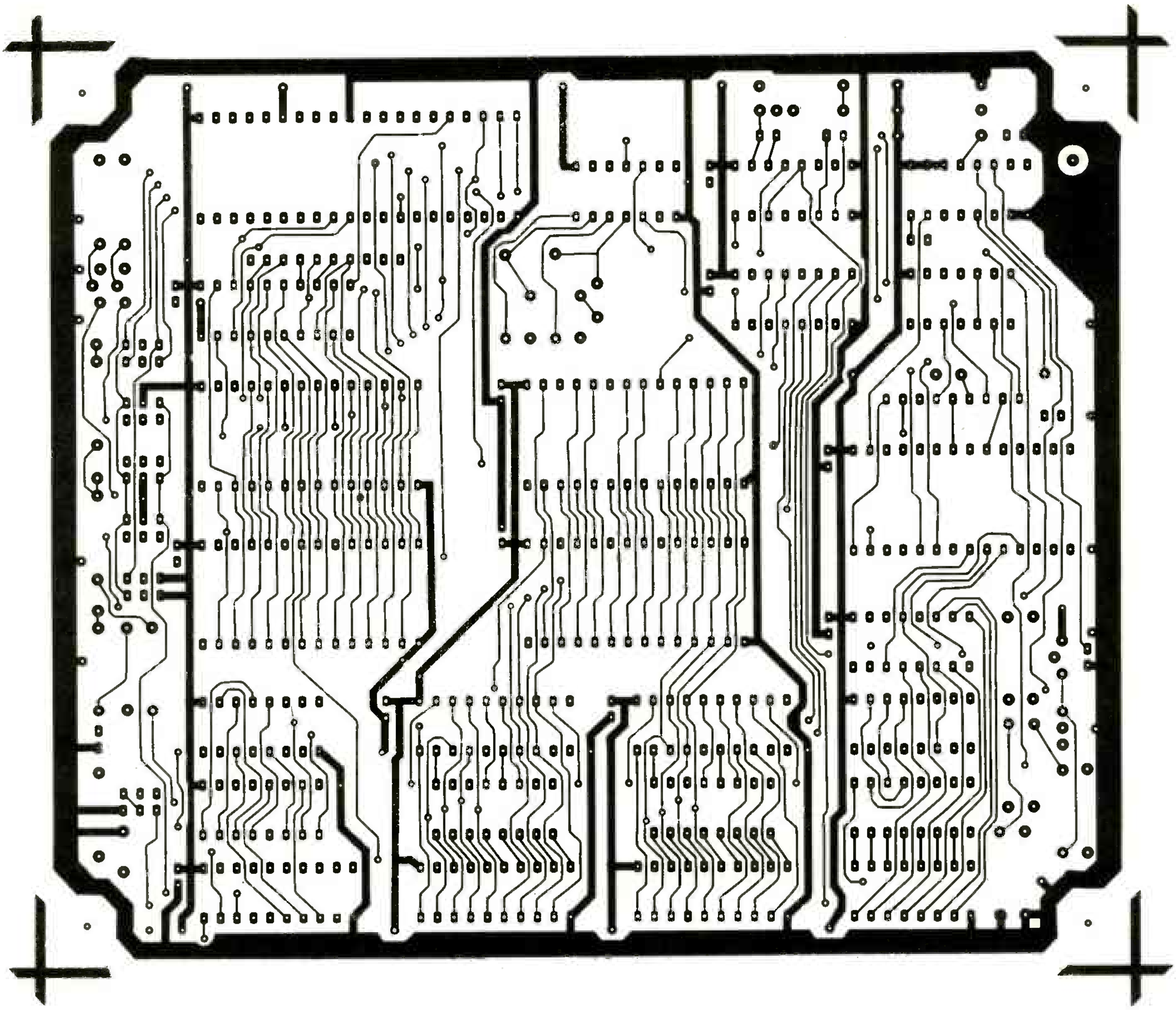


FIG. 1—THE CONTROL COMPUTER SCHEMATIC. Note that IC9 is the system memory. It is contained in ROM and is available from the supplier indicated in the Parts List. Then pin numbers shown for IC9 are *socket* pins. If a 2732 or 2764 is used, then pin 23 should be connected to A11 and not 5 volts. Also, pin 26 should be connected to A13, and not 5 volts. In both cases, you have to cut a trace and add a wire jumper.



6-5/8 INCHES

FIG. 2—THE FOIL PATTERN FOR the control computer's component side is shown above.

When the 8088 is reset, it will begin execution at address FFFFØH. That means our system ROM should occupy the highest memory position. (Remember that we're not decoding the highest-order address lines, so that when the 8088 looks at address FFFFØ, it will see the system ROM.

EPROM programming

Programming the 2716 EPROM is a simple matter. The programming voltage may be applied as a DC voltage to pin 21, the V_{PP} pin. The address and data must be stabilized for 50 milliseconds, and during that time, a single TTL-level pulse is applied to the $\overline{CE}$/PGM pin (pin 18). (It is pulsed from low to high.)

Rather than the more usual method of surrounding the EPROM being programmed with a bi-directional latch, the address and data information will be taken directly from stabilized address and data busses. The disadvantage of our approach is that the microprocessor cannot be doing anything else during that 50-ms interval when the busses are stabilized—including timing the 50 milliseconds. We will have to use a hardware timer. The advantages of our method are fewer components, software simplicity, and a small board size. (Figures 2 and 3 show full-sized foil patterns for the double-sided printed-circuit computer board. The power supply for the computer is contained on a second board. We'll talk about that board in a future installment of this article.) In fact, the EPROM programmer is completely invisible to the software—the EPROM appears to the operator as a very slow-to-write RAM-like device.

We will operate the 2716 from the microprocessor bus by externally qualifying $\overline{RD}$ and $\overline{CS}$ with IC17-a. The output of that OR gate is applied to the 2716 $\overline{OE}$ pin (pin 20).

The 2716's $\overline{CE}$/PGM line (pin 18) will be normally low and go high whenever $\overline{CS}$ and $\overline{WR}$ are true. Those two signals (at IC20, pins 1 and 2) are the trigger conditions for the 74LS123 50-ms one shot whose output (IC20, pin 4) is connected to the 8088 RDY input and the 2716 $\overline{CS}$/PGM input. Whenever the RDY line is low, the 8088 inserts wait states into the current microprocessor instruction. The wait state holds the current bus status (for 50 ms, as determined by C14 and R10) until the RDY line is returned high.

The specifications for the programming voltage are +25 ± .5 volts DC at 30 milliamps. We have found that reliable programming can be achieved with a programming voltage as low as 22 volts. (A programming voltage of 24 volts has worked well for us.) The maximum V_{pp}

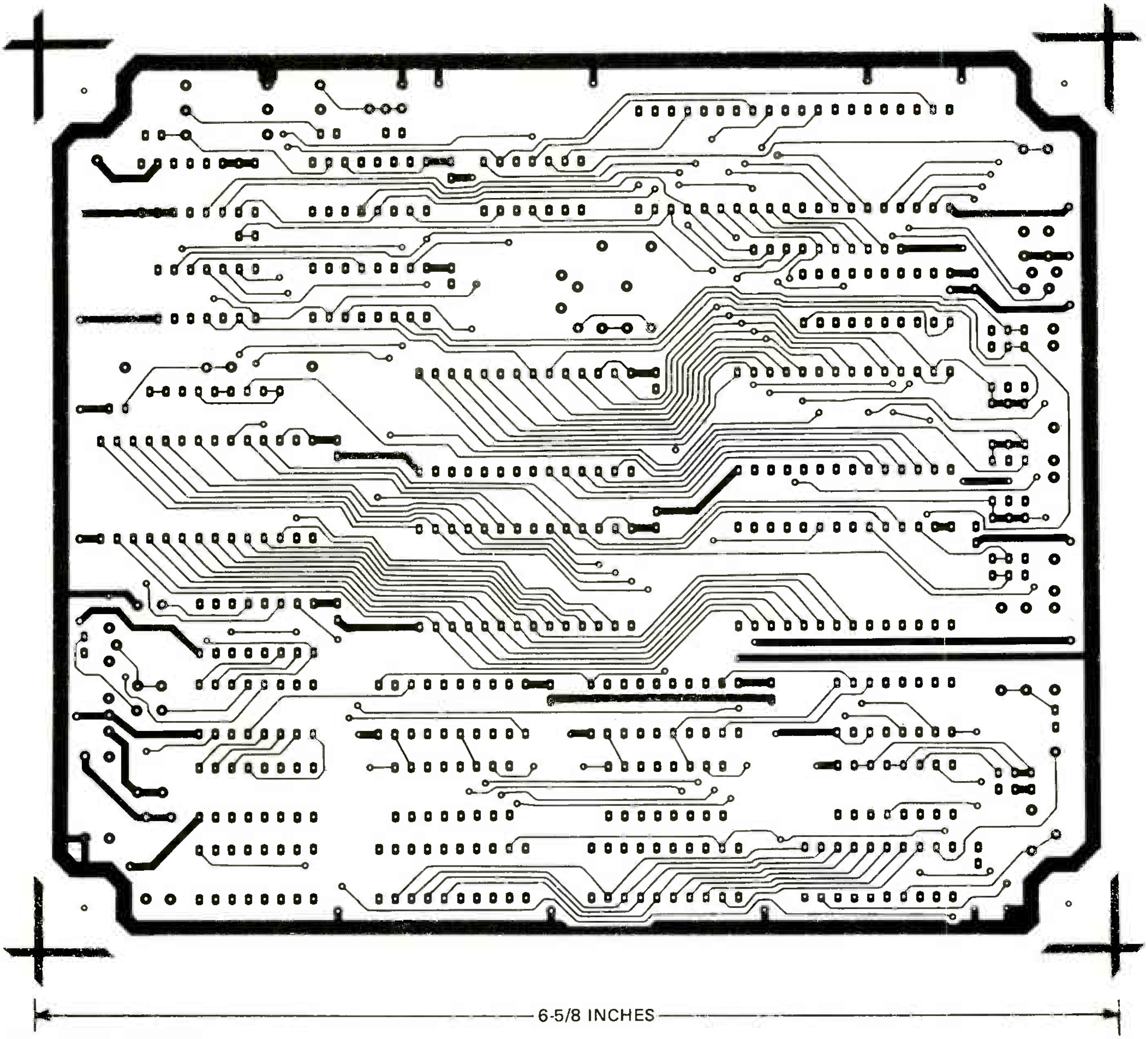


FIG. 3—THE SOLDER SIDE of the computer printed-circuit board.

voltage specification is an extremely important one to follow. We met up with disaster with a programming voltage of 26 volts. If the V_{pp} voltage is exceeded *even for a few nanoseconds*, the EPROM will fry! That means that the V_{pp} supply must not overshoot during turn-on or turn-off. Because we need to control the ramp-on and -off characteristics we will use a power supply design that always switches the supply on and off for each byte programmed. (The switching supply makes the control computer more versatile because it allows you to use other EPROM's—for example the 2732—that require a switched V_{pp} supply. The 2716 doesn't require a switched supply.) That switching programming supply is located on the separate power supply board. We'll discuss that circuit and its construction in a future part of this article.

Programming an EPROM involves only setting appropriate locations to "ø." A fully erased EPROM has all of its memory locations filled with 1's.

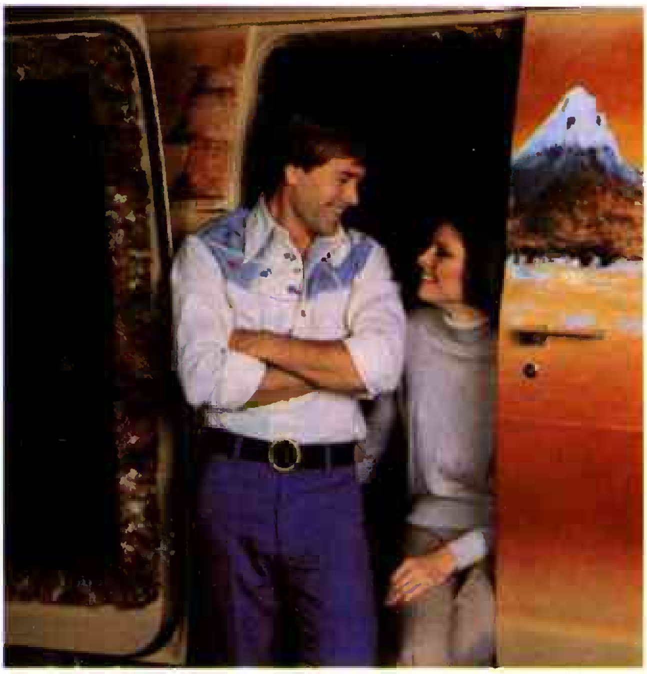
The time will come—either because of a programming mistake or because you no longer need a particular program—that you'll want to erase your programmed EPROM. You can erase the EPROM's by exposing them to ultraviolet light. Direct sunlight will erase an EPROM in about a week. Room-level fluorescent light will erase an EPROM in about 3 years. (Although that's not an efficient erasure method, it is still a good idea to cover the window with a label to block out room/sun light.) A commercial EPROM eraser is simply a source of ultraviolet (UV) light that irradiates the EPROM. You can make one yourself with a General Electric G15TB 18-inch germicidal bulb in a conventional fluorescent-lamp holder. **Do not look into the bulb when it is on.** The light is much more intense than it appears and quickly damages the eyes. Place the EPROMS to be erased within one inch of the bulb and leave it on for 10–15 minutes. That should change all the bits in the EPROM to 1's.

The microprocessor requires a system clock signal, which we obtain with a conventional TTL-type crystal oscillator (IC19, XTAL1, and other associated components). The frequency of the clock is 4.00 MHz, even though the 8088 could run at 5 MHz. The 33% duty-cycle constraint on the clock signal would require either a special clock generator or additional TTL chips.

A reset pulse is also required by the 8088, which we generate by using one-half of a 74LS123 (IC20-a) during power-up or whenever the reset line is grounded and released.

continued on page 94

Go after the best of everything.



Don't settle for less. Especially when it comes to electronics training...because everything else in your life may depend on it. That's why you ought to pick CIE!

Part 2 IN THE FIRST PART OF this article we showed you how to build the video test generator. However, due to space limitations, we could not show you Figs. 6-11; As promised, those appear this month. Now it's time to check out the unit and learn how to use it.

Checkout and alignment

Once you're sure that all the circuit connections are OK and that there are no inadvertent shorts to the chassis, you can apply power. Check the power-supply voltages and verify proper outputs. If the voltages are not correct, be sure to rectify the problem before proceeding.

Set S1 to the EXT position. Connect an oscilloscope to TP1 and trigger the scope from TP9 (or the horizontal-rate output from J4 on the front panel). Adjust the scope until the display shows approximately one line of video as depicted in Fig. 12. Be sure that the scope is DC-coupled, because you want to adjust R2 and R3 until the blanking level is at zero volts, and the peak-to-peak amplitude of the signal is two volts. Now set S1 to the UP/DOWN STEP position, and adjust R5 until the blanking level is again at zero.

At this point you should verify that the up/down-step and the gray-level signals resemble those shown in Fig. 1. The gray level should be selectable (8 levels) by momentarily pushing S2. When S2 is held closed, the generator should "walk through" the gray levels successively.

The next step is to align the multiburst generator. To do that, set S1 to the MULTIBURST position. Put the scope probe on test-point TP1, and trigger the scope from TP6. Adjust R34 until the signal on the scope is about 500 kHz. Then, trigger the scope from TP5 and adjust R36 for 1 MHz. Continue in a similar manner with the other test points, adjusting for the frequencies (at TP1) shown in Table 1.

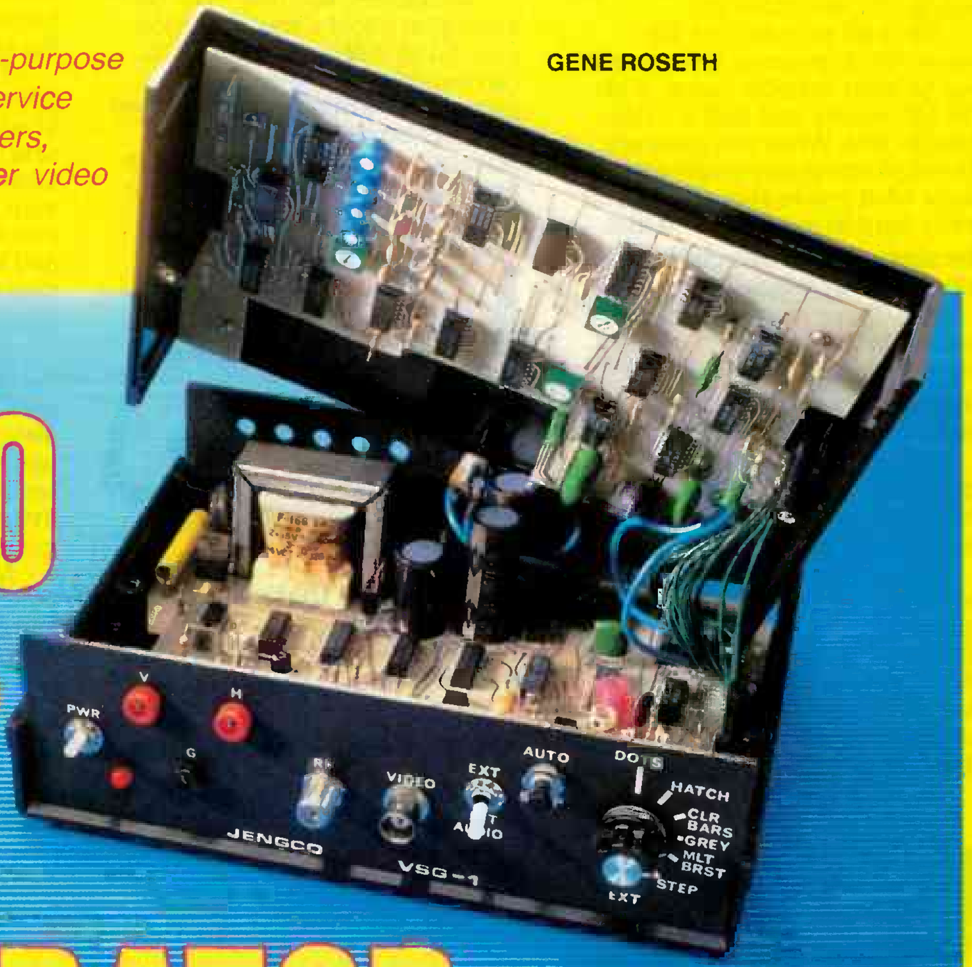
Leave the probe on TP1 and trigger from the HORIZONTAL RATE jack (or TP9) again. Verify that the multiburst signal looks like the one shown in Fig. 1. Next, place the scope probe on TP7 (with the scope set to trigger internally). Adjust R52 for the best-looking sinewave.

You are now ready to align the RF section. Using 75-ohm coaxial cable, connect a TV to J2 (RF OUT). Be sure to use

Build this low-cost, general-purpose video test generator and service TV receivers, video amplifiers, monitors, VCR's, and other video equipment.

GENE ROSETH

VIDEO TEST GENERATOR



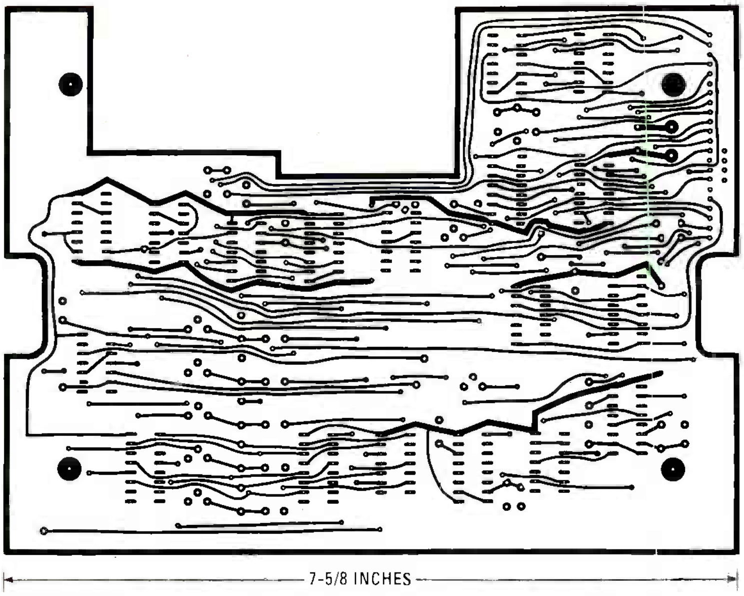


FIG. 6—THE BOARD B component-side foil pattern is shown here reduced 50 percent.

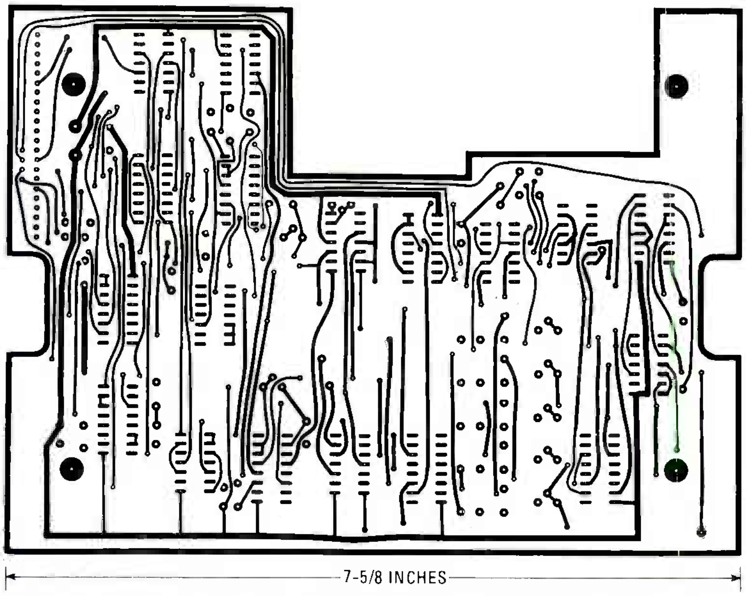


FIG. 7—THE BOARD B solder-side foil pattern is shown here, also reduced 50 percent.

the 75-ohm input of the TV or use a balun for impedance matching, if necessary. Set the TV tuner to channel 3, put the fine tuning at mid-range, and disable the AFT if possible. Adjust coil L1 (with a nonconductive tool) until the best display appears. Rotate S1 through 6 positions (don't worry about the EXT position) and check all signals for proper display. At this point, don't be concerned if there is no color on the color-bar display. Place S3 in the INTERNAL-AUDIO position and adjust L2 until the 1500-Hz tone is heard.

The last step is to accurately adjust the frequency of the master oscillator. The best way to do that is to use a frequency counter at TP14, and adjust C22 until the counter reads 3.579545 MHz. Alternatively, you can adjust C22 by using the TV; Set S1 to the CLR BARS position and turn C22 until the color locks in. That method is less accurate than using a frequency counter. Whether that is acceptable depends on your application.

TABLE 1

Scope trigger	Adjustment	Frequency (at TP1)
TP6	R34	500 kHz
TP5	R36	1 MHz
TP4	R38	2 MHz
TP3	R40	3 MHz
TP2	R42	3.58 MHz

Using the video test generator

The video test generator is used, in general, as the source of video reference signals. The output of the generator is connected to the device or system under test, and the output from that device or system is observed on an oscilloscope. By knowing what the system's output *should* be, and then comparing that to the actual output for any deviations, you can locate the causes of many problems.

In this section, we'll first discuss some of the problems and distortions commonly found in video equipment and systems and how they can be identified using one or more test signal(s). Some of the problems are peculiar to a particular class of equipment (receivers, for example), and some may be found in most or all types of video gear, including receivers, videocassette recorders (VCR's), distribution amps, repeaters, switches, routing systems, etc. After we look at some of the common problems, we'll address the subject of interfacing for the purpose of gen-locking and, finally, we'll look at the external digital video input.

To begin, let's consider poor frequency response: That is a general class of distortions which we must break up into different cases for closer examination. We'll start by saying that the video signal has a wide bandwidth (from DC to 4 MHz) and all that spectrum plays an important part.

Low-frequency distortions usually show up as gradual picture-shading changes, typically right after an abrupt scene change. The problem can be caused by a poor DC-restoration circuit somewhere in the video chain. Power-line hum can also cause a similar, gradual shading change. To test for that situation, do the following: Place the test generator in either the up/down-step or the gray-level mode. Depress and hold S2, the auto-step button; That sends gray-level changes to the system under test at a 1-Hz rate. Trigger your oscilloscope from the vertical-rate jack and observe the system output (DC coupled). If the blanking level changes, then low-frequency distortion exists. A good companion check for problems in this part of the spectrum is to use the gray-level mode at its highest level (maximum white). Observe the system output on a DC-coupled oscilloscope at a sweep rate of about 30-Hz, so that two or three fields are visible. Distortion will cause a tilt to the signal such that the sync tips within the vertical-blanking interval are not at the same level as those during the active portion of the picture. And the entire scope display will have a sawtooth component to it. That problem is most frequently caused by insufficiently sized coupling capacitors between stages of a video chain or between stages of individual amplifiers.

Mid- and high- frequency distortions cause problems ranging from simple left/right shading changes to loss of picture detail or image ringing. To test for that problem use the multiburst signal. Observe the output of the system under test at the horizontal rate. If the white-flag portion of the multiburst test signal is tilted, mid-frequency distortion is indicated. Higher-frequency problems show up as

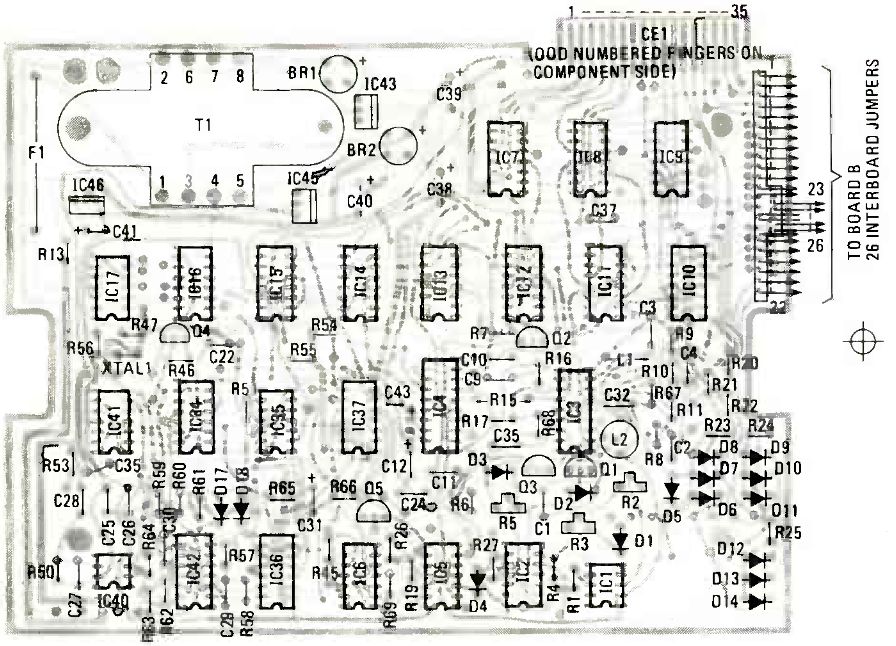


FIG. 8—BOARD A: ON-BOARD PARTS-PLACEMENT. When installing components, be sure to watch the polarity of the diodes, transistors, electrolytic capacitors, and other polarized components.

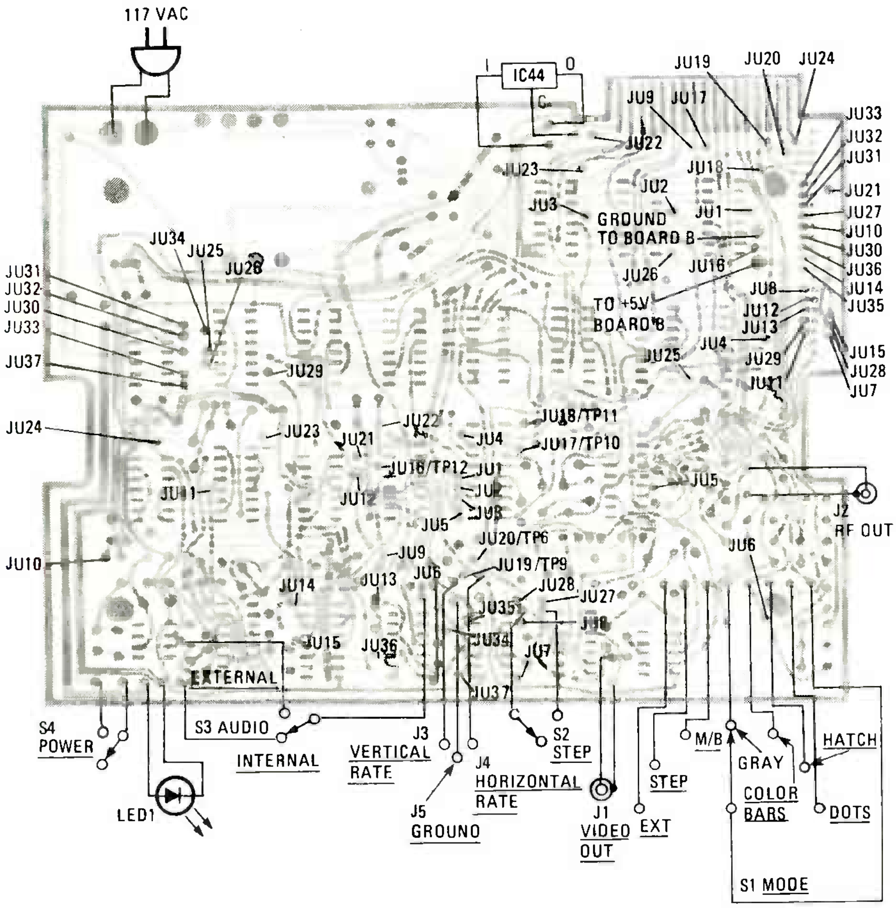


FIG. 9—BOARD A: OFF-BOARD PARTS PLACEMENT and jumper diagram. Note that besides the 37 on-board jumpers, there are also 26 inter-board signal jumpers as well as +5V and ground inter-board jumpers.

amplified or attenuated burst packets. The multiburst test signal is versatile and convenient. It will give a quick indication of system performance. An interesting exercise is to apply this signal to a properly adjusted VCR. The output signal from the VCR may surprise you—it is a result of the various compromises that are made in its design.

Amplifier non-linearity is another common distortion in video systems. It is characterized by loss of detail at some gray levels. To test for that condition, use the up/down step test signal and verify that all steps are of equal magnitude in both ascending and descending directions. Increase the vertical gain of your scope when doing this test. Also, check the step transitions for overshoot or round corners.

Scan non-linearity in receivers and monitors is best tested using the hatch- and dot-pattern signals. Equidistant spacing within each axis as viewed on the screen indicates proper scanning. Those two signals also serve well for color-convergence adjustments; of course, the alignment should attempt to achieve all white dots and lines.

While we are on the subject of receiver/monitor alignment it is worthwhile mentioning the use of the up/down step signal again. A properly operating receiver or monitor should easily resolve all eight of the gray-level steps contained in the signal. That's a quick check and should indicate if further testing is called for.

The color-bars signal provides the standard six colors (three primary and three complementary) in order of ascending luminance level (blue, red, magenta, green, cyan, yellow). That signal is primarily used for subjective system evaluation, as well as for adjustment of receivers. But if you have access to a vectorscope, the

continued on page 139

TABLE 2

Card-edge pin	Function
1	GREEN LSB IN (2^0)
2	VERT RESET CONTROL IN
3	BLUE MSB IN (2^2)
4	HORIZ RESET IN
5	GREEN MSB IN (2^2)
6	GROUND
7	GREEN 2^1 IN
8	GROUND
9	BLUE 2^1 IN
10	GROUND
11	RED LSB IN (2^0)
12	GROUND
13	RED 2^1 IN
14	GROUND
15	EXT AUDIO IN
16	GROUND
17	COMPOSITE SYNC OUT
18	GROUND
19	BLUE LSB IN (2^0)
20	GROUND
21	RED MSB IN (2^2)
22	GROUND
23	BURST GATE OUT
24	GROUND
25	+ 5 VDC (10 mA) OUT
26	GROUND
27	BLANKING OUT
28	GROUND
29	HORIZ DRIVE OUT
30	GROUND
31	VERT DRIVE OUT
32	GROUND
33	VERT RESET IN
34	GROUND

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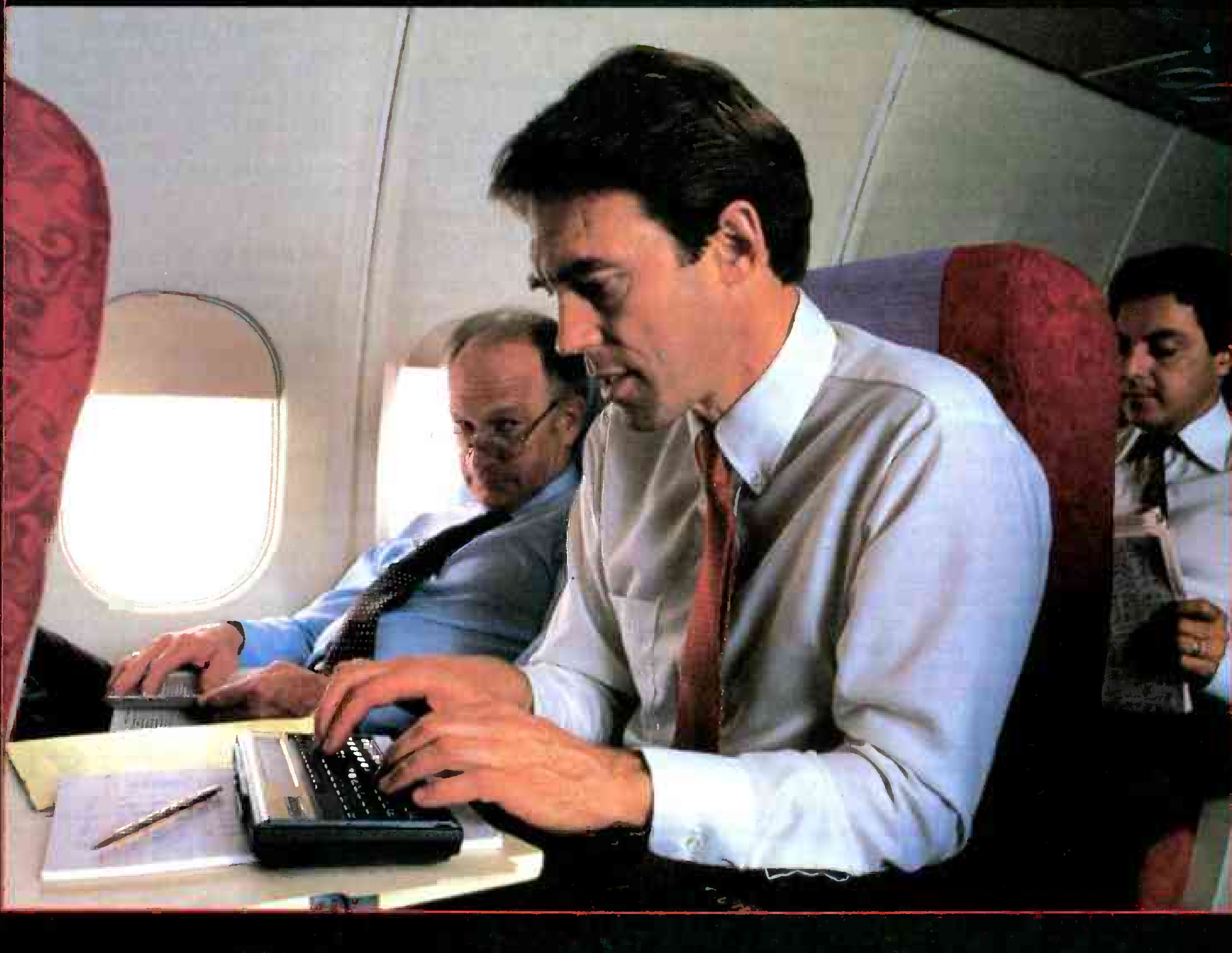
Working with Databases

Don't Get Stuck



Don't Get Stuck

HERB FRIEDMAN

It's not what the advertisements say that you should watch out for—it's what they don't say! Here's some things you should look out for if you want to avoid "getting stuck."

SOFTWARE IS ONE OF THE FEW THINGS SOLD IN THIS COUNTRY that is *not* guaranteed to do the job you expected or paid for. Unfortunately, software advertising—and in many instances the newspaper and magazine reviews of the software—has something in common with the pitch used to sell Indian Snake Oil. You know: "Two slugs of the stuff will cure everything from 'the vapors' to Saint Vitus's dance."

The difficulty with much of the software sold for personal computers is that the user is rarely told what it *doesn't* do; and often, the very thing it doesn't do is the reason why you purchased the software in the first place. It often appears that software advertising works on the principle that if you make an almost endless list of claims for a particular software—all of which are true—the user will infer that it will also do other things.

When it comes to software not doing what the user expects, it doesn't matter whether it's a small $20 software package from someone running a part-time business from the kitchen table or a program from one of the "major" houses whose software prices start somewhere around $500 and head for the stratosphere. The object of both enterprises is to sell software, and as long as they don't make an unsubstantiated claim the "missing" performance is your problem, not theirs.

We're going to look at some of the "missing" features or unusual performance we've run across when testing software for coverage in **Radio-Electronics**. To avoid embarrassing anyone we're not going to name brands or mention names; instead we'll give you an idea of the kind of problems to look for. Often, what bugs us will be of absolutely no concern to you because you have no need for that feature. But maybe our discoveries will give you an insight into what to look for in the software you're interested in.

Sorting problems

A "sort" has always plagued low-cost personal-computer software. A few years back one of the major software suppliers came out with a rather good mailing list that had only one substantial problem: it took nominally 20 minutes to sort (alphabetize) 100 names and addresses. That was never mentioned in the advertising or even in the reviews. Several years later a few magazine columnists got up their courage and mentioned the long sort. But that was about 12 months after the software had been replaced with a mailing list that could sort 500 names in under 15 seconds—and even that's not fast.

Well, you would assume that programmers have finally learned how to write a sort program. Not so! A recent mini-database filing system, intended primarily for cataloging, which can locate random information before your finger gets off the RETURN key, takes just short of 9 minutes to sort two entries (that's correct, *two* entries). It has some form of "breakthrough in the state of the sorting art" whose speed increases with the number of entries. If you have 500 entries the sort zips through and in seconds everything is alphabetized. But if you have maybe five or ten entries you could prepare lunch while waiting for the sort to finish.

Now you might think that low cost is the reason for sloppy software. That's not necessarily true. Price often has no relationship to sloppy programming or missing features. Three relatively expensive programs, that cost from $200 to almost $1000 prove that price does not go hand in hand with a program's performance or conveniences.

Word processing

Whenever **Radio-Electronics** runs an article on word processing in which we make any reference whatsoever to MicroPro's (33 San Pablo Ave, San Rafael, CA 94903) *WordStar*, we invariably get mail from software suppliers to the effect their software is better. (For some reason saying *WordStar* is like waving a red flag at a bull.) Two recent responses illustrate the difficulty we have in selecting software for coverage. The first "better than *WordStar* word processor" came with a 140-page reference manual and a 256-page book on how the program was developed. (Right away we knew we were in for trouble because of the principle: "The thinner the documentation the better the program." A tutorial should not be necessary for general use.)

The truth is that the software was dynamite—actually, more like slightly damp dynamite. While it had almost every feature one could think of, it automatically stored each page on the disk. In order to re-read what had been written you had to go into a review mode and search through each page. Also, if you decided to change a word or character, you had to enter a review mode, find the desired page, edit the change, and then the page was saved as a new page—leaving you with both the old page and the new page. Unlike CP/M systems, which make one automatic backup, if you edit a page five times you have five disk files, one for each page. By the sixth page you will probably be climbing the walls.

Now the "automatic page save" was never mentioned in the advertisements. It is, in fact, a carryback to the old dedicated word processors that were intended for the preparation of business letters. You get a lot of work out of the typing pool with auto-saves at the end of the letter, but personal computers are rarely used for that kind of work. The people who wrote the program had their training on the older word processors and simply did not know it wasn't right for personal computers. But the user did not know about the "page save" feature until he or she owned the software.

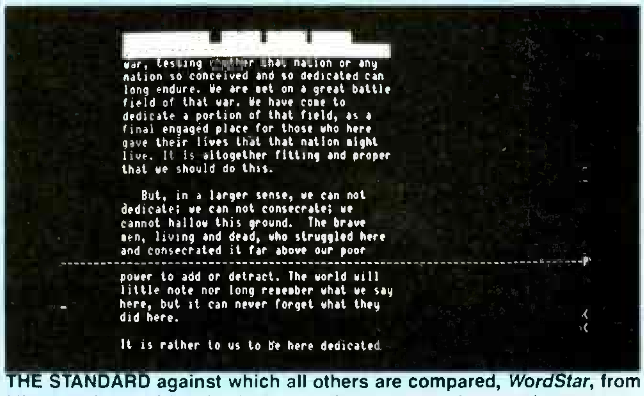
Another respondent pointed out to us that his word processor, which cost almost three times as much as *WordStar* (and that piece of software has never been called "inexpensive" to begin with) was better, and provided a long checklist of features to prove the point. Comparing the two feature for feature, they were almost identical, except that the competitor's product could do a screen print—the screen display could be printed exactly as shown (which *WordStar* cannot do). But the competition did not have a "page break," a line across the screen that shows where one page ends and another begins.

While a screen print is a much desired feature, in this day and age there is no excuse for new word-processing software not to have a page break so a user can quickly check and edit a multi-page document. And we don't mean a page break called up by exiting the edit mode and loading a view or review mode—we mean an on-screen page break. When you're paying "big bucks" for software you're entitled to *all* the modern features.

OK, we'll compromise: for inexpensive software a "view mode" page break is all right if it shows the page number being viewed. Either way, if you're into multi-page documents, that is almost a must-have feature; but few advertisements state clearly whether a word processor has a page break, and even fewer tell you what form it takes. One program displays the page formatting in graphics that zips through so fast that if you blink you'll will miss two pages.

Databases

Our third problem came up with a rather decent database-management system that impressed us because it wasn't necessary to take a course in programming to use it. Naturally, it claimed to outperform Ashton-Tate's (9929 West Jefferson Boulevard, Culver City, CA 90230) *dBase II*. (For competition, *dBase II* is to database management what *WordStar* is to word processing.) The problems we ran into were due to the fact that



THE STANDARD against which all others are compared, *WordStar*, from Micropro, is considered to be among the most complete word processors on the market.

the program was written in BASIC, and really consisted of three separate programs that auto-loaded each other.

Now there is nothing wrong with BASIC—some truly great software is written in BASIC—but BASIC is very fussy about error trapping. First it turned out there were a few unusual conditions during data entry when the errors were not trapped: The program closed the files and recycled from the beginning: no real loss but it's very time consuming and frustrating. But the sort program was even worse. A mistake in the keyboard entry could produce a RESET to BASIC, with all the files on the disk remaining open. In our usual error-trapping tests, the software worked well; it was the unusual error that crashed the program—but error trapping is supposed to catch everything.

Graphics

Graphics software is another award-winner at creating problems; and we have a good number of examples to keep you on your toes. First, there's the software house with an absolutely superb budget-priced graphics program that's suitable for use in school for instruction in graphics; it's also excellent for home-and-family and small business use. The problem is that the printer routines are not standard and just a few of the latest model printers will print the graphic display. Unfortunately, unless the salesperson that you are dealing with is an expert, you're not going to find out about the printing problem until after you purchase the software and take it home.

Then we have a superb graphic program that makes those multi-function charts you see in the IBM advertisements. The problem here is that the programmer did not know or realize that the printer for which it was specifically written came in two models. One printer simply zipped through the print; the other would put a single tick on the paper, then return the print head to the left hand edge of the paper, move it across the page to the position for the next tick, then return to the left, and continue to repeat the process until the print was made. A simple six-bar graph took almost 30 minutes to print, and we could hear the head-positioning motor start to slow down from the excessive back-and-forth motion.

Another graphics program had everything going for it: price, performance, ease of use. It was a really nice little program. We wanted to use one of its graphs to illustrate how it worked. Typically, we run articles through a printer buffer to free the computer for other work, particularly when we're processing graphics—which can seemingly tie up the computer forever. Low and behold the whole right column of the display didn't print when using our regular printer buffer. Whether the problem was in the software on the buffer we didn't take time to uncover. Suffice to say, if you do graphics and you use a printer buffer as a matter of course, make certain the buffer and the software work with each other, or disconnect the buffer.

It doesn't take big, expensive software to give you heartburn. When evaluating software we often have to transfer the program from one computer to another. That is generally done through a "null modem" at 4800 to 9600 baud; anything slower and we would fall asleep waiting. When we were evaluating software for a particular computer we were limited to transfers at 1200 baud maximum. So we tried some very inexpensive software that claimed it would allow us to do the job at 9600 baud. Only after getting the software did we discover we also had to make a somewhat sophisticated modification to the computer. We had had enough trouble getting that computer to run: there was no way we were going into its guts and mess around with the circuit.

The thing was that the software was so cheap that it didn't pay to send it back through the whole insurance and return-receipt hassle. (We have to wonder how many others didn't return the software for the same reason.)

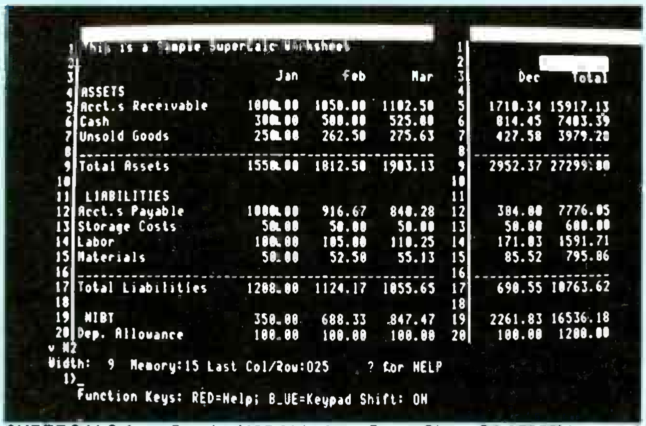
We've had several experiences with software it didn't pay to return. Often, they involve a "screen dump"—a means to print hardcopy of exactly what appears on the screen.

From the early days of personal computing we have had the luxury of the NEWDOS "JKL" screen dump. For those of you not familiar with Radio Shack computers using the NEWDOS operating system, by simply pressing the JKL keys simultaneously the user gets a print of what appears on the screen, often with some degree of graphics representation. (It depends on the printer.) We have evaluated many "screen-dump" routines that profess to print exactly what you see on the screen. Unfortunately, they often turn out to be BASIC subroutines that must be appended to BASIC programs. If the BASIC program runs and produces a screen display, then the routine dumps the screen to the printer. On the other hand, if you were writing the program and wanted a quick screen-dump (instead of a listing) it doesn't work; the screen-dump must be part of the program.

Another variation of the screen-dump is software that can be integrated with disk BASIC to run as a command file. The problem is that the instant it's called up as a command file it prints exactly what's on the screen, which is usually the screen prompt and the command line for the program—that's all. If you need screen-dump software, doublecheck on whether it will work when you need it, even for word processing.

Another thing to watch out for is that the software you purchase is convenient and accurate. First, let's look at convenience. We had heard about what was supposed to be an absolutely spectacular income-tax package that had all the major and most of the minor schedules. So we assumed that some **Radio-Electronics** readers with their own business would be interested. The program was fantastic, a magnificent job. The only problem was the printout, which was in an electronic spreadsheet format that had to be laboriously transferred by hand to the Internal Revenue Service forms. Income-tax software should really print on the IRS forms, most of which are generally available in tractor feed for those of you who are accountants or do tax preparation.

Admittedly, some electronic spreadsheet programmers (for that's what they are) are skilled artists: we have seen spreadsheet work that the software house that sells the program claims cannot be done. There are spreadsheets for just about everything under the sun, even complete payroll systems that include formatted printout for paychecks and W2 forms. We have also seen spreadsheets that are simply wrong. (In fact, for some three years the "tutorial" software supplied with one of the spreadsheets had an accounting error.) We were once demonstrating an IRA retirement spreadsheet that had received many favorable reviews when a financial planner in the audience rose to claim the demonstration was defective because an annuity value was substantially in error. Now the formula was so long that it literally ran off the screen, but the financial advisors in the audience whipped out their calculators and after almost 30 minute's effort established that not only was the retirement formula incorrect, but so was the compound-interest income formula.



SUPERCALC, from Sorcim (405 Aldo Ave., Santa Clara, CA 95050) is one of the better electronic spreadsheets currently available.

That taught us a good point: namely, before using any calculating software check it out with values you know to be correct. (And if you don't know, ask an expert.)

Finally, consider whether the software really makes your life or work any easier. Sometimes the effort isn't worth the result—and you rarely find out about that until you run the software. Our introduction to unnecessarily expanding the workload was a family income-tax program that made the user go through every single entry; there was no way to skip over any of the screen prompts. In our evaluation we did the income tax for a college student whose entire income was on a W2, with no interest or dividends. It could have been written up on IRS form 1040-EZ in about 5 minutes. Some 50 minutes later we managed to get it through the income-tax program, after constantly pressing ENTER (no value) in response to prompts. And then the final tax was in error; by just a few pennies, but nevertheless it did not agree with the tax tables.

By the way, the tax programs offer an interesting thought. In order to keep up with the changes in the tax rates, forms, and laws it's generally necessary to purchase yearly updates. If you add the cost of the updates to the cost of the basic software, and consider that the program is good for about four years, it will most likely be less expensive and faster to have an accountant or professional tax preparer do your income taxes. (Don't forget. You must add in the cost of the extra-support software for the income tax forms for your own state.)

We've shown just a few of the things that can go wrong with what otherwise appears to be perfectly satisfactory software. The point to keep in mind is always be suspicious about features that aren't claimed, and always worse-case check your software for features that even the programmer doesn't know exist. **R-E**

HERB FRIEDMAN

Portables and Totables

Portable and totable computers are the latest rage in personal computers. In this article we'll find out more about them, including if they're right for you.

TWO OF THE HOTTEST SELLING ITEMS IN THE COMPUTER MARKETplace are the portable and totable computers. No, they are not the same thing. If it can fit into an attache case or your shirt pocket—and that covers rather a broad range of sizes and weights—it's a portable. On the other hand, a totable is really a desktop computer that's been scrunched into a case that will just about slip under an airplane seat. It would normally be called a desktop computer except for the fact that the case has a handle. The totable weighs in at a little under 30 pounds, and is best moved by using a luggage carrier: one of those collapsible hand trucks with small wheels that travellers use to move their luggage to and from airports.

Looking at value and performance versus cost, portables, and to a lesser degree totables, grade out relatively expensive. If you get one or the other you are buying convenience, not necessarily performance. In many instances you must trade off performance for something with a handle.

The first of the true portable computers—not a programmable calculator—was Radio Shack's (One Tandy Center, Ft. Worth, TX 76102) *PC-1*, which was manufactured by Sharp (10 Sharp Plaza, Paramus, NJ 07652); it was also sold directly by Sharp. (The only real difference was that the unit sold by Sharp had a more informative manual.) The *PC-1* was a real attention-getter. Powered by camera-type batteries, it had a one-line LCD readout, a moderately sized but decent version of BASIC, a small CMOS memory that "remembered" the program even when the computer was turned off, and a built-in calculator that could be used independent of the computer. Priced at slightly over $200 it was a great gift, particularly for high-school graduates going on to study computer science.

The *PC-1* also had connections for an accessory battery-powered cassette tape interface, or a device that combined a cassette interface with a small printer that used rolls of adding-machine paper. The printouts were small and best-suited for making program listings.

Over the years, pocket-computer features have been greatly expanded. The latest models—though still having single-line displays—feature extended BASIC, have limited graphic capability (though there's not much you can do on one line), have built-in quartz clocks, expandable memory, and even optional printers that can print graphics. On the flip side of the coin, the latest base-model pocket portables, with features similar to those available on the original models, sell for under $100.

The problem with the pocket portables, however, is that they are inconvenient for general use. Among the major limitations are itty-bitty calculator-type pushbuttons, which means each program must be punched in a key at a time—a long, error-prone process even if the computer has some form of single-key-entry for BASIC programming functions. What does "single-key entry" mean? It means that if you touch the "P" key the entire command PRINT is entered; touch, perhaps, the key "L" and the computer loads a program from the cassette. The computer has its own internal program that knows when a "P" is the letter "P" and when a "P" is the command PRINT.

Programming problems notwithstanding, for persons who work in the field (such as civil engineers, architects, salespersons, and the like), who need immediate access to a few fixed computer programs, or some means of quick data entry and storage, the pocket portables are an unquestioned asset. That's particularly true if all the user needs is information that can be displayed on a single line. (Yes, a printer can be used for multi-line output, but a combined computer and printer assembly is too large for the pocket.) Then again, if the primary purpose of the pocket portable is computations, a programmable calculator will possibly do the same thing at substantially lower cost.

And if you're thinking about getting a pocket portable for someone going into computer science, think about it twice. Most schools want the students to have a particular kind of computer, or one with specific features, and pocket portables rarely meet either requirement.

In your lap

But no matter how the performance of a pocket computer might be rationalized, a one-line display simply is not convenient for anything more than minimal data entry, or a series of individually displayed values.

For portable computer power that's something more than a substitute for a programmable calculator, the real choice is something usually called a "lap" computer. A lap computer has a full-size keyboard with typewriter keys, yet it is small enough to fit on the user's lap or slip into an attache case.

Those units are powered by alkaline or rechargeable batteries, or a plug-in AC adapter; the adapater can also operate as a battery charger if the computer has rechargeable batteries. Lap computers feature a multi-line LCD readout, an enhanced BASIC, a substantial amount of CMOS memory that will retain your program and information even after the power switch is turned off, and, at the very least, has some kind of built-in text-editing software. Other features depend on the particular model.

Presently, there are three lap computers generally available: the Radio Shack *Model 100*; the NEC (1401 Estes Ave., Elk Grove Village, IL 60007) *PC-8201A* (which is very similar to the *Model 100*), and the Epson (3415 Kashiwa St., Torrance, CA 90505) *HX-20*. The *Model 100* is the most systemized of the lap portables, meaning it can be used to its maximum potential without the need for external accessories. Its basic hardware features include a 40-column by 8-line LCD readout, 8K of RAM (expandable to 24K), a direct-connect answer/originate modem, a parallel printer (Centronics type) output, and a cassette-tape interface.

But all things considered, the *Model 100's* strength is its internal ROM-based software, which includes extended Microsoft BASIC; a decent text editor suitable for the preparation of documents; an address/telephone index file that will automatically dial a telephone number through the internal modem; a mini-database called *Schedule* that will keep track of appointments, daily expenses, and personal notes (such as who you took to dinner), and a full telecommunications package that controls the data exchange through the modem.

The NEC *PC-8201A* is similar in appearance to *Model 100*, and other than the different location of a few keys and a somewhat superior keyboard layout it's difficult to tell them apart at first glance. Even the display is the same 40 columns × 8 lines. In fact, both start out with essentially the same basic package, but they diverge in the concept of their final purpose. Whereas the *Model 100* is intended primarily for material that will eventually be used for telecommunications or dumped into a larger computer, the NEC *PC-8201A* is part of a complete portable package that includes several battery-powered devices: a cassette recorder, a thermal printer, a direct-connect modem, optional nickel-cadmium batteries (the NEC's basic power supply is alkaline batteries), and outboard adapters to drive an 80-character × 24-line monitor or a TV modulator that produces a 40-character × 16-line display on a TV set.

The NEC's internal ROM software is similar to the *Model 100's*: it includes enhanced Microsoft BASIC,a text editor, and telecommunications software. As for RAM, the NEC is supplied with 16K versus the *Model 100's* 8K. The NEC's internal RAM can be expanded to 64K, the *Model 100's* can be expanded to 32K. (Actually, it's possible that even 24K might be sufficient because text processing gets somewhat slow once the document exceeds about 20K.) A port on the side permits an additional 32K of RAM with battery backup to be plugged in. The program or text can be dumped to the plug-in RAM, which can then be unplugged and stored for up to two years without losing its "memory." (Super-memory isn't all that much of a blessing for either unit, because; it can make the computer starts to run so slowly that the typing gets several words ahead of the display.)

THE KAYPRO LINE of totable computers. Shown here are the *Kaypro 2*, *Kaypro 4*, and *Kaypro 10*.

As for what to do with the computers: Both obviously can be used for moderate document preparation since they can feed a standard printer, and both can dump their stored text into a larger personal computer for extensive processing by standard word-processing software. (Radio Shack's *Scripsit* works very well on text prepared with a lap computer). For the journalist, reporter, salesperson, or anyone else in the field, both lap computers are superior to a pencil and a pad, and copy can be submitted by modem rather than telephoned to the rewrite desk.

The original lap computer was the Epson *HX-20*, which simply didn't work out as conveniently as the later two units. In fact, there are two models of the *HX-20*, the original which came only with enhanced BASIC in ROM and empty sockets for future ROM programs, and the new model, which is simply the old model with a "word processing" ROM added. Though the *HX-20* is about the same size as the Radio Shack and NEC lap computers, its screen is much smaller, only 20 columns × 4 lines, which is simply too small for convenient word processing.

One reason for the small display is the inclusion of a miniature printer that uses small rolls of adding-machine-type paper, and provisions have been made for an optional cassette recorder that slides directly into the top of the case. The printer is fine for listing programs. There is also a standard serial output port so that a standard printer can be used for both BASIC listings and word processing. The cassette recorder, which uses special sub-miniature cassettes, has its own 80-page manual, which should give you some idea of complexity of its use and operation.

The *HX-20* has an RS-232-C I/O that can be used with an optional acoustic-coupled modem. Unfortunately, the computer does not have built in telecommunications software. Also, the modem accommodates the older series-500 telephone handsets; the newer "princess" type handsets do not fit into the acoustic cups at all.

Essentially, the *HX-20* appears to have been intended for BASIC programming, with word processing and communications an afterthought. But if your needs are for writing sophisticated BASIC programs when away from your desktop computer, the *HX-20* will do it nicely.

The totables

A "totable" (sometimes also called a "tranportable") is a desktop computer that has somehow been shoehorned into a

AMONG THE NEWEST of the totables, the Radio Shack *Model 4P* is a transportable version of that company's desktop *Model 4*.

cabinet that will just about fit under an airline seat. Weighing in somewhere between 25 and 30 pounds they are not the kind of thing you're likely to stroll with down the street; hence, we do not call them portables even though they have a handle and are called "portables" by some manufacturers.

The first of the totables, the one that literally created the genre, was Osborne's (26538 Danti Court, Hayward, CA 94545) *Osborne-1*, which had virtually no standard features. It also used single-density disk drives when almost everyone else had switched to double-density drives. The *Osborne-1* is no longer manufactured. Those currently being sold are warehouse stock and demonstrators.

The first truly well-done totable was the *Kaypro II*, which is still Kaypro's (PO Box N, Del Mar, CA 92014) standard model and the basis for the company's two other models. The *Kaypro II* has a 9-inch screen with an 80-column × 24-line display, 64K of RAM, and two double-density disk drives providing nominally 200K storage per drive (400K total). The same model with double-sided double-density drives, having 400K storage per drive, is sold as the *Kaypro 4*. Both models feature the CP/M-80 operating system in a standard configuration, meaning it will run just about all CP/M software. The exceptions are CP/M variations that are hardware dependent. There is a standard parallel output for Centronics-type printers and a standard RS-232-C serial output for a serial printer or a modem. The computer is bundled with a software package that varies from time to time. One software option consists of CP/M, Microsoft BASIC, and *Wordstar*; another consists of CP/M, Microsoft BASIC, SBasic, *Perfect Writer*, *Perfect Speller*, *Perfect Calc*, *Perfect Filer*, *The Word* (spelling checker), and a program called *Uniterm*, which can read six other 5¼-inch computer disk formats.

Both Kaypro models have unusually good reputations for ruggedness, even when manhandled. They are essentially desktop systems that happen to close up. Though the software packages are extensive, do not be carried away by quantity; many users will have no need for Microsoft BASIC, SBasic, or perhaps the filing program. To get your money's worth, select the package with the software you really need.

Dual-purpose models of the *Kaypro II* and *Kaypro 4* are designated *plus 88*, which means they can be software-switched from an 8-bit Z80 mode to a 16-bit 8088 mode for the MS-DOS operating system. Do not assume, however, that *plus 88* means you can run IBM software. If the IBM software is hardware dependent—meaning it uses or requires specific or proprietary hardware features of the IBM *PC*—then it won't run on the Kaypro or any other MS-DOS computer that isn't IBM *hardware* compatible.

An even more advanced version of the Kaypro computer is the *Model 10*, which features a built in 10-megabyte hard disk as well as a double-sided double-density floppy disk. It comes bundled with the larger software package on the hard disk. A significant variation in features between the *Kaypro Model 10* and the other models is that the *Model 10* has a parallel printer output and two serial I/O's; one for a modem, the other for a printer or any other purpose, and each can be individually configured (baud rate, etc.).

An important consideration when using a hard-disk drive is that the heads must be parked in a safe area on the disk to prevent rough handling or jarring from causing the head to crash on an active part of the magnetic coating. The "parking" software for the computer is not automatic; it must be specifically run when the user closes down, thereby leaving open the possibility that the computer will be moved with unparked heads. That's something you must consider if you have any intention of transporting the computer by plane or vehicle.

All three Kaypros deliver about the maximum performance you can expect from an 8-bit computer. They aren't fancy, and won't do color or complex graphics, but they will run just about every piece of major 8-bit software. If you need something for small business use, those computers will probably handle all your needs. In fact, some computer dealers will deliver a *Kaypro II* complete with a daisywheel printer for under $2000—an attractive price.

Among the most recent totable computers is the Radio Shack *Model 4P*, a totable version of their desktop *Model 4*. The *Model 4P* is supplied with 64K of RAM which can be expanded to 128K. It has a 9-inch monitor with an 80-column × 24-line display, two double-density 184K disk drives (368K total), a parallel Centronics-type printer output, and room for a user-installed 300 baud modem. As for software, it is supplied with the TRS-DOS version 6.0 operating system and Microsoft Disk BASIC.

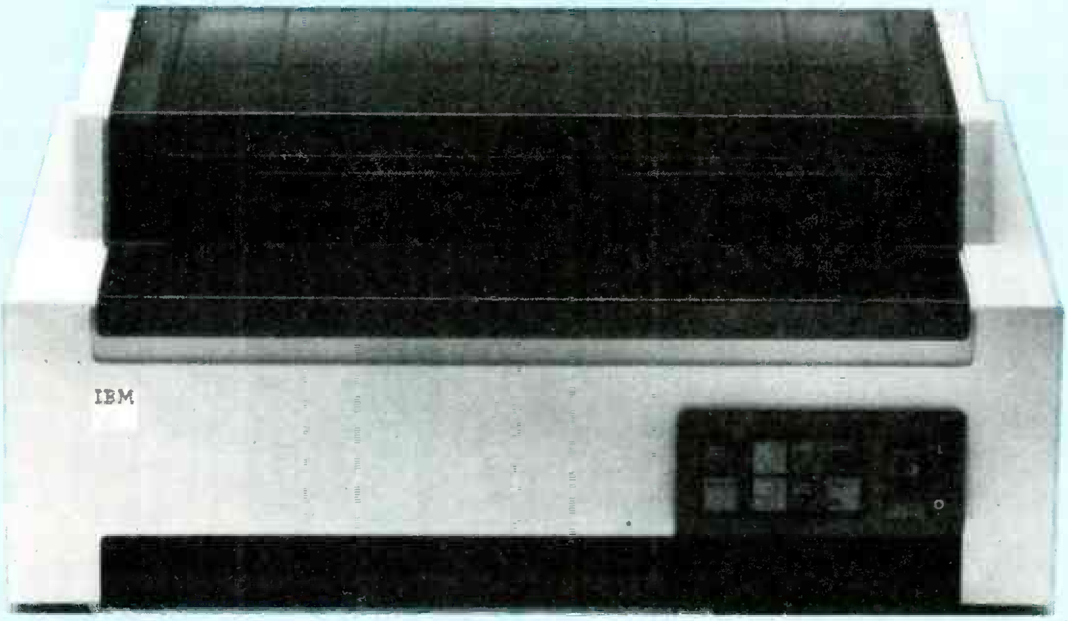
Though the *Model 4P* is similar to the *Model 4* there are a few significant differences between the two that you should be aware of. Firstly, the *Model 4* contains the *Model III* ROM's, which means the *Model 4* will automatically function as a *Model III* if the user runs a *Model III* program. For both CP/M and the *Model 4* mode the *Model III* ROM's are automatically switched out. In the *Model 4P* computer the *Model 4* ROM's are replaced by software. The user loads software that simulates the *Model III* ROM's in the lower 16K of RAM; thus the *Model 4P* will also run *Model III* programs.

The second variation between the two machines involves the serial output. The dual-disk-drive version of the *Model 4* has a built in RS-232-C interface. The *Model 4P* does not have the serial interface; instead, there is space for an optional 300-baud auto-dial/auto-answer direct connect modem that can be installed by the user.

Since CP/M *Plus* was not available when this article was prepared (It is now—*Editor*), the computer could run only TRS-DOS programs intended for the *Model III*, *Model 4*, and *Model 4P*. However, the non-Radio Shack Montezuma Micro Version 2.2 CP/M is specifically designed to run on the *Model 4/4P* computers; it opens up the computer to most of the available CP/M software.

Do you need a portable or totable?

While the concept of the portable and totable computers is interesting, the major consideration should be: "Does it have any real value for me?" Even the best models trade off something for size: color capability, screen size, speed, or expansion capability—there is always something. However, if your requirements dictate that you simply must have a computer or even just a word processor tucked in your attache case, or bouncing in the trunk of your car, you have no choice—you must select the model with the specific features needed to make your work easier or more productive. **R-E**



What's New in Printers

New technologies, new features, and falling prices can make shopping for a printer more exciting, and confusing, than ever before. In this article we'll show you what's new and what's coming in printers for your home and office.

MARC STERN

WHEN YOU TALK ABOUT PRINTERS, THERE'S ONE THING THAT you can be certain of—that is that the state-of-the-art is constantly changing. For instance, technologies that once cost thousands of dollars are now coming within the reach of the average home computerist. Also, conventional printers, such as dot-matrix and daisywheel types, are enjoying both improved performance and decreased cost.

In this article we are going to take a look at the current state-of-the-art in printers. Included will be both a look at what's new in such familiar printer technologies as thermal, dot-matrix, and daisywheel, and a look at some new technologies that are now, or may someday be, practical and affordable for the personal-computer owner.

Ink-jet printers

Take the ink-jet printer, for instance. Only a few years ago, a sophisticated ink-jet printer's cost ranged from well over $2,500 to as much as $50,000. Today, those prices have dropped to as low as $895, with the most sophisticated units on the market running upwards of $30,000. What's more, today's ink-jet printers are capable of full-color printing as well as graphics work.

There are basically two main technologies used in ink-jet printing—continuous-stream and drop-on-demand. In continuous-stream printing, a constant stream of ink is ejected from a single channel and letters are formed by the movement of the printhead. As the ink is ejected, it is selectively charged using a pair of electrodes. The charged ink is applied to the paper, forming the output. The uncharged ink falls into a reservoir and is recycled through the printer, after passing through a filtering system. Continuous-stream technology is used in very sophisticated printers, that cost upwards of $30,000.

Drop-on-demand technology is far less expensive, and is available to the personal computer owner in printers from, among others, Siemens Communications Systems, Inc. (240 E. Palais Rd., Anaheim, CA 92805) in its *PT88-T2* and *2717-M203* printers.

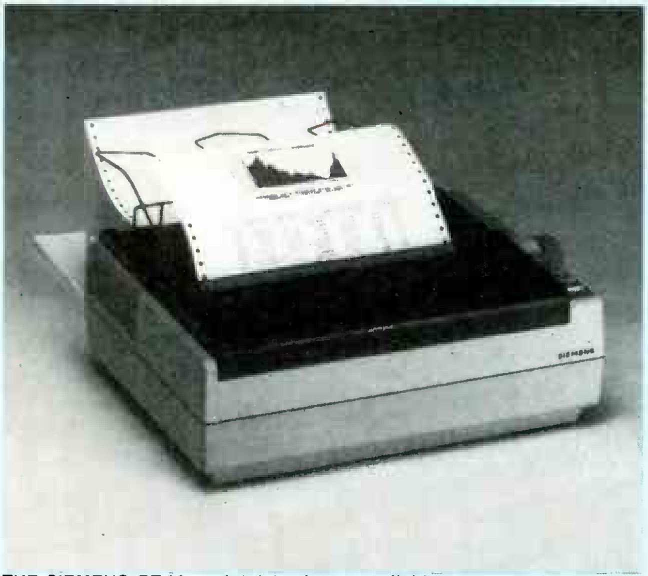
Let's take a closer look at drop-on-demand ink-jet printers.

Ink-jet basics

If you were to look at the output of a typical drop-on-demand ink-jet printer, you would probably wonder how the unit differs from a dot-matrix printer because the result looks much same; ink dots are still used to form the characters. But, the technology used to produce those characters is radically different.

Unlike the dot-matrix (and daisywheel) impact printers that you might be familiar with, the drop-on-demand ink-jet printer is a non-impact type. An impact printer is any printer whose printhead element or a part of it actually strikes the paper, while a non-impact printer's printhead never does. For example, a dot-matrix printer has a tiny printhead filled with wires. Each one of those wires is controlled by the printer's logic circuitry and fires after it is activated by a small solenoid. The firing is controlled by the logic and the print produced is based on the character set contained within a special ROM in the printer.

Ink-jet machines also make use of a printhead and platen, but



THE SIEMENS *PT-88*, an ink-jet printers available to personal-computer owners, makes use of drop-on-demand technology.

unlike impact printers, no part of the printhead in an ink-jet machine touches the paper. The result is that there is very little noise, one of the more common complaints about impact printers, whether they are dot-matrix or daisywheel.

Instead, tiny drops of ink are sprayed out of a series of nozzles and those are used to form the letters or graphics of the final output. Either a low-pressure area or special electrostatic circuitry is used to form the characters after the ink is fired at the paper. The nozzles are connected to a series of ink-filled channels, which are linked to an ink cartridge, which supplies the ink for the printing process.

A closer look

If you were to look at the printhead of a drop-on-demand printer, you would see a series of nozzles; the number and pattern of nozzles will vary from machine to machine. Those nozzles are connected to the ink channels. A piezoelectric crystal tube in each channel is stimulated by an electrical pulse, causing the crystal to expand slightly and this increases the pressure inside the channel. In turn, the increased pressure pushes the ink away from the crystal and toward the nozzle, where a tiny ink droplet forms.

As the pressure is decreased when the crystal contracts, the droplet breaks away from the ink stream and is, in turn, deposited on the surface of the paper. Like the dot-matrix-type printers, the dots are arranged in a pattern that forms the letter.

To keep the ink from being deposited where it isn't supposed to be, the ink-jet printer uses a slight negative pressure to keep the ink inside the channel when that particular jet nozzle isn't being used. Thus, if you were to look at a cutaway of the print head, you would see a slightly concave indentation in the surface of the ink.

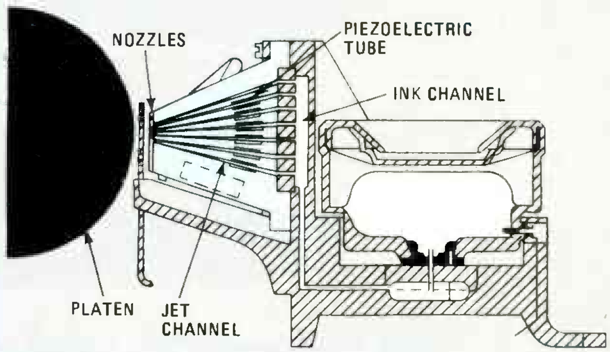
Ink-jet advantages

An ink-jet printer has several advantages over a dot-matrix or a daisywheel impact printer and the first is the noise level. Quite typically, the ink-jet printer is a fairly quiet machine, one which will fit in well with a home computer setup. Its noise level contrasts quite markedly with the rat-tat-tat of the daisywheel machine or the loud whirring of the dot-matrix printer.

Another advantage is low maintenance cost. Since there are few moving parts in the typical ink-jet printer, its maintenance requirements are very low. Further, because the printhead never touches the paper, it isn't degraded as are those of impact machines. Thus, its life can be much longer. The life of the typical ink-jet printhead is in the vicinity of 10-billion characters, as opposed to about 200-million for the average sophisticated dot-matrix printhead. And, because the ink-jet machine doesn't depend on a ribbon that is subject to wear, the print quality remains constant over time.

Another advantage of ink-jet printers is speed. Quite typically, those machines race along at between 150 to nearly 300 characters-per-second. In contrast, the top print speed of an average dot-matrix machine is about 200 characters-per-second. Most letter-quality printers—daisywheel printers—run from 12 to 40 characters-per-second.

The primary disadvantage of a drop-on-demand ink-jet printer lies in its inability to produce more than one copy at a time and in the fact that its output still looks like a "computer" printout—the dots in its matrix are quite evident. Further, top-quality print runs require special absorbent papers, although bond paper does the job adequately.



AN INK-JET PRINTER'S PRINTHEAD. This cross-section shows the key parts in a drop-on-demand system.

Graphics capability

One of the beauties of the ink-jet printer is its graphics capability. Because of their precise tracking capability and because they are not limited to using dot-matrix impact pins, the ink-jet printer is capable of very highly detailed graphics. For instance, it is possible to program the Siemens *PT88* printer in 1/72-inch increments. That means you can produce some highly complex graphics with subtle variations of grey, black, and white.

Another area where the ink-jet printer shines is in color-graphics printing. Although dot-matrix printers are capable of color printing, they have some drawbacks. Since they are limited to the use of multi-color ribbons, dot-matrix machines take a longer time to produce a color output. Each color or color combination requires a different pass of the printhead and that slows things down more than just a little bit. Also, since the separate dots never completely line up, it is possible that there will be gaps in the final printout and solid areas may end up incompletely filled. Finally, since dot-matrix machines must rely on ribbons and since ribbons tend to wear out fairly quickly, outputs produced later in the ribbon's lifetime will be lighter than those produced earlier.

In contrast, a color ink-jet printer uses a special four-color ink cartridge and applies the colors, or combinations of color, when called upon by the graphics programming in the microcomputer. Since it is capable of multi-color output, the time needed to create the final output is shortened considerably. Further, solid-color areas appear much more uniform in density because it is possible to overlap the ink dots. Also, since it is possible to mix the colors directly on the printout, the ink-jet printer is capable of printing many more color combinations and hues than a dot-matrix machine.

Because the printhead of the ink-jet machine is microprocessor-controlled, it is possible to have the printhead dither. When the printhead dithers, it mixes the ink droplets in different intensities, thus creating darker or lighter color intensities.


To master the computer, master the software
Challenge your ability.
Take charge of your computer.
Take pride in the results.
You've invested in the computer. Now invest in yourself. Writing your own software lets you define your own boundaries, broaden your problem-solving resources and puts you in complete command at the keyboard. It's challenging. It's exciting. And now it's easier than ever before with Self-Study Computer Courses from Heathkit/Zenith.
Master today's most powerful contemporary languages including Microsoft BASIC, PASCAL and FORTRAN. And learn the popular CP/M and MS-DOS operating systems, too. When you need to know, we'll take you as far as you want to go.
For more information, write: Heath Company, Benton Harbor, MI 49022
Or circle the reader service number.
An Individual Learning Course in
CP/M
MS-DOS
An Individual Learning Course
An Individual Learning Course
Programming in
Microsoft BASIC
Heathkit
Heathkit/Zenith
CP-227

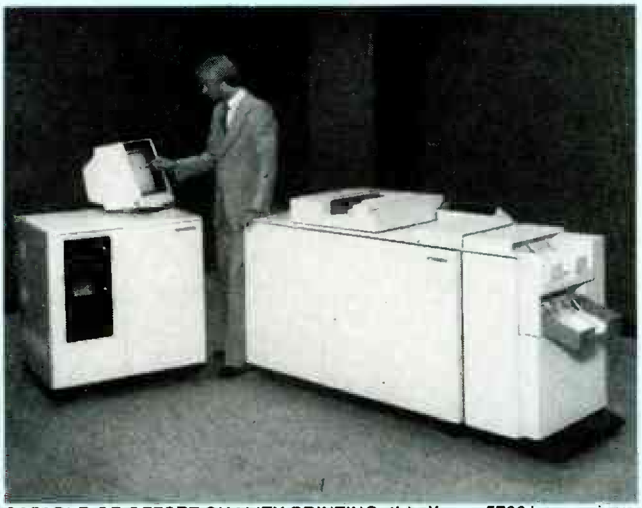
Cost comparisons

In general, you will find that the cost of ink-jet printers has fallen markedly during the last year, as have the prices of just about all computer printers. Roughly a year ago, it wasn't uncommon for a good reasonable-cost ink-jet printer to cost between $2,500 and $6,000, with some of the top-quality machines costing up to $50,000. Now, the cost of a good ink-jet printer is approaching that of some of the more capable dot-matrix machines on the market, about $895. Even top-quality machines have had price drops, too, to the $30,000 region. As for a good color ink-jet printer, you'll still have to wait some time until the prices drop even further. Even though their prices have dipped in the recent months, you'll still find them expensive pieces of equipment, ranging in price from $5,500 to nearly $12,000.

Laser printing

Although their cost puts them beyond the means of most personal computer owners, if you own a large business, or have need of offset-printer-quality output, you may be interested in some of the laser printers currently on the market.

One such machine is the Xerox (Printing Systems Division, 880 Apollo Street, El Segundo, CA 90245) *5700*. That system can produce documents in a wide variety of type styles (up to 256 can be stored), and in type sizes ranging from 6 to 24 points. Graphics can also be accommodated. Printing can be done on both sides of a page, plain paper is used, and up to 43 pages a minute can be produced.



CAPABLE OF OFFSET-QUALITY PRINTING, this Xerox *5700* laser printer can produce documents with a wide variety of type styles and sizes.

The key to the printer is a laser-imaging system. That imaging system has a resolution of up to 90,000 dots-per-square-inch, which is why the system can produce copy that compares favorably with offset printing. The key to the machine's versatility is the fact that the location of each dot on the page can be individually controlled. Thus almost any image can be reproduced. Once the image is created, the actual printing is done using Xerox's xerographic (photocopy) process.

You may be wondering about the cost for all of this. Well, the basic *5700* system can be had for about $65,000.

Dot-matrix developments

Perhaps the key development in the dot-matrix printer realm during the last year is the increasing density of the printhead. Quite typically, printheads used to have dot densities of 5 × 7 or 7 × 7 and now they routinely feature 9 × 7 or 9 × 9 dot densities in standard (draft) mode, and as many as 18 or 24 × 7 or 9 in the near-letter-quality mode.

The dot density of a printhead isn't hard to determine. It merely means the number of pins the printhead contains in vertical and horizontal rows. For instance, if the density of a printhead is 7 × 7, it would have 49 little metal pins enclosed in the printhead in seven horizontal rows and seven vertical rows. If the density is 9 × 7, then there are nine vertical rows and seven horizontal ones.

The biggest criticism of the dot-matrix printer in the past has been its "computerish" hardcopy output. That means that the printout is made up of very noticeable dots, no true descenders, and is very hard to read. However, that criticism has been pretty much nullified by the near-letter-quality output of some dot-matrix printers.

Using overlapping vertical rows of pins, those printers actually lay down two slightly offset dots during its print run. Those dots give the hard-copy a more "typed" look when it is printed. The dot-matrix manufacturers are able to achieve this thanks to the fact that they are using printheads with finer wires, which permits greater density (18 or 24 × 9). Since those heads also usually feature two extra horizontal rows of pins, they are also capable of having true descenders on such letters as "g" or "y."

At one time—about a year-and-a-half-ago, that type of output was available only on machines costing more than $1,200, but now it is available on dot-matrix printers costing little more than $495. And, even low-cost printers—$199 to $499—have printhead densities of 7 × 7 or 9 × 7, so that their output has a more professional quality.

One problem with the new near-letter-quality dot-matrix printers is that they take away one of the dot-matrix printer's biggest advantages—speed. That's because generating the slightly offset dots needed to produce the nicer looking output requires that each letter be actually printed twice, slowing down the entire process. But printer manufacturers have found a way to let us "have our cake and eat it, too." That is, all but the least expensive dot-matrix machines these days are dual-mode. They offer a high-quality but slow near-letter-quality mode as well as a less attractive looking, but much faster draft mode. Typically, the print speeds on those machines vary from 40 to 80 characters-per-second in the near-letter-quality mode and from 160 to 200 characters and more in the draft mode.

Dot-matrix printheads

Let's look at the typical printhead. A dot-matrix printer is called an impact printer with good reason. Its printhead contains fine wires that are fired electrically into a ribbon, which strikes a piece of paper, thus producing the image.

The firing of the pins is controlled by solenoids that are activated by electrical pulses received from the character-generation ROM. That ROM contains the ASCII code for the characters and the pins corresponding to that code are all fired at the same time to produce the required letter.

As are ink-jet machines, dot-matrix printers are almost universally bidirectional printing units—they print on both passes across the paper—and they usually feature logic-seeking printheads. Logic-seeking printheads seek the shortest path between two printing points thus cutting printing time. Because they are logic-seeking and microprocessor-controlled, dot-matrix printheads are usually capable of graphics output. Typically, most of them have a special programmable graphics mode that is capable of laying down nearly 80 × 80 dots-per-inch, and, even more if special graphics software is used.

Since there are few moving parts in a dot-matrix printer, other than the linefeed motor and motor used to move the printhead, those units tend to be fairly reliable. Printheads last a long time, on the order of 200 million characters, although that isn't as long as a typical ink-jet printer.

The biggest drawbacks of dot-matrix printers are their noise and the fact that ribbons wear out fairly quickly. Most dot-matrix machines emit noise in the 65- to 85-dB range, which makes them rather uncomfortable to be near for any length of time. Newer machines, however, tend to be a little quieter.

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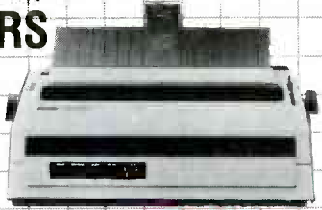

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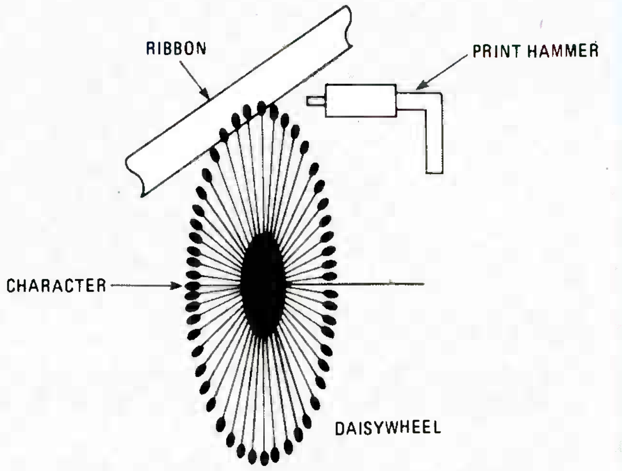
THE SMITH-CORONA *TP-1* was one of the first low-cost, bidirectional daisywheel printers for personal computer use.



THE CHARACTERS on a daisywheel are located at the ends of the "petals," when a hammer strikes the petal, the character is printed.

Dot-matrix machines also seem to run through ribbons very quickly, especially if they are used a great deal. That means that early printouts are good quality, but later printouts tend to be lighter and harder to read. And, if those ribbons aren't used quickly, they tend to dry out and also produce lighter printouts.

Daisywheel developments

The other type of impact printer on the market is the letter-quality or daisywheel printer and its variant, the thimble printer. Both rely on essentially the same technology, but, during the last year, their capabilities have been increased markedly.

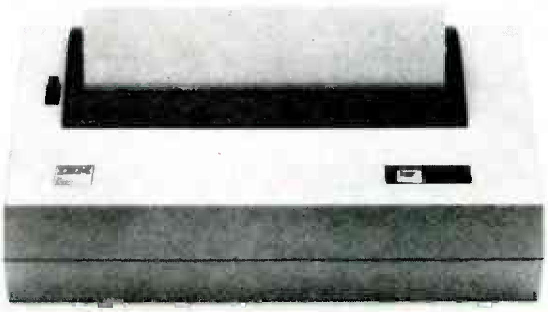
At one time, the average low-cost daisywheel printer was a unidirectional, noisy, slow-speed affair. It did produce top-quality printing, but the tradeoff was that it took forever to complete a printout. Those units tended to operate very slowly—12 to 18 characters-per-second—tying up the computer for long periods as they slowly worked their way through documents. If you wanted higher-speed, bi-directionality, and microprocessor control in you daisywheel, you had to spend nearly $3,000.

But, the last year or so has seen a change in this, beginning with the Smith-Corona (65 Locust Ave., New Canaan, CT 06840) *TP-1*. That was the first low-cost, bidirectional daisywheel printer for personal computer use. It debuted at a price of under $800 and set the trend toward lower-priced home units, whose prices seemed to keep on dropping. Now, it seems most major printer manufacturers have a low-cost daisywheel available.

The key to the change in the daisywheel market was the introduction of microprocessors in those devices. That development allowed low-cost daisywheel printers to gain bidirectionality and logic-seeking capability. It also enables the daisywheel to be used for something that was once the province of the dot-matrix printer—graphics. Because the printhead can now be controlled with computer precision, the low-cost daisywheel printer can be programmed for a minimal level of graphics. It can produce such things as charts, graphs, and some limited pictorial matter.

Let's take a look at a daisywheel printhead. Where a dot-matrix machine uses solenoids and pins, the daisywheel uses a whirling disk with flexible petals,and a small hammer. Each letter is fully formed on a petal of the printwheel, which somewhat resembles a daisy; it's from the printwheel that the machine gets its name.

As the printhead moves across the page, it receives the ASCII codes output from the character-generation ROM. However, instead of those pulses activating a series of wires, they cause the whirling disk to align the appropriate letter-petal with the ribbon. The petal is then struck by the hammer, which produces the letter.



ONE OF THE NEWEST thermal printers, this unit from IBM (P.O. Box 2989, Delray Beach, FL 33444) is for use with the *PCjr*.

The key drawbacks of this machine, again, involve noise and speed. Even at their quickest, they are only about one-quarter to one-half as fast as the slowest dot-matrix machines on the market. But, the quality of the print they produce, since the letters are fully formed, can't be topped. Also, those printers give you the capability of changing typefaces or type sizes easily as the daisywheels themselves can be changed.

A variation of the daisywheel printer is the thimble printer. In those machines, rather than a daisywheel, the print element resembles an upside-down thimble with spokes. As with the daisywheel, each of the spokes contains a fully formed letter.

Thermal printers

Thermal printers are dot-matrix devices. However, rather than using ink to do the printing, they use special heat-sensitive paper and pass it over a series of heated pins to create the print out. Thermal printers have always been among the least expensive devices on the market, but have suffered from the fact that the required paper is expensive and their output is often of poor quality. On the plus side, those printers are fairly fast.

The picture for thermal printers has gotten much better of late. For one thing, many of the new machines are capable of using plain paper. What's more, thermal printers capable of multicolor output have now reached the market. Those use plain paper and heat-sensitive dye. The paper is drawn over a heater bar after the dyes are laid down creating the image. The result is a fairly inexpensive color printer. R-E

HERB FRIEDMAN

Gadgets and Gizmos

A look at some genuinely useful devices that can make life with your computer a bit more pleasant.

WITH THE POSSIBLE EXCEPTION OF IBM—WHO LEARNED QUICKly from the mistakes of others—most manufacturers of personal computers went out of their way to "marry" the user to one brand of hardware. Through the use of non-standard connectors and signal lines, unusual hardware both in the computer and disk drives, and in some instances off-the-wall software, the object was to preclude the purchase of third-party hardware and software.

Fortunately, as with all things, there was more intelligence outside the companies than inside, and so a vast third-party hardware and software marketplace was created by unaffiliated entrepreneurs who manufacture or sell all sorts of gadgets, gizmos, and accessories for personal computers. In some instances the third-party vendors are so successful they eventually force the original manufacturer into providing similar equipment.

In this article we are going to take a look at some of the interesting and useful products that are available. Some you might have read about, others will be new ideas; some were developed on a kitchen table, others by the largest manufacturers.

While we're going to discuss specific devices for specific hardware, bear in mind that similar equipment is usually available for other systems. For example, if we cover an accessory add-on clock for a Radio Shack computer, it pays to ask if there's one available for your Apple, because there is.

Whether the accessories come from someone's basement or garage, or the manufacturer of the computer hardware, they add a notable degree of performance to personal computing, particularly to the low cost computers or those no longer supported by a manufacturer.

Standard I/O

For example, Osborne sold many *Osborne-1* computers before the company went bankrupt. To say that the computer had many quirks would be kind, but because there are so many users and because the computer is still being sold let's look at how third-party gadgets handle two of the machine's more prominent hassles. First, the remote video monitor output. The *Osborne-1* has an itty-bitty built in screen, so for extended viewing an accessory external monitor is needed to avoid eye strain. The computer's video monitor output, however, isn't standard composite video; it was intended for an Osborne monitor never seen in this neck of the woods. The second difficulty is the modem interface—it used a circuit known only to Osborne. Again, the object was to force the user to purchase an Osborne peripheral—a modem.

Third-party vendors take care of both problems at reasonable prices. The *Exmon* panel plug-in adapter (no wiring changes) from JMM Enterprises, Inc. (115 Battersby Ave., Enumclaw, WA 98022) provides the *Osborne-1* with a composite-video output, which allows any standard composite-video monitor to be used with the original 52-column screen computer. If the computer was upgraded to 80/104 columns the adapter still works in the 52-column mode. (It moderately "scrambles" an 80-column display.)

As for the modem port, that's handled by a device called an *Osbreak* from Image Sales (Box 200, 2442 N.W. Market St., Seattle, WA 98107). The device connects to the Osborne's 9-pin modem connector and creates a standard 25-pin DB-25 RS-232-C input/output as well as a "true break" signal. A small push-button switch on the *Osbreak's* cabinet produces the "true break" required by some time-share computer and database networks. The *Osbreak* also permits a serial printer to remain connected to the computer while using a modem because the modem and printer no longer have to share a single RS-232 connector on the front panel.

Speaking of RS-232 interfaces, if you're into using different

THERE ARE MANY double-density disk upgrades for the *Model 1*, including this one from Radio Shack itself.

modems, printers, and other RS-232 peripherals you have probably learned the hard way that there is really no such thing as an RS-232 "standard." What's a handshaking line for one device is nothing for another. If you run into RS-232 matching problems, one of the handiest gadgets you can have around is the *RS-232 Wiring Adapter* from B&B Electronics (Box 475, Mendota, IL 61342); that device lets you patch RS-232 connections in any pattern. It has DB-25 connectors at each end of a small printed circuit board whose foils terminate in a row of minisockets (two rows of sockets). To test a connection, you install a supplied jumper from an input socket to an output socket. When you get the connections down pat you simply wire a standard RS-232 connector to conform to your jumpers.

Upgrading the *Color Computer*

One of the computers for which there is a seemingly endless list of gadgets is Radio Shack's *Color Computer*. No one can quite figure out what Radio Shack had in mind for the color computer because expansion possibilities appeared—at first glance—to be sharply limited. It received some bad press, was even rumored to be on the verge of being discontinued, but here it is full of life, due mostly to third-party gadgets.

Let's run through some of the gadgets that made the unit a real winner—you might find just the item you're looking for. First off, there's the calculator-key keyboard of the pre-1983 model. No problem here: replacement with a keyboard having typewriter keys is a 15-minute job for anyone. The keyboard is from Spectrum Projects (93-15 86th Drive, Woodhaven, NY 11421). You open the cabinet, unplug the old keyboard, plug in the new keyboard, close the cover, and you're ready to type on real keys.

How about some "letter quality" word processing from a *Color Computer* using a daisywheel printer with a polyethelene ribbon, the same kind of ribbon used on IBM typewriters that produce "camera ready" (for offset printing) documents. There are some real cheap but excellent printers that can do this, such as the Smith-Corona *TP-1* and the Brother *HR-1* and *HR-15*. But how do you connect those Centronics-type parallel printers to the "mickey mouse" 600-baud serial output of the *Color Computer*? You do it with a *Color-Computer*-to-Centronics printer interface from Botek Instruments (4949 Hampshire, Utica, MI 48087). Unlike other hardware of every kind, the Botek unit comes with every cable and connector you will need, there are no extras. Just plug it in the way you get it. (Will wonders never cease?) By the way, by changing the unit's Radio-Shack compatible input connector for a DB-25 you can use the device to interface other serial-output computers with a Centronics-type printer.

Finally, before we leave the *Color Computer*, consider the expansion port, of which there is only one. You can plug in a ROM program cartridge or a disk-drive interface, but not both at the same time. At least that's the way it was designed. But one of the most successful add-on's for that computer is a six-slot ROM port extender that allows the user to keep up to six ROM or RAM cartridges and/or the disk controller plugged in and ready to go at the touch of a switch. The device is from J-Nor Industries, Inc. (6272 W. North Ave., Chicago, IL 60639).

As the *Color-Computer* blossomed from a basic instructional machine into a rather sophisticated but inexpensive professional quality computer (lots of dynamite software is now available, among them one of the very best word processors), the single expansion port proved too limiting even for Radio Shack, and their latest catalog lists a port expansion unit that will accommodate up to four program cartridges and/or disk drive controller.

Updating older computers

Were you one of the original computer hobbyists who built the Heathkit *H8* computer? The *H8* remains a good, rugged computer, but its single density hard-sectored disk drives are now somewhat behind the times. In fact, it's often difficult just to locate hard-sectored disk media, not to forget up-to-the-minute modern software. But the plug-in *FDC-H8* controller from C.D.R. Systems, Inc. (7210 Clairemont Mesa Blvd., San Diego, CA 92111) will upgrade your *H8* to both hard and soft-sectored operation in double density. The unit allows use of both hard and soft-sectored 5¼-inch disks, 8-inch disks, and double-density. If you also use one of the *Z80* upgrade cards available for the H8 you should be able to read or run just about any modern CP/M software.

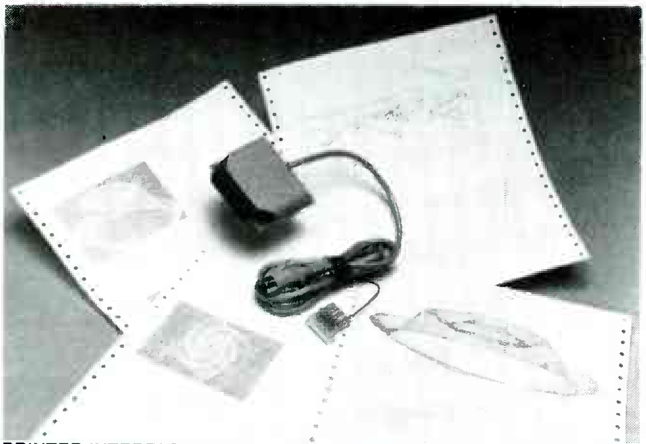
Speaking of "Old Timers," the grand-daddy of them all is the Radio Shack *Model I* computer. About 300,000 were sold, most of which appear to be still in use. (They are hard to come by in the used-equipment marketplace and command almost their original price.) A *Model I* with the expansion interface has lots of I/O ports and busses sticking out and ready for use. Give a hobbyist an accessible I/O or buss and he'll probably build something to use the connection. That's exactly what happened. Until the introduction of the IBM *PC*, there were more gadgets and gizmos for the *Model I* than for any other computer—perhaps more than for all other personal computers put together.

The *Model I* has never really gone out of style and there are some exceptionally useful gadgets and gizmos still being produced for that computer. The list is almost endless, but here are a few highlights you might find useful. First off, a disk-system double-density upgrade which more or less doubles the storage capacity of the disk. There are several upgrade kits available including Radio Shack's own (which must be installed by a Radio Shack service center). For many, the least troublesome installation will be the Percom *Doubler* from Percom Data (11220 Pagemill Rd., Dallas, TX 75243). Percom's upgrade is user installed; it simply plugs in. It is supplied with the *Dosplus* 3.4 operating system, a good system presently being used by many independent software houses because they can provide a full run-time program for the *Model I* using it. (Radio Shack does not usually permit independent software houses to provide a run-time TRSDOS.)

If you want to experiment with voice synthesis, but have a tight budget, the old *Model I* is the way to go. For under $100 Alpha Products (79-04 Jamaica Ave., Woodhaven, NY 11421) will provide you with the software and a voice synthesizer that plugs right into the side of a *Model I* computer, using the old screen printer port on the expansion interface. Voice synthsizers are also available for other computers, most notably those from Apple and IBM, but not at $70 including the software.

Other *Model I* gadgets also available from Alpha Products include a plug-in clock module with a battery backup that displays time and/or date, a selector switch for two printers that plugs into the printer port of the expansion interface, and even a plug-in joystick for games.

Getting away from the computer itself, do you find yourself connecting and disconnecting plugs and cables when you change peripherals? Does going on line to a database through a modem mean you must disconnect your serial printer? Does changing to a daisywheel printer require you to disconnect the high-speed line printer? Maybe you need something like the active serial port expander, from Bay Technical Associates, Inc.



PRINTER INTERFACE, the *Card/?* from Cardco (313 Mathewson, Wichita, KS 67214) lets you use a Centronics-type printer with a Commodore computer.

PRINTER BUFFERS like the *Microbuffer* from Practical Peripherals free the computer for other tasks during printing.

(Highway 603, Bay St. Louis, MS 39520). An active port expander isn't just a simple switch. It has separate UART's, buffers, and handshaking, and each port can operate with a different configuration (ie., baud rate, stop bits, and handshaking) so you can drive any attached device without taking peripherals apart to move internal DIP switches.

Printer accessories

While we're on the subject of peripherals, one of the most commonly used printers is the Epson *MX-80* (and the newer version, the *RX-80*). Unfortunately, the printer accommodates only tractor-feed paper, the kind with the holes punched along the edges. If you want to use single sheets such as letterheads you must insert the sheet in a special plastic carrier that must first be pushed through past the print head before it reaches the tractor mechanism, a procedure that has been known to cause more print head damage than anything else. A better way to handle single sheets such as letterheads is to retrofit the printer with a *Micro-Grip Friction Feed* from Bill Cole Enterprises, Inc. (Box 60, Wollaston, MA 02170-0060). That device provides a small friction feed area for single sheets, yet it doesn't interfere when feeding tractor paper. While it isn't exactly a factory modification it does work. The device requires only a screwdriver and the opening of an *MX-80's* cabinet (no soldering). The same job can be done on an *RX-80* without opening the cabinet.

For those with the opposite problem—that of using continuous tractor feed paper or forms on a single-sheet daisywheel printer—the manufacturer usually has a tractor feed accessory, though they often cost in the hundreds of dollars. The popular Smith-Corona *TP-1* and *TP-2* printers used with budget priced computer systems also have a tractor feed option, whose selling price, however, bears no relationship to the list price of about $200. With some careful shopping you should be able to pick up *TP-1* or *TP-2* tractors for about $60. (It's the same tractor for both.) They are not the easiest thing to install, but all it takes is a screwdriver, perhaps pliers, and a lot of patience.

One of the all-time award-winning gadgets for printers is *Fingerprint* from Dresselhause Computer Products (837 East Alosta Ave., Glendora, CA 91740). Fingerprint installs inside Epson printers, including the versions of that printer from computer manufacturers such as IBM and Texas Instruments. It will also retrofit the Okidata *Microline 82* printer. The device provides 8 to 10 functions that are normally under software control by just touching the printer's off-line, formfeed, and linefeed operating keys in the proper order. The extra functions include condensed printing, emphasized (double-strike), double-size characters, automatic 8-space left indent so you can punch binder holes without cutting into text, automatic perforation skip-over, even itallic print. It's a plug-in device and installation requires opening of the cabinet and a modest degree of dexterity. If you have ever plugged a integrated circuit having 20 or more pins into a socket, installation shouldn't take you more than 15 minutes from beginning to end.

While on the subject of printers, don't overlook some interesting interfaces that allow the use of standard printers with the Commodore and Atari computers, both of which have proprietary printer I/O's for their own printers. If you want to connect one of the inexpensive daisywheel printers to those computers, it normally can't be done. But there are a number of printer interfaces that will allow you to use a centronics-compatible printer with those computers. Just about any retailer that carries Atari or Commodore accessories will stock one or more of those.

In closing we'll cover what is rapidly becoming one of the most desired peripherals: the "printer buffer." Basically, a printer buffer is a memory device connected between the computer and the printer. When you want to print, you dump the contents of the computer's RAM to the printing buffer, which in turn feeds the printer. Within seconds your computer is free for use while the buffer takes minutes or even hours to feed your documents to the printer. Buffers are available with 16K to 256K of RAM: the bigger your documents the more RAM needed for a total dump. (This article's manuscript was handled by a 16K buffer, and took almost 23 minutes to print on a rather slow daisywheel printer. But, instead of staring at a "dead" screen for 23 minutes, we were able to use the computer to process a mailing list.)

Printer buffers are usually available as stand alone devices—complete unto themselves. But several models can be integrated directly into the computer. The *Microbuffer* line from Practical Peripherals (31245 La Baya Drive, Westlake Village, CA 91363) has "bare" models that plug directly into the *Apple II* series of computers and the Epson family of printers. Orange Micro (1400 N. Lakeside Ave., Anaheim, CA 92804) has a buffer that "docks" directly onto their *Grappler+*, Epson *APL*, and Apple parallel interfaces.

The list of gadgets and gizmos available for personal computers is almost endless, ranging from super-colossal "professional" joysticks (whatever "professional" is supposed to mean) to disk emulators for the IBM that require a second mortgage on the old homestead. We have only attempted to look at accessories that provide greater computing power or convenience for the user with a low cost computer system. **R-E**

Radio Electronics YOUR OWN Computer APRIL 1984

HERB FRIEDMAN

Working with Databases

One of the best uses for a computer is to organize your records. Here's a look at some software that can help make that task easy.

PERSONAL COMPUTERS DO TWO THINGS WITH EXTRAORDINARY speed, reliability, and patience: They "crunch" numbers and shuffle data. When we say a computer can "crunch numbers" we mean it will allow you to feed in seemingly endless numerical data and mathematically process the data until the end of time if that's what it takes to arrive at the solution to your question or problems

When we say a computer can shuffle data we mean a computer will accept any kind of information—alpha (letters and punctuation), numeric, (numerals) and alphanumeric (any string of characters such as 123XY4D?)—store it, relate it to other data, extract specific bits and pieces of the data, rearrange the data in a convenient or desired order, or display to the user any of the data in any preferred order.

Depending on the kind of data, how sophisticated the processing by the computer, and the way in which the information is displayed to the user, the software that shuffles data is called a database, personal information management system, mailing list, checkfile, or just a plain old-fashioned filing program. For simplicity we'll refer to all data-handling software as a "database."

Most of the database software for personal computers, particularly for the lower cost models, handle all the data through RAM, eventually storing it on disk or tape. What the software does is create electronic storage bins in which the user-supplied data are placed, with the information usually entered through the keyboard. The program keeps track of what data goes where by reserving specific labeled areas in memory. The labels might be LAST NAME, FIRST NAME, TELEPHONE NUMBER, STOCK NUMBER, INSURANCE POLICY, FURNITURE, or almost anything. Depending on the particular kind of filing program, the data might be stored under the name provided by the user, or it might be a numerical representation created by the computer for its own use in handling the data. Even if stored under a name or numeric designation created by the computer, when the information is eventually fed back to the user as a screen display or printout it will be accessed by the user-assigned name, such as NAME, ADDRESS, etc.

When you need a particular kind of information, the computer reaches into the appropriate bin, shuffles through the assorted data you have placed there, and then extracts what you asked for.

For example, if we wanted an electronic file of our property for insurance purposes we might use a program such as Hayden's *Personal Property Inventory* (Hayden Book Co., Rochelle Park, NJ 07662), which creates four electronic bins named ITEM, DESCRIPTION, SERIAL NUMBER, and VALUE. Each of the electronic bins is called a field. There is the "ITEM" field, the "DESCRIPTION" field, etc. In a sense, the word "field" is generic for "storage bin." You can put any kind of information in the bins. But when your files have different fields, each bin, or field, must contain the same kind of information.

For example, an ITEM field is the storage bin for the name of the item. The DESCRIPTION field stores the characteristics of the item. The SERIAL NUMBER field holds the date the item was purchased. The VALUE field stores the cost of the item.

To ensure you get the information out correctly, the computer relates the data in one field with the data in other fields, so that if you specify a search for data on a "widget" the screen would fill with all the information on the widget: the description, serial number, and value.

Depending on the particular software, the program might even create new field data from the other fields. For example, assume that we had stored five items, each having a value of $5. We might possibly create another field called TOTAL VALUE whose data will be the sum of all the individual entries in the VALUE field. In this case, if we asked for a report on the TOTAL VALUE field, the screen would display TOTAL VALUE = $25, representing five items of $5 each. If we added data on a sixth item whose value was $6, the TOTAL VALUE field would contain the value $31.

Programs that simply file information that can be accessed at will are logically called "electronic files." Files that permit the data to be compared, mathematically processed, and whose data can be extracted in random bits and pieces and presented in a final report in numerous configurations are called "database managers"—meaning the user can not only file but manipulate the stored data so it produces a report in a specific format.

Report software for an associated database can produce a report on anyone or anything. Push a button and the computer will print paychecks from the payroll records stored in the database. Push another button and it will not only tell how many widgets were sold for each minute of last week, it will project how many widgets will be sold per minute in 1987; and will tell

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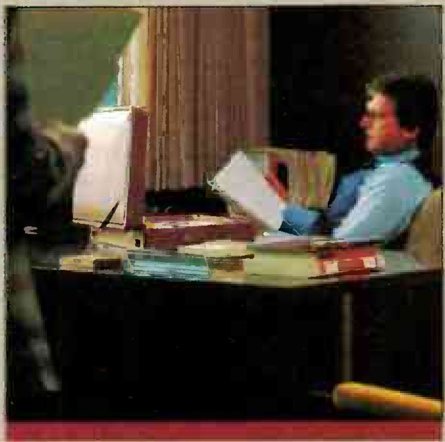

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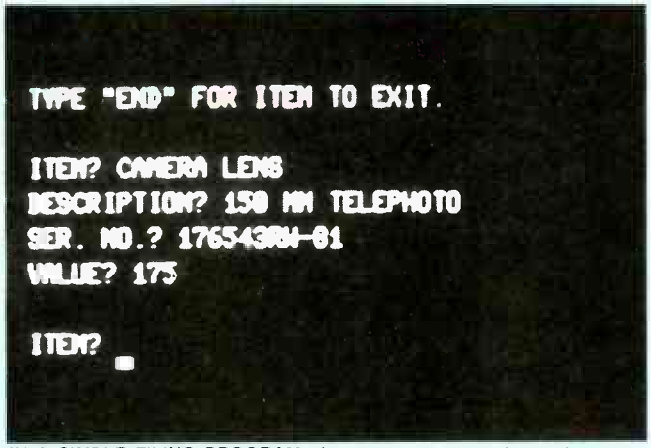


IN A SIMPLE FILING PROGRAM, the on-screen prompts are kept to a minimum. The "?" is used by this program to tell you when to enter data.

the boss how many keys per minute each word processor operator types, and the length of everyone's coffee break, and the exact second (not minute) the assembly line workers punched in.

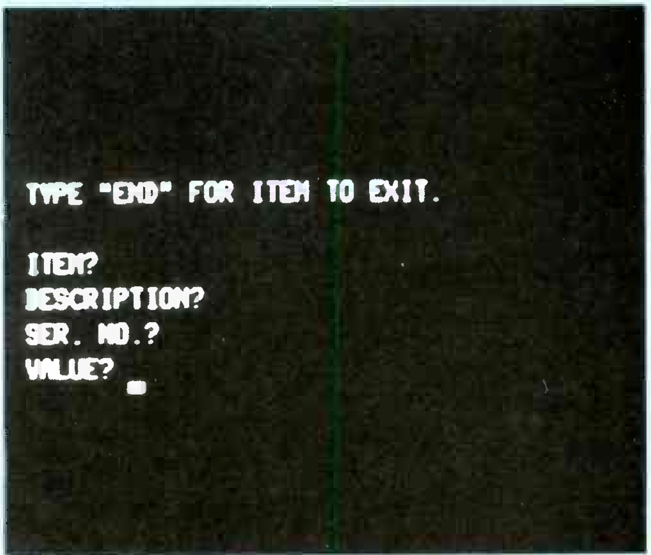
While database managers have enormous power in the sense the user can virtually write the data-handling program itself, they often prove to be extremely complex and difficult to use. For example, *dBase II* from Ashton-Tate (9929 West Jefferson Boulevard, Culver City, CA 90230), the best known of the personal computer database managers, is usually difficult to learn. There is even a separate training course (tutorial) for *dBase II*, and yet another expensive program to interpret the user's ideas into the *dBase II* "language." While some users can get a grip on the program in a matter of weeks, there are others who spend better than a half year and still cannot write the database.

The problem with these super database-management programs is the myth that everyone needs one. In fact, when run on a small personal computer—meaning 64K of RAM or less and a 5¼-inch disk system with a storage capacity of about 200K per side, the super database is often difficult to organize, time consuming to use, and relatively expensive. Most home-and-family and small-business users simply don't need that much "sophistication"—here sophistication is a euphemism for complexity.

The truth is that many users can get by with discrete data filing software—meaning individual programs that perform one particular database function—rather than a super-database that can processes every conceivable file and record. To help you understand the kind of programs available in dedicated software, we'll take a look at some of the simple data-filing systems.

Let's start off with something very simple but very convenient: a random-access information file—a computer simulation of a 3 × 5 file card. Such a file is a good way to organize the bits and pieces of information we would like to have at our fingertips. Such information might include who we're supposed to meet for lunch next Thursday; where we hid Mom's gold wedding band when we went on vacation; where we filed that issue of **Radio-Electronics** with the article on direct-broadcast satellites; how much we paid for our cameras and where we placed the original sales slips (for insurance); the name of the person who refinished the office desks, etc.

There are many so-called "filing systems" but none the equal of *SeekEasy* (Correlation Systems, 81 Rockinghorse Rd., Rancho Palos Verdes, CA 90274). *SeekEasy* is self-contained; it does not require a word processor for data entry. It is totally random for both entry and search, with the entered information treated as a single field. The user can enter up to two lines (160 characters) of anything in any order. One entry might be: "Lunch, Feb. 3, 2 PM, Joe Smith, Widgets, Inc." while another entry might be: "IRA Account 1983, East Bank Of The Missouri, 145-5678."



THIS IS HOW the simple filing program may look when data has been entered. It is nothing spectacular, but it does work.

If on Feb. 3 the user simply enters "Lunch," "Feb. 3," "Joe," "Smith," "2 PM," or any combination, the entire entry will be displayed. Similarly, entering any piece of information from the IRA entry will call up the entire entry.

Even if the user gets the spelling or numbers incorrect a random access file will display and/or print the nearest equivalent. Naturally, the more precise and detailed the search-data entries, the narrower the range of displayed file information.

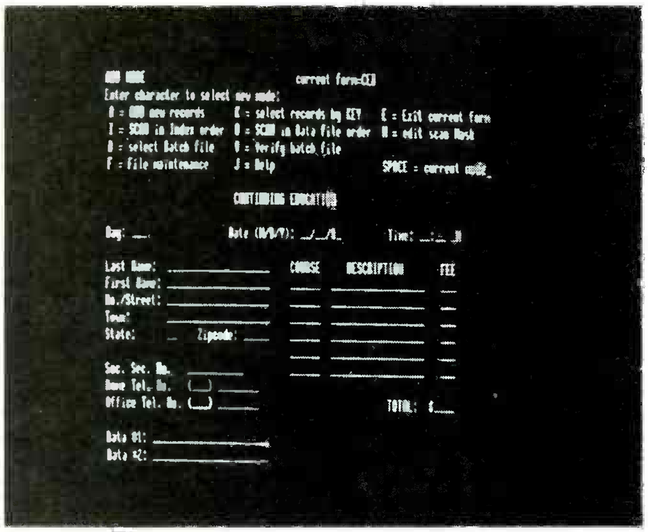
Random access files such as *SeekEasy* have no fields, no definitions, no report structure, nothing except total search of every character. If the information is there it will find it. Unfortunately, some random access programs are slower than others, anywhere from a few seconds to almost an hour. Again, for conventional personal computers the fastest we have seen or used is *SeekEasy*, which will random access 2.5K per second. Under the most difficult search conditions—the least amount of descriptive information—the program takes only 10 seconds to locate one of 100 records on a 5¼-inch double-density disk system.

We have gone into a little extra detail on *SeekEasy* so that as we cover other types of filing systems you can put them in the proper perspective in terms of complexity of data entry, search and reports, speed, and ease of use.

When you need it all!

One of the real heavyweights in database management that doesn't require a college course in how to program to use is *Infostar* from MicroSoft (10700 Northup Way, Bellevue, WA 98004). That program really consists of two separate programs *Datastar*, which is the filing system, and *Reportstar*, which creates screen and printed reports. The user can purchase either program separately, or the complete package. *Datastar* allows the user to create a specific screen layout for entering data by simply moving the cursor around the screen and then typing in both graphic and character prompts.

A typical *Datastar* screen might contain lines composed of dots, with each dot representing a possible character entry. The



THE SCREEN DISPLAY generated by a more advanced filing program. Note the full set of "help" prompts that appear at the top.

screen can also have special automatic formating for such things as telephone numbers or Social Security numbers. The program then "remembers" the screen. The nice part about *Datastar* is that it works on every conceivable level, from rank beginner to advanced programmer. Once the screen is created it can be used as-is, or each prompt can be keyed to accept only certain types of information, or even convert information. For example, a NAME field can be keyed to accept only alpha characters, no numerals, with all entries automatically converted to upper case letters. In addition, some fields might be designated numeric only, while still others can be derived from other fields. For example, if five fields have numerical entries, a sixth field, one that is perhaps called TOTAL, or SUM will be the value of the sum of the five numerical fields, or a field might contain derived information within a specific range.

The major point is that you only use as much of *Datastar* as you can handle. The more you learn the more you use.

Same thing with *Reportstar*. You can create either screen or printout formats—even new report fields—from the information in the *Datastar* file. Again, you can limit your reports to only the features you can handle comfortably.

An extra value of the *Infostar* system—particularly for the small businessman whose filing requirements might be constantly changing — is that as the user gets greater skill with the program, he or she can usually upgrade the formats without having to redo the entire database.

Basic systems

SeekEasy and *Infostar* are rather expensive programs, even though they run on moderate cost 8-bit machines. Similar features, although they are not as convenient to use or as flexible, are available in budget priced software for the low-priced personal computers.

For example, there's *Filewriter*, from Dynateck MicroSoftware, Inc. (7847 North Caldwell Ave., Niles, IL 60648), for the Commodore 64. That is a "program generator," which means that you create the screen prompts you want and the software then writes a program in BASIC that will perform exactly the functions you indicated on the screen.

The created program will store your information, retrieve it, and allow you to make updates and deletions. You can even moderately customize the entry fields for alpha or numerics only, date only, etc., much as you would do when using *Datastar*. You don't get the flexibility of a "professional" filing system such as *Datastar*, and the entry for each field can be no longer than a single line, but you get a lot of performance at the lowest possible price in a system that can be handled by the newcomer to personal computing. Also, *Filewriter* comes with a very thin but excellent manual that's easily understood by the beginner. It's also an excellent training aid for those who want to learn something about database management.

If you can put up with a program that's relatively slow to load and relatively slow to run, and you know nothing about programming or database management but need somewhat extensive computerized files, consider one of the more sophisticated program generators. Among the better ones is *The Producer* (Software of the Future, Inc., PO Box 1245, Arlington, TX 76004-1245).

That program is particularly well suited for the beginner because it comes with unusually good cassette-based training tapes. It's more sophisticated, and requires more skill than *Filewriter*, but you can eventually end up with a full-featured database that will do just about anything you want—the trade-off is that it will do it quite a bit slower than the super-database management systems.

Basement bargains

Now that the youngsters who used to hang out at Radio Shack in the late 1970's have grown up and graduated as computer-science majors, we're getting some really excellent low-cost database software for the budget priced home-and-family computers. Even though the programs might be priced as cheaply as a discounted "arcade game," some of them are good enough to be considered for part-time or small business use. For example, consider the basic Radio Shack *Color Computer* package consisting of the computer and a cassette recorder (no disk). One of the most convenient filing systems you're likely to run across for any computer is the $25 ROM-cartridge *Color File* for that minimum system.

Color File's power is an almost unbelievable sorting facility for what is obviously a rock-bottom price. The screen comes up with eight field selections. Seven are data fields with the usual home-and-family database labels such as ADDRESSES, WARRANTIES, CAR MAINTENANCE, etc. The eighth selection permits the user to define seven fields of his own choosing, each field having a limit of up to 32 characters each including the prompt. Each field can accept as many different entries (words, descriptions, or numerals) as will fit on the line. For example, if one field is designated INSURANCE, the entries might read: LIABILITY, AUTO, EQUIPMENT.

Now here's where the super-sort feature of *Color File* comes in. Once the data is stored in memory, the user can then sort on any field, sort again on any of the data for that field, sort yet again, then call up the records from that sort, pick a second field, sort once or more on the second field, and then repeat the whole procedure for the remaining five fields. *Color File* will even sort on partial data. For example, if a field contains, widgets, gizmos, and gadgets, *Color File* will locate the record if you sort the "widg." To do that with almost any top-of-the-line database-management system would take anyone other than an expert several weeks of effort, and that's assuming, of course, they had the programming skill to start with.

Color File does not create its own fields, nor will it sum fields, and its 32 character line length including screen prompts is somewhat limiting, but for filing and retrieving information it's hard to do better.

As you can see, there are sharp differences in the way ordinary data can be processed by a personal computer, not to overlook the fact that the software can range in price from almost pocket change to several hundred dollars. Also, the same type of sophisticated feature, such as a multi-field sort, really doesn't depend on price. Surprisingly enough, the lowest-cost software might very well have the exact data-handling feature most needed for your use. When it comes to shuffling data, don't look at the brand name, the price, nor even the myth. Quite often, the best data-handling software is designed to do only one specific job, but do it extremely well. **R-E**

Telephone Add-On

NO MORE WRONG NUMBERS!

Receive only the calls you want to receive with this inexpensive and easy-to-build telephone accessory.

GARY McCLELLAN

Part 2 LAST TIME WE STARTed building a device that keeps unwanted telephone calls from reaching you. It's time now to finish assembling the main board. Once that's done, we'll turn our attention to the second part of the project, the decoder board. Incidently, the decoder board has fewer parts and is easier to build than the main board, so it shouldn't take as long to complete.

Before we continue, an incorrect Radio Shack number was given in the Main Board Parts List for RY1; the correct number is 275-213. Now, picking up from where we left off last time, let's turn to the diodes.

Be sure to observe the polarities of those devices. Install four 1N4002 diodes at D8–D11, next to the fuse. Then go to SO1 install a 1N4148 diode at D7. Move over to IC5 and install four 1N4002 diodes at D3–D6. Finish up by installing 1N4002 diodes at D2 and D1 as shown.

The capacitors are installed next. Since there are many, they will be installed a few at a time. Be sure to push the capacitor bodies firmly against the board before soldering in place. Also, double-check the polarities before soldering the tantalum or electrolytic capacitors in place.

Start by installing a 0.01-µF disc at C2. Then install a 0.22-µF film at C1. Move to the right and install a 47-µF electrolytic at C3. Then install a 1-µF tantalum at C4. Make sure the capacitors are installed properly before continuing.

Continue by installing a 0.1-µF polyester at C5. Then a 1-µF tantalum at C6. (Be careful not to install it in the R5 or R7 positions.) Install another 1-µF tantalum at C7. And install a 0.1-µF disc capacitor at C8.

Continue by installing another 1-µF tantalum at C10. Then install a 0.1-µF polyester at C12. After that, install another 0.1-µF polyester at C11, just below IC5. Move over the IC4 socket and install a third 0.1-µF polyester at C9.

At this point, the remaining capacitors are installed. First install 0.1-µF discs at C16 and C17. Then install a 470-µF electrolytic at C15. Make sure it is installed properly before soldering in place. Finally, install 0.01-µF discs at C13 and C14, next to F1.

Now the transistors and two IC's may be installed. Be sure to position the flat side of the transistor cases as shown in the parts-placement diagram. Start at the top of the board. Install a 2N2222 transistor at Q2. Then install the other 2N2222 at Q1, near RY1. Move on to the IC's, install a 78L05A at IC7 and another 78L05A at IC6.

Some wire jumpers are required and they will be installed now. Use pieces of leftover resistor or capacitor leads for them. Note that there are four jumpers and that they are located around the IC3 and IC4 sockets. Start with the jumper above IC3. Bend a lead to fit, then install it as shown. Move to the right of IC3 and install another jumper as shown. Finally, move to SO1 and install two jumpers above it. Be careful not to put a jumper in place of R16. Two other jumpers, located on the foil side of the board, will be installed later.

The resistors are installed next. Since there are so many, they will be installed a few at a time.

Start by installing a 10K potentiometer at R12. Then move to the left and install a 1K resistor at R1. Then install a 10K resistor at R13 and a 4.7K resistor at R4. Then install a 100K unit at R6.

Continue by installing a 33K resistor at R8 and a 22K resistor at R9. Move to the left, next to IC1, and install a 10K resistor at R2. Then install a 1K resistor at R3. Jump over the capacitors and install a 270K resistor at R5. Then install a 10K unit at R7.

The remaining resistors, which are grouped around the IC4 socket, are installed next. Install a 100K resistor at R16, a 10-megohm resistor at R14, and a 2.2K resistor at R20.

The next step is to install the two insulated wire jumpers on the foil side of the board. Simply cut to pieces of insulated wire to the appropriate length and carefully solder them in place.

Finish up the assembly by installing the IC's. Install the M290 into the IC2 socket. Then install a CD4538 into the IC3 socket and a CD4093 into the IC4 socket.

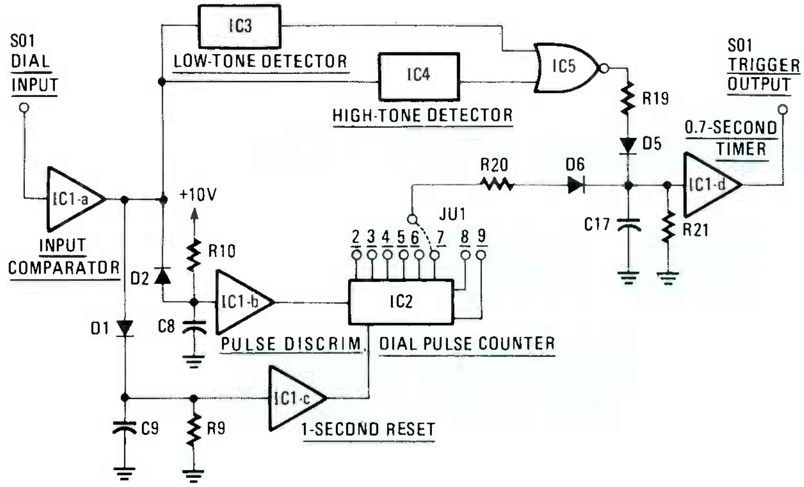


FIG. 5—THE VARIOUS STAGES of the decoder board are shown in this simplified schematic diagram.

The decoder board

Lets discuss the circuitry briefly and then build the board. The decoder has one basic job; to detect tone pairs from *Touch-Tone* phones or detect pulses from rotary-dial phones. A desired code number is programmed into the board, and whenever that number is detected, the board produces an output.

Returning to the main board, an output from the decoder triggers a one-shot. The one-shot enables a 2-Hz oscillator. As a result, the project produces a distinctive beep-beep-beep sound for ten seconds. That is what tells you to answer the phone.

Figure 5 shows a simplified schematic diagram of the board; the complete schematic is shown in Fig. 6. Incoming dial pulses or tones from the phone line appear on the DIAL pin of PL1. The tones or pulses drive IC1-a, an analog comparator. That device provides gain and squares up all signals.

The output from IC1-a branches in two directions: to the tone-detector circuitry and to the dial-pulse circuitry. The tone-detector circuitry consists of two phase-locked tone-detectors, IC3 and IC4. Recall that pushbutton tone telephones produce two tones; low and high. (That's why the system is known as DTMF or *D*ual-*T*one *M*ulti-*F*requency.) The low tones have frequencies of less than 1 kHz, while the high tones have frequencies that are above 1 kHz. At any rate, when the appropriate low and high tones are present, IC3 and IC4 produce logic-low outputs. Gate IC5 detects that condition and produces a logic-high output. The output from IC5 goes to a timer circuit that will be discussed shortly.

Note that the tone detectors are adjusted to respond to the number "7." That means that the low-tone detector, IC3, is adjusted for 842 Hz and the high-tone detector, IC4, for 1209 Hz.

The dial-pulse circuitry consists of three parts—a pulse discriminator, a one-second reset, and a dial-pulse counter. Comparators are used for everything except for the dial-pulse counter.

The purpose of the pulse discriminator is to prevent tones from pushbutton phones, as well as any other stray audio, from clocking the dial-pulse counter. In effect, that circuit works as a low-pass filter.

In operation, input signals cause the output of IC1-a to pulse high. If the frequency is too high, diode D2 prevents capacitor C8 from charging. As a result, comparator IC1-b never triggers, and no output goes to the counter. But if the frequency is low, C8 has time to charge through resistor R10. The comparator then triggers and each pulse clocks the dial-pulse counter. Note that the values of R10 and C8 are set for 45 milliseconds, or half the pulse width of a standard rotary-dial phone.

The purpose of the one-second reset circuitry is to reset the dial-pulse counter one second after the pulses stop. That way, the circuitry will be ready for the next call. In operation, input signals cause the output of IC1-a to pulse high. That causes capacitor C9 to charge through diode D1. At the same time comparator IC1-c triggers, removing the reset from the dial-pulse counter so that the counter is free to count pulses. About one second after the pulses stop, C9 is discharged through resistor R9. Thus, comparator IC1-c is untriggered and resets the dial-pulse counter.

The purpose of the dial-pulse counter, IC2, is to count pulses from rotary-dial type phones. It has eight decoded outputs and each output represents the number dialed. Note that there are two other outputs, but they are reserved for housekeeping purposes. Also note that the desired output, "7", is jumpered to the 0.7-second timer circuitry. Note that for simplicity, only the "7" output is shown in Fig. 6.

The remaining bit of circuitry on this board is a 0.7-second timer. The purpose of that circuit is to prevent false triggering, mainly by the tone detectors, which can sometimes be tricked by human speech. For that circuit to produce an output, either the decoded tones or the dial pulse must be present for at least 0.7 second. For times less than that, the circuit will not produce an output.

In operation, a good pair of tones makes the output of IC5 high. That causes capacitor C17 to charge through resistor R19 and diode D5. If the tones last over 0.7 second, comparator IC1-d triggers and produces a high output. That triggers the beeper circuitry on the main board through the TRIG output of PL1. In the case of a rotary-dial phone, a good number makes the jumpered output of IC2 high. So capacitor C17 charges through resistor R20 and diode D6.

Note that after the tones or dial pulses disappear, resistor R21 discharges capacitor C17, untriggering the comparator. So the TRG output goes low and the circuitry is ready for the next call.

That completes the theory—on to assembly!

Assembly

Start by referring to the Parts List for the decoder board and obtaining all of the parts. Here are a few suggestions that may be helpful as you shop.

The IC's are all industry standard, and many manufacturers make them. For example, the National LM567CN is also made by Signetics (NE-567N) and Exar (XR-567CP).

The only capacitor that might cause problems is C17—a 1μF tantalum type. A low-leakage electrolytic may be substituted for that capacitor if needed.

As for the resistors, R14 and R17 may require some searching. To make things easier, a supplier and part number is given in the Parts List. Also, two odd-value resistor types are used; 6.2 kilohms and 180 kilohms. If you can't get the 6.2-kilohm units, simply parallel a 6.8-kilohm resis-

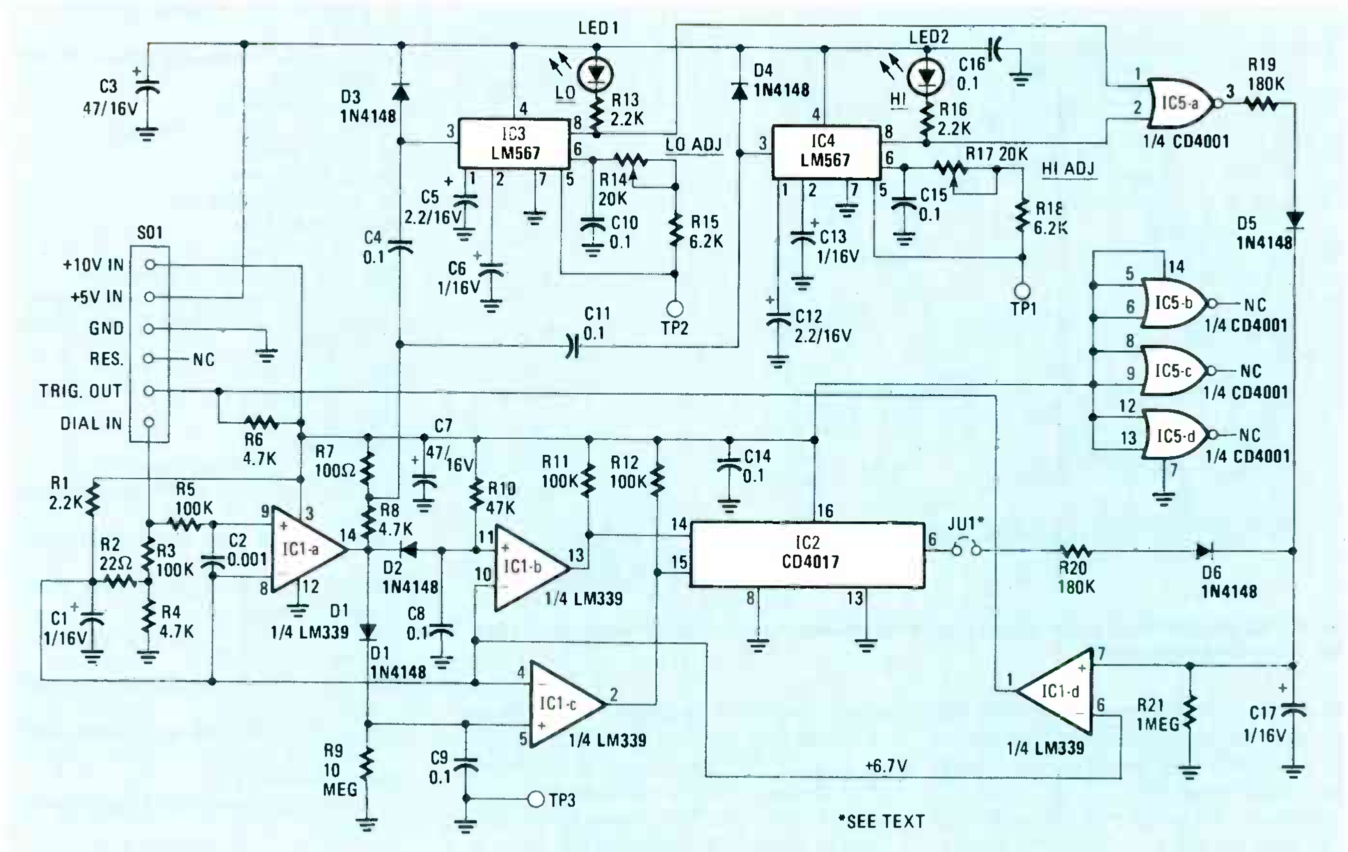


FIG. 6—**SCHEMATIC DIAGRAM** of the decoder board. Note that all signals to and from the main board are routed via SO1.

tor with a 68-kilohm unit. As for the 180-kilohm unit, simply parallel a 220-kilohm resistor with a 1-megohm unit.

You'll also need a PC board. If desired, order the set from the supplier given in the Parts List. Otherwise, you can make your own using the pattern shown in Fig. 7.

Once you have the parts, assembly can begin. Refer to Fig. 8. the parts-placement diagram, and position the board as shown.

Start with the IC sockets. Install a 14-pin socket at IC1 and solder in place. Then install another 14 pin IC socket at IC5. After that, install a 16-pin unit at IC2. Finish up the IC sockets by installing 8-pin units at IC3 and IC4.

Continue assembly with the two LED's. Be sure to look at the plastic cases carefully; one side should be flattened. And the lead closest to the flattened side should be shorter than the other. Install each LED with the flattened side (and short lead) to your right. Install LED2 first, near the top of the board. Then install LED1 in the same manner.

Continue assembly by installing the capacitors. Since there are so many, they will be installed a few at a time. Be sure to install the polarized capacitors with the + sign as shown in the figure, and double-check your work after soldering.

Install a 1-μF tantalum capacitor at C17 along the top of the board. Then move to your left and install a 0.1-μF disc capaci-

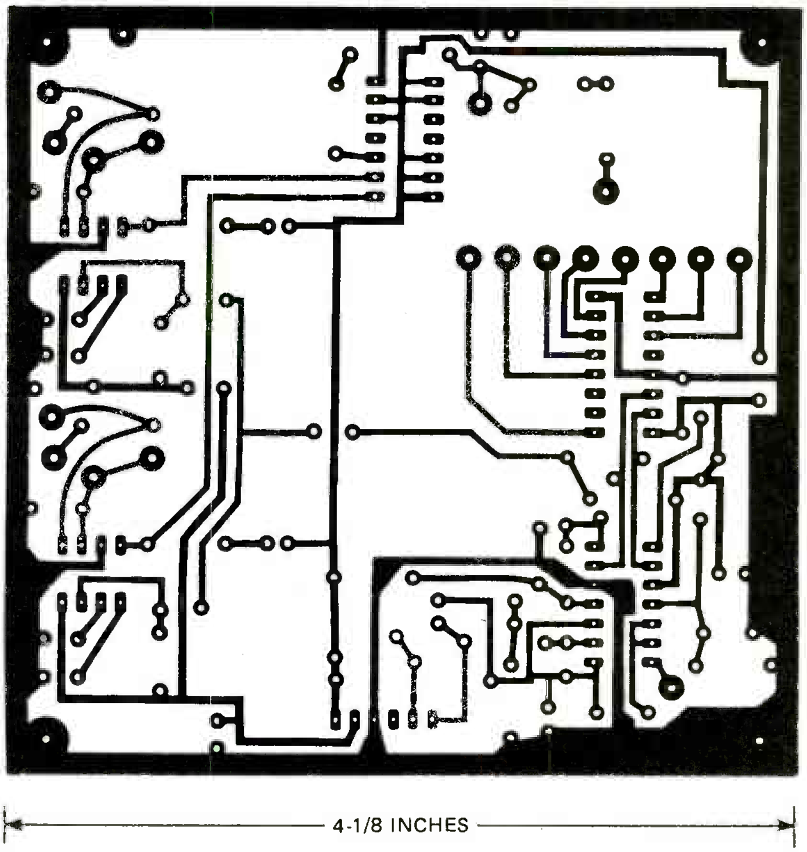


FIG. 7—**FOIL PATTERN** for the single-sided decoder board is shown here full size.

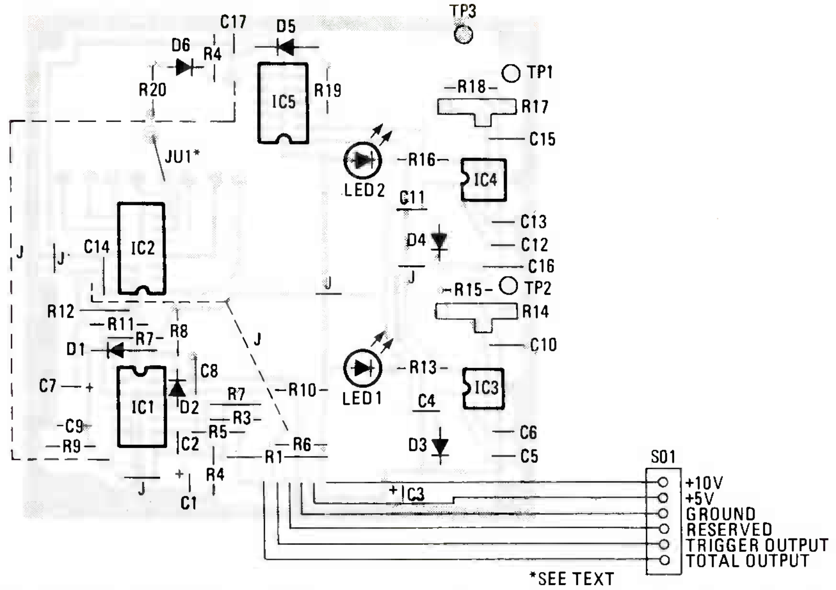


FIG. 8—THE UNUSED PADS around IC2 are provided to allow for the selection of a code number other than 7. See the text for details.

PARTS LIST—MAIN BOARD

All resistors ¼-watt, 5% unless otherwise noted
R1, R3—1000 ohms
R2, R7, R11, R13—10,000 ohms
R4—4700 ohms
R5—270,000 ohms
R6, R16—100,000 ohms
R8—33,000 ohms
R9—22,000 ohms
R10, R14, R15, R19—10 megohms
R12—10,000 ohms, potentiometer, linear taper, PC-board mount (Radio Shack 271-218)
R17—330 ohms
R18—470 ohms
R20—2200 ohms

Capacitors
C1–0.22 µF, 250 volts, metal film
C2, C13, C14—0.01 µF, 50 volts, ceramic disc
C3—47 µF, 16 volts, radial leads, electrolytic
C4, C6, C7, C10—1 µF, 16 volts, radial leads, tantalum
C5, C9, C11, C12—0.1 µF, 50 volts, polyester
C8, C16, C17—0.1 µF, 16 volts, ceramic disc
C15—470 µF, 25 volts, radial leads, electrolytic

Semiconductors
IC1—TIL-119 optoisolator (Texas Instruments)
IC2—M290 ring-detector subsystem (Mendakota—see below)
IC3—CD4538 CMOS one-shot (RCA)
IC4—CD4093BE CMOS Schmitt trigger NAND gates
IC5—MOC-5010 optoisolator (Motorola)
IC6, IC7—78L05ACP 5-volt, 100-mA regulator (Motorola)
Q1, Q2—2N2222 NPN transistor
D1–D6, D8–D11—1N4002 diodes
D7—1N4148 diode
F1—0.25 amp, 3AG fuse
PL1—6 pin male PC-header (GC Electronics 41-046 or similar)
RY1—DPDT relay, 12-volt DC coil (Radio Shack 27S-213 or equivalent)
PB1—Piezoelectric buzzer (Radio Shack 273-060 or equivalent)
S1—SPST momentary pushbutton switch (Radio Shack 275-618 or equivalent)
Miscellaneous: PC board, solder, wire, 2 PC-mount fuse clips (Littlefuse 122087), IC sockets, etc.
The following is available from Mendakota Products, Ltd., PO Box 20HC, 1920 W. Commonwealth Ave., Fullerton, CA 92633: A set of three PC boards and the M290 ring detector IC (order part No. NWR). The cost is $26.00 postpaid in the U.S. and Canada. The M290 is available for $12. California residents please add 6% sales tax. Sorry, no C.O.D's or credit-card orders.

tor at C14. Move to the left some more and install a 47-µF electrolytic capacitor at C7. And after that, install a 0.1-µF polyester capacitor at C9.

Move to the bottom of the board and continue. Install a 1-µF electrolytic capacitor at C1. Then move up and install a 0.001-µF polyester capacitor at C2. Next, install a 0.1-µF polyester unit at C8.

Install another 47-µF electrolytic capacitor at C3. Then move up and install 0.1-µF polyester units at C4 and C10. Back up and install a 2.2-µF electrolytic capacitor at C5. Then above it, install another 1-µF electrolytic unit at C6.

Move up and install a 0.1-µF disc capacitor at C16. Be careful not to install it at R15 by mistake. Then install another 2.2-µF electrolytic capacitor at C12. After that, install another 1-µF electrolytic capacitor at C13. Finish up the capacitors by installing 0.1-µF polyester units at C11 and C15.

Continue with the four component-side jumpers. Use short pieces of leftover capacitor leads for those. Install the first jumper next to C14, along the lefthand side of the board. Then move to the bottom left side and install another jumper. Move to the center of the board and install the two remaining jumpers between the LED's.

Next, install jumper JU1. When that jumper is installed as shown the pulse-dial circuitry will respond to a dialed 7. The remaining pads in that area are provided to allow you to select a different code number and are normally unused.

Continue assembly with the resistors. Since there are so many, they will be installed a few at a time. Start at the top of the board by installing a 1-megohm unit at R21. Then install 180K units at R20 and R19 on either side of the IC5 socket. After that, move down and install 100K units at R12 and R11, adjacent to the IC2 socket.

Install a 100-ohm resistor at R7, below R11. Be careful not to place that resistor in the D1 position. Then move to the right and install a 4.7K resistor at R8. Move to the lower lefthand corner of the board and install a 10-megohm resistor at R9. After that, move to the right and install another 4.7K resistor at R4.

Install two more 100K resistors at R5 and R3. Then move up and install a 22-ohm unit at R2. Move to the right and install a 47K resistor at R10. After that, install another 4.7K resistor at R6. Next, install a 2.2K unit at R1. Bend the leads to size first, then install.

Move to the top of the board and install a 6.2K resistor at R18. After that, install a 20K potentiometer at R17. Be sure to push the body of the potentiometer firmly against the board before soldering it in place. After that, install another 2.2K resistor at R16.

Install another 6.2K resistor at R15. Then install another 20K potentiometer at R14. Push the body firmly against the board before soldering. Finish up the by installing another 2.2K unit at R13.

Continue assembly by installing three short pieces of wire at the pads marked TP1-TP3. Use short pieces of leftover resistor wire, cut to a length of ⅜-inch for that. Install two of the wires at the holes above R18. Then install the remaining one next to R15.

Next, we turn to the diodes. When installing the diodes, be sure to position them as shown. Double-check your installation after soldering. Note that all diodes are 1N4148's.

Install a diode at D5 as shown. Then install a diode at D6 to the left of it. Move down to the IC1 socket and install diode D1 next to it. Then install diode D2 to the right of it. Move to the IC3 socket and install diode D3 next to it. And finally, move to the IC4 socket and install diode D4 next to it.

Continue by installing two insulated foil-side wire jumpers. Note that they are shown as dashed lines in Fig. 8.

PARTS LIST—DECODER BOARD

All resistors 5%, 1/4 watt unless otherwise noted
R1, R13, R16—2200 ohms
R2—22 ohms
R3, R5, R11, R12—100,000 ohms
R4, 46, R8—4700 ohms
R7—100 ohms
R9—10 megohms
R10—47,000 ohms
R14, R17—20,000 ohms, 15-turn potentiometer, PC-mount (Radio Shack 271-340 or equivalent)
R15, R18—6200 ohms
R19, R20—180,000 ohms
R21—1 megohm
Capacitors
C1, C6, C13—1µF, 16V, electrolytic, radial leads
C2—0.001µF, 50V, polyester
C3, C7—47µF, 16V, electrolytic, radial leads
C4, C8, C9, C10, C11, C15—0.1µF, 50V, polyester
C5, C12—2.2µF, 16V, electrolytic, radial leads
C14, C16—0.1µF, 16V, ceramic disc
C17—1µF, 16V, tantalum
Semiconductors
IC1—LM339 linear quad comparators (National)
IC2—CD4017 CMOS counter (RCA)
IC3 IC4—LM567 linear tone decoders (National)
IC5—CD4001 CMOS quad NOR gates (RCA)
D1–D6—1N4148 silicon switching diodes
LED1, LED2—jumbo red LED's (Radio Shack 276-041 or equivalent)
SO1—6-pin female plug (Calectro 41-126 or equivalent)
S2—SPST rocker switch (Radio Shack 275-690)
T1—12 VAC, 250mA, plug-in transformer (Jameco AC-250 or equivalent)

Miscellaneous: PC board, front-panel board, 2×5×5-inch cabinet (CM5-200, Pac Tec, Inc., Enterprise and Executive Aves., Philadelphia, PA 19153)(Radio Shack 270-218), 12-foot modular telephone cord (Radio Shack 279-374 or equivalent), IC sockets, 4 1-inch threaded spacers for 4-40 screws, 4 0.125-inch unthreaded spacers, 4 4-40×0.25 inch screws, 7 4-40×0.5 screws, 11 No. 4 lockwashers, 3 4-40 nuts, 0.25-inch cable clamp, etc.

Cut a piece of insulated hookup wire to about 2.5 inches and strip both ends. Install one end in the hole next to C14, near the IC2 socket. Then install the other end in the hole between resistors R6 and R10.

Cut a piece of insulated hookup wire to about 4 inches and strip both ends. Install one end in the hole near the top of the board, next to C17 and the IC5 socket. Then install the other end in the hole below the IC1 socket.

Continue by installing connector SO1. If possible, use a piece of six-conductor ribbon cable for the wiring; it gives a neater appearance. However, short pieces of hookup wire will work fine.

Cut a piece of cable (or six wires) about 2.5 inches long and strip all ends. Install SO1 at one end.

IMPORTANT! Insert the wires from SO1 into the board so that the key (raised plastic ridges) on SO1 points DOWN. Double-check all of them before you do any soldering.

Observe the preceding precaution, then insert each wire into the holes on the board and solder.

Complete the assembly by installing the IC's. Be sure to position them with pin 1 as shown. Install an LM339 into the IC1 socket. Then install a CD4017 into the IC2 socket. After that, install a CD4001 into the IC5 socket. Finally, install the LM567's into the IC3 and IC4 sockets.

Basically, all that's left for next time is to do the cabinet work, install the boards, and perform a few adjustments. That shouldn't take long to do and then this project will be standing guard over your phone! **R-E**

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You, as a Mailing List Protection Agent, will have your address and a code name used as a decoy. For example, if your name is Robert Smith, you may give yourself the code name of James Smith. This way you can distinguish your personal mail from the decoy mail. Now, when you get your daily mail, you will simply sort the coded mail from the personal mail and put the date on the face of the envelopes of the coded mail. Each week you will take all of your coded mail and put it in a special package that we will supply. Then you will forward it to us for payment. What could be easier?

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When your package of coded dated mail arrives at our office, we will count the number of pieces in the package and send you a check the same day along with another special package for your next group of coded dated mail. We then match the mail you sent us and forward it to the proper list owner for his use.

When you receive the next correspondence from us, it will include the following: 1) A payment of 30¢ for each coded dated piece of mail inside. 2) A payment for the postage money you spent to send us the previous package. 3) Another special package for the next group of mail.

Examples: Suppose various packages contained the following quantities of coded dated mail on different occasions. Here is how much money you would receive . . .

Group One contains 384 pieces in the package you forwarded us - WE PAY YOU $115.20 plus the postage money you spent to send us the package!

Group Two contains 671 pieces in the package you forwarded us - WE PAY YOU $201.30 plus the postage money you spent to send us the package!

Group Three contains 917 pieces in the package you forwarded us - WE PAY YOU $275.10 plus the postage money you spent to send us the package!

We want you because we have a current need for agents with decoy addresses all over the United States. Our address is so well known that it could never be used as an effective decoy. Not to mention, many of our list owner clients are involved in regional mailings, thus we need decoys in all 50 states. Consequently, it doesn't matter where you live, you can become a Mailing List Protection Agent as long as you have an address in the United States or Canada.

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In order to get officially registered as a Mailing List Protection Agent, you must pay a one time fee as indicated on the LIFETIME REGISTRATION CERTIFICATE. The fee covers all the computer costs of getting your code name and address integrated into the system, setting up your file for payment in our office, and start-up kit we will send you as soon as you register.

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Designing with Linear IC's

This month we inaugurate our new back-to-school series. This time around we'll be looking at linear IC's, and how you can use them in your own designs.

JOSEPH J. CARR

INTEGRATED-CIRCUIT TECHNOLOGY HAS made the job of circuit design much simpler. That's because those devices have progressed to the point that very few external components are needed to form a fully functional circuit. Consider, for instance, an operational amplifier: when setting the gain of those devices, the design simply entails picking the *ratio* of two resistors.

That's not to say, however, that working with linear IC's does not present its own unique problems. The purpose of this article, and the ones that will follow, is to introduce you to the various types of linear IC's. In the coming months we'll be looking at how those devices work, and how to use them successfully in your circuit designs.

IC construction

As you can see in Fig. 1-a, an IC is made up of layers of p-type and n-type semiconductor material. The bottom-most layer of the IC is called the substrate. The substrate is about 6 mils thick and its area can measure from 50 × 50 to 160 × 160. In our example, the substrate is p-type material. In other IC's it could just as easily be n-type; it all depends on the design of the particular device.

The IC is fashioned by stacking alternating layers of p-type and n-type semiconductor material on the substrate as shown in Fig. 1-a. Each layer measures about 5- to 30-micrometers thick.

That brings us to one of the most basic design considerations that must be remembered when designing IC circuits. The p-type substrate and n-type next layer form a PN "diode" junction that must be reverse biased under normal conditions. The circuit designer must keep that constraint in mind. Although some clever designers are able to use forward bias for that junction, accidental reverse bias can destroy the device. In general, then, the substrate should be connected to either ground or to the case if it is made of metal.

Incidently, the circuit formed by the IC is shown in Fig. 1-b.

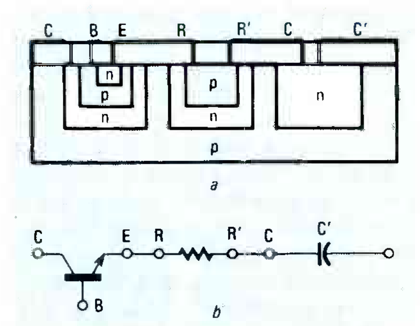

FIG. 1—ALL THE COMPONENTS in an IC are formed from layers of p-type and n-type semiconductor material. The circuit for the device shown in *a* is shown in *b*.

Differential amplifiers

The heart of most linear IC amplifiers is the transistor differential amplifier shown in Fig. 2. A differential amplifier is designed to produce an output signal that is proportional to the difference between two input signals.

Transistors Q1 and Q2 form a differential pair because their emitters are tied together and their emitter currents are determined by a common constant-current source. Since the current, I_3, from the constant-current source can not vary, it can neither increase nor decrease in response to changes in load. Since the sum of the transistor's emitter currents, $I_1 + I_2$, is equal to I_3, we may conclude that keeping the sum constant, because I_3 is constant, requires one of the currents to decrease if the other increases. In other words: If I_1 increases, then I_2 will decrease, and if I_1 decreases, then I_2 will increase. Those relationships are critical to understanding the operation of the differential amplifier circuit.

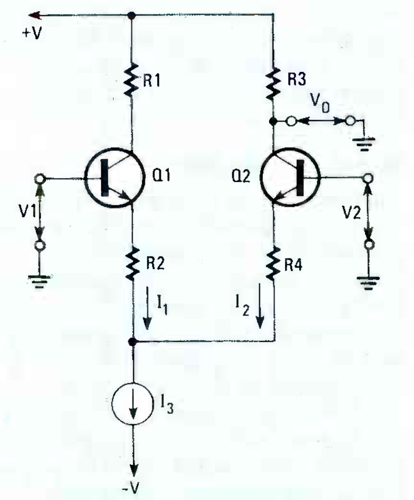

FIG. 2—THE DIFFERENTIAL AMPLIFIER, shown here, is the circuit on which the operational amplifier is based.

For purposes of this discussion, we will assume that the collector and emitter currents of the transistors are identical. (In fact, however, those currents differ by the amount of the base current.) We will therefore assume further: that I_1 and I_2 are also the collector currents of Q1 and Q2 respectively.

The voltage appearing at the collector of Q2 is our output signal V_O. The base of Q2 is designated the inverting input (symbolized by a − sign), while the base of Q1 is the noninverting input (symbolized by a + sign). By definition, those two inputs produce equal but opposite effects on the output signal. That means the two inputs will produce out-of-phase outputs. The output signal produced by the noninverting input is in phase with the input signal; the output signal produced by the inverting input is out of phase with the input signal. A consequence of that action is that identical voltages applied to both inputs will cancel each other and produce zero output.

Let's first examine the operation of the inverting input—the base of Q2. When both V1 and V2 are zero, then V_O is at a quiescent value, or zero. If V2 is made positive, current I_2 will increase (Q2 is

NPN). The voltage drop across R3 will also increase, so V_O will go down. In other words, a positive-going input signal produces a negative-going output; the input is an inverting input.

The noninverting input is the base of Q2. When V1 is made positive, current I_1 will increase. Since the sum $I_1 + I_2$ is constant, current I_2 must therefore decrease. With I_2 decreased, the voltage across R3 is less, so V_O increases. In that case, then, a positive-going input signal creates a positive-going output signal; thus the base of Q1 is truly a noninverting input.

Operational amplifiers

By far the most popular IC linear amplifier is the operational amplifier, whose schematic symbol is shown in Fig. 3. The typical IC op-amp consists of a differential input amplifier followed by a high-gain amplifier chain. The output stage must be bipolar, meaning that it can go either positive or negative.

Let's examine the pinout of an op-amp for a moment. First, what is not present in the device shown in Fig. 3-a? The answer to that is that no ground or common terminal is used! There are two power-supply terminals (V+ and V−), but no ground. Rest with that mystery for a bit; we'll explain it shortly.

Finishing up with the pinout, the two inputs, inverting and noninverting, are the same as discussed previously. The output terminal is self-explanatory.

The ideal op-amp has the following properties: Infinite open-loop gain, infinite input impedance, zero output impedance, zero noise contribution, infinite bandwidth, and, finally, inputs that "stick together."

Open-loop gain means the gain with no feedback, and for the ideal op-amp it is infinite. The open-loop gain for real op-amps is not infinite, but it is very, very high (20,000 for inexpensive devices, over 1,000,000 for premium-grade ones).

Infinite input impedance implies that the ideal op-amp input will neither sink nor source current. Again, real op-amps differ from the ideal. The input impedance is not infinite, but is very, very high (1 megohm to over 10^{12} ohms).

The output impedance of real op-amps is not zero, but is very low (usually under 100 ohms). That property makes it a nearly ideal voltage source to drive any following stages.

Zero noise contribution means the op-amp supplies no noise of its own to the output signal. That ideal is rarely met, however, and one must use premium-grade "low noise" devices if noise is a factor.

What about infinite bandwidth? Few op-amps have gain-bandwidth products over 2–3 MHz, and frequency-compensated types (e.g. 741) will provide sub-

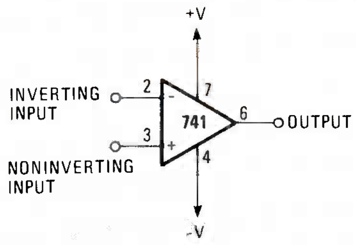

FIG. 3—SCHEMATIC SYMBOL for an op-amp. Note that there is provision for positive and negative supplies, but no ground terminal.

stantial gain only to 10 kHz.

What does "inputs that stick together" mean? It means we must treat both inputs the same. If we apply a voltage to one input, then we must treat the other as if the same voltage were applied to it also! And that is not just some theoretician's mumbo-jumbo. If you apply 2 volts to the inverting input, you will measure 2 volts on the noninverting one as well! That property will be very important when we analyze op-amp circuits in the months to come. In fact, you may have already been exposed to that concept, but under the confusing heading of "virtual ground." A virtual ground occurs when the noninverting input is grounded. In that case, we must treat the inverting input as if it were also grounded! Hence, the inverting input is said to be at "virtual" ground.

Designing circuits around the operational amplifier is made a lot easier by the fact that gain is set simply by the ratio of feedback and input resistors. We can tailor frequency response with simple R-C networks, or even just a capacitor in parallel with the feedback resistor.

The operational amplifier also simplifies the design of electronic integrators, differentiators, and logarithmic amplifiers. In fact, it was in those kinds of circuits that the op-amp was first used. The name "operational" amplifier came about because that type of amplifier could perform mathematical operations in analog computer circuits.

The power supply for operational amplifiers, and many other linear IC's, is shown in Fig. 4. Although batteries are shown here, electronic regulated power supplies may be substituted. The typical op-amp will operate at any potentials between ±4.5 volts and ±18 volts, with some operating at ±22 volts.

There are actually two separate supplies used: +V and −V. The +V power supply is positive with respect to ground, while −V is negative with respect to ground. There is no ground terminal on the op-amp. The signal common is the ground terminal of the power supply. The inverting and non-inverting input signals, and the output signal, are referenced to the power-supply common!

Power-supply decoupling capacitors are not always needed, but it is a good idea to include them. Generally those decoupling capacitors are placed close to the body of the op-amp, rather than at the power supply. For frequency-compensated devices such as the 741, you might be able to get away with no decoupling at all. But for all uncompensated types use 0.1-µF capacitors to ground both the +V and −V inputs. It is also wise to use 1-µF tantalum capacitors in parallel with the 0.1-µF units in order to take care of low frequency decoupling.

Power-supply specifications for op-amps can be a little confusing. We have two basic problems: supply-rail limit and maximum allowable voltages.

The supply-rail limit refers to the minimum difference between the power-supply potential and the maximum output signal voltage. For common 741-type devices, that potential be might 3.5 volts. The maximum signal output potential, therefore, is 3.5 volts below the power-supply voltage.

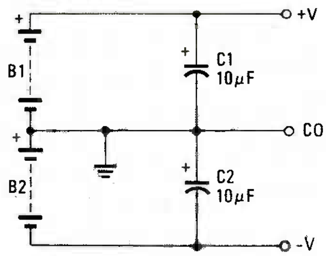

FIG. 4—POWER SOURCE for an op-amp. Note that regulated voltage sources could be used in place of the batteries.

How does that affect the designer? Suppose you are designing the input signal amplifier for a 10-volt A/D converter. You want the maximum signal amplitude to be 10-volts, obviously. The DC power-supply potential must be 10 + 3.5, or 13.5-volts DC. If you had planned to use ±12-volt DC supplies, then your signal would clip on peaks! For 12-volt DC supplies, the maximum output signal would be 12 − 3.5, or 8.5 volts!

Some op-amps have small supply-rail limits. The BiMOS devices, for example, can come within 0.5 volt of the supply rail. The usual way of guessing that limit (if it isn't published) is to count the number of PN junctions (base-emitter or base-collector) in the transistors between the output terminal and either power supply terminal, then multiply by 0.6 volt. The positive (+V) and negative (−V) supply-rail limits may be different on some op-amps.

The problem of maximum supply potential comes about only when trying to operate the device at maximum, and not thoroughly reading the spec sheet. The V_{MAX} ratings might be ±18-volts DC, leading one to believe that +V and −V may both be 18-volts DC. That's not always true! Look for the specified terminal-to-terminal maximum voltage; that is, the maximum voltage that may safely be applied between +V and −V terminals of the op-amp.

Let's look at a "for instance!" The 741 device has maximums for −V and +V of ±18-volts DC, but a terminal-to-terminal maximum of only 30 volts. If we applied 18-volts DC to both +V and −V, the potential would be +V − −V = 18 − (−18) = 36 volts. That potential exceeds the 30-volt limit. If we apply maximum potential to one terminal, then the other must be derated to stay within the specification. For example, in the case above let's assume +V is 18-volts DC. The maximum allowable for −V is 30 − 18, or 12 volts DC. In that case, we would set +V = 18 volts DC and −V = 12 volts DC.

We also sometimes see a related problem that causes op-amp burn-out at strange times. If the supply voltages rise unevenly at turn-on, or decay unevenly at turn-off, it is possible that some op-amps will burn out. Such problems occur mostly when one supply has a lot more capacitance than the other, or when one supply is a lot more heavily loaded than the other.

A similar problem occurs if the input voltage is allowed to rise higher than a supply voltage. The result can be an incorrectly biased substrate and burn-out of the device. That problem usually occurs only when there is some energy-storage device, such as a large capacitor, at the input terminal. In that case, the input voltage may decay at a slow enough rate that some voltage remains at the inputs after power to the device has been removed.

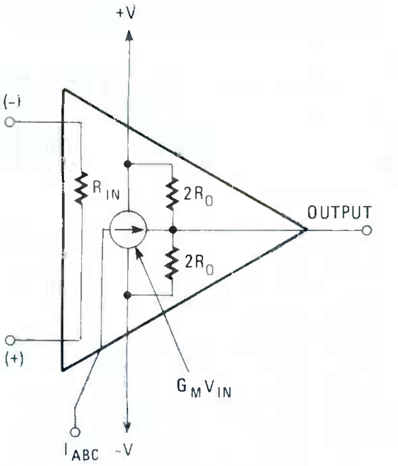

FIG. 5—AS THIS MODEL of the operational transconductance amplifier shows, the input of that device acts as a simple resistance while the output acts as a current source.

Current-difference amplifiers

The operational amplifier is only one form of linear IC There are, of course, dozens of others. Many of them are special-function devices (e.g. cassette-tape recorder pre-amplifiers, etc), but at least two devices have quite a bit in common with the op-amp.

One of those devices is the current-difference amplifier (CDA); that device is also called the Norton amplifier. In essence, the CDA is a current-input/voltage-output device, so it can be called a trans-resistance amplifier.

The CDA is particularly useful in automotive applications, or other cases where a single monopolar power supply is used. Although the CDA never caught on like the op-amp, it is nonetheless very useful. We will examine the CDA in detail in a future article.

The OTA

The other device that has a lot in common with an op-amp is the OTA (*O*perational *T*ransconductance *A*mplifier). Figure 5 is a circuit model for that device. The input is modeled as a simple resistance much like an ordinary operational amplifier. The output, however, is modeled as a current source, where the magnitude of the current is equal to $G_M V_{IN}$; the "gain," therefore is the transconductance (G_M).

The transconductance operational amplifier will also be discussed in full in a future article.

In the next part of this series we will get down to brass tracks with the op-amp. Discussed will be the inverting-follower circuit configuration, how to set gain, and how to determine minimum input resistances. We will also introduce you to certain op-amp problems—and their solutions. R-E

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923863R	26 post double row male
923864R	34 post double row male
923865R	40 post double row male
923866R	50 post double row male

GENDER CHANGERS

Used to connect 2 cables which have the same gender.

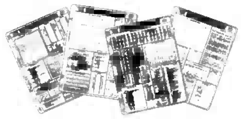
Part No.	Description
JRSM-M	Connects 2 male (DB25P) cables
JRSF-F	Connects 2 female (DB25S) cables

D-SUB CONNECTORS

SOLDER-TYPE CONTACTS

Part No.	Description
DE9P	9 Pin Plug
DE9S	9 Pin Socket
DE9H	Hood for DE9 Series Connectors
DA15P	15 Pin Plug
DA15S	15 Pin Socket
DA15H	Hood for DA15 Series Connectors
DB25P	25 Pin Plug (Meets RS232)
DB25S	25 Pin Socket (Meets RS232)
DB25H	Hood for DB25 Series Connectors
DC37P	37 Pin Plug
DC37S	37 Pin Socket
DC37H	Hood for DC37 Series Connectors
DD50P	50 Pin Plug
DD50S	50 Pin Socket
DD50H	Hood for DD50 Series Connectors

MICRO CHARTS



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Part No.	Description
MLZ80	Z80 CPU
ML6502	6502 (65XX)
ML7400	5400/7400 TTL Pinouts
ML8080A	8080A/8085A

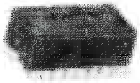
JE750 4-Digit Fluorescent Alarm Clock Kit

The JE750 Alarm Clock Kit is a versatile 12-hour digital clock with 24-hour alarm. The clock has a bright 0.5" high blue-green fluorescent display. The display will automatically dim with changing light conditions. The 24-hour alarm allows the user to disable the alarm and immediately re-enable the alarm to activate 24 hours later. The kit includes all documentation, case and wall transformer. Other features: flashing colon, alarm tone 500Hz once per sec., 10 minute snooze alarm, am/pm indicator. Size: 6⅝"L x 3¼"H x 1¾"D.

Part No. JE750 Kit

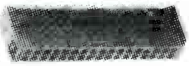
Insulation Displacement Connectors

Dip Plug Connectors



Part No.	Description
609-14	14 Contact Dip Plug Connector
609-16	16 Contact Dip Plug Connector
609-24	24 Contact Dip Plug Connector
609-40	40 Contact Dip Plug Connector

Socket Connectors



Mates 2 rows of .025" sq. dia. posts on patterns of .100" centers.

Part No.	Description
S20	20 Contact Socket Connector
S26	26 Contact Socket Connector
S34	34 Contact Socket Connector
S40	40 Contact Socket Connector
S50	50 Contact Socket Connector

Card-Edge Connectors

Mates with double-sided 1/16" PC board with contact fingers on .100" centers.

Part No.	Description
C20	20 Contact Card-Edge Connector
C26	26 Contact Card-Edge Connector
C34	34 Contact Card-Edge Connector
C40	40 Contact Card-Edge Connector
C50	50 Contact Card-Edge Connector

D-Sub Connectors

FLAT CABLE CONTACTS

Part No.	Description
CDE9P	9 Contact Plug
CDE9S	9 Contact Socket
CDA15P	15 Contact Plug
CDA15S	15 Contact Socket
CDB25P	25 Contact Plug
CDB25S	25 Contact Socket
CDC37P	37 Contact Plug
CDC37S	37 Contact Socket

DATA BOOKS

Part No.	Description
210830	Intel Memory
210844	Intel Microprocessor
30001	National CMOS
30003	National Linear
30005	National TTL Logic
30009	Intersil Data
30013	Zilog Microprocessor

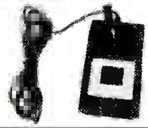
SPEAKER

1-3/16" Square • 5/32" Thick
8 Ohm • .40 Watt

• Stainless steel diaphragm • Ultra Slim
• For alarms, music sounds, telephone equipment, computers, speech aids, etc.

Part No. TS30S

JOYSTICKS



Part No.	Description
JS100K	100K Linear Taper Pots (with knob)
JS150K	150K Linear Taper Pots (with knob)
JVC-40	40K Video Controller in case (w/knob)

Jim-pak electronic components

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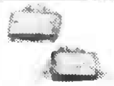
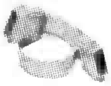
CENTRONICS

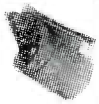


⇦ Solder Type
Insulation Displacement Type ⇨

Part No.	Description
CEN36M	36 Contact Male-Insulation Displace.
CEN36F	36 Contact Female-Insulation Displace.
57-30360	36 Contact Male - Solder
57-60360	36 Contact Female - Solder

INSULATION DISPLACEMENT CABLE ASSEMBLIES





Part No.	Description
S20-36	20-pin 36" Single-End Socket
S26-36	26-pin 36" Single-End Socket
S34-36	34-pin 36" Single-End Socket
S40-36	40-pin 36" Single-End Socket
S50-36	50-pin 36" Single-End Socket
S20-6-S	20-pin 6" Double-Ended Socket
S20-18-S	20-pin 18" Double-Ended Socket
S26-18-S	26-pin 18" Double-Ended Socket
S50-18-S	50-pin 18" Double-Ended Socket
DB25P-10-P	25-pin male 10' Double-Ended Plug
DB25P-10-S	25-pin male 10' 25-pin female
CEN36M-5	36-pin Centronics 5' male
CEN36M-5-F	36-pin Centronics 5' male to female
CEN36M-5-M	36-pin Centronics 5' male to male

CIRCLE 88 ON FREE INFORMATION CARD

CONTROL COMPUTER

continued from page 51

The I/O

The RS-232 port is really part of I/O system, which we'll be discussing in a future installment of this article. However, we must introduce it now because it is required for any operator I/O. It also must be used to confirm proper operation of the basic system.

The RS-232 port can be implemented in two distinctly different manners. The first and easiest is to use a UART (*U*niversal *A*synchronous *R*eceiver *T*ransmitter) IC. The UART constantly waits for an incoming character, receives it according to whatever protocol has been programmed, and stores the character in a holding register until the microprocessor requires it. Transmission is simply a matter of writing the character to the UART's transmit register.

The other alternative—the one that we'll use—is to use one input and one output of the board to send and receive the serial data. That method requires the microprocessor to assume control of the entire process of data reception and transmission. However, it eliminates the requirement for a large and expensive component. The principal limitation of this approach is that the microprocessor must know when to expect a character and it must be executing its input routine before the character is sent to the board. That's not a problem for most applications. In the case of BASIC, it means that all console commands and program INPUT statements are handled easily. However, there can be no INKEY$ statement.

The eighth output and eighth input of the bit-addressable I/O port will be used to implement the RS-232 port. The requirement for a negative voltage supply for the RS-232 link can be avoided with a bit of foxy circuit design. The incoming RS-232 signal is normally at the "mark" or negative level. Every character transmission ends with a stop bit designed to return the line to the negative level. We can generate our level from the incoming RS-232 line. That approach works fine for cables of less than 10 feet long. If longer cables are used, a separate negative supply between −5 and −12 volts DC should be used. Such a supply is available from the power-supply board, which—as we mentioned previously— we'll discuss in a future installment.

When examining serial asynchronous waveforms, remember that a logic one is less than −3 volts DC and a logic zero is greater than +3 volts DC. The line is held in the mark or one state when not active. The transmission always begins with a start bit = 0 and ends with a stop bit = 1. The stop bit returns the line to the mark state.

Full duplex serial operation that means separate wires carry data to and from the control computer (and terminal). Pin 2 of the RS-232 connector is transmitted data *to* the computer. Pin 3 is received data *from* the computer. At the terminal, those two pins are reversed so that pin 2 is an output and pin 3 an input. If you are using a personal computer as a terminal, you must determine if the RS-232 port of your computer is configured as a terminal or as a computer. Whatever the case may be, connect the board's input to the terminal's output and vice versa.

PARTS LIST—COMPUTER BOARD

All resistors ¼-watt, 5% unless otherwise noted

R1,R4,R14–R18—1000 ohms
R2,R5,R6—user-determined. To be discussed next month
R3,R11,R12—10,000 ohms
R7—680 ohms
R8—390 ohms
R9—12,000 ohms
R10—2,000 ohms
RN1—4.7K × 9 resistor network

Capacitors

C1—user-determined. To be discussed next month
C2—150 pF, ceramic disc
C3–C8,C11–C13,C16–C20—0.1 µF, ceramic disc
C9—0.001 µF
C10—27 pF
C14,C15—10µF, 16 volts, electrolytic

Semiconductors

IC1—ADC0804 A/D converter (National)
IC2,IC3—74LS541 octal buffer and line driver
IC4—SN75478 seven high-current darlington drivers (TI, also Sprague ULN-2003, Motorola MC1413)
IC5—4051 8-input analog multiplexer
IC6,IC7—74LS377 octal latch
IC8—74LS251 8-input digital multiplexer
IC9—System ROM. 2716, 2732, or 2764. 450 ns maximum access time.
IC10,IC12—TMM 2016P-2 (Toshiba or similar) 2K × 8 static RAM, 450 ns.
IC13—Programmed EPROM (2716)
IC14—EPROM to be programmed
IC11—74LS259 8-bit addressable latch
IC15—74LS373 octal latch
IC16—74LS139 dual 2-to-4 line decoder/multiplexer
IC17—74LS32 quad OR gate
IC18—8088 microprocessor
IC19—74LS04 hex inverter
IC20—74LS123 dual one-shot
Q1,Q2—2N3904
Q3—2N3906
D1,D2, D4–D8—1N4148
D3—1N4001

Miscellaneous: IC sockets, PC board, mounting hardware, etc.

The following are available from Vesta Technology, Inc., 2849 W. 35th Ave., Denver, CO 80211: KIT 1—Kit of all parts needed to control 7 LS-TTL outputs, monitor 7 inputs, program EPROM's, RS-232 serial port, and 2K RAM (does not include operating system—see below), $99.95; KIT 2—Kit of all parts for full-capacity I/O and 4K RAM (does not include operating system—see below), 169.95; Operating systems contained in ROM: BASIC I operating system, $12.95; BASIC II operating system, $29.95; Forth operating system, $79.95; Assembled, tested, and burned-in control computer with BASIC II operating system, $279; RS-232 cable, $24.95; 2716 EPROM, $6.95. Add $6 for shipping, handling, and insurance.

PARTS LIST—POWER-SUPPLY/ BSR LINK BOARD

All resistors ¼ watt, 5% unless otherwise noted

R1,R19—200 ohms
R2,R7,R8,R20—100 ohms
R3,R4,R11,R12,R15—1000 ohms
R6,R10—4700 ohms
R9—1 ohm (a jumper works fine)
R13—10,000 ohms trimmer potentiometer
R14—15,000 ohms
R16—220 ohms
R17—10,000 ohms
R18—470 ohms

Capacitors

C1,C2—0.1 µF, ceramic disc
C3,C5—0.01 µF, ceramic disc
C4,C6—0.047 µF, ceramic disc
C7—10 µF, 25 volts, tantalum
C8—150 pF, ceramic disc
C9—1 µF, 16 volts, electrolytic
C10—0.14 to 0.47 µF, 200 volts, electrolytic
C11—3300 µF, 16 volts, electrolytic
C12—500 µF, 50 volts, electrolytic

Semiconductors

IC1—ULN2003 darlington array (Sprague)
IC2—TL497 switching regulator
IC3—74LS00 quad NAND gate
IC4—LM340-5 +5-volt regulator
IC5—LM320-5 −5-volt regulator
Q1—2N3904
Q2—2N3906
D1,D3,D5,D6,D10—1N4001
D2,D4,D7–D9—1N4148
T1—11Z2100 1:1:1 pulse transformer (Sprague)
T2—16 volts, center tapped, 0.4 amps. (Signal ST-4-16 or similar)
S1—normally open momentary pushbutton switch

Miscellaneous:line cord, printed-circuit board, IC sockets, heat sink for regulator, mounting hardware, etc.

The following are available from Vesta Technology, Inc., 2849 W. 35th Ave., Denver, CO 80211: Power-supply/BSR-link kit, including all components, $59.95; Assembled, tested, and burned in power supply, $109. Add $6 for shipping, handling and insurance.

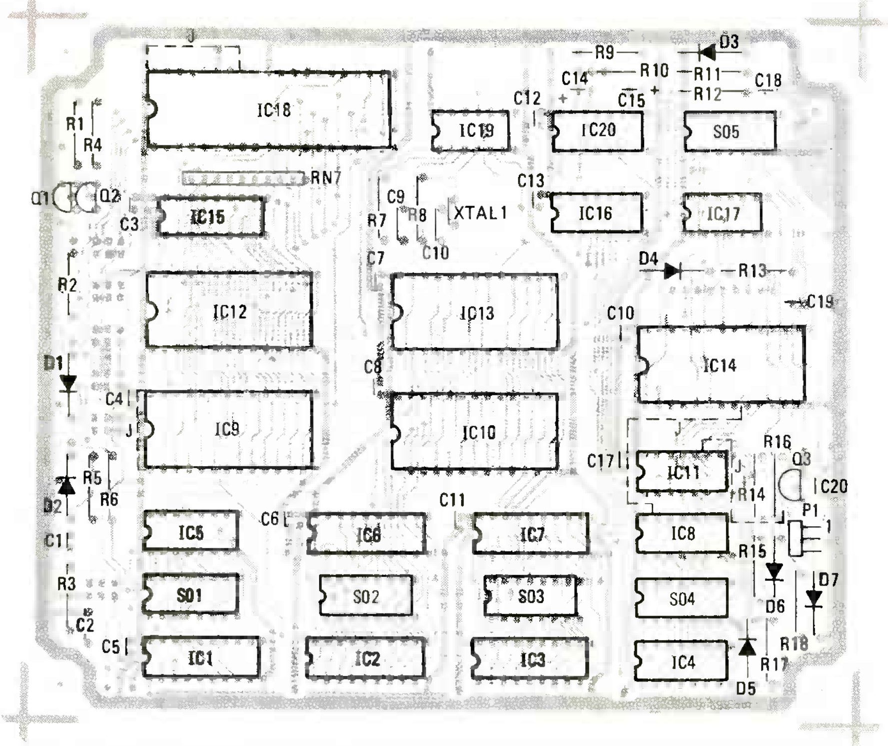


FIG. 4—PARTS-PLACEMENT DIAGRAM for the computer board. The dashed lines represent foil-side jumpers. There are many "unused" pads; they are for future expansion and experimentation. For example, note that a 28-pin socket is provided for the 24-pin 2716 (IC14). That allows larger EPROM's to be programmed. Simply plug the 2716 (or other 24-pin device) into the socket leaving pins 1 and 2 of the socket unoccupied.

Building the control computer

The actual assembly of the assembly of the controller requires no special techniques. You can use a printed-circuit board (we showed the foil patterns for the double-sided board in Figs. 2 and 3) or you can wire-wrap the project. You are probably better off with the PC board. Troubleshooting will be easier, and assembly will be quicker—about an hour, assuming you already have the board. (If you are not able to make your own board, see the Parts List for a supplier). Wire-wrapping the project will take about 16 hours. One note on wire-wrapping: Do not give into the temptation of wire-wrapping directly to the leads of the discrete components. The integrity of a wire-wrap joint depends on the square corners of the posts.

If you have the printed-circuit board, simply follow the parts-placement diagram in Fig. 4. Be careful not to create solder bridges, and when you are finished, wash the board in flux solvent. That will remove any flux residues left on the board. Don't forget that we've showed the foil and parts-placement diagrams for only the computer board. The power supply and BSR-type controller will be located on a separate board of the same size. We'll discuss that single-sided board next time, and we'll give you some more hints on the control computer's construction.

Troubleshooting

After you install all the parts, carefully inspect your board. You should check that all IC's are in the correct sockets and that they are correctly oriented. Transistors and diodes should also be checked. Then measure the power-supply voltages. Although we have not yet discussed the board for the power supply and BSR-type controller, you can test the computer board if you have a +5-volt DC regulated supply.

Regardless of what supply you use, ensure that it is the correct voltage, and be sure to orient it correctly. Reversing the power-supply polarity is like reversing an IC, only it's more efficient—it will burn out *all* of the IC's. The BASIC operating system should be inserted into the system ROM socket (IC9). The first memory socket (IC12) should contain a 2016 RAM IC. Do not insert additional memory yet. Also, unneeded I/O should be removed. Get your terminal to the proper protocol (4800 baud, no parity, 8 data bits, full duplex, caps lock on) and connect it to the board. Apply +5 volts DC. If the BASIC prompt (>) appears, we can assume that the basic microprocessor circuits are correct. (If you use the BASIC II operating system, then you do not have to set your terminal to 4800 baud. Simply hit the space bar within 7 seconds after the board is turned on or reset.)

If the BASIC prompt does not appear, then we have some troubleshooting to do. Unfortunately, though, we've run out of room to talk about it this month. But it's the first thing we'll deal with next time.

Along with the troubleshooting hints, we'll look at the power supply, remote controller, and also the I/O capabilities of the computer R-E

HOBBY CORNER

Testing transistors

EARL (DOC) SAVAGE, K4SDS, HOBBY EDITOR

IN THE FEBRUARY 1984 "HOBBY CORNER," we discussed how to make realistic battery tests. Well, this month we'll turn to another testing problem. Glen Gartner (PA) asked a question about how to test bipolar transistors. He needs a procedure that uses minimal equipment—such as only a multimeter. Since that topic is sure to interest many of you, we'll spend some time on it. We'll start with a look at some transistor basics.

Essentially, a transistor is a couple of diodes that share a common element. That sharing causes one diode to be affected by what happens in the other. Of course, that is an over-simplification—you could not make a transistor using two discrete diodes—but that model does generate a mental picture that is helpful to us.

Current flow in a transistor

You know that a diode is a two-terminal device that passes current in one direction, but has a very high resistance to current flowing in the opposite direction. Conventional current flows freely from the diode's anode to cathode. Figure 1 shows the schematic symbol for a diode—current flows in the direction of the arrow.

Now let's get back to the transistor. You know that there are two bipolar types: PNP and NPN. The symbol for the PNP transistor is shown in Fig. 2-a. Figure 2-b shows how you can *think* of the PNP transistor. In effect, there are two diodes with a common cathode (the base). From our discussion of diodes, it is clear that the PNP transistor has low resistance to current flow from emitter to base and also from the collector to base.

Figure 3-a shows the symbol for an NPN transistor. Figure 3-b shows how you can *think* of it—two diodes with a common anode (the base). Thus, the NPN transistor should have a low resistance from the emitter to base and also form the collector to base.

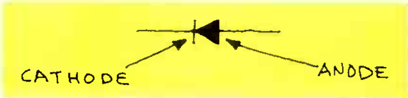


FIG. 1

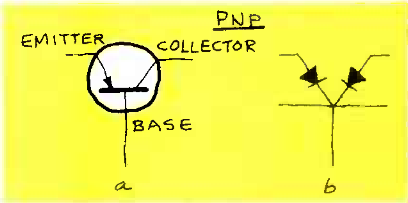


FIG. 2

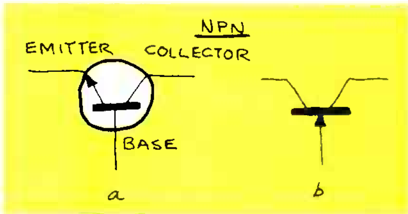


FIG. 3

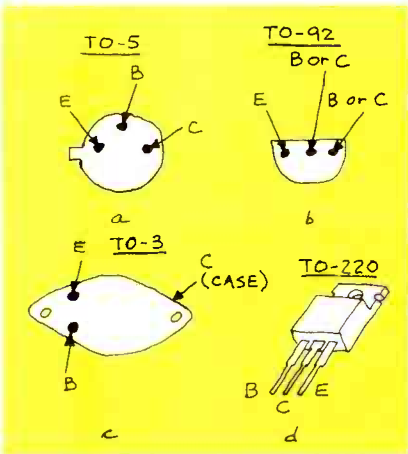


FIG. 4

AN INVITATION

To better meet your needs, "Hobby Corner" has undergone a change in direction. It has been changed to a question-and-answer form. You are invited to send us questions about general electronics and its applications. We'll do what we can to come up with an answer or, at least, suggest where you might find one.

If you need a basic circuit for some purpose, or want to know how or why one works, let us know. We'll print those of greatest interest here in ""Hobby Corner." Please keep in mind that we cannot become a circuit-design service for esoteric applications; circuits must be as general and as simple as possible. Please address your correspondence to:

Hobby Corner
Radio-Electronics
200 Park Ave. South
New York, NY 10003

Now that we know how to think of the transistors, we can go about testing them. But first we have to be able to identify the leads. Figure 4 shows some common transistor-package types along with their pinouts.

The next task is to determine the polarity of your multimeter probes when it is in the resistance-reading mode. *Do not assume that the black one is negative!* You can test the polarity by tracing the internal wiring of the meter or by using a second meter. Of course, you can use a marked diode and measure its resistance in both directions—the resistance will be greater when the negative probe is on the anode. Once you determine the probe polarities, mark your meter permanently so that you won't have to check it again.

Now you're finally ready to find out whether the transistor is a PNP or NPN type. Before I tell you, think about the information we've gone over so far. You have everything you need to make the test. Can you figure it out?

Connect one meter probe (in the high-resistance range) to the base of the transistor. Measure the resistance to the emitter and, again, to the collector. Then connect the other probe to the base and repeat the measurements. Both of the first two readings will be higher than both of the second set of readings. If not, you either have a defective transistor or you have identified the three leads incorrectly.

Assuming that both readings in one set are greater than both in the other set, apply this rule: If the readings are higher when the negative probe is on the base, the transistor is an NPN type. Otherwise, it is a PNP transistor. Once you get the hang of making this measurement, you can test transistors quickly—at least in less time than it takes to explain it!

Is it good?

Now you have the leads identified and you know the transistor type. However, you still do not know if the transistor works! There are several ways to test a transistor. First you can substitute a transistor known to be good for a suspect one in a circuit. If the circuit then functions, the original transistor is bad. On the other hand, if it doesn't function, you cannot be sure of the transistor—either it or another component could be bad.

You can also test many transistors with a multimeter. In this procedure, start with the highest resistance scale each time and move down as necessary. Here are the steps:

1. Connect the probes to the base and collector.
2. Note the resistance.
3. Reverse the probes and note the resistance.
4. Connect the probes in the direction of the highest resistance.
5. Short the emitter to the base. If the transistor is good, the reading will decrease.
6. Change the base probe to the emitter.
7. Short the emitter to the base. If the transistor is good, the reading will increase.

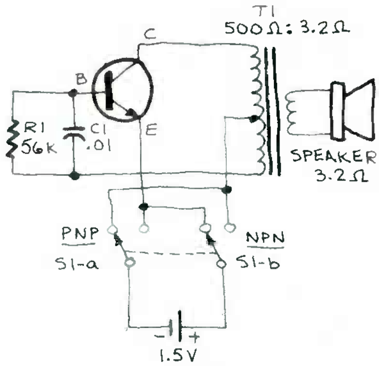


FIG. 5

A simpler and more reliable way to test a transistor is to put it in a test circuit. The simple audio oscillator shown in Fig. 5 will beep softly with every good bipolar transistor that you plug into it. The resistor and capacitor values are not critical—almost anything in the ballpark will work. In addition, the voltage is so low that the transistor won't be damaged if you plug the leads in wrong or if the switch is in the wrong position. For convenience, you can build this little tester in a small utility box, so that it will be on hand whenever you need it.

There is, of course, a fourth way to test transistors. I have admitted my laziness to you in the past, so it will come as no surprise that I use a handy-dandy commercial transistor checker. You, too, might take a look at Radio Shack's *22-025*. It's small, versatile, and costs less than $15. It will check transistors both in-circuit and out-of-circuit, and will even give a relative beta measurement. You can also use it as a continuity checker or as an audio oscillator. Like the checker circuit we built, the tester is safe—you can plug transistors in backward and not damage them.

All right, Glen, you and other readers can surely find one suitable way to do your

continued on page 113

STATE OF SOLID STATE

Making true RMS measurements

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

THE ACCURACY OF MEASURED RMS VALues of AC voltages has always been questionable. That's because the shape of the AC wave being measured can drastically affect the readings of many voltmeters. In most multimeters and AC panel-meters, the AC wave is rectified to develop a DC voltage that is proportional to the RMS value. For example: two popular analog multimeters specify their AC voltage accuracy as 5% of full-scale value when measuring a 60-Hz sinewave. Accuracy "goes out the window" if the input signal's shape is nonsymmetrical or if the signal approaches a triangle or pulsed waveform.

Semiconductor manufacturers have developed monolithic RMS-to-DC converters that permit AC voltages to be measured with maximum errors that are a small fraction of one percent. A recent addition to this category of devices is the AD637 from Analog Devices (One Technology Way, PO Box 280, Norwood, MA 02062).

That IC is a monolithic, high-accuracy RMS-to-DC converter that can be used to compute the true RMS value of any complex AC waveform. In addition, the device computes the square, mean-square, and absolute values of complex AC (or AC superimposed on DC) input waveforms. Its circuit features a wide bandwidth: 8 MHz when the input is 2 volts RMS or above, and 600 kHz with a 100-millivolt RMS input. The circuit includes built-in compensation for *crest factor* and handles signals with crest factors of up to 10 with less than a 1% increase in error. Crest factor, CF, is the ratio of a signal's peak amplitude to its RMS value: CF = $(V_{PEAK})/(V_{RMS})$. Sine and triangle waves have low crest factors that do not exceed 2. Pulse trains with low duty-cycles have much higher crest factors. For example, a rectangular pulse series with a 1% duty cycle has a crest factor of 10.

A voltage equal to the logarithm of the RMS output signal is brought out to a separate pin on the AD637 so that the user can make direct measurements in decibels. The dB-measurement range is 60 dB; the 0-dB voltage-reference level can be set to between 0.1 volt and 2.0 volts RMS by providing an external reference current.

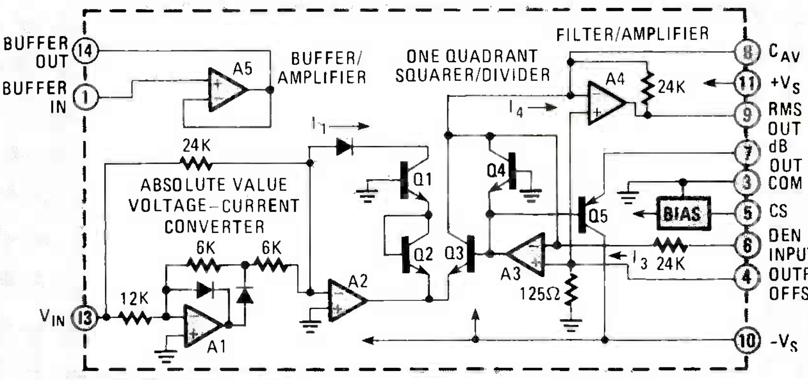


FIG. 1

How the circuit functions

The only external component required for RMS-to-DC conversion is a capacitor that controls the averaging-time period and determines the low-frequency accuracy, ripple level, and settling time.

Figure 1 is a functional diagram of the IC. We can think of it as being made up of 4 main sections. The first is an absolute-value circuit (active rectifier) made up of A1, A2, and their associated components. The second is a squarer/divider made up of A3 and Q1–Q5. Third is a filter/amplifier, A4, and fourth is buffer/amplifier A5. (The buffer amplifier can be used either as an input buffer or in an active-filter configuration; it is a user option.)

The input voltage, V_{in}, is rectified by active rectifier A1-A2 to produce a unipolar current, I_1. That current drives one input to the squarer/divider which has the transfer function: $I_4 = I_1^2/I_3$

The output current of the squarer/divider, I_4, drives A4 which, along with the external averaging capacitor connected to pin 9, forms a lowpass filter. If we make the R-C time constant of the filter much longer than the longest period of the input signal, A4's output will be proportional to the average value of I_4. The output is taken back to A3 to provide current I_3, the denominator of the transfer-function equation above. See the standard RMS conversion circuit in Fig. 2. Current I_3 equals the average value of I_4 and is returned to the squarer/divider to complete the operation: $I_4 = \text{Avg}\,[I_1/I_4] = I_{1RMS}$ and $V_{out} = V_{in\ RMS}$

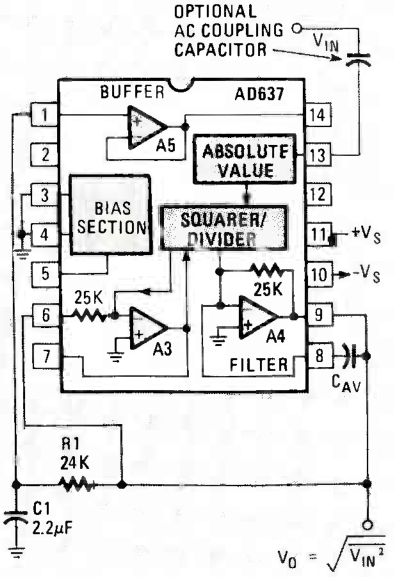


FIG. 2

The averaging time constant

The AD637 can handle both DC and AC input voltages. Its DC output will track exactly the absolute value of a DC input and will approach the true RMS value of an AC input. The deviation from the true RMS value is the averaging error caused by AC ripples riding on the DC output signal. That is a factor of the input signal's frequency and the averaging time constant, τ, (25 ms/μF × C_{AV}) and is defined as the peak value of the AC ripple component plus the DC error. That is illustrated in Fig. 3.

The peak value of the AC ripple as a percentage of the output signal is

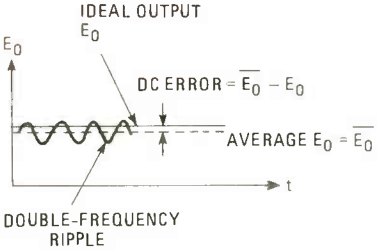


FIG. 3

50/6.3τf, where τ is greater than 1/f and f is the signal frequency. The DC error is also frequency dependent; it varies as the percentage of the reading by $1/(0.16 + 6.4\tau^2 f^2)$. The magnitude of ripple decreases the accuracy of the measurements being made. The amount of error can be reduced by increasing the value of the averaging capacitor, C_{AV}. However, that has two disadvantages: 1) The capacitance of C_{AV} can become extremely high. 2) The settling time of the AD637 increases in direct proportion to the value of the averaging capacitor. Settling time T_S equals 115 ms/μF × C_{AV}.

A preferred method of reducing ripple is to add a one- or two-pole filter network connected between output terminal pin 9 and the buffer amplifier input, pin 14. A single-pole filter, such as the R1–C1 network in Fig. 2, provides the best compromise between ripple and settling time.

When C1 is made 3.3 times C_{AV}, the magnitudes of the AC and DC errors are equal at 50 Hz. If we set C_{AV} to 1 μF and C1 to 3.3 μF, we reduce the ripple for a 60-Hz input signal from 5.3% (when C_{AV} is used alone) to 0.15% and settling time increases by not more than three times.

The AD637 is available with two accuracy ranges (types J and K) for a 0 to +70° C temperature range. A type S is available with a operating-temperature range of −55°C to +125°C. All devices are packaged in ceramic 14-pin DIP's. For additional information, write to Analog Devices, PO Box 280, Norwood, MA 02062. Ask for a copy of the booklet *High Precision Wide-Band RMS-DC Converter, the AD637*.

New Darlington power transistors

RCA recently introduced a family of six 2-amp Darlington power transistors. The six complementry devices, three NPN and three PNP, are housed in TO-220AB packages. The TIP110, TIP111, and TIP112 are NPN devices and are rated for a collector-to-emitter breakdown voltage (V_{CEOsus}) of 60, 80, and 100 volts, respectively. The TIP115, TIP116, and TIP117 PNP devices have the same V_{CEO} ratings, respectively. **R-E**

SERVICE CLINIC

Microprocessors and VCR's

JACK DARR, SERVICE EDITOR

MICROPROCESSORS HAVE BEEN INCORPORATED into almost every type of electronic device in use today. For instance, in many stereo and TV sets, they are often used along with sensors to control the AFC (*A*utomatic *F*requency *C*ontrol) so that if the tuned frequency begins to drift, the microprocessor can automatically compensate for that change. But that's not the only thing that they can be used for. VCR's use them to stop or start operations according to the condition of the system. For example, RCA's *VJP900* VCR uses a rather complex system of sensors and microprocessors to monitor the operation of the system. Other microprocessors control such things as the tuning process, the time-delayed recording, and the remote control functions. This month we'll see how some of those microprocessors are used to control the tuning and sensing operations of that VCR. We'll start with the sensing circuitry.

Sensing circuit

Take a look at Fig. 1; it shows a diagram of the trouble-sensing circuitry found on the system-control board. That board contains two IC's and various sensing devices that are used to detect such things as moisture, end of the tape, and the rotation of the take-up reel. The two IC's, IC802 (system-control microprocessor-*B*—one of five microprocessors in the unit) and IC806 (a quad comparator) are used to monitor the output of the sensors and act according to the signals they receive.

The dew sensor is a moisture-sensitive resistive-semiconductor device that is used to tell the microprocessor when the moisture level in the system offers a threat to the operation of the unit. With all the delicate electronics in a VCR—to say nothing of its intricate machinery—excess moisture could damage the machine. The dew sensor, a small flat device about an inch square, is mounted near the middle of the "works" in most VCR's. In Fig. 1, that device is connected to the non-inverting input (pin 9) of one of the op-amps contained in IC806. During normal operation (when there is little or no moisture detected), the resistance of the dew sensor is high—around 80,000 ohms. That causes a logic high to be developed at pin 9 of IC806. (Any voltage below 1.2 volts is a logic low, anything else is a logic high.) When that happens, a high is passed on to the system-control microprocessor (IC802) at pin 6. That input signal tells IC802 that the moisture level is safe. On the other hand, when the dew sensor detects an excessive amount of moisture, its resistance decreases, which causes a logic low to be applied to the comparator. That, in turn, causes the comparator to output a logic low to IC802, and the microprocessor places the VCR in the stop mode.

In the rewind mode, an infrared-sensitive phototransistor is used to detect the end of the tape. When the end of the tape is reached, an infrared light is passed through the clear segment of tape at the end of the reel. That infrared light causes Q903 to generate a logic-high signal that is input at pin 5 to another of the comparators contained in IC806. That comparator, in turn, outputs a high signal that is fed to the system-control microprocessor at pin 28. On receiving the signal, the microprocessor places the unit in the stop mode. Note that as long as there is tape on the reel, no infrared signal is detected by the sensor, and the microprocessor will allow the operation to continue. The fast-forward sensor operates in the same manner, with it's output applied to pin 7 of IC806.

One of the novel things about this VCR is the takeup-reel-rotation detector. Detection of take-up-reel rotation is accomplished by the combination of an LED and light-sensitive transistor in one package (Q905). The sensor (located at the bottom of the take-up turntable) is used along with a segmented disk that has eight reflective and non-reflective areas. The disk is located at the bottom of the take-up reel. When the segmented disk is rotating, the reflected light is detected by Q905 and causes a squarewave to be generated. That signal is capacitively coupled to the final op-amp in IC806. The op-amp's output is then fed to the microprocessor at pin 3. If that signal were to disappear during tape operation, the microprocessor would put the VCR in the stop mode.

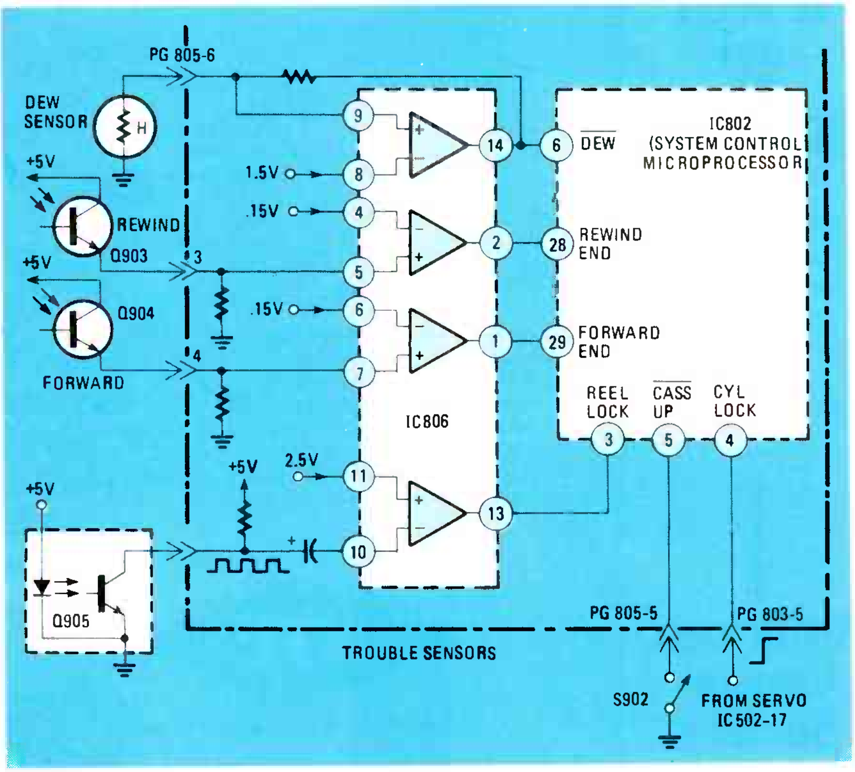


FIG. 1

The cassette-up switch, connected to pin 5 of IC802, is used to tell the microprocessor when the cassette basket is loaded and in the down position. With the basket in that position, switch S902 is closed and a high signal is input to IC802. That signal causes the system-control microprocessor to enable the VCR. On the other hand, if the cassette is placed in the basket but the basket isn't pushed down, the cassette-up switch opens and the VCR stops.

The last sensor operation that we'll look at is the cylinder-lock detector. The cylinder-lock signal is supplied by cylinder-servo circuit IC502 (not shown) and is input to the microprocessor at pin 4. During normal operation the cylinder servo generates a logic low signal. If the cylinder's motor speed were to decrease, a logic high would be generated by the servo IC. That signal is then passed to the microprocessor, which will shut down the VCR upon receiving that signal.

Service tips

If the VCR does not go into the play mode, check the outputs of all the trouble sensors. The dew sensor should have less than 1.5 volts at it's input. If the correct voltage is present, check the output of the end-of-reel sensors (rewind and forward) at PG805 pins 3 and 4. Both outputs should be less than 0.15 volt. Also, confirm that there is a logic high input at pin 5 of the system-control microprocessor. If any of those voltage levels are incorrect, service the appropriate sensing section. In addition, if the VCR makes no attempt to load the tape from the cassette, the problem can most likely be found in the reel-rotation or the cylinder-lock detectors. Those two detectors will turn on the system only after the tape-loading sequence has been completed.

If, after loading the cassette in the basket, the VCR immediately ejects (unloads) the tape, check to make sure that there is a 1-volt peak-to-peak squarewave during the time of load completion. If that's missing you may have a bad rotation-detector (Q905) or capstan servo problems. If it's normal, check the cylinder-lock signal: it should be a logic high before the loading sequence is completed. At the end of that sequence it should go to a logic low. If not, you could have a problem in either the cylinder-servo circuitry or the drive IC.

Tuning section

As we said earlier, there are many microprocessors in the *VJP900*. Almost as many as Presidential candidates! And they're like politicians in more ways than one. When the VCR is turned on they all "shake hands" with one another. (We're not kidding: there are lines labelled *handshake* lines, which are separated into two parts: one is RDY (ready) and the other is ACKnowledge). Those lines are shared by the timer and remote-control microprocessors. When one of the microprocessors is ready to send data, it pulls the RDY line on the receiving microprocessor low. The receiving microprocessor, in turn, outputs a high on the ACK line, meaning "ready when you are." The sending microprocessor then transmits a 16-bit word. Each bit of the data confirms the ready status of the receiving microprocessor. Note that you cannot see these signals on a conventional oscilloscope. However, you can usually monitor the receiver by reading the logic level at the input.

The remote-control microprocessor monitors the status of the whole unit by checking the microprocessor on the sensor board. If anything is wrong with any one of the five microprocessors, the VCR will be shut down. Also, if the tab on the cassette is missing you cannot record; the VCR shuts down and will not start.

The *VJP900* also has a PLL (*P*hase-*L*ocked *L*oop) electronic tuner that is controlled by the PLL microprocessor. That microprocessor also keeps track of the remote-control micro-

continued on page 107

MICROPROCESSOR TECHNOLOGY

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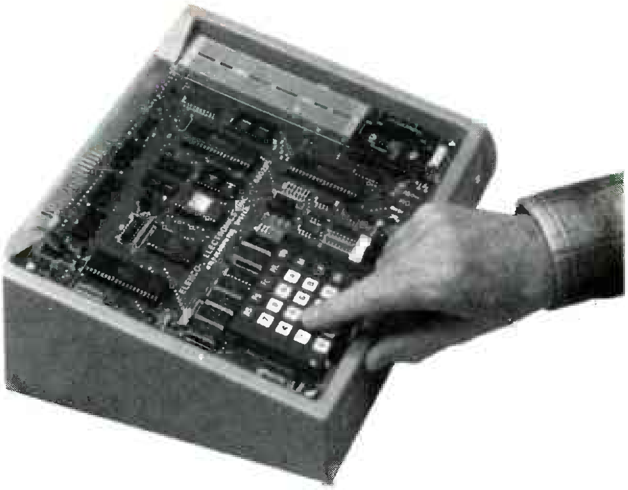

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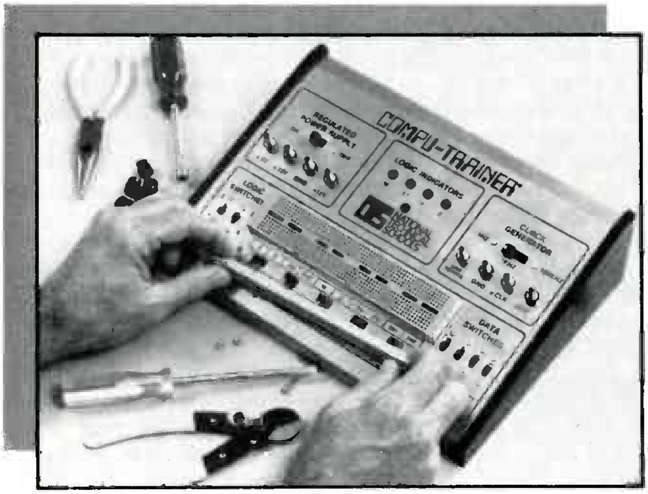

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COMMUNICATIONS CORNER

RF power measurements

HERB FREIDMAN, COMMUNICATIONS EDITOR

AS ANY ELECTRONICS ENGINEER OR TECHnician, radio amateur, or CB'er can tell you, RF power measurements can be a real headache. As an example, consider the problem we ran into recently.

We were involved in a project that called for the upgrading of an existing two-transmitter set up where one transmitter was the backup for the other. All that was really being done was replacing one of the older transmitters with a new one. The completed installation was to resemble the one shown in Fig. 1; a rather simple circuit that switched either transmitter to the transmission line. (For simplicity, the dummy load, safety interlocks, etc. are not shown.)

Note the location of the output-power meter. It's really part of a combination power/VSWR metering panel: in effect, two meters in one. One of the meters was for VSWR calibration and measurement; the other was calibrated directly in watts for RF output power.

The problem

Now, lets look at the problem. With both transmitters working into a dummy load, a 6-kW output was measured. But when switched to the transmission line the original transmitter produced a meter indication of almost 6 kW, while the new one produced a meter reading of only 4.2 kW. What was the cause of the apparent loss of nearly 2 kW when operating into the transmission line? In reality, there was no loss of any kind. The problem was simply an incorrect reading caused by *standing waves*.

If you think about it for a moment, you'll realize that an RF-power meter is simply a forward-power VSWR indicator, with its own calibration adjustment and an RF-watts scale. Consider how such a device works. A sample of RF energy is picked off the center conductor of the transmission line by a probe that is inserted under the coaxial shield. It is then rectified and the resulting DC is passed through a calibration potentiometer to the meter indicator. If the meter's indication is to serve as the calibration for a VSWR meter, then the meter scale simply has a calibration mark and the calibration potentiometer is adjusted so the forward power causes the meter pointer to fall on that mark. If the same meter has a scale calibrated in RF watts, the potentiometer is adjusted until the meter indicates either the calculated output, or the value indicated by a precision wattmeter when the transmitter is working into a dummy load. (Obviously, that is not intended to be a precision measurement, but a relatively accurate guide for a technician.)

Now we are ready to tackle the question of what caused the apparent loss of power when the second transmitter was switched in. In reality, there was no loss; it was simply an incorrect meter reading caused by the standing waves on the transmission line. The RF power that was sensed by the meter was affected by standing waves at the location of the probe.

Let's look at what we mean by that. If the line is flat with almost a 1:1 VSWR, the current and voltage at any probe location along the line will be equal to any other location (excluding normal copper losses). So that, regardless of where the probe is located, it will always sense the same amount of RF and the meter calibration would be valid anywhere along the line. But if there is any amount of mismatch, standing waves will be produced along the line and the RF sensed by the VSWR probe will depend on the magnitude of the standing wave at the location of the probe. That's why there is a potentiometer for forward power calibration.

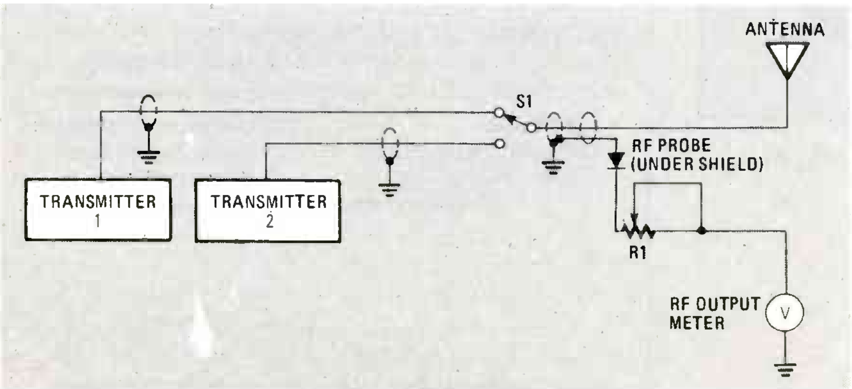

FIG. 1

But why wasn't the location or magnitude of the standing wave the same when the transmitters were switched? Actually, in the old transmitter installation they were constant regardless of which transmitter was used. That's because the designers of the original installation used exactly one wavelength of transmission line between the transmitters and the coaxial selector-switch. Regardless of which transmitter was switched in, the transmission line length remained the same. By now you should have figured out the problem. If not, think about what happens if there is any change in the length of the transmission line? Correct—the relative magnitude, and possibly the position, of the standing waves can change. The probe, which formerly might have been located at a node, might now be on the peak of the standing wave, so that the RF sensed by the probe will not be the same and it will be necessary to re-adjust the calibration potentiometer for the correct power reading.

Because of the new location of one transmitter, a low ceiling, and other such irreversible considerations, it was impossible to maintain equal lengths of transmission line (or multiples) between the transmitters and the selector switch, so the physical length of the line depended on the particular transmitter in use. That, in turn, affected the amount of RF sensed by the VSWR probe. Hence, the RF output power indication was incorrect when the transmitters were switched unless the meter was recalibrated.

Now it might be logical to assume that there's real big trouble with the antenna system if a change in transmission line length can produce a variation of almost 33% in output power measurement. Actually, the system was very good—the measured VSWR being a shade over 1.1:1.

Keep all of this in mind for the next

time you're working on a transmitter/antenna installation and you get VSWR-derived output power values that you know are too good to be true, such as a 6-watt output from a CB rig with a 4-watt input. (Some people really believe, you can get more out than you put in.) Or, on the other side of the coin, if there's excessivly low output power. Say for example, you're working on an HF or VHF transmitter rated for 100-watts RF output. Working into a dummy load you get that 100-watt output, but when working into a transmission line you get considerably less. Suspect the location of the RF probe before you start fixing the transmitter. If possible, connect a ¼-wavelength section of transmission line between the transmitter and the output end of the transmission line. If the meter reading changes drastically you know the problem is caused by the location of the standing waves and requires changing the calibration of the meter or the location of the probe rather than a repair to the transmitter. R-E

SERVICE CLINIC

continued from page 101

processor as well as the system-control microprocessor to make sure all systems are go. If no fault is detected in any of the sub-systems, you can go ahead with the recording; if not, nothing happens. A microprocessor is like a politician in many ways: however, you can trust them for one thing. They won't shake your hand and then go back to Washington and raise your taxes! R-E

SERVICE QUESTIONS

LET'S TRY AGAIN

When I disconnect the yoke on this Sony KV 9000 color TV, the sound comes on and the vertical sweep returns. Several things were suggested by you in the last letter but none helped. Could you try polishing up the crystal ball again for me because I am up against a wall on this one.—J.A.H., Colorado Springs, CO

Let's give it another go. You know, this may be a silly question to ask, but did you completely overrule the possibility of an intermittent short in the yoke winding? Shorted turns in the horizontal windings would load down the 17- and 20-volt supplies, which are scan derived. Those voltage sources are used to power the audio and also vertical circuitry. A simple resistance check of the coils will not suffice in the case of an intermittent short. Some sort of a "ringing" test should be done; that will tell you much more about the yoke's true quality. Good luck and keep us posted.

HELPFUL HINT

I never miss "Service Clinic" and have found your articles very helpful in my work. I also appreciate your printing of tips from readers. Here's one I discovered.

Last fall, the video-detector diode in our old RCA CTC-17 went out. Not being able to find another, I ended up installing a new Schottky-barrier UHF diode which was available at a local Radio Shack store (catalog No.5082-2835).

With the new diode in place, the picture came on with extremely high contrast and, although the PIV rating of the device is only 5 volts, a VTVM measured 18 volts across the detector output. Also, When the AGC was adjusted to obtain the normal contrast range, the picture showed improved sharpness and saturation.

I have tried that on other sets and their owners have remarked how much better their picture looked. Also, I have yet to have any callbacks in regards to making that substitution.

PICTURE SLIPS

On a Zenith 12CB12ZX the problem is that the picture slips sideways. The horizontal tubes check good on a tube tester. I tried replacing Q404 (sync separator) and Q407 (the horizontal-phase detector) without success. The voltage measurements around Q407 are: 10.6 volts at the collector, −9.42 volts at the base, and 1.04 volts at the emitter—R.S., Oklahoma City, OK

The first thing I would do is change the 6LN8. That failing, I would want to know why the voltages around Q407 are so far out of the ballpark. My schematic calls for 0.82 volts on the collector. The base is likewise far off. Resistance readings from the collector and base to ground, should be 47K and 10K respectively.

TUNER DRIFTS

The tuner in my 13JC10 Zenith seems to drift and then go into a snowy picture. By switching the channel selector back and forth, you can lock the picture back in. The trouble is intermittent. I replaced the tuner twice, but the problem still exists.—B.G., Shawnee, KS

If one is available, a tuner subber could help a great deal on this one. If the picture is still unreliable, you should then look for an intermittent condition in the IF strip. If the problem disappears when you use the substitute tuner, you can focus on the tuner feeds. Monitor the B+, AGC, and AFC terminals on the set's tuner and look for changes. If you're still unsure, you can substitute these different feeds with appropriate external voltages.

FAULTY TUNER

I have a Sylvania E46 to repair. I think the tuner is bad. I can get channel 7 (some of the time) but no others. The channel-indicator readout works only sometimes, but even then, the numbers are wrong. I think the memory module will have to be replaced, but I know it's expensive. Can I tune the set to Channel 3 and use the cable box? How about using a solid state tuner from a discarded TV set?—S.M., W. Palm Beach, FL

A new memory module would no doubt solve all your problems, but you do have alternatives. If you inject a small variable voltage into the tuning voltage input to the tuner you should be able to scan through and stop at Channel 3. You can then measure the voltage and duplicate it with a fixed voltage. Your readout will be inaccurate, but as you state in the rest of your letter, that doesn't matter. As for using an external tuner, sure. I made my own tuner subber with one I pulled out of a scrap set. The only factor that has to be watched carefully is the B+. AGC requirements are fairly standard. **R-E**

VIDEO GENERATOR

continued from page 139

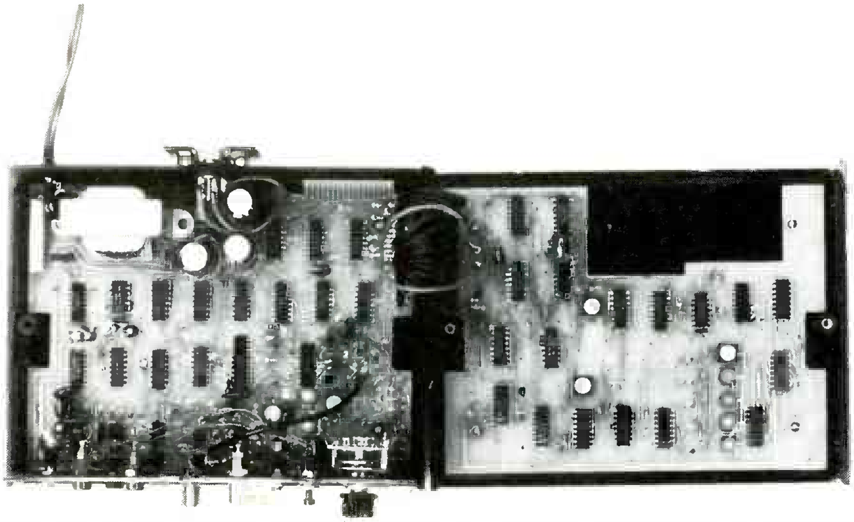

FIG. 11—SUGGESTED MOUNTING METHOD of the two boards is shown here in a photograph of the author's prototype.

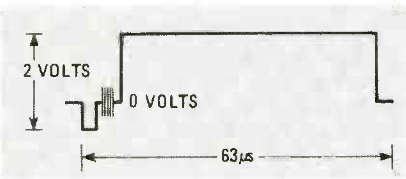

FIG. 12—ONE HORIZONTAL LINE of video should be seen at TP1 when the test generator is in the EXT mode.

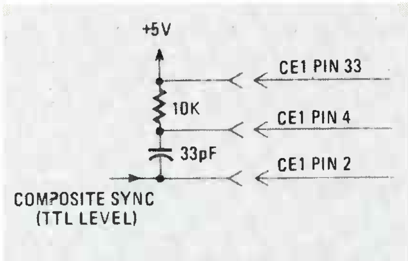

FIG. 13—THIS CIRCUIT can be used to allow gen-locking from a source of composite sync (LS-TTL level).

The inputs are connected via the same 34 pin edge connector and consist of the audio input, three sync inputs for gen-locking, and nine RGB digital video inputs. The audio input is used only for the RF-modulated output and can replace the generator's internal 1500-Hz oscillator.

There are various ways you might gen-lock the unit using the three sync inputs. The vertical and horizontal reset can be driven separately (you must use pulses of less than 800 ns duration). If you do that with the vertical-reset control high (or not connected) then the vertical timing is reset to the beginning of each field. If the vertical-reset control is "low" then the vertical timing is reset to the fifth vertical separation pulse. That allows it to act like a conventional integrated sync-separator circuit.

Another possibility is to use a circuit such as shown in Fig. 13. That allows gen-locking from a source of composite sync (at LS-TTL levels). It should be noted that those schemes will lock the scanning timing but not the chrominance oscillator: color can still be produced, however.

One of the more intriguing capabilities of the test generator is its ability to accept digital RGB data, format the data with the proper sync signals, and then output the

TABLE 3

Color out	Red inputs			Green inputs			Blue inputs		
Card-edge pin	21	13	11	5	7	1	3	9	19
WHITE	1	1	1	1	1	1	1	1	1
LIGHT GRAY	1	0	1	1	0	1	1	0	1
DARK GREY	0	1	1	0	1	1	0	1	1
BLACK	0	0	0	0	0	0	0	0	0
BRIGHT RED	1	1	1	0	0	0	0	0	0
PALE RED	0	1	0	0	0	0	0	0	0
BRIGHT GREEN	0	0	0	1	1	1	0	0	0
BRIGHT BLUE	0	0	0	0	0	0	1	1	1
BRIGHT YELLOW	1	1	1	1	1	1	0	0	0
ORANGE	1	1	1	1	0	0	0	0	0
FLESH	1	1	1	1	1	0	1	0	1

data. The possibilities range from the creation of other simple test patterns, to interfacing with a microcomputer for the production of dynamic video color imagery for computer games, interactive learning, etc.

Table 3 lists the digital inputs that can be used to produce blank rasters for several colors. Note that each primary color (red, green, and blue) has three inputs, and thus, $2^3 = 8$ input levels. Other colors (a total of 512) are possible.

As a simple example, suppose you wish to have the signal generator provide a solid red raster (perhaps for adjusting receiver purity). Simply connect the three red inputs (RLSB, R, RMSB) high, and the six green and blue inputs low. Now when the generator is in the EXT mode, it supplies a composite-video signal with a constant red image.

For complicated applications involving computer control you must choose between two general approaches. In the first method, the signal generator acts as the master timing source and the computer software synchronizes to the vertical- and horizontal- drive signals. In the second approach, the computer is the master clock and provides sync and reset signals to the signal generator in addition to the RGB data. **R-E**

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COMPUTING SYSTEM FUNDAMENTALS, by Kenneth J. Danhof & Carol L. Smith; Addison-Wesley Publishing Company, Inc., South Street, Reading, MA 01867; 6½ × 9½ inches; 323 pages, including appendices, bibliography, and index; hardcover; $26.95.

Intended as a textbook for an introductory course on computer organization and systems at the sophomore or junior level, this book assumes that the reader has had a first course in programming with a high-level language such as FORTRAN or PL/1.

The course presented here is structured in terms of programming "levels" and four "modules" support the development. The first Module (chapters 1-5) introduces the specific microcomputers that will be studied: the Motorola *6800* and the Intel *8085*. Here the student is taken from the machine-language level to the assembly-language level.

Module II (chapters 6 and 7) is an introduction to system I/O programming. Module III (chapters 8, 9, and 10) introduces students to the high-level programming language: PL/M, and Module IV (chapters 11 and 12) contains a discussion of interrupt I/O and some of the many applications areas of microprocessors.

The course presupposes a rather modest laboratory, which includes the microcomputers themselves (at least one which has an extended memory) and a terminal.

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TELEMETRY COMPUTER SYSTEMS, An Introduction, by O.J. Strock; Prentice-Hall, Inc., Englewood Cliffs, NJ 07632; 366 pages, including appendicies, glossary, and index; 7¼ × 10¼ inches; hardcover; $49.95.

This book was prepared as a textbook for two-day classes that the author has presented at more than a dozen locations in North America and Asia. It is the first of its kind to explain telemetry technology from a systems-development perspective; document theory with concrete, substantive examples presented through application analysis; give practical theory and application of the dedicated microcomputer in telemetry use, and show uniquely derived computer software in the real-time system.

This work is an overview of both theory and practice, and is especially keyed to the information needs of persons directly involved in procurement and application of today's telemetry systems.

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LEARNING AND TEACHING WITH COMPUTERS, Artificial Intelligence in Education, by Tim O'Shea and John Self; A Spectrum Book, Prentice-Hall, Inc., Englewood Cliffs, NJ 07632; 307 pages, including glossary, acronymography, bibliography, acknowledgements, and index; 6 × 9¼ inches; softcover, $12.95 (also available in hardcover, $18.95).

This book gives educators and students a balanced view of what has already been achieved in computer-assisted learning, together with a description of research that is likely to affect the role of computers in tomorrow's education.

The author's main conclusion is that, by taking account of the nature of artificial intelligence, the designers of educational computer systems may provide facilities that are considerably more sophisticated than those available today.

Blackboards and chalk may soon by replaced by visual-display units. This book will be valuable for all teachers and parents who want to adapt quickly and successfully to the new opportunities opened up by computer-assisted learning. **R-E**

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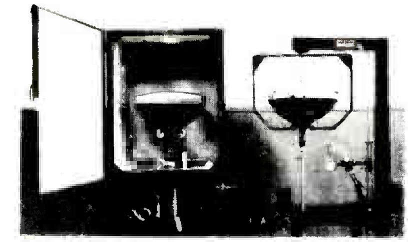

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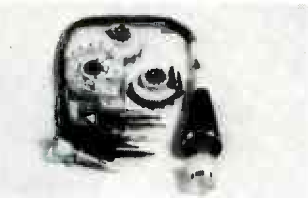

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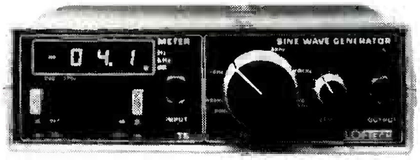

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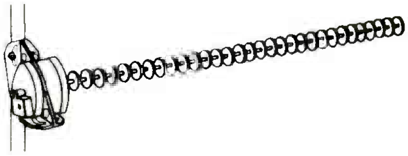

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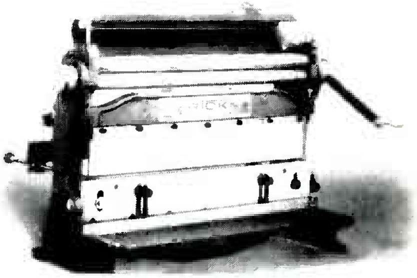

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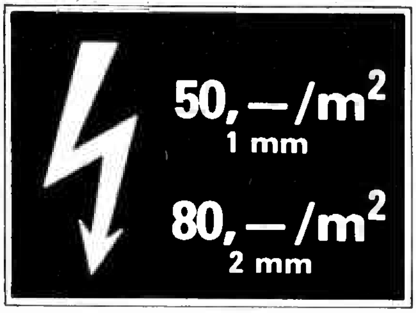

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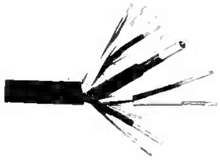

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IC's, Product Reliability Report, is 24 pages on coated paper, 8½ × 11 inches, and deals with reliability programs instituted by Precision Monolithics, Inc., for its linear circuits.

Covered in the report are device and package reliability monitor programs; data analysis; temperature accelerated life testing programs; PMI assigned activation energies, and failure mechanisms with failure-rate calculations. The brochure is free from **Precision Monolithics, Incorporated,** 1500 Space Park Drive, Santa Clara, CA 95050.
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DRAWING BOARD

continued from page 40

and since it's the last output in the chain, we're connecting it back to the data input of the IC. Remember that we have to make sure that the incoming data at the clock input is constantly recirculated around and around the daisy-chained flip-flops in the 4018. Any change in the input data to the IC has to be fed into it at the clock input and not the data input. All that we're using the data input for is to make sure that whatever we feed into the 4018 stays there.

Losing the Q_5 output means that we

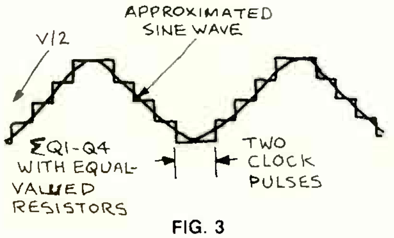

FIG. 3

output waveform) the top only remains for two incoming clock periods instead of three, as it did in Fig. 2-b. That not only helps us fit the crest of the sinewave but gives the rise and fall on either side a better shape making the fit even better. Of course, as we've seen over and over again, you can't get something for nothing and we're paying a price here as well. Let's not forget that while we may have an easier time fitting the curve, we've lost one of the outputs and consequently our resolution has suffered. But, as with so many other things, trade-offs are the name of the game in electronics as well.

Picking the ideal resistor values to give us the best approximation of a sinewave involves a lot of math. The principle behind the whole thing, however, isn't really that hard to visualize. Figure 4 gives us a graphic representation of the problem. What we're looking at there is the first 180 degrees of the sinewave. The generating of the sinewave means that all of the outputs are going to come into play during each half of the full-cycle. Take another look at Fig. 1, you'll see that the sequential rise and fall of the flip-flop outputs

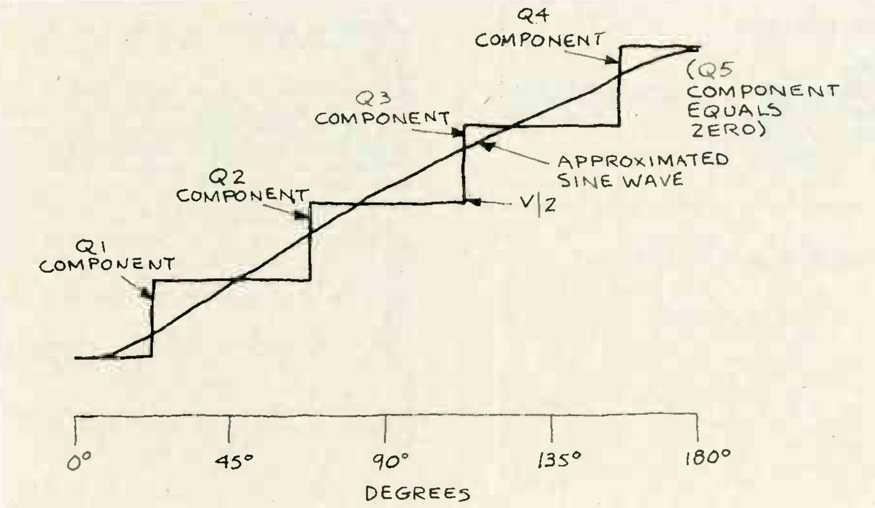

FIG. 4

don't use it to generate the sinewave but we still need it to recirculate the data. The result of eliminating that output is shown in Fig. 3: There have been two changes, the one we expected and one that's just one of those lucky breaks. The most obvious change is the flattening at the top of the waveform. That's what we expected and isn't really any great surprise. We've overlaid the output waveform with a sinewave again and you can see that it is a better fit than we got earlier in Fig. 2-b. Even though the drawing of the sinewave is crude, you can see that it's going to be a much better fit.

The second change isn't quite as obvious because the drawings aren't exactly to scale. Since we've lost one of the outputs (the one that produced the top of the

determine the shape of the summed waveform. Because each of the outputs is out of phase (or delayed) by exactly one incoming clock pulse, each of the outputs controls the amplitude of the output waveform at 45 degree (or 180/4) intervals. (We're dividing by four instead of five because the Q_5 output is not being used. Even though we're allowing for the time it takes to change state, it adds nothing to the amplitude of the output waveform.)

Finding the correct resistor values, therefore, means a bit of trigonometry and some more analysis. Don't be put off by the math; it's not all that difficult and understanding it only involves common sense and curiosity—two very important tools for anyone who wants to be involved in electronics. **R-E**

HOBBY CORNER

continued from page 97

transistor checking. I recommend the methods in this order: 1) commercial tester/test circuit; 2) substitution; 3) multimeter. The multimeter method should be considered only as an emergency measure—that's because it does not work with all transistors.

Cat-birds

Leroy Jack (NE) needs some ideas on how to protect birds from his cats. It seems that they particularly relish wrens and Leroy wants to give the birds more of an even chance. He says that he has tried attaching bells to the cat's collars but that has produced only limited success. He wonders about putting a small audio oscillator on those collars.

Sure, you could do that, Leroy, but battery weight could be a problem if the oscillator is to operate very long. We would be more inclined to use a little 3909 IC—usually referred to as an "LED flasher."

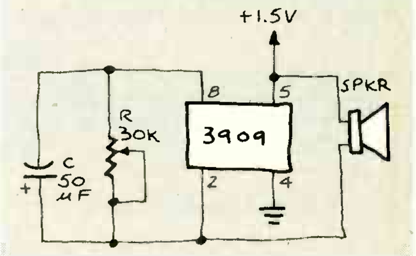

FIG. 6

If you put the 3909 in the circuit shown in Fig. 6, you can get sound with a low current requirement. We're not sure as to what kind of sound will be most effective in this application. Probably an occasional "click" will work as well as anything else. That is what you will get from the circuit shown. Other frequencies can be generated by varying the value of potentiometer and the capacitor.

That's all we have room for this time. Hang in there—your question may be coming up next month.

By the way, you may be wondering how the questions are chosen for answering here in the column. What I try to do is to select those questions that will be of the greatest interest to the greatest number of readers. That depends on the subject to the question and the range of the possible applications of the answer.

I am sure that you know that your questions are appreciated by all of us. Keep them coming. Oh yes, you don't have to wait until you have a question before you write—I'll be glad to see your comments and suggestions, too. **R-E**

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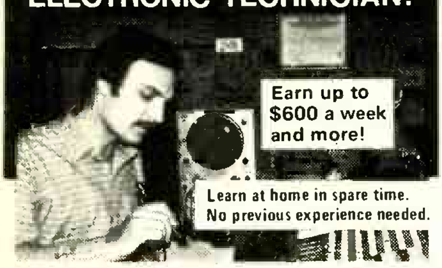

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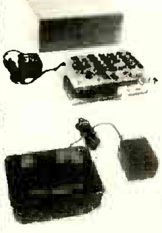

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2SC-1913	.44
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2SC-1947	1.68
2SC-1956	4.05
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2SC-1972	4.05
2SC-1975	.86
2SC-2026	.24
2SC-2028	.60
2SC-2029	.71
2SC-2073	.32
2SC-2075	.41
2SC-2098	3.28
2SC-2120	.07
2SC-2131	1.85
2SC-2153	.22
2SC-2166	.50
2SC-2237	2.56
2SC-2238	.34
2SC-2278	.23
2SC-2365	3.42
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2SC-2369	.78
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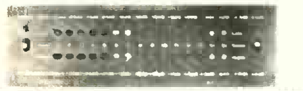

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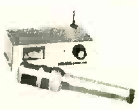

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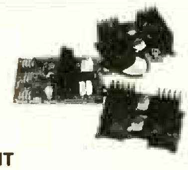

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Transformer
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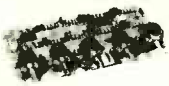

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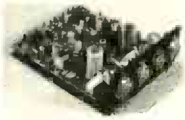

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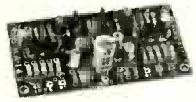

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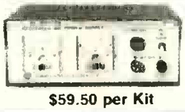

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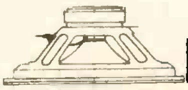

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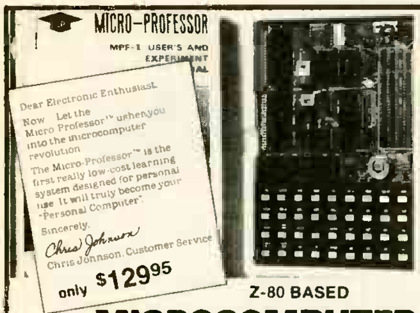

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SOLDER TAIL DIP SOCKETS

- Single beam
- Low profile
- YOUR CHOICE: TIN OR GOLD*

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TEXAS INSTRUMENTS GOLD EDGEBOARD CONNECTORS

Solder Tab · Solder Eyelet · Wire Wrap

- RELIABLE, COST-EFFICIENT CONTACT DESIGN
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- Copper-nickel-tin C.A. 725 alloy.
- Bifurcated contact points.
- Preloaded, cantilever spring design
- Contacts are user removable.

H4 SERIES .100" x .200" EDGEBOARD CONNECTORS

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H4 SERIES .125" x .250" EDGEBOARD CONNECTORS

[illegible]

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Parameter	V SERIES
Operating Temperature Range	-40°C to + 85°C
Capacity Range	0.01μF to 1.0μF
Capacity Tolerance Δc/c	±2.5%
Standard Capacity Tolerance	±5%
Dissipation Factor (Max.)	1.0%
Insulation Resistance (20°C)	1000MΩ μF
Voltage Coefficient (DC)	Negligible
Aging Rate	Negligible
Electrodes	Met. film
Lead Spacing	200, 300
Self-Healing	Yes
WVdc	50V

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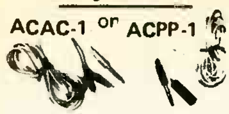

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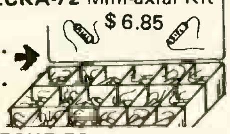

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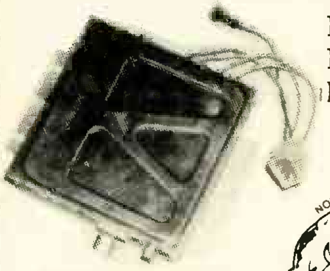

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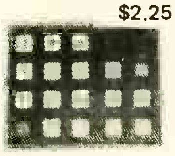

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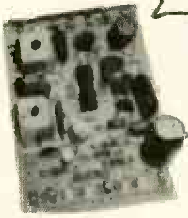

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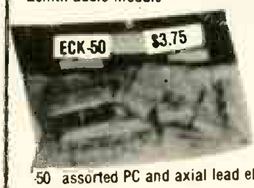

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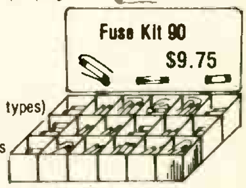

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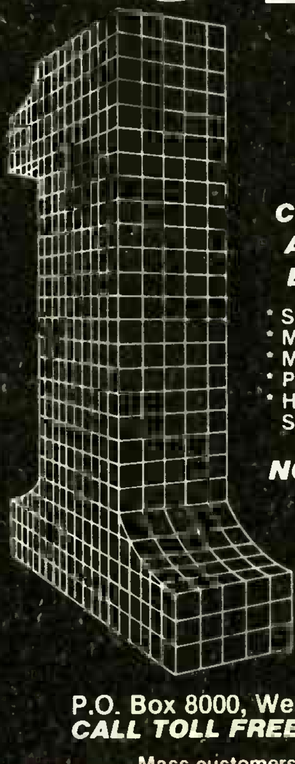

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5101	256 x 4	(450ns) (cmos)	3.95
2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	.99
2102L-2	1024 x 1	(250ns) (LP)	1.49
2111	256 x 4	(450ns)	2.49
2112	256 x 4	(450ns)	2.99
2114	1024 x 4	(450ns)	8/9.95
2114-25	1024 x 4	(250ns)	8/10.95
2114L-4	1024 x 4	(450ns) (LP)	8/12.95
2114L-3	1024 x 4	(300ns) (LP)	8/13.45
2114L-2	1024 x 4	(200ns) (LP)	8/13.95
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TC5516	2048 x 8	(250ns) (cmos)	9.95
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HM6116-4	2048 x 8	(200ns) (cmos)	4.75
HM6116-3	2048 x 8	(150ns) (cmos)	4.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	6.95
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LP = Low Power   Qstat = Quasi-Static

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UPD411	4096 x 1	(300ns)	3.00
MM5280	4096 x 1	(300ns)	3.00
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
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4116-200	16384 x 1	(200ns)	8/12.95
4116-150	16384 x 1	(150ns)	8/14.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
MK4332	32768 x 1	(200ns)	9.95
4164-200	65536 x 1	(200ns) (5v)	5.95
4164-150	65536 x 1	(150ns) (5v)	6.95
MCM6665	65536 x 1	(200ns) (5v)	8.95
TMS4164-15	65536 x 1	(150ns) (5v)	8.95

5V = single 5 volt supply

EPROMS

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2758	1024 x 8	(450ns) (5v)	5.95
2716	2048 x 8	(450ns) (5v)	3.95
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TMS2516	2048 x 8	(450ns) (5v)	5.50
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns) (5v)	5.95
2732	4096 x 8	(450ns) (5v)	4.95
2732-250	4096 x 8	(250ns) (5v)	8.95
2732-200	4096 x 8	(200ns) (5v)	11.95
2732A-4	4096 x 8	(450ns) (5v) (21vPGM)	6.95
2732A	4096 x 8	(250ns) (5v) (21vPGM)	9.95
2732A-2	4096 x 8	(200ns) (5v) (21vPGM)	13.95
2764	8192 x 8	(450ns) (5v)	6.95
2764-250	8192 x 8	(250ns) (5v)	7.95
2764-200	8192 x 8	(200ns) (5v)	19.95
TMS2564	8192 x 8	(450ns) (5v)	14.95
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5v = Single 5 Volt Supply   21vPGM = Program at 21 Volts

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PE-14T	X	9	8,000	119.00
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PL-265T	X	30	9,600	255.00
PR-125T	X	25	17,000	349.00
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10.0	2.95
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4022	.79	74C10	.35
4023	.29	74C14	.59
4024	.65	74C20	.35
4025	.29	74C30	.35
4026	1.65	74C32	.39
4027	.45	74C42	1.29
4028	.69	74C48	1.99
4029	.79	74C73	.65
4030	.39	74C74	.65
4034	1.95	74C76	.80
4035	.85	74C83	1.95
4040	.75	74C85	1.95
4041	.75	74C86	.39
4042	.69	74C89	4.50
4043	.85	74C90	1.19
4044	.79	74C93	1.75
4046	.85	74C95	.99
4047	.95	74C107	.89
4049	.35	74C150	5.75
4050	.35	74C151	2.25
4051	.79	74C154	3.25
4053	.79	74C157	1.75
4060	.89	74C160	1.19
4066	.39	74C161	1.19
4068	.39	74C162	1.19
4069	.29	74C163	1.19
4070	.35	74C164	1.39
4071	.29	74C165	2.00
4072	.29	74C173	.79
4073	.29	74C174	1.19
4075	.29	74C175	1.19
4076	.79	74C192	1.49
4078	.29	74C193	1.49
4081	.29	74C195	1.39
4082	.29	74C200	5.75
4085	.95	74C221	1.75
4086	.95	74C244	2.25
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	14.95	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
4527	1.95	74C929	19.95

6800

68000	49.95
6800	2.95
6802	7.95
6803	19.95
6808	13.90
6809E	14.95
6809	11.95
6810	2.95
6820	4.35
6821	2.95
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	7.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95
6800 = 1MHZ	
68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B40	19.95
68B45	19.95
68B50	5.95
68B00 = 2 MHZ	

6500

1 MHZ	
6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	6.95
6532	9.95
6545	22.50
6551	11.85
2 MHZ	
6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95
3 MHZ	
6502B	9.95

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1791	24.95
1793	26.95
1795	29.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
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8088	29.95
8089	89.95
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8156	6.95
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8185-2	39.95
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CRT5037	24.95
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8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	79.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

Z-80

2.5 Mhz	
Z80-CPU	3.95
Z80-CTC	3.95
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	3.95
Z80-SIO/0	11.95
Z80-SIO/1	11.95
Z80-SIO/2	11.95
Z80-SIO/9	11.95
4.0 Mhz	
Z80A-CPU	4.49
Z80A-CTC	4.95
Z80A-DART	9.95
Z80A-DMA	12.95
Z80A-PIO	4.49
Z80A-SIO/0	12.95
Z80A-SIO/1	12.95
Z80A-SIO/2	12.95
Z80A-SIO/9	12.95
6.0 Mhz	
Z80B-CPU	9.95
Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	19.95
Z80B-SIO/2	39.95
ZILOG	
Z6132	34.95
Z8671	39.95

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74LS02	.25	74LS175	.55
74LS03	.25	74LS181	2.15
74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	1.29
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	1.39
74LS113	.39	74LS374	1.39
74LS114	.39	74LS375	.95
74LS122	.45	74LS377	1.39
74LS123	.79	74LS378	1.18
74LS124	2.90	74LS379	1.35
74LS125	.49	74LS385	3.90
74LS126	.49	74LS386	.45
74LS132	.59	74LS390	1.19
74LS133	.59	74LS393	1.19
74LS136	.39	74LS395	1.19
74LS137	.99	74LS399	1.49
74LS138	.55	74LS424	2.95
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74LS151	.55	74LS645	2.20
74LS153	.55	74LS668	1.69
74LS154	1.90	74LS669	1.89
74LS155	.69	74LS670	1.49
74LS156	.69	74LS674	14.95
74LS157	.65	74LS682	3.20
74LS158	.59	74LS683	3.20
74LS160	.69	74LS684	3.20
74LS161	.65	74LS685	3.20
74LS162	.69	74LS688	2.40
74LS163	.65	74LS689	3.20
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
74LS166	1.95	81LS97	1.49
74LS168	1.75	81LS98	1.49
74LS169	1.75	25LS2521	2.80
74LS170	1.49	25LS2569	4.25

74S00

74S00	.32	74S132	1.24	74S225	7.95
74S02	.35	74S133	.45	74S240	2.20
74S03	.35	74S134	.50	74S241	2.20
74S04	.35	74S135	.89	74S244	2.20
74S05	.35	74S138	.85	74S251	.95
74S08	.35	74S139	.85	74S253	.95
74S09	.40	74S140	.55	74S257	.95
74S10	.35	74S151	.95	74S258	.95
74S11	.35	74S153	.95	74S260	.79
74S15	.35	74S157	.95	74S273	2.45
74S20	.35	74S158	.95	74S274	19.95
74S22	.35	74S161	1.95	74S275	19.95
74S30	.35	74S162	1.95	74S280	1.95
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74S37	.88	74S168	3.95	74S288	1.90
74S38	.85	74S169	3.95	74S289	6.89
74S40	.35	74S174	.95	74S301	6.95
74S51	.35	74S175	.95	74S373	2.45
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74S65	.40	74S182	2.95	74S381	7.95
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74S85	1.99	74S189	6.95	74S412	2.98
74S86	.50	74S194	1.49	74S471	4.95
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74S113	.50	74S196	1.49	74S474	4.95
74S114	.55	74S197	1.49	74S482	15.25
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7808T	.75	7912T	.85
7812T	.75	7915T	.85
7815T	.75	7924T	.85
7824T	.75		
		7905K	1.49
7805K	1.39	7912K	1.49
7812K	1.39	7915K	1.49
7815K	1.39	7924K	1.49
7824K	1.39		
		79L05	.79
78L05	.69	79L12	.79
78L12	.69	79L15	.79
78L15	.69		
		LM323K	4.95
78H05K	9.95	UA78S40	1.95
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C, T = TO-220 K = TO-3
L = TO-92

7400

7400	.19	74123	.49
7401	.19	74125	.45
7402	.19	74126	.45
7403	.19	74132	.45
7404	.19	74136	.50
7405	.25	74143	4.95
7406	.29	74145	.60
7407	.29	74147	1.75
7408	.24	74148	1.20
7409	.19	74150	1.35
7410	.19	74151	.55
7411	.25	74153	.55
7413	.35	74154	1.25
7414	.49	74155	.75
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7425	.29	74163	.69
7427	.29	74164	.85
7430	.19	74165	.85
7432	.29	74166	1.00
7437	.29	74167	2.95
7438	.29	74170	1.65
7442	.49	74173	.75
7445	.69	74174	.89
7446	.69	74175	.89
7447	.69	74177	.75
7448	.69	74181	2.25
7451	.23	74184	2.00
7473	.34	74185	2.00
7474	.33	74191	1.15
7475	.45	74192	.79
7476	.35	74193	.79
7482	.95	74194	.85
7483	.50	74195	.85
7485	.59	74197	.75
7486	.35	74198	1.35
7489	2.15	74221	1.35
7490	.35	74246	1.35
7492	.50	74247	1.25
7493	.35	74259	2.25
7495	.55	74273	1.95
7497	2.75	74276	1.25
74100	1.75	74279	.75
74107	.30	74366	.65
74109	.45	74367	.65
74116	1.55	74368	.65
74121	.29	74393	1.35
74122	.45		

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9000

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9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
96S02	1.95

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LM301	.34	LM340 (see 7800)		LM565	.99	LM1558H	3.10
LM301H	.79	LM348	.99	LM566	1.49	LM1800	2.37
LM307	.45	LM350K	4.95	LM567	.89	LM1812	8.25
LM308	.69	LM350T	4.60	NE570	3.95	LM1830	3.50
LM308H	1.15	LM358	.69	NE571	2.95	LM1871	5.49
LM309H	1.95	LM359	1.79	NE590	2.50	LM1872	5.49
LM309K	1.25	LM376	3.75	NE592	2.75	LM1877	3.25
LM310	1.75	LM377	1.95	LM709	.59	LM1889	1.95
LM311	.64	LM378	2.50	LM710	.75	LM1896	1.75
LM311H	.89	LM379	4.50	LM711	.79	ULN2003	2.49
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LM324	.59	LM392	.69	LM1310	1.49	LM3916	3.95
LM329	.65	LM393	1.29	MC1330	1.69	MC4024	3.95
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H = TO-5 CAN T = TO-220 K = TO-3

RCA

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CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
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CA 3060	2.90	CA 3096	3.49
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CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3160	1.19		

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TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

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TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
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MAN 72	.3"	CA	.99
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FND-507 (510)	.5"	CA	1.49
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JUMBO GREEN	.18	.15
JUMBO YELLOW	.18	.15
LED MOUNTING HARDWARE	.10	.09

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6 POSITION	.90
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- ★ COLOR MATCHES APPLE
- ★ FITS STANDARD 5¼" DRIVES, INCL. SHUGART
- ★ INCLUDES MOUNTING HARDWARE AND FEET

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14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		
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ZIF = TEXTOOL (Zero Insertion Force)		

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SPDT mini-toggle	1.25
DPDT mini-toggle	1.50
SPST mini-pushbutton	.39

OPTO-ISOLATORS

4N26	1.00	MCA-7	4.25
4N27	1.10	MCA-255	1.75
4N28	.69	IL-1	1.25
4N33	1.75	ILA-30	1.25
4N35	1.25	ILQ-74	2.75
4N37	1.25	H11C5	1.25
MCT-2	1.00	TIL-111	1.00
MCT-6	1.50	TIL-113	1.75

TRANSISTORS

2N918	.50	MPS3706	.15
MPS918	.25	2N3772	1.85
2N2102	.75	2N3903	.25
2N2218	.50	2N3904	.10
2N2218A	.50	2N3906	.10
2N2219	.50	2N4122	.25
2N2219A	.50	2N4123	.25
2N2222	.25	2N4249	.25
PN2222	.10	2N4304	.75
MPS2369	.25	2N4401	.25
2N2484	.25	2N4402	.25
2N2905	.50	2N4403	.25
2N2907	.25	2N4857	1.00
PN2907	.125	PN4916	.25
2N3055	.79	2N5086	.25
3055T	.69	PN5129	.25
2N3393	.30	PN5139	.25
2N3414	.25	2N5209	.25
2N3563	.40	2N6028	.35
2N3565	.40	2N6043	1.75
PN3565	.25	2N6045	1.75
MPS3638	.25	MPS-A05	.25
MPS3640	.25	MPS-A06	.25
PN3643	.25	MPS-A55	.25
PN3644	.25	TIP29	.65
MPS3704	.15	TIP31	.75
		TIP32	.79

DISK DRIVES

TANDON

TM100-1 5¼" (FOR IBM) SS/DD	229.00
TM100-2 5¼" (FOR IBM) DS/DD	259.00

SHUGART

SA 400L 5¼" (40 TRACK) SS/DD	199.95
SA 400 5¼" (35 TRACK) SS/DD	189.95

PERTEC

FD-200 5¼" SS/DD	179.95
FD-250 5¼" DS/DD	199.95

MPI

MP-52 5¼" (FOR IBM) DS/DD	249.00

NOTE: Please include sufficient amount for shipping on above items.

EDGE-CARD CONNECTORS

S-100 ST	3.95
S-100 WW	4.95
72 pin ST	6.95
72 pin WW	7.95
50 pin ST	4.95
44 pin ST	2.95
44 pin WW	4.95

RESISTORS

¼ WATT 5% CARBON FILM ALL STANDARD VALUES FROM 1 OHM TO 10 MEG OHM

50 PCS. SAME VALUE	.025
100 PCS. SAME VALUE	.02
1000 PCS. SAME VALUE	.015

DIODES

1N751	5.1 volt zener	.25
1N759	12.0 volt zener	.25
1N4148	(1N914) switching	25/1.00
1N4004	400PIV rectifier	10/1.00
KBP02	200PIV 1.5amp bridge	.45
KBP04	400PIV 1.5amp bridge	.55
VM48	Dip-Bridge	.35

VISA

MasterCard

OUR BUYER BLEW IT... & BOUGHT TOO MANY OF THESE!

4116 250NS 8/7.95

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
10	.50	4.40	.83	7.30
16	.55	4.80	1.00	8.80
20	.65	5.70	1.25	11.00
25	.75	6.60	1.32	11.60
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

D-SUBMINIATURE

DESCRIPTION	SOLDER CUP MALE	SOLDER CUP FEMALE	RIGHT ANGLE PC SOLDER MALE	RIGHT ANGLE PC SOLDER FEMALE	IDC RIBBON CABLE MALE	IDC RIBBON CABLE FEMALE	HOODS BLACK	HOODS GREY
ORDER BY	DBxxP	DBxxS	DBxxPR	DBxxSR	IDBxxP	IDBxxS	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	—	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	—	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	—	2.95
50	6.06	9.24	—	—	—	—	—	3.50

For order instructions see "IDC Connectors" below.

MOUNTING HARDWARE 1.00

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
CONTACTS 10	.82	.85	1.86	2.05	1.15	—	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "**xx**" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH**10**SR.

JDR Microdevices

1224 S. Bascom Avenue, San Jose, CA 95128
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(408) 995-5430 • Telex 171-110

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TERMS: Minimum order $10. For shipping and handling include $2.50 for UPS Ground and $3.50 for UPS Air. Orders over 1 lb. and foreign orders may require additional shipping charges — please contact our sales department for the amount. CA residents must include 6% sales tax, Bay Area and LA residents include 6½%. Prices subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sale.

CIRCLE 49 ON FREE INFORMATION CARD

FOR APPLE COMPUTER USERS

JDR Microdevices

THOUSANDS SOLD!

JDR 16K RAM CARD FOR APPLE II+

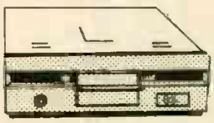
- ★ Expand your 48K Apple to 64K
- ★ Fully compatible with Apple Language System — Use in place of Apple Language card
- ★ Highest quality card features: gold edge connector, sockets for all IC's.
- ★ 2 YEAR WARRANTY

Kit with Instructions $40.95 **$44.95**
Bare PC Card $14.95

GET SLIM IN 1984!

JDR HALF-HEIGHT DISK DRIVE

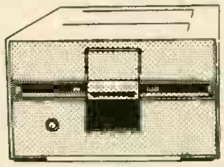
- ★ 35 Track if used with Apple Controller
- ★ 40 Track Controller and DOS Available (Call for Price)



$209.95

MA SYSTEMS

FD-35 DISK DRIVE



$199.95

- ★ Shugart Mechanism — Made in U.S.A.
- ★ Direct Replacement for Apple Disk II
- ★ Compatible with Apple Controller or other Apple compatible controllers
- ★ Specially designed electronics with **low power** consumption
- ★ DOS 3.3 and 3.2 compatible
- ★ One Year Warranty

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APPLE COMPATIBLE POWER SUPPLY

- ★ Use To Power Apple-Type Systems
- ★ +5V @ 5A +12V @ 3A -5V @ .5A -12V @ .5A
- ★ Instructions Included

$79.95

BMC BMX-80 PRINTER

- ★ 80 CPS Dot Matrix Printer
- ★ Prints Bi-Directional in 40, 80, 71 or 142 Columns in Normal, Double Width or Compressed Text.
- ★ Print Superscript As Well As Superb Graphics in Character or Bit Image

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- ★ 80 Column Card for Apple II+
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- ★ 2 Year Warranty

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- ★ 80 Column Card for Apple IIe
- ★ 64K RAM Expandable to 128K

64K RAM Upgrade $47.60

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- ★ Hi Resolution Graphics
- ★ Printer Card
- ★ Centronics Parallel Interface

Graphmax with Color & Zoom Options ... $149.95

NASHUA DISKETTES

5¼" WITH HUB RING		
MD1	SOFT SECTOR, SS/SD	19.95
MD1D	SOFT SECTOR, SS/DD	26.25
MD2D	SOFT SECTOR, DS/DD	30.75
MD2F	SOFT SECTOR, DS/QUAD DENSITY	45.00
MD110	10 SECTOR HARD, SS/SD	19.95
MD210D	10 SECTOR HARD, DS/DD	30.75
8" WITHOUT HUB RING		
FD1	SOFT SECTOR, SS/SD	24.75
FD1D	SOFT SECTOR, SS/DD	30.00
FD2D	SOFT SECTOR, DS/DD	36.75

OTHER ACCESSORIES FOR APPLE II

THUNDERCLOCK $129.95

- ★ Real-Time Clock Calendar
- ★ Software Included
- ★ Mountain Software Compatible
- ★ BSR Control Options Available

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VERBATIM DATALIFE DISKETTES

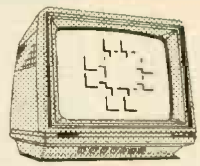
SS/DD SOFT SECTOR **$29.95**

SS/DD 10 HARD SECTOR **$29.95**

5¼" DISKETTE FILE

- ★ ATTRACTIVE, FUNCTIONAL DISK STORAGE SYSTEM
- ★ 75 DISK STORAGE CAPACITY
- ★ MOLDED FROM DURABLE SMOKED PLASTIC WITH FRONT CARRYING HANDLE

$16.99



MONITORS

BMC MONITOR STAND MODEL PA-900
Your Display Will Tilt & Swivel **$29.95**

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BMC	BM 12AUW GREEN 12"	$89.95
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NEC	JB1201M - 20 MHZ GREEN	$169.00
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7400

**Number of Pins of each I.C. for easy Socket purchase

Part No.	**Pins	Price	Part No.	**Pins	Price	Part No.	**Pins	Price
SN7400N	14	.25	SN7472N	14	.29	SN74156N	16	.59
SN7401N	14	.25	SN7473N	14	.35	SN74157N	16	.59
SN7402N	14	.25	SN7474N	14	.35	SN74160N	16	.69
SN7403N	14	.25	SN7475N	16	.45	SN74161N	16	.69
SN7404N	14	.25	SN7476N	16	.35	SN74162N	16	.89
SN7405N	14	.25	SN7479N	14	4.95	SN74163N	16	.69
SN7406N	14	.45	SN7480N	14	.89	SN74164N	14	.69
SN7407N	14	.29	SN7482N	14	1.49	SN74165N	16	.69
SN7408N	14	.25	SN7483N	16	.59	SN74166N	16	.89
SN7409N	14	.25	SN7485N	16	.59	SN74167N	16	2.95
SN7410N	14	.25	SN7486N	14	.35	SN74170N	16	1.29
SN7411N	14	.25	SN7489N	16	2.25	SN74172N	24	4.95
SN7412N	14	.49	SN7490N	14	.39	SN74173N	16	.69
SN7413N	14	.39	SN7491N	14	.79	SN74174N	16	.69
SN7414N	14	.49	SN7492N	14	.39	SN74175N	16	.69
SN7416N	14	.25	SN7493N	14	.39	SN74176N	14	.69
SN7417N	14	.25	SN7494N	14	.89	SN74177N	14	.69
SN7420N	14	.19	SN7495N	14	.49	SN74179N	16	1.49
SN7421N	14	.49	SN7496N	16	.89	SN74180N	14	.69
SN7422N	14	.49	SN7497N	16	3.25	SN74181N	24	1.95
SN7423N	16	.59	SN74100N	24	1.95	SN74182N	16	1.19
SN7425N	14	.29	SN74104N	14	1.19	SN74184N	16	2.49
SN7426N	14	.29	SN74105N	14	1.19	SN74185N	16	2.49
SN7427N	14	.25	SN74107N	14	.29	SN74190N	16	.69
SN7428N	14	.59	SN74109N	16	.39	SN74191N	16	.69
SN7430N	14	.25	SN74116N	24	1.49	SN74192N	16	.69
SN7432N	14	.29	SN74121N	14	.39	SN74193N	16	.69
SN7437N	14	.25	SN74122N	14	.69	SN74194N	16	.69
SN7438N	14	.29	SN74123N	16	.49	SN74195N	16	.69
SN7439N	14	.59	SN74125N	14	.45	SN74196N	14	.89
SN7440N	14	.19	SN74126N	14	.45	SN74197N	14	.89
SN7441N	16	.89	SN74132N	14	.49	SN74198N	24	1.19
SN7442N	16	.45	SN74136N	14	.69	SN74199N	24	1.19
SN7443N	16	1.25	SN74141N	16	.89	SN74221N	16	1.19
SN7444N	16	1.25	SN74142N	16	3.95	SN74251N	16	.79
SN7445N	16	.69	SN74143N	24	3.95	SN74276N	20	2.49
SN7446N	16	.69	SN74144N	24	3.95	SN74279N	16	.79
SN7447N	16	.69	SN74145N	16	.59	SN74283N	16	1.49
SN7448N	16	.69	SN74147N	16	1.49	SN74284N	16	2.95
SN7450N	14	.19	SN74148N	16	1.19	SN74285N	16	2.95
SN7451N	14	.19	SN74150N	24	1.19	SN74365N	16	.55
SN7453N	14	.19	SN74151N	16	.59	SN74366N	16	.55
SN7454N	14	.19	SN74152N	14	.59	SN74367N	16	.55
SN7459N	14	.25	SN74153N	16	.59	SN74368N	16	.55
SN7460N	14	.39	SN74154N	24	1.25	SN74390N	16	1.49
SN7470N	14	.29	SN74155N	16	.59	SN74393N	14	1.49

74LS

74LS00	14	.25	74LS92	14	.55	74LS192	16	.79
74LS01	14	.25	74LS93	14	.55	74LS193	16	.79
74LS02	14	.29	74LS95	14	.79	74LS194	16	.69
74LS03	14	.25	74LS96	16	.89	74LS195	16	.69
74LS04	14	.35	74LS107	14	.39	74LS197	14	.79
74LS05	14	.25	74LS109	16	.39	74LS221	16	.89
74LS08	14	.29	74LS112	16	.39	74LS240	20	1.09
74LS09	14	.29	74LS113	14	.39	74LS241	20	1.09
74LS10	14	.29	74LS114	14	.39	74LS242	14	1.09
74LS11	14	.35	74LS122	14	.49	74LS243	14	1.09
74LS12	14	.35	74LS123	16	.89	74LS244	20	1.49
74LS13	14	.39	74LS125	14	.59	74LS245	20	1.49
74LS14	14	.59	74LS126	14	.49	74LS247	16	1.09
74LS15	14	.35	74LS132	14	.59	74LS248	16	1.09
74LS20	14	.29	74LS133	16	.59	74LS249	16	1.09
74LS21	14	.29	74LS136	14	.39	74LS251	16	.59
74LS22	14	.29	74LS138	16	.89	74LS253	16	.59
74LS26	14	.29	74LS139	16	.79	74LS257	16	.59
74LS27	14	.29	74LS151	16	.59	74LS258	16	.59
74LS28	14	.35	74LS153	16	.59	74LS260	14	.59
74LS30	14	.29	74LS154	24	1.29	74LS266	14	.69
74LS32	14	.39	74LS155	16	.69	74LS273	20	1.49
74LS33	14	.55	74LS156	16	.69	74LS279	16	.49
74LS37	14	.35	74LS157	16	.69	74LS283	16	.69
74LS38	14	.35	74LS158	16	.59	74LS290	14	.89
74LS40	14	.29	74LS160	16	.69	74LS293	14	.79
74LS42	16	.55	74LS161	16	.69	74LS298	16	.89
74LS47	16	.75	74LS162	16	.69	74LS352	16	1.29
74LS48	16	.75	74LS163	16	.69	74LS353	16	1.29
74LS49	14	.75	74LS164	14	.69	74LS365	16	.49
74LS51	14	.25	74LS165	16	1.19	74LS366	16	.49
74LS54	14	.25	74LS166	16	1.19	74LS367	16	.49
74LS55	14	.29	74LS168	16	1.19	74LS368	16	.49
74LS73	14	.39	74LS169	16	1.19	74LS373	20	1.49
74LS74	14	.39	74LS170	16	1.49	74LS374	20	1.49
74LS75	16	.39	74LS173	16	.69	74LS375	16	.69
74LS76	16	.39	74LS174	16	.69	74LS386	14	.45
74LS78	16	.39	74LS175	16	.69	74LS393	14	1.19
74LS83	16	.65	74LS181	24	2.95	74LS399	16	1.49
74LS85	16	.89	74LS190	16	.89	74LS670	16	1.49
74LS86	14	.39	74LS191	16	.89	81LS95	20	1.49
74LS90	14	.55				81LS97	20	1.49

74S/PROMS*

74S00	14	.35	74S114	14	.55	74S243	14	2.49
74S02	14	.35	74S133	16	.45	74S244	20	2.49
74S03	14	.35	74S134	16	.50	74S251	16	1.19
74S04	14	.45	74S135	16	.69	74S253	16	1.19
74S05	14	.45	74S136	14	1.39	74S257	16	1.19
74S08	14	.39	74S138	16	.89	74S258	16	1.19
74S09	14	.39	74S139	16	.89	74S260	14	.79
74S10	14	.35	74S140	14	.55	74S280	14	1.95
74S11	14	.35	74S151	16	.99	74S287*	16	1.95
74S15	14	.35	74S153	16	.99	74S288*	16	1.95
74S20	14	.35	74S157	16	.99	74S373	20	2.49
74S22	14	.35	74S158	16	.99	74S374	20	2.49
74S30	14	.35	74S160	16	2.49	74S387*	16	1.95
74S32	14	.45	74S174	16	1.19	74S471*	20	5.95
74S38	14	.89	74S175	16	1.19	74S472*	20	4.95
74S40	14	.39	74S188*	16	1.49	74S473*	20	4.95
74S51	14	.35	74S194	16	1.49	74S474*	24	4.95
74S64	14	.39	74S195	16	1.49	74S475*	24	4.95
74S65	14	.39	74S196	14	1.49	74S570*	16	2.95
74S74	14	.55	74S240	20	2.25	74S571*	16	2.95
74S85	16	2.49	74S241	20	2.25	74S572*	18	4.95
74S86	14	.55	74S242	14	2.49	74S573*	18	4.95
74S112	16	.55				74S940	20	2.49
74S113	14	.55				74S941	20	2.49

CA—LINEAR

CA3010H		1.35	CA3081N	16	.99	CA3130E	8	.89
CA3039H		1.35	CA3082N	16	1.19	CA3140E	8	.79
CA3046N	14	1.35	CA3083N	16	1.49	CA3160H		1.19
CA3059N	14	2.95	CA3086N	14	.69	CA3161E	16	2.95
CA3060N	16	2.95	CA3089N	16	1.69	CA3162E	16	6.95
CA3065E	14	1.49	CA3096N	16	1.49	CA3189E	16	1.59
CA3080E	8	.89				CA3401N	14	.59

CD—CMOS

CD4000	14	.29	CD4040	16	1.19	CD4098	16	1.95
CD4001	14	.29	CD4041	14	1.19	CD4506	16	1.19
CD4002	14	.29	CD4042	16	.89	CD4507	14	1.19
CD4006	14	1.19	CD4043	16	.79	CD4508	24	3.95
CD4007	14	.29	CD4044	16	.79	CD4510	16	1.29
CD4009	16	.59	CD4046	16	1.19	CD4511	16	1.19
CD4010	16	.59	CD4047	14	1.29	CD4512	16	1.29
CD4011	14	.29	CD4048	16	.59	CD4514	24	2.49
CD4012	14	.29	CD4049	16	.39	CD4515	24	2.49
CD4013	14	.39	CD4050	16	.39	CD4516	16	1.19
CD4014	16	1.19	CD4051	16	.99	CD4518	16	1.19
CD4015	16	.39	CD4052	16	.99	CD4520	16	1.19
CD4016	14	.49	CD4053	16	.99	CD4526	16	1.49
CD4017	16	1.19	CD4056	16	2.95	CD4528	16	1.49
CD4018	16	.99	CD4059	24	7.95	CD4529	16	1.69
CD4019	16	.59	CD4060	16	1.49	CD4543	16	1.95
CD4020	16	1.19	CD4066	14	.59	CD4562	14	6.95
CD4021	16	1.19	CD4068	14	.39	CD4566	16	1.39
CD4022	16	1.19	CD4069	14	.29	CD4583	16	2.49
CD4023	14	.29	CD4070	14	.39	CD4584	14	.69
CD4024	14	.69	CD4071	14	.29	CD4723	16	1.19
CD4025	14	.23	CD4072	14	.29	CD4724	16	1.19
CD4026	16	2.49	CD4073	14	.29	MC14409	16	13.95
CD4027	16	.45	CD4075	14	.29	MC14410	16	13.95
CD4028	16	.69	CD4076	16	1.19	MC14411	24	11.95
CD4029	16	1.29	CD4078	14	.49	MC14412	16	13.95
CD4030	14	.39	CD4081	14	.29	MC14419	16	7.95
CD4034	24	2.49	CD4082	14	.29	MC14433	24	13.95
CD4035	16	1.49	CD4093	14	.49	MC14538	16	1.19
(More in Catalog)						MC14541	14	1.19

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$2.95
2650	40	MPU (2MHz)	9.95
MCS6502	40	MPU w/Clock	5.95
MCS6502B	40	MPU w/Clock at [illegible]MHz	9.95
6809	40	CPU—8-bit (Internal Clock) 1MHz	14.95
6809E	40	CPU—8-bit (External Clock) 1MHz	14.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N	40	CPU-Sgl chip 8-bit (128 bytes Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	9.95
INS8070N	40	CPU (64 bytes RAM)	29.95
INS8073N	40	CPU w/Basic Micro Interpreter	29.95
P8085A	40	CPU	4.95
8086	40	CPU 16-bit 5MHz	24.95
8088	40	CPU 8/16-bit	29.95
8155	40	HMOS RAM I/O Port-Timer	6.95
8748	40	HMOS EPROM MPU	24.95

Z80, Z80A, Z80B, Z8000 SERIES

Part No.	**Pins	Function	Price
Z80	40	CPU (MK3880N)(780C) 2MHz	$3.95
Z80-CTC	28	Counter Timer Circuit	3.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	10.95
Z80-DMA	40	Direct Memory Access Circuit	9.95
Z80-PIO	40	Parallel I/O Interface Controller	3.95
Z80-SIO/0	40	Serial I/O (TxCB and RxCB Bonded)	12.95
Z80-SIO/1	40	Serial I/O (Lacks DTRB)	12.95
Z80-SIO/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80-SIO/9	40	Serial I/O	12.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	4.49
Z80A-CTC	28	Counter Timer Circuit	4.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	9.95
Z80A-DMA	40	Direct Memory Access Circuit	12.95
Z80A-PIO	40	Parallel I/O Interface Controller	3.95
Z80A-SIO/0	40	Serial I/O (TxCB and RxCB bonded)	12.95
Z80A-SIO/1	40	Serial I/O (Lacks DTRB)	12.95
Z80A-SIO/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80A-SIO/9	40	Serial I/O	12.95
Z80B	40	CPU (MK3880N-6) 6MHz	9.95
Z80B-CTC	28	Counter Timer Circuit	12.95
Z80B-DART	40	Dual Asynch. Receiver/Transmitter	19.95
Z80B-PIO	40	Parallel I/O Interface Controller	12.95
Z8001	48	CPU Segmented	44.95
Z8002	40	CPU Non-Segmented	34.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6500/6800/68000 SERIES

Part No.	**Pins	Function	Price
MC6502A	40	MPU with clock and RAM (2MHz)	6.95
MC6520	40	Peripheral Inter. Adapter	4.95
MC6800	40	MPU	2.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6809E	40	CPU (1MHz) External (Locking)	14.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	2.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8-bit ROM (MC68A30-8)	9.95
MC6850	24	Asynchronous Comm. Adapter	3.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	7.95
MC68000L8	64	MPU 16-Bit (8MHz)	49.95
MC68488P	40	General Purpose Int. Adapter	9.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	9.95
MCM68764	24	64K EPROM (450ns)	24.95
SY6522	40	Peripheral Inter. Adapter	7.95

8080A SERIES

Part No.	**Pins	Function	Price
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8080A	40	CPU	2.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
8156	40	RAM with I/O Port and Timer	6.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	3.95
DP8216	16	Bi-Directional Bus Driver	1.95
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Control/Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	3.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	5.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	8.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-Bit Bi-Directional Receiver	3.95
DP8307	20	8-Bit Bi-Directional Receiver	3.95
DP8308	20	8-Bit Bi-Directional Receiver	3.95
DP8310	20	Octal Latched Peripheral Driver	4.95
8741	40	8-Bit Univ. Peripheral Interface	29.95
8755	40	16K EPROM with I/O	24.95

DISK CONTROLLERS

Part No.	**Pins	Function	Price
INS1771-1	40	Single Density	16.95
FD1791	40	Single/Dual Density (Inv.)	29.95
FD1793	40	Single/Double Density (True)	29.95
FD1795	40	Dual Density/Side Select (Inv.)	29.95
FD1797	40	Dual Density/Side Select True	29.95

SPECIAL FUNCTION

Part No.	**Pins	Function	Price
DS0025CN	8	Dual MOS Clock Driver (5MZ)	2.49
DS0026CN	8	Dual MOS Clock Driver (5MZ)	1.95
INS2651	28	Communication Chip	8.95
MC3470P	18	Floppy Disk Read Amp System	4.95
MM58167AN	24	Microprocessor Real Time Clock	8.95
MM58174AN	16	Micro Compatible Time Clock	7.95
COP402N	40	Microcontroller w/64-digit RAM and Direct LED Drive	5.95
COP402MN	40	Microprocessor w/64-digit RAM & Direct LED Drive w/N Buss Int.	5.95
COP470N	20	32-seg VAC Fluor. Drvr. (20-pin pkg.)	3.25
MM5369AA/N	8	Prog. Oscillator/Divider (60Hz)	1.79
MM5369EST	8	Prog. Oscillator/Divider (100Hz)	1.95

DYNAMIC RAMS

Part No.	**Pins	Function	Price
1103	18	1024x1 (300ns)	.99
4027	16	4096x1 (250ns)	2.49
4116N-2	16	16,384x1 (150ns) 1.89 -	8/14.95
4116N-3	16	16,384x1 (200ns) 1.69 -	8/12.95
4116N-4	16	16,384x1 (250ns) 1.49 -	8/10.95
4164N-150	16	65,536x1 (150ns) 6.95 -	8/49.95
4164N-200	16	65,536x1 (200ns) 5.95 -	8/44.95
MM5261	18	1024x1 (300ns) .49 -	8/1.95
MM5262	22	2048x1 (385ns)	.10
MM5270	18	4096x1 (250ns) MK4096	4.95
MM5280	22	4096x1 (200ns) 2107	3.95
MM5290-2	16	16,384x1 (150ns) 1.89 -	8/14.95
MM5290-3	16	16,384x1 (200ns) 1.69 -	8/12.95
MM5290-4	16	16,384x1 (250ns) 1.49 -	8/10.95
MM5298-3	16	8192x1 (200ns)	1.69

STATIC RAMS

Part No.	**Pins	Function	Price
1101	16	256x1 (650ns)	1.49
2101	22	256x4 (450ns) 8101	2.49
2102	16	1024x1 (350ns)	.89
21L02	16	1024x1 (450ns) L.P.	1.49
2111	18	256x4 (450ns) 8111	2.95
2112	16	256x4 (450ns) MOS	1.95
2114	18	1024x4 (450ns) 1.49 -	8/9.95
2114L	18	1024x4 (450ns) L.P. 1.95 -	8/13.95
2114-2	18	1024x4 (200ns) 1.75 -	8/11.95
2114L-2	18	1024x4 (200ns) L.P. 2.25 -	8/14.95
2147	18	4096x1 (70ns)	4.95
2148	18	1024x4 (70ns)	4.95
TMS4045	18	1024x4 (450ns)	3.95
TMS40L47-45	20	1024x4 (450ns)	2.95
5101	22	256x4 (450ns) CMOS	2.95
MM5257	18	4096x1 (450ns) 4044	4.95
HM6116P-3	24	2048x8 (150ns) CMOS	5.95
HM6116P-4	24	2048x8 (200ns) CMOS	4.95
HM6116LP-4	24	2048x8 (200ns) L.P. CMOS	5.49
HM6264P-15	28	8192x8 (150ns) CMOS	39.95
27LS00	16	256x1 (80ns) L.P.	9.95
7489	16	16x4 (50ns) 3101	2.25
74C920	22	256x4 (250ns)	3.95
74C921	18	256x4 (250ns) CMOS	3.95
74C929	16	1024x1 (250ns) CMOS (6501)	3.95
74C930	18	1024x1 (250ns) CMOS (6518)	3.95
74S189	16	16x4 (35ns) 93405	1.95
74S200	16	256x1 (80ns) 93410	3.95
74S206	16	256x1 (60ns) 93411	3.95
74S289	16	16x4 (35ns) 3101	2.25
82S10	16	1024x1 (50ns) O.C. (93415)	3.95
82S25	16	16x4 (50ns) O.C. (74S289)	2.25

PROMS/EPROMS

Part No.	**Pins	Function	Price
1702A	24	256x8 (1us)	4.95
2708	24	1024x8 (450ns)	3.95
2708-5	24	1024x8 (550ns) SM00246	2.95
TMS2516	24	2048x8 (450ns) 2716	5.95
TMS2532	24	4096x8 (450ns) NMC2532	6.95
TMS2564	28	8192x8 (450ns)	14.95
TMS2716	24	2048x8 (450ns) 3 voltage	9.95
2716	24	2048x8 (450ns)	4.95
2716-1	24	2048x8 (350ns)	5.95
2716Q-5	24	2048x8 (550ns)	4.49
2732	24	4096x8 (450ns)	6.95
2732A-3	24	4096x8 (300ns)	7.95
2732A-4	24	4096x8 (450ns) 21V	6.95
2732Q-4	24	4096x8 (550ns)	5.95
2758Q-A	24	1024x8 (450ns)	2.95
2764-4	28	8192x8 (450ns)	9.95
2764 3	28	8192x8 (300ns)	14.95
MM5204Q	24	512x8 (1us)	4.95
MCM68764	24	8192x8 (450ns)	24.95
27128	28	16,384x8 (450ns) 128K EPROM	59.95
74S188	16	32x8 PROM O.C. (6330-1)	1.49
74S287	16	256x4 PROM T.S. (6301-1)	1.95
74S288	16	32x8 PROM T.S. (6331-1)	1.95
74S387	16	256x4 PROM O.C. (6300-1)	1.95
74S471	20	256x8 PROM T.S. (6309-1)	5.95
74S472	20	512x8 PROM T.S. (6349-1)	4.95
74S473	20	512x8 PROM O.C. (6348)	4.95
74S474	24	512x8 PROM T.S. (DM87S296N)	4.95
74S475	24	512x8 PROM O.C. (6340)	4.95
74S476	18	1024x4 PROM T.S.	6.95
74S478	24	1024x8 PROM T.S.	8.95
74S570	16	512x4 PROM O.C. (6305)	2.95
74S571	16	512x4 PROM T.S. (6306)	2.95
74S572	18	1024x4 PROM O.C. (6352)	4.95
74S573	18	1024x4 PROM T.S. (82S137)	4.95
82S23	16	32x8 PROM O.C. (27S18)	2.95
82S115	24	512x8 PROM T.S. (27S15)	9.95
82S123	16	32x8 PROM T.S. (27S19)	2.95
82S126	16	256x4 PROM O.C. (27S20)	2.95
82S129	16	256x4 PROM T.S. (27S21)	2.95
82S130	16	512x4 PROM O.C. (27S12)	3.95
82S185	18	2048x4 PROM T.S. (TBP24S81)	9.95
82S190	24	2048x8 (80ns)	14.95
82S191	24	2048x8 (80ns)	14.95
DM87S180N	24	1024x8 PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8 PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4 PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4 PROM T.S. (82S185)	9.95
DM87S190N	24	2048x4 PROM O.C. (82S190)	14.95
DM87S191N	24	2048x8 PROM T.S. (82S191)	14.95

DATA ACQUISITION

Part No.	**Pins	Function	Price
DC10		Mostek DC/DC Convert. +5V to -9V	2.95
MC3470P	18	Floppy Disk Read AMP System	4.95
MC1408L7	16	7-bit D/A Converter (DAC0807LCN)	1.49
MC1408L8	16	8-bit D/A Converter (DAC0808LCN)	2.25
ADC0803LCN	20	8-bit A/D Converter (±1/2LSB)	4.95
ADC0804	20	8-bit A/D Converter (1LSB)	3.49
DAC0806	16	8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28	8-bit A/D Converter (8-Ch. Multi.)	4.49
ADC0817	40	8-bit A/D Converter (16-Ch. Multi.)	9.95
DAC1000	24	10-bit D/A Conv. Micro Comp. (0.05%)	7.95
DAC1008	20	10-bit D/A Conv. Micro Comp. (0.20%)	6.95
DAC1020	16	10-bit D/A Conv. (0.05% Lin.)	7.95
DAC1022	16	10-bit D/A Conv. (0.20% Lin.)	5.95
DAC1222	18	12-bit D/A Conv. (0.20% Lin.)	6.95
LM334Z		Constant Current Source	1.19
LM335Z		Temperature Transducer	1.40
LM399H		Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
AY-5-1013A	40	30K Baud Uart (TR1602)	3.95

Digitalker™

DT1050 — Applications: Teaching aids, appliances, clocks, automotive, telecommunications, language translations, etc.

The DT1050 is a standard DIGITALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences. The "voice" output of the DT1050 is a highly intelligible male voice. Female and children's voices can be synthesized. The vocabulary is chosen so that it is applicable to many products and markets.

The DT1050 consists of a Speech Processor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

DT1050 Digitalker™ .... $34.95 ea.
MM54104 Processor Chip .... $14.95 ea.

DT1057 - Expands the DT1050 vocabulary from 137 to over 260 words. Includes 2 ROMs and specs.
Part No. DT1057 .... $24.95 ea.

INTERSIL

*Evaluation Kits

Part No.	**Pins	Function	Price
7045IPI	28	CMOS Precision Timer	14.95
7045EV/Kit*	28	Stopwatch Chip, XTL	19.95
7106CPL	40	3½ Digit A/D (LCD Drive)	9.95
FE0203D		3½ Digit LCD Display for 7106 & 7116	19.95
7106EV/Kit*	40	IC, Circuit Board, Display	34.95
7107CPL	40	3½ Digit A/D (LED Drive)	11.95
7107EV/Kit*	40	IC, Circuit Board, Display	29.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD	16.95
7201IUS		Low Battery Volt Indicator	2.25
7205IPG	24	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	24	Stopwatch Chip, XTL	14.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
7207AIPD	14	Oscillator Controller	5.95
7207AEV/Kit*	14	Freq. Counter Chip, XTL	7.95
7215IPG	24	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	24	4 Func. Stopwatch Chip, XTL	14.95
7216A[illegible]	28	8 Digit Univ. Counter C.A.	29.95
7216CIJI	28	8 Digit Freq. Counter C.A.	24.95
7216DIPI	28	8 Digit Freq. Counter C.C.	19.95
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI	10.95
7226AIJL	40	8 Digit Univ. Counter	29.95
7226AEV/Kit*	40	5 Function Counter Chip XTL	74.95

30009 1983 INTERSIL Data Book (1356p.) **$9.95**

NEW PRODUCT! 74HC High Speed CMOS

74HC00	14	.59	74HC139	16	.99	74HC251	16	.89
74HC02	14	.59	74HC147	16	1.19	74HC253	16	.99
74HC03	14	.75	74HC151	16	.89	74HC257	16	.89
74HC04	14	.59	74HC153	16	.99	74HC259	16	1.49
74HCU04	14	.65	74HC154	24	2.49	74HC266	14	1.19
74HC08	14	.59	74HC157	16	.89	74HC273	20	2.89
74HC10	14	.59	74HC158	16	.89	74HC280	14	3.95
74HC11	14	.59	74HC160	16	1.29	74HC373	20	2.39
74HC14	14	.85	74HC161	16	1.29	74HC374	20	2.39
74HC20	14	.59	74HC162	16	1.29	74HC390	16	1.49
74HC27	14	.59	74HC163	16	1.29	74HC393	14	1.49
74HC32	14	.75	74HC164	14	1.29	74HC533	20	2.39
74HC42	16	.99	74HC165	16	2.79	74HC534	20	2.39
74HC51	14	.75	74HC173	16	1.69	74HC595	16	3.95
74HC58	14	.75	74HC174	16	.99	74HC688	20	3.19
74HC73	14	.79	74HC175	16	.99	74HC4002	14	.59
74HC74	14	.79	74HC192	16	1.39	74HC4017	16	2.19
74HC75	16	.89	74HC193	16	1.39	74HC4020	16	1.39
74HC76	16	.79	74HC194	16	1.09	74HC4024	14	1.59
74HC85	16	1.59	74HC195	16	1.09	74HC4040	16	1.39
74HC86	14	.69	74HC237	16	2.95	74HC4060	16	1.39
74HC107	14	.79	74HC240	20	1.95	74HC4075	14	.59
74HC109	16	.79	74HC241	20	1.95	74HC4078	14	.69
74HC112	16	.79	74HC242	14	1.95	74HC4511	16	2.69
74HC113	14	.79	74HC243	14	1.95	74HC4514	24	3.79
74HC132	14	.99	74HC244	20	1.95	74HC4538	16	2.39
74HC137	16	1.95	74HC245	20	2.49	74HC4543	16	3.49
74HC138	16	1.09						

74HCU04 is unbuffered. All others are buffered.

NEW Programmable Array Logic (PALS)

Part No.	**Pins	Function	Price
PAL10H8	20	Octal 10-Input AND-OR Gate Array (High Output)	$3.95
PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	3.95
PAL14H4	20	Quad 14-Input AND-OR Gate Array (High Output)	3.95
PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL16L8	20	Octal 16-Input AND-OR-Invert Gate Array	9.95
PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	7.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	7.95
PAL16R4	20	Quad 16-Input Register AND-OR Gate Array	7.95

30012 1982 NATIONAL PAL Data Book (176p.) .. **$5.95**

74C—C/MOS

74C00	14	.35	74C95	14	1.39	74C221	16	1.95
74C02	14	.35	74C107	14	.89	74C240	20	1.95
74C04	14	.29	74C151	16	2.49	74C244	20	1.95
74C08	14	.35	74C154	24	3.49	74C373	20	2.49
74C10	14	.35	74C157	16	2.25	74C374	20	2.49
74C14	14	.69	74C160	16	1.19	74C901	14	.59
74C20	14	.35	74C161	16	1.19	74C903	14	.59
74C30	14	.35	74C162	16	1.19	74C906	14	.59
74C32	14	.39	74C163	16	1.19	74C911	28	8.95
74C42	16	1.39	74C164	14	1.49	74C912	28	8.95
74C48	16	1.95	74C173	16	1.19	74C915	18	1.19
74C73	14	.79	74C174	16	1.19	74C917	28	8.95
74C74	14	.69	74C175	16	1.19	74C922	18	4.49
74C85	16	1.95	74C192	16	1.49	74C923	20	4.95
74C86	14	.39	74C193	16	1.69	74C925	16	5.95
74C89	16	5.95	74C195	16	1.39	74C926	18	5.95
74C90	14	1.19				80C95	16	.69
74C93	14	1.19				80C97	16	.69

LINEAR

TL071CP	8	.79	LM340T-5		.79	LM723N	14	.55
TL072CP	8	1.39	LM340T-12		.79	LM733N	14	1.00
TL074CN	14	1.95	LM340T-15		.79	LM739N	14	1.95
TL081CP	8	.59	LF347N	14	1.49	LM741CN	8	.35
TL082CP	8	1.19	LM348N	14	.99	LM747N	14	.69
TL084CN	14	1.95	LM350K		4.95	LM748N	8	.59
LM301CN	8	.35	LF355N	8	1.10	LM1310N	14	1.49
LM302H		1.95	LF356N	8	1.10	LM1458CN	8	.59
LM304H		1.95	LM370N	14	4.49	LM1488N	14	.89
LM305H		.99	LM373N	14	3.95	LM1489N	14	.89
LM307CN	8	.45	LM377N	14	1.95	LM1496N	14	1.95
LM308CN	8	.69	LM380N	14	.89	LM1800N	18	2.49
LM309K		1.25	LM381N	14	1.79	LM1871N	18	2.95
LM310CN	8	1.75	LM382N	14	1.39	LM1872N	18	3.25
LM311CN	8	.69	LM384N	14	1.79	LM1877N-9	14	2.49
LM312H		2.49	LM386N-3	8	.89	LM1889N	18	2.25
LM317T		1.19	TL494CN	16	3.95	LM1896N	14	2.95
LM317K		3.95	TL496CP	8	1.19	LM2002T		1.95
LM318CN	8	1.95	NE531V	8	2.95	LM3189N	16	1.59
LM319N	14	1.95	NE544N	14	2.95	LM3900N	14	.59
LM320K-5		1.35	NE550A	14	1.95	LM3905CN	8	1.19
LM320K-12		1.35	NE555V	8	.35	LM3909N	8	.99
LM320K-15		1.35	LM556N	14	.69	LM3914N	18	2.95
LM320T-5		.89	NE564N	16	2.95	LM3915N	18	2.95
LM320T-12		.89	LM565N	14	1.19	LM3916N	18	2.95
LM320T-15		.89	LM566CN	8	1.49	RC4136N	14	1.25
LM323K		5.95	LM567V	8	.99	RC4151NB	8	1.95
LM324N	14	.59	NE570N	16	3.95	RC4194TK		4.49
LM337T		1.95	LM703CN	8	1.19	NE5532	8	2.49
LM338K		6.95	LM709N	14	.49	NE5534	8	1.69
LM339N	14	.69	LM710N	14	.69	ICL8038B	14	3.95
LM340K-5		1.35	LM711N	14	.79	LM13080N	8	1.19
LM340K-12		1.35				LM13600N	16	1.19
LM340K-15		1.35				MORE AVAILABLE		

30003 1982 Nat. Linear Data Book (1952 pgs.) . **$11.95**

LOW PROFILE (TIN) SOCKETS

	1-9	10-99	100-up
8 pin LP	.16	.14	.13
14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

SOLDERTAIL (GOLD) STANDARD

	1-9	10-99	100-up
8 pin SG	.30	.27	.25
14 pin SG	.43	.39	.37
16 pin SG	.47	.43	.41
18 pin SG	.53	.49	.47
24 pin SG	.69	.65	.61
28 pin SG	.81	.76	.72
36 pin SG	1.09	1.03	.97
40 pin SG	1.21	1.14	1.08

SOLDERTAIL STANDARD (TIN)

	1-9	10-99	100-up
14 pin ST	.29	.27	.25
16 pin ST	.34	.32	.30
18 pin ST	.38	.36	.34
20 pin ST	.45	.43	.41
24 pin ST	.49	.46	.43
28 pin ST	.69	.67	.63
40 pin ST	.99	.95	.89

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-9	10-99	100-up
8 pin WW	.49	.45	.42
10 pin WW	.65	.62	.59
14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
18 pin WW	.89	.85	.79
20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
28 pin WW	1.59	1.50	1.45
36 pin WW	1.85	1.75	1.69
40 pin WW	1.99	1.89	1.79

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VOICE SYNTHESIZER FOR APPLE AND COMMODORE

NEW!

JE520AP

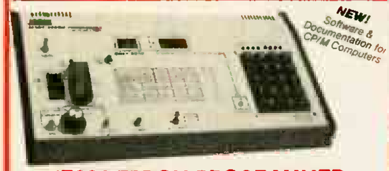
JE520CM

• Over 250 word vocabulary-affixes allow the formation of more than 500 words • Built-in amplifier, speaker, volume control, and audio jack • Recreates a clear, natural male voice • Plug-in user ready with documentation and sample software • Case size: 7¼"L x 3¼"W x 1-3/8"H

APPLICATIONS: • Security Warning • Teaching • Instrumentation • Telecommunication • Handicap Aid • Games

The JE520 VOICE SYNTHESIZER will plug right into your computer and allow you to enhance almost any application. Utilizing National Semiconductor's DIGITALKER™ Speech Processor IC (with four custom memory chips), the JE520 compresses natural speech into digital memory, including the original inflections and emphases. The result is an extremely clear, natural vocalization.

Part No.	Description	Price
JE520CM	For Commodore 64 & VIC-20	$114.95
JE520AP	For Apple II, II+, and //e	$149.95



NEW! Software & Documentation for CP/M Computers

JE664 EPROM PROGRAMMER

8K to 64K EPROMS — 24 & 28 Pin Packages

Completely Self-Contained — Requires No Additional Systems for Operation

· Programs and validates EPROMs · Checks for properly erased EPROMs · Emulates PROMs or EPROMs · RS232C Computer Interface for editing and program loading · Loads data into RAM by keyboard · Changes data in RAM by keyboard · Loads RAM from an EPROM · Compares EPROMs for content differences · Copies EPROMs · Power Input: 115VAC, 60Hz, less than 10W power consumption · Enclosure: Color-coordinated, light tan panels with molded end pieces in mocha brown · Size: 15⅝"L x 8⅝"D x 3⅛"H · Weight: 5⅝ lbs.

The JE664 EPROM Programmer emulates and programs various 8-Bit Word EPROMs from 8K to 64K-Bit memory capacity. Data can be entered into the JE664's internal 8K x 8-Bit RAM in three ways: (1) from a ROM or EPROM; (2) from an external computer via the optional JE665 RS232C BUS; (3) from its panel keyboard. The JE664's RAMs may be accessed for emulation purposes from the panel's test socket to an external microprocessor, in programming and emulation, the JE664 allows for examination, change and validation of program content. The JE664's RAMs can be programmed quickly to all "1"s (or any value), allowing unused addresses in the EPROM to be programmed later without necessity of "UV" erasing. The JE664 displays DATA and ADDRESS in convenient hexadecimal (alphanumeric) format. A "DISPLAY EPROM DATA" button changes the DATA readout from RAM word to EPROM word and is displayed in both hexadecimal and binary code. The front panel features a convenient operating guide. The JE664 Programmer includes one JM16A Jumper Module (as listed below).

JE664-A EPROM Programmer. $995.00
Assembled & Tested (includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The RS232C Interface Option implements computer access to the JE664's RAM. This allows the computer to manipulate, store and transfer EPROM data to and from the JE664. A sample program listing is supplied in MBASIC for CP/M computers. Documentation is provided to adapt the software to other computers with an RS232 port. 9600 Baud, 8-bit word, odd parity and 2 stop bits.

FOR A LIMITED TIME A SAMPLE OF SOFTWARE WRITTEN IN BASIC FOR THE TRS-80* MODEL I, LEVEL II COMPUTER WILL ALSO BE PROVIDED.

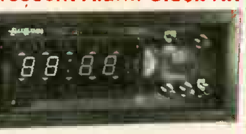
JE664-ARS EPROM Prog. w/JE665 Option. $1195.00
Assembled & Tested (includes JM16A Module)

EPROM JUMPER MODULES — The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets the JE664 for the proper programming pulses to the EPROM and configures the EPROM socket connections for that particular EPROM.

JE664 EPROM Jumper Mod. No.	EPROM	Programming Voltage	EPROM MANUFACTURER	PRICE
JM08A	2708	25V	AMD, Motorola, Nat., Intel, TI	$14.95
JM16A	2716, TMS2516 (TI)	25V	Intel, Motorola, Nat., NEC, TI, AMD, Hitachi, Mostek	$14.95
JM16B	TMS2716 (3-V's)	-5V,+5V,+12V	Motorola, TI	$14.95
JM32A	TMS2532	25V	Motorola, TI	$14.95
JM32B	2732	25V	AMD, Fujitsu, NEC, Hitachi, Intel, Mitsubishi, National	$14.95
JM32C	2732A	21V	Fujitsu, Intel	$14.95
JM64A	MCM68764, MCM68L764	21V	Motorola	$14.95
JM64B	2764	21V	Intel, Fairchild, OKI	$14.95
JM64C	TMS2564	25V	TI	$14.95

4-Digit Fluorescent Alarm Clock Kit

NEW!



• Bright 4-digit 0.5" high display • 10 minute snooze alarm • AM/PM indicator • Automatic display dimmer

The JE750 Clock Kit is a versatile 12-hour digital clock with 24-hour alarm. The clock has a bright 0.5" high blue-green fluorescent display. The display will automatically dim with changing light conditions. The 24-hour alarm allows the user to disable the alarm and immediately re-enable the return to activate 24 hours later. The kit includes all documentation, components, case and wall transformer. Size: 6⅝"L x 3¼"W x 1⅜"D.

JE750 Alarm Clock Kit $29.95

13⅛"L x 4¼"W x ¾"H

Misumi 54-Key Unencoded Matrix All-Purpose Keyboard

· SPST keyswitches · 20 pin ribbon cable connection · Low profile keys · Features: cursor controls, control, caps (lock), function, enter and shift keys · Color (keycaps): grey · Weight: 1 lb.

KB54 . . . . $14.95

18"L x 7⅝"W x 1½"H

71-Key ASCII Cherry Keyboard

· 7 bit parallel ASCII with strobe · 11 key numeric keypad · SPST mechanical keyswitches · 15/30 card-edge connector · Features: escape, control, cursor controls, plus ten additional function keys · Color: white · Weight: 2 lbs. · Spec. included

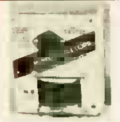
KB1801 . . . . $29.95

21⅞"L x 9.8"W x 3⅛"H

106-Key 8-Bit Serial ASCII Keyboard

· Numeric and cursor keypad · 10 user definable keys · 7 LED function displays · Security lock · N-key rollover · Uses Intel 8048/8748 · Color: white w/black panel · Documentation included · Weight: 6½ lbs.

KB139 . . . . $59.95



Power/Mate Corporation REGULATED POWER SUPPLY +5VDC @ 3 Amp/ +6VDC @ 2.5 Amp

· Input: 105-125/210-250VAC at 47-63 Hz · Output: 5VDC @ 3.0 Amps/6VDC @ 2.5 Amps · Line regulation: 0.05% · Load reg.: 0.1% · Open frame mounts on any 1 of 3 surfaces · Size: 4⅞"L x 4"W x 2⅛"H · Weight: 2 lbs.

EMA5/6B $29.95

Power/Mate Corporation REGULATED POWER SUPPLY +5VDC @ 6 Amp/ +6VDC @ 5 Amp

· Input: 105-125/210-250VAC at 47-63 Hz · Output: 5V @ 6A/6V @ 5A · Line reg.: 0.05% · Load reg.: 0.1% · Open frame mounts on any one of three surfaces · Size: 5⅝"L x 4⅞"W x 2⅞"H · Wt: 4 lbs.

EMA5/6C $39.95

POWER SUPPLY +5VDC @ 7.6 AMP, 12VDC @ 1.5 AMP SWITCHING

·Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.6 amp. · Fan volt./power supply select switches (115/230VAC) · Output: 5VDC @ 7.6 amp, 12VDC @ 1.5 amp · 8 foot black power cord · Size: 11½"W x 13¼"D x 3¾"H · Weight: 6 lbs.

Part No. PS94VOS $39.95

POWER SUPPLY 4-Channel Switching

Microprocessor, mini-computer, terminal, medical equipment and process control applications. Input: 90-130VAC 47-440Hz. Output: +5VDC @ 5A, -5VDC @ 1A; +12VDC @ 1A, -12VDC @ 1A. Line reg.: ±0.2%. Ripple: 30mV p-p. Load reg.: ±1%. Overcurrent protection. Adj: 5V main output ± 10%. 6-3/8"L x 1-7/8"W x 4-15/16"H. Wt. 1½ lbs.

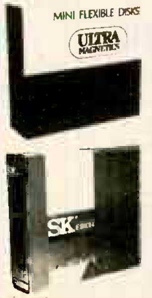
Part No. FCS-604A . . . . $69.95 each

Switching Power Supply for APPLE II, II+ & //e™

· Can drive four floppy disk drives and up to eight expansion cards
· Short circuit and overload protection · Fits inside Apple computer
· Fully regulated +5V @ 5A, +12V @ 3A, -5V @ .5A, -12V @ .5A
· Direct plug-in power cord included · Size: 9⅞"L x 3½"W x 2¼"H
· Weight: 2 lbs.

KHP4007 . . . . $79.95

DISKETTES AND ACCESSORIES



5¼" and 8" Diskettes

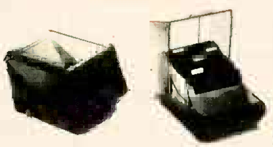
SSDD = Single Sided Double Density; DSDD = Double Sided Double Density; SSQD = Single Sided Quad Density; DSQD = Double Sided Quad Density

Part No.	Description	Boxed	PRICE
ULTRA MAGNETICS — 5¼" DISKETTES			
UM51401	5¼" SSDD Soft Sector with Hub Ring and Envelope	10	$24.95
UM00096	5¼" SSDD Soft Sector with Hub Ring (Bulk)	100	169.95
UM52401	5¼" DSDD Soft Sector with Hub Ring and Envelope	10	32.95
UM00140	5¼" DSDD Soft Sector with Hub Ring (Bulk)	100	239.95
UM51801	5¼" SSQD Soft Sector with Envelope (96TPI)	10	34.95
UM00214	5¼" SSQD Soft Sector 96TPI (Bulk)	100	259.95
UM52801	5¼" DSQD Soft Sector with Envelope (96TPI)	10	41.95
UM00217	5¼" DSQD Soft Sector 96TPI (Bulk)	100	299.95
SK (ESKEL) — 5¼" DISKETTES			
SK1D	5¼" SSDD Soft Sector with Hub Ring and Envelope	10	20.95
SK1DB	5¼" SSDD Soft Sector with Hub Ring (Bulk)	100	149.95
SK2D	5¼" DSDD Soft Sector with Hub Ring and Envelope	10	26.95
SK2DB	5¼" DSDD Soft Sector with Hub Ring (Bulk)	100	199.95
ULTRA MAGNETICS — 8" DISKETTES			
UM81726	8" SSSD IBM-Compatible (128 B/S, 26 Sectors) and Envelope	10	34.95
UM00825	8" SSSD IBM-Compatible (128 B/S, 26 Sectors) Bulk	100	239.95
UM82726	8" DSDD Soft Sector (Unformatted) with Envelope	10	49.95
UM00840	8" DSDD Soft Sector (Unformatted) Bulk	100	299.95

All diskettes listed above are soft-sectored. All have Hub Rings with the exception of the Quad Density and the 8" Series.

DISKETTE ACCESSORIES

Disk Minder



• Attractive, functional disk storage system • 50 (8") or 75 (5¼") disk storage capacity • Easy filing and retrieving • Protects disk from dust contamination • Molded from durable smoked plastic with front carrying handle • Size: 7"W x 6½"H x 9¼"D • Weight: 2 lbs

Part No.	Description	Price
DM75	Stores 75 (5¼") Diskettes	$19.95 each
DM50	Stores 50 (8") Diskettes	$29.95 each

MINI-PAK

• Stores 10 (5¼") diskettes • Protects disk from dust contamination • Durable smoked plastic • Size: 6"L x 5⅞"H x 1⅞"D

Part No.	Description	Price
MP-10	Stores 10 (5¼") Diskettes	$2.95 each

Diskette Envelopes

Sleeves for Bulk-Purchased Diskettes

• Tear proof • Lint/contaminant free • Anti-static protect. • Wear resist

Part No.	Description	Price
MP5201	10 White 5¼" Envelopes	10 for $1.49
MP5201-100	100 White 5¼" Envelopes	100 for $10.95
MP8201	10 White 8" Envelopes	10 for $1.95
MP8201-100	100 White 8" Envelopes	100 for $17.95

Vinyl Pages

For 3-Ring Binders

Protects disks from dirt, scratches, dust, spills, and other contaminants. Reduces the risk of getting dirt near your disk drive head. Size 8½" x 11"

Part No.	Description	Price
PC001	2 Pocket 5¼" Vinyl Page	10 for $7.95
PC001-2	4 Pocket 5¼" Vinyl Page	10 for $8.95
PC014	1 Pocket 8" Vinyl Page	10 for $7.95
PC014-2	2 Pocket 8" Vinyl Page	10 for $8.95

Mail Pak™

• Holds up to 3 diskettes • Ideal for mailing and retail packaging • Dust proof and durable • Transparent sleeve allows easy identification

Part No.	Description	Price
MP-05	Holds 3 ea. 5¼" Diskettes	$2.49 each
MP-08	Holds 3 ea. 8" Diskettes	$3.95 each

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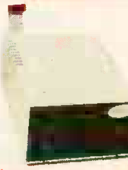
8" FLOPPY DISK DRIVE

• Single-Sided
• 77 Tracks
• 400/800K Bytes Capacity
• Industry Standard

The **FDD100-8 8" Floppy Disk Drive** (Industry Standard) features single or double density. Recording mode. FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or eq. disk cartridge. Power. 115VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs. Incl. 96-pg. manual.

FDD100-8 . . $169.95 ea.



5¼" APPLE™ Direct Plug-In Compatible Disk Drive

• Uses Shugart SA390 mechanics • 143K formatted storage • 35 tracks — compatible with Apple controller • Complete with connector and cable — just plug into your disk controller card • Size: 6"L x 3½"W x 8-9/16"D • Weight: 4¼ lbs.

Part No. ADD-514 $195.95

5¼" TEAC DISK DRIVE

Single-Sided Half-Height 5¼" Drive

· Single or double density · 48 TPI · 40 tracks · 6ms track to track · 5W power consumption · Brushless DC direct-drive motor · 160KBytes formatted storage · One year warranty parts and labor

Double your work space with the TEAC 5¼ FLOPPY DISK DRIVE. Because the TEAC FD55A Drive is half the height of conventional drives, you can fit up to four TEAC drives in the same space where two conventional drives fit. Or, have room for two floppy disk drives and a hard disk drive. Includes operating manual. Requires +5VDC @ .55A and +12VDC @ .3A. Size: 5¾"W x 1⅝"H x 8"D. Wt: 3 lbs.

FD55A $249.95

5¼" SHUGART DISK DRIVE

Double-Sided Half-Height 5¼" Drive

· Single or double density · 48 TPI · 40 tracks · 409KBytes formatted storage · 6ms track to track · Brushless DC direct-drive motor · One year warranty parts and labor · Media and interface compatible with the SA450

Backed by the Industry's largest and most experienced engineering sales and service organization, the SA455 is the smart solution for a wide range of desktop applications. Includes operating manual. Requires: +5VDC @ .7A and +12VDC @ .75A. Size: 5.88"W x 1.63"H x 8"D. Wt 3.3 lbs.

SA455 . . . . $259.95

5¼" PANASONIC DISK DRIVE

Double-Sided Half-Height 5¼" DRIVE
Shugart SA455 Equivalent

· Single or double density · 48 TPI · 40 tracks · 6ms track to track · 327KBytes formatted storage · One year warranty parts and labor

The JA551 is perfect for word processors, personal and portable computers, small business computers and terminal add-ons. Includes operating manual. Requires: +5VDC @ .9A and +12VDC @ 1 A. Size: 5.88"W x 1.63"H x 8"D. Wt 3.3 lbs.

JA551-2 . . . . $239.95

DISK DRIVE CABLE CUSTOM

We stock a wide variety of signal cables and 3 power cable kits to meet your disk drive requirements. We also customize cable assemblies for many other applications. Call for a price quote.

IBM MEMORY EXPANSION KIT COMPAQ COMPATIBILITY

SAVE HUNDREDS OF $$$ BY UPGRADING MEMORY BOARDS YOURSELF!

Most of the popular memory boards allow you to add an additional 64K, 128K, 192K, or 256K. The IBM64K Kit will populate these boards in 64K byte increments. The kit is simple to install — just insert the nine 64K RAM chips in the provided sockets and set the two groups of switches. Directions are included.

IBM64K (Nine 200ns 64K RAMs) $49.95

EXPAND YOUR MEMORY

TRS-80 to 16K, 32K, or 48K

**Model 1 = From 4K to 16K Requires (1) One Kit
Model 3 = From 4K to 48K Requires (3) Three Kits
Color = From 4K to 16K Requires (1) One Kit

**Model 1 equipped with Expansion Board up to 48K Two Kits Required
— One Kit Required for each 16K of Expansion —

TRS-16K3 *200ns for Color & Model III $12.95
TRS-16K4 *250ns for Model I $10.95

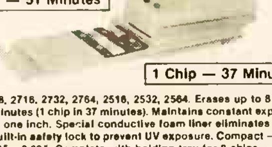
TRS-80 Color 32K or 64K Conversion Kit

Easy to install kits comes complete with 8 ea. 4164-2 (200ns) 64K dynamic RAMs and conversion documentation. Converts TRS-80 color computers with D, E, ET, F and NC circuit boards to 32K. Also converts TRS-80 color computer II to 64K. Flex DOS or OS-9 required to utilize full 64K RAM on all computers.

TRS-64K2 . . . . $44.95

UV-EPROM Eraser

8 Chips — 51 Minutes



1 Chip — 37 Minutes

Erases 2708, 2716, 2732, 2764, 2516, 2532, 2564. Erases up to 8 chips within 51 minutes (1 chip in 37 minutes). Maintains constant exposure distance of one inch. Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact — only 9.00" x 3.70" x 2.60". Complete with holding tray for 8 chips.

DE-4 UV-EPROM Eraser . . . $79.95
UVS-11EL Replacement Bulb . . $16.95

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NE572 Audio Compressor/Expander. Two channels, either can be used for compression or expansion. Dynamic range greater than 110 dB. Ideal for hi-fi noise reduction, communications speech processing. With data. 276-1781 .... Sale 4.99

Voltage Regulator ICs

Type	Adjustable	Cat. No.	Each
LM723	0 to 40 VDC	276-1740	.89
LM317T	1.2 to 37 VDC	276-1778	2.79

Type	Fixed Output	Cat. No.	Each
7805	+5 VDC	276-1770	1.59
7812	+12 VDC	276-1771	1.59
7815	+15 VDC	276-1772	1.59
7905	−5 VDC	276-1773	1.59
7912	−12 VDC	276-1774	1.59

4000-Series CMOS ICs

With Pin-Out and Specs Low As 79¢

Type	Cat. No.	Each
4001	276-2401	.79
4011	276-2411	.79
4013	276-2413	.99
4017	276-2417	1.49
4023	276-2423	.99
4049	276-2449	.99
4066	276-2466	.99

TTL Digital ICs

With Pin-Out and Specs

Type	Cat. No.	Each
7400	276-1801	.59
7404	276-1802	.79
7408	276-1822	.79
7447	276-1805	1.19
7490	276-1808	.89

Replacement Transistors

Type		Cat. No.	Each
2N1305	PNP	276-2007	1.19
MPS222A	NPN	276-2009	.79
PN2484	PNP	276-2010	.89
MPS3904	NPN	276-2016	.69
TIP31	NPN	276-2017	.99
TIP3055	NPN	276-2020	1.59
MPS2907	PNP	276-2023	.79
MJE34	PNP	276-2027	1.49
2N3053	NPN	276-2030	.89
MPS3638	PNP	276-2032	.79
TIP120	NPN	276-2068	1.29
2N3055	NPN	276-2041	1.99
MJ2955	PNP	276-2043	2.19
2N4124	NPN	276-2057	.59
2N4401	NPN	276-2058	.59
MPSA06	NPN	276-2059	.59
MPSA13	NPN	276-2060	.59
MPSA42	NPN	276-2061	.69
MU4891	UJT	276-2029	.99
2SD313	NPN	276-2048	1.79
2SC945	NPN	276-2051	.79
2SC1308	NPN	276-2055	7.95
2N3819	N-FET	276-2035	.99
MPF102	N-FET	276-2062	.99

Operational Amplifiers

Type		Cat. No.	Each
741	(Single)	276-007	.79
MC1458	(Dual)	276-038	.99
LM324	(Quad)	276-1711	1.29
TL082	(Dual)	276-1715	1.89
TL084	(Quad)	276-1714	2.99
LM3900	(Quad)	276-1713	1.39
LM339	(Quad)	276-1712	1.49

Audio Power Amplifiers

Type	Cat. No.	Each
LM383/TDA2002	276-703	3.19
LM386	276-1731	1.09
TA7205AP	276-705	2.99
LM380	276-706	1.59

Ceramic Disc Capacitors

Low As 39¢ Pkg. of 2

For RF, Bypass and Coupling Applications. Hi-Q. Moisture-proof coating. 50 WVDC minimum.

pF	Cat. No	Pkg. of 2	pF	Cat. No.	Pkg. of 2
4.7	272-120	.39	.001	272-126	.39
47	272-121	.39	.005	272-130	.39
100	272-123	.39	.01	272-131	.39
220	272-124	.39	.05	272-134	.49
470	272-125	.39	.1	272-135	.49

Electrolytic Capacitors

Axial Leads

µF	WVDC	Cat. No.	Each
4.7	35	272-1012	.49
10	35	272-1013	.59
22	35	272-1014	.69
47	35	272-1015	.69
100	35	272-1016	.79
220	35	272-1017	.89
470	35	272-1018	.99
1000	35	272-1019	1.59
2200	35	272-1020	2.49
3300	35	272-1021	2.99
4700	35	272-1022	3.59
470	50	272-1046	1.59
1000	50	272-1047	1.99
2200	50	272-1048	3.49

PC-Mount Leads

µF	WVDC	Cat. No.	Each
220	16	272-956	.79
470	16	272-957	.89
1000	16	272-958	.99
4.7	35	272-1024	.49
10	35	272-1025	.59
22	35	272-1026	.69
47	35	272-1027	.69
100	35	272-1028	.79
220	35	272-1029	.89
470	35	272-1030	.99
1000	35	272-1032	1.59
100	50	272-1044	.89

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NEW!

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Approx. 1" x 5/16". PC-mount pins. Contacts rated 1 amp at 125 VAC. Low-current coils.

Coil	Cat. No.
5 VDC, 20 milliamps	275-232
12 VDC, 11 milliamps	275-233

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16.95 Set — Receiver, Transmitter

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Only 1.98 Each

Archer Pak	Cat. No.
50 Silicon Diodes	276-1620
8 Digital ICs	276-1651
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15 Silicon NPN Transistors	276-1617
6 Linear ICs	276-1652
25 Assorted Zener Diodes	276-1629
12 Potentiometers	271-1605
20 Assorted LEDs	276-1622
15 All-Purpose NPN Transistors	276-1603
15 PNP Transistors	276-1604
25 1N4000-Series Diodes	276-1653
5 Optocouplers	276-1654

1/4-Watt, 5% Resistors

39¢ Pkg. of 5

Ohms	Cat. No.	Ohms	Cat. No.
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100	271-1311	15k	271-1337
150	271-1312	22k	271-1339
220	271-1313	27k	271-1340
270	271-1314	33k	271-1341
330	271-1315	47k	271-1342
470	271-1317	68k	271-1345
1k	271-1321	100k	271-1347
1.8k	271-1324	220k	271-1350
2.2k	271-1325	470k	271-1354
3.3k	271-1328	1 meg	271-1356
4.7k	271-1330	10 meg	271-1365
6.8k	271-1333	—	—

Digital Logic Probe With Tone and LED Indicators

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The fast way to "peek inside" TTL, LS and CMOS digital circuits. Color-coded LEDs indicate high, low or pulsed states. Simultaneous tone output frees your eyes. Min. detectable pulse width: 50 ns. With user's tips. 22-302 .... 19.95

Auto Radio Installation Guide

Save $1.00

Reg. 2.95

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Helps you choose a replacement radio. Detailed instructions for installation and removal in 1975-1982 American cars, light trucks, and many imports. 101 pages. 62-1331 .... Sale 1.95

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8275	28.95
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Z80A-CTC	4.90
Z80A-DART	10.95
Z80A-DMA	15.95
Z80A-PIO	4.90
Z80A-SIO/0	15.95
Z80A-SIO/1	15.95
Z80A-SIO/2	15.95
Z80A-SIO/9	15.95

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Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	18.95

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8T28	1.84
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8T96	.88
8T97	.88
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VOLTAGE REGULATORS

7805T	.74	7905T	.84
78MO5C	.34	7908T	.84
7808T	.74	7912T	.84
7812T	.74	7915T	.84
7815T	.74	7924T	.84
7824T	.74	7905K	1.44
7805K	1.34	7912K	1.44
7812K	1.34	7915K	1.44
7815K	1.34	7924K	1.44
7824K	1.34	79L05	.78
78L05	.68	79L12	.78
78L12	.68	79L15	.78
78L15	.68	LM323K	4.90
78H05K	9.90	UA78S40	1.90
78H12K	9.90		

C,T = TO-220   K = TO-3   L = TO-92

DIP SWITCHES

4 POSITION	.84
5 POSITION	.89
6 POSITION	.89
7 POSITION	.94
8 POSITION	.94

IC SOCKETS

	1-99	100
8 pin ST	.12	.10
14 pin ST	.14	.11
16 pin ST	.16	.12
18 pin ST	.19	.17
20 pin ST	.28	.26
22 pin ST	.29	.26
24 pin ST	.29	.26
28 pin ST	.39	.31
40 pin ST	.48	.38
64 pin ST	4.20	call
ST = SOLDERTAIL		
8 pin WW	.58	.48
14 pin WW	.68	.51
16 pin WW	.68	.57
18 pin WW	.98	.89
20 pin WW	1.04	.97
22 pin WW	1.34	1.23
24 pin WW	1.44	1.30
28 pin WW	1.64	1.44
40 pin WW	1.94	1.75
WW = WIREWRAP		
16 pin ZIF	6.70	call
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ZIF = TEXTOOL (Zero Insertion Force)

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32.768khz	1.90
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4.0	3.90
5.0	3.90
5.0688	3.90
5.185	3.90
5.7143	3.90
6.0	3.90
6.144	3.90
6.5536	3.90
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14.31818	3.90
15.0	3.90
16.0	3.90
17.430	3.90
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22.1184	3.90
32.0	3.90

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¼ WATT 5• CARBON FILM ALL STANDARD VALUES FROM 1 OHM TO 10 MEG OHM

50 PCS.	1.25
100 PCS.	2.00
1000 PCS.	15.00

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5¼" DISKETTES ATHANA OR NASHUA

SSSD	18.95
SSDD	22.95
DSDD	27.95

5¼" DISKETTES NO LABEL

SINGLE SIDED DOUBLE DENSITY (WITH JACKETS AND HUB RING)

Pack of Ten	$ 16.95
Pack of 100	$149.00

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80 Column Card	129.95
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Paddles Apple	9.95
Z80 Card	129.95
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Disk Drive	224.95
Controller Card	69.95

Joy Stick


Cooling Fan


Disk Drive

The Flip Sort Plus™

The Flip Sort Plus™ adds new dimensions to storage. Designed with similar elegant lines as the original Flip Sort™, in a transparent smoked acrylic. The Flip Sort Plus™ has a storage capacity of over 100 diskettes and has all the outstanding features you have come to expect from the flip sort Family. **24.95 each**

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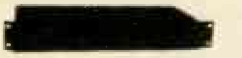
SOLID STATE STEREO REVERBERATION AMPLIFIER



Specifications: • Total harmonic distortion less than .05% • Frequency response 10 Hz to 50K Hz +ldB • S/N Ratlon 90dB • Reverberation time 0 to 3 sec. • Input 150MV/50K ohm • Max. Input 2V • Accepts input from tape, phono, or aux.
Includes and LED Reverb Level display. Kit comes with all electronic components, transformer and instructions, and 19" rack mount cabinet.

Model TA-2400 .... $89.95

AMATEUR MICROWAVE Receiver System 1.9-2.5 GHZ

MICROWAVE RECEIVER SYSTEM

• Commercial grade construction • Sturdy Parabolic aluminum reflector antenna • High gain 50 dB! • Line of sight distance 45 miles! • Complete system, power supply, cable, assembled reflector antenna, and downconverter. • Downconverter mounted in attractive cabinet.

90 day warranty on PS-5!

PS5 Assembled $109.95
Kit Form....... $ 79.95

Microwave Preamp! NEW KIT

Use with PS-3 Kit. Adds 20-25 db gain to boost reception distance.
- Low Noise
- High Gain
- Can be used with all existing stop sign board receivers!
- 1.9-2.5 gHZ Freq. Range

PS-4 (Kit)............. $34.95

SOLID STATE STEREO GRAPHIC EQUALIZER PRE AMP KIT

Specifications: • Total Harmonic Distortion: Less than 0.05% • Intermodulation Distortion: (70Hz: 7KHz = 4:1 SMPTE Method) Less than 0.03% • Frequency Response: Overall 10HZ ~ 100KHz +0.2dB—1dB. • RIAA Curve Deviation: (Phono) +0.2dB. -0.2dB (30Hz ~ 15KHz) • Channel separation (at rated output 1KHz) • Phono. Tuner. Aux and Tape Monitor better than 70dB. • Input sensitivity and impedance (1KHz for rated output).
Phono: 2MV 47K ohms Aux: 130MV 50K ohms. **Tuner:** 130MV 50K ohms. **Tape:** 130MV 50K ohms. **Graphic Equalizer Control:** 10 Band Slide Control. **Frequency Bands:** 31 5Hz: G3Hz: 125Hz: 250Hz: 500Hz: 1KHz: 2KHz: 4KHz: 8KHz: 16KHz also with on panel selector for Phono. Tuner. Aux 1 and Aux 2. **Power Supply:** 117 VAC. Kit comes with all electronic components, transformer, instructions and a 19" rack mount type metal cabinet.

TA-2500 (Kit) $119.00

20 STEP LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 40 3-color LED's to indicate sound level output of your amplifier from -57 dB to 0 dB. Comes with an attractive silk screen printed panel. Has selector switch to allow floating or gradual output indicting. Kit includes all parts, Front panel and power supply

TY-45 (Kit)
$34.95

SPY EAR

A very popular device designed to listen to sounds & voices through rooms or 3 ft. thick concrete walls.
Place listening sensor against wall and earphone in ear. Adjust volume control! Clearly hear things you may not want to!

CM-8................. $89.95

INFRA-RED REMOTE CONTROL SWITCH KIT

Infra-red Remote Control switch can be used to control appliances up to 500 W.
The TK-41 has effective control up to 10 meters. No antenna needed. Features latest IC controller which excludes interferences from light or AC pulse signal

TK-41 Kit $24.95

STEREO AMP KIT 160 Watt Total 80W + 80W

This is a solid state all transistor circuitry on board stereo amplifier. Power output employs 2 pairs of matching Darlington transistors. T.H.D. less than .05% between DC to 200 KHz. Power supply requires 30 VCT 2 amp × FMR.

TA-802
$39.95

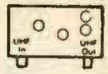
Transformer (optional)
$9.95

LOW TIM DC STEREO PRE-AM KIT TA-2800

Incorporates state of D.C. design that gives a frequency response from OHz-100KHz + .5dB. • Features tone defeat switch. loudness, treble, midrange, bass, balance. • Contains quad BiFet op-amp to develop T.H.D. of .005% at rated output • Input sensitivity phone 2.5 MV tuner, aux, tape play 100MV/100K • Power supply + 15 volt DC at .2A. Kit comes with regulated power supply, all you need is a 15-20 VCT .2 amp. XFMR.

TA-2800 ONLY $44.50
XFMR
$4.50 ea.

UHF TV PREAMP

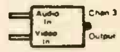


FEATURES:
- 25 dB gain!
- Kit

Your reception will dramatically improve! This unit will enable you to pull in signals you never knew were there! For both indoor and outdoor use. Input and output impedance 75 ohm. No adjustment! Easy assembly.

JH-0 Kit $23.95

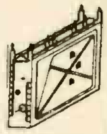
R.F. MODULATOR



Combine both audio and video output onto channel 3 or 4 of your T.V. set. Single J.C. chip (MC 1374) makes for quick and easy assembly. Single adjustment control! A must for every video recording or computer enthusiast.

VH-0 Kit $19.95

PHILIPS VARACTOR TUNER



Comes with adaptor board to directly replace Mitsumi tuner! Can use this with any board drilled for Mitsumi! High gain and phenomenal picture quality.

Specifications: • Freq. Range: UHF 470-899 mHz • Output: Channel 3 • Input: 75 ohm • Gain: 18 dB

ELC 1045.............. $23.95

DIGITAL MULTIMETER

- 3½ digit LCD meter
- Input impedence 20 Ohm
- hFE measurement
- DC .5% accuracy
- DCA up to 10 amps
- Leads and battery included

MIC-3300A $59.95
Carrying Case .... $ 9.95

Add 10% shipping on orders under $35.00. Orders over $35.00, add 5%. Catalog-$1.00. Visa & Mastercharge accepted.

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7404	.19	7490	.35
7405	.23	7491	.79
7407	.29	7492	.55
7408	.28	7494	.60
7409	.19	7496	.69
7410	.19	74121	.29
7411	.24	74123	.78
7414	.49	74145	.59
7417	.25	74148	1.19
7420	.19	74150	1.19
7423	.59	74151	.55
7430	.25	74153	.55
7432	.29	74155	.69
7438	.29	74157	.55
7439	.59	74159	1.65
7442	.45	74160	.69
7446	.69	74165	.69
7447	.69	74170	1.29
7451	.19	74174	.69
7453	.19	74181	1.85
7454	.19	74190	.69
7472	.19	74191	.69

74LS00

74LS00	.23	74LS153	.55
74LS03	.24	74LS154	1.85
74LS04	.24	74LS157	.65
74LS05	.25	74LS162	.69
74LS08	.28	74LS163	.65
74LS10	.25	74LS164	.69
74LS11	.34	74LS170	1.45
74LS15	.35	74LS174	.55
74LS20	.25	74LS175	.55
74LS27	.29	74LS181	2.15
74LS30	.25	74LS190	.89
74LS32	.29	74LS194	.69
74LS38	.35	74LS197	.79
74LS42	.49	74LS240	.95
74LS47	.75	74LS241	.99
74LS74	.35	74LS244	1.29
74LS76	.39	74LS245	1.49
74LS86	.39	74LS253	.53
74LS90	.55	74LS257	.59
74LS92	.55	74LS273	1.49
74LS113	.39	74LS279	.49
74LS123	.79	74LS366	.49
74LS125	.49	74LS367	.45
74LS136	.39	74LS373	1.49
74LS138	.55	74LS374	1.49
74LS139	.55	74LS670	1.49
74LS151	.55		

CMOS

4000	.29	4073	.29
4001	.25	4075	.29
4002	.29	4076	.79
4007	.29	4078	.29
4009	.39	4081	.29
4010	.45	4082	.29
4011	.25	14412	8.95
4012	.25	4502	.95
4013	.38	4503	.65
4014	.79	4510	.85
4015	.39	4512	.85
4017	.69	4516	1.45
4018	.79	4518	.89
4019	.39	4520	.79
4020	.75	4526	1.25
4021	.79	4527	1.95
4023	.29	4536	4.25
4025	.29	4555	1.49
4027	.45	4556	1.15
4030	.39	4581	3.50
4034	1.95	4583	2.50
4035	.85	4584	.75
4041	.75	74C00	.35
4042	.69	74C02	.35
4043	.79	74C14	.59
4047	.95	74C15	.35
4049	.35	74C154	3.20
4051	.79	74C161	1.19
4066	.39	74C164	1.39
4069	.29	74C221	1.75
4070	.35	74C901	.39

MISC.

9601	.75
9602	1.50
DS8640	.89
8811	.69
DS8820	1.45
INS8060	15.95
DM8130	3.00
9300	.69
82S23	2.95
8233	1.95
8234	1.95
8266	2.25
8273	3.25
8281	.69
82S123	2.95
82S141	4.95
8833	2.25
8T09	1.25
8T37	1.75
8T97	1.50
8S54	2.25
NE510	3.95
3341	5.95
75107	.75
75108	.75
75110	2.25
75150	.95
75325	1.75
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Z-80A-CPU	4.95
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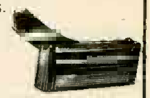
8279	8.95
8279-5	10.00
2716	3.95
2732	4.95

RIBBON CABLE CONNECTOR

These very popular 40 PIN ribbon cable connectors are used by a number of mfgs. of micros for internal board to board terminations and I/O port connections.

W/strain relief $1.95

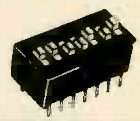


40 CONDUCTOR RIBBON CABLE gray color 70¢/ft.

DIP SWITCHES

High quality DIP switches mfg. by CTS Available in the following configurations.

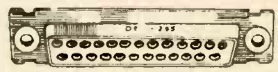
4 POS—80¢
5 POS—80¢
6 POS—80¢
7 POS—80¢



DB-25 S (FEMALE)

The most popular computer connector Mfg. by AMP .025" gold PC pins with mfg. holes.

$1.50



LINEARS

LM301	.49	MC1350	1.15
LM311	.65	LM1458	.49
LM317T	1.19	MC1496	1.25
LM319	1.95	LM1889	2.25
LM317K	3.95	LM3900	.59
LM323K	4.95	LM3914	3.95
LM324	.59	7805T	.80
LM339	.99	7805K	1.45
LM350K	4.95	7808T	.80
LF353	.95	7812T	.80
LM380	1.29	7812K	1.45
LM389	1.35	7815T	.80
LM386	.89	7818T	.80
LM555	.50	7905T	.90
NE564	2.95	7906T	.90
LM565	1.00	7912T	.90
LM723	.49	7915T	.90
LM741	.35	7918T	.90
MC1330	1.25		

74S00

74S00	.32	74S157	.95
74S04	.35	74S240	2.20
74S11	.35	74S244	2.20
74S15	.35	74S257	.95
74S32	.40	74S571	2.95
74S74	.50		

74H01

74H01	.25	74H50	.35
74H04	.28	74H51	.35
74H08	.35	74H53	.35
74H20	.35	74H55	.35
74H21	.29	74H62	.35
74H30	.35	74H72	.55
74H40	.32		

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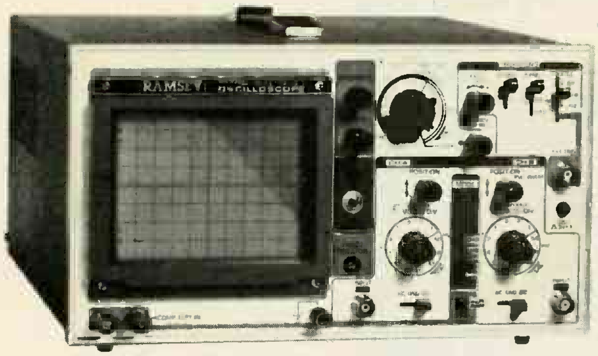
CIRCLE 90 ON FREE INFORMATION CARD

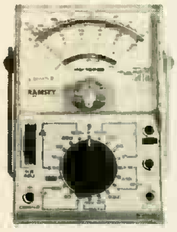
RAMSEY — THE FIRST NAME IN ELECTRONIC TEST GEAR



NEW FROM RAMSEY 20 MHz DUAL TRACE OSCILLOSCOPE

Unsurpassed quality at an unbeatable price, the Ramsey oscilloscope compares to others costing hundreds more. Features include a component testing circuit that will allow you to easily test resistors, capacitors, digital circuits and diodes • TV video sync filter • wide bandwidth & high sensitivity • internal graticule • high quality rectangular CRT • front panel trace rotator • Z axis • high sensitivity x-y mode • very low power consumption • regulated power supply • built-in calibrator • rock solid triggering • high quality hook-on probes

$399.95 high quality hook-on probes included



RAMSEY D-1100 VOM-MULTITESTER

Compact and reliable, designed to service a wide variety of equipment. Features include • mirror back scale • double-jeweled precision moving coil • double overload protection • an ideal low cost unit for the beginner or as a spare back-up unit.

$19.95

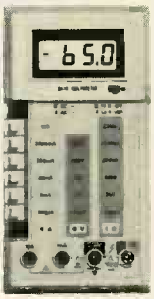
test leads and battery included

RAMSEY D-2100 DIGITAL MULTITESTER

A compact easy to use unit designed to operate like a pro. Featuring • 3½ digit LCD • low BAT. indicator • all range overload protection • overrange indication • auto-polarity • Transistor Tester • dual-slope integration • vinyl carrying case

$54.95

h_{FE} test leads, battery & vinyl carrying case included

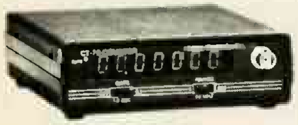


RAMSEY D-3100 DIGITAL MULTIMETER

Reliable, accurate digital measurements at an amazingly low cost • In-line color coded push buttons, speeds range selection • abs plastic tilt stand • recessed input jacks • overload protection on all ranges • 3½ digit LCD display with auto zero, auto polarity & low BAT. indicator

$59.95

test leads and battery included



CT-70 7 DIGIT 525 MHz COUNTER

Lab quality at a breakthrough price. Features • 3 frequency ranges each with pre amp • dual selectable gate times • gate activity indicator • 50mV @ 150 MHz typical sensitivity • wide frequency range • 1 ppm accuracy

$119.95 wired includes AC adapter

CT-70 kit $99.95
BP-4 nicad pack 8.95

CT-90 9 DIGIT 600 MHz COUNTER

The most versatile for less than $300. Features 3 selectable gate times • 9 digits • gate indicator • display hold • 25mV @ 150 MHz typical sensitivity • 10 MHz timebase for WWV calibration • 1 ppm accuracy

$149.95 wired includes AC adapter

CT-90 kit $129.95
OV-1 0.1 PPM oven timebase 59.95
BP-4 nicad pack 8.95

CT-125 9 DIGIT 1.2 GHz COUNTER

A 9 digit counter that will outperform units costing hundreds more. • gate indicator • 24mV @ 150 MHz typical sensitivity • 9 digit display • 1 ppm accuracy • display hold • dual inputs with preamps

$169.95 wired includes AC adapter

CT-125 kit $149.95
BP-4 nicad pack 8.95

CT-50 8 DIGIT 600 MHz COUNTER

A versatile lab bench counter with optional receive frequency adapter, which turns the CT-50 into a digital readout for most any receiver • 25 mV @ 150 MHz typical sensitivity • 8 digit display • 1 ppm accuracy

$169.95 wired

CT-50 kit $139.95
RA-1 receiver adapter kit 14.95

DM-700 DIGITAL MULTIMETER

Professional quality at a hobbyist price. Features include 26 different ranges and 5 functions • 3½ digit, ½ inch LED display • automatic decimal placement • automatic polarity

$119.95 wired includes AC adapter

DM-700 kit $99.95
MP-1 probe set 4.95

PS-2 AUDIO MULTIPLIER

The PS-2 is handy for high resolution audio resolution measurements, multiplies UP in frequency • great for PL tone measurements • multiplies by 10 or 100 • 0.01Hz resolution & built-in signal preamp/conditioner

$49.95 wired includes AC adapter

PS-2 kit $39.95

PR-2 COUNTER PREAMP

The PR-2 is ideal for measuring weak signals from 10 to 1,000 MHz • flat 25 db gain • BNC connectors • great for sniffing RF • ideal receiver/TV preamp

$44.95 wired includes AC adapter

PR-2 kit $34.95

PS-1B 600 MHz PRESCALER

Extends the range of your present counter to 600 MHz • 2 stage preamp • divide by 10 circuitry • sensitivity: 25mV @ 150 MHz • BNC connectors • drives any counter

$59.95 wired includes AC adapter

PS-1B kit $49.95

ACCESSORIES FOR RAMSEY COUNTERS

Telescopic whip antenna—BNC plug .. $ 8.95
High impedance probe, light loading ... 16.95
Low pass probe, audio use 16.95
Direct probe, general purpose use 13.95
Tilt bail, for CT-70, 90, 125 .... 3.95

master charge — BANKAMERICARD VISA

PHONE ORDERS CALL 716-586-3950

TELEX 466735 RAMSEY CI

TERMS: • satisfaction guaranteed • examine for 10 days; if not pleased return in original form for refund • add 6% for shipping and insurance to a maximum of $10.00 • overseas add 15% for surface mail • COD add $2.50 • orders under $10.00 add $1.50 • NY residents add 7% sales tax • all kits have a 90 day parts warranty. All wired units have 1 year parts and labor warranty.

RAMSEY

RAMSEY ELECTRONICS, INC.
2575 Baird Rd.
Penfield, N.Y. 14526

CIRCLE 79 ON FREE INFORMATION CARD

PARTS LIST

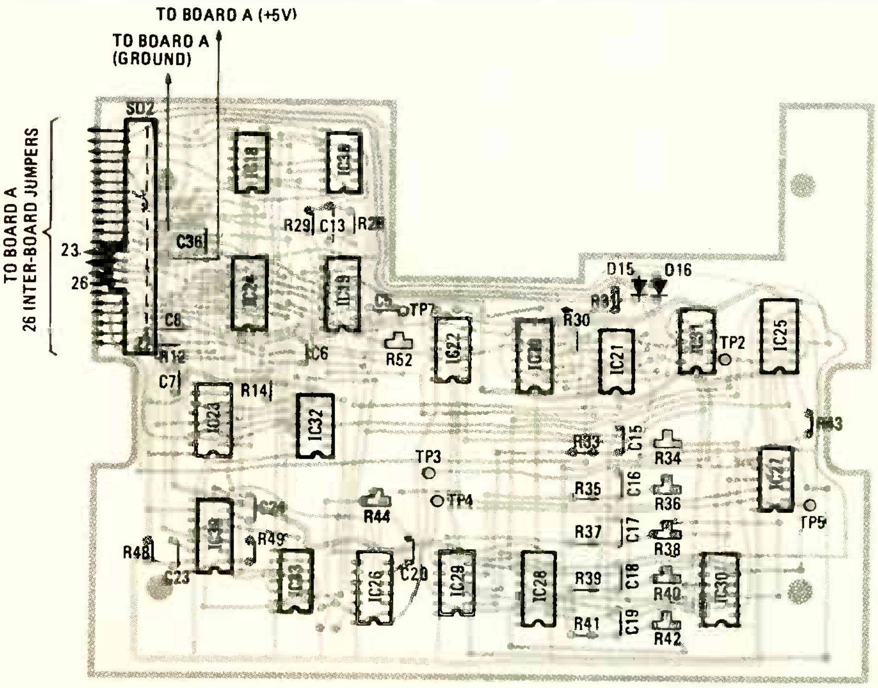
All resistors ¼-watt, 5%, unless noted
R1—68 ohms
R2,R5,R36,R38,R40,R42,R52—5000 ohms, trimmer potentiometer
R3—200 ohms, trimmer potentiometer
R4,R12,R14,R39,R41,R53—1000 ohms
R6,R23,R37—3300 ohms
R7,R15,R18,R48—4700 ohms
R8—75 ohms
R9,R10—220 ohms
R11—100 ohms
R13,R47—470 ohms
R16—27,000 ohms
R17—2200 ohms
R19, R20–R22, R24–R27, R29–R31, R33,R43,R45,R50,R51,R54–R56, R63 R65,R69—10,000 ohms
R28—1 megohm
R32,R62—47,000 ohms
R34—10,000 ohms, trimmer potentiometer
R35—68,000 ohms
R44—50,000 ohms, trimmer potentiometer
R46,R61,R66—100,000 ohms
R49,R67,R68—15,000 ohms
R57,R58,R60,R64—33,000 ohms
R59—22,000 ohms

Capacitors
C1—0.002 µF, ceramic disc
C2,C4—0.001 µF, ceramic disc
C3—75 pF, mica
C5,C8,C24–C26,C29—0.1 µF, ceramic disc
C6,C7—47 pF, ceramic disc
C9,C10,C15,C16,C32—100 pF, ceramic disc
C11,C28,C30,C34–C37,C42—0.1 µF, ceramic disc
C12,C31,C41,C43—1 µF, 16 volts, tantalum
C13—0.2 µF, ceramic disc
C14—330 pF, ceramic disc
C17,C33—22 pF, ceramic disc
C18,C19,C21—10 pF, ceramic disc
C20—470 pF, ceramic disc
C22—5–40 pF, trimmer capacitor
C23—10 pF, ceramic disc
C27—5 pF, ceramic disc
C38,C39—4700 µF, 16 volts, electrolytic
C40—1000 µF, 16 volts, electrolytic

Semiconductors
IC1—LH0002CN current amplifier (National)
IC2,IC21,IC27—4066 quad bilateral switch
IC3—LM1889 TV video modulator
IC4—LM1886 TV video matrix D/A converter
IC5—74LS32 quad OR gates
IC6—74LS03 quad NAND gates
IC7–IC15—74LS151 one-of-eight selector/multiplexer
IC16,IC23,IC24—74LS161 synchronous 4-bit counter
IC17—74LS00 quad NAND gates
IC18—74LS20 dual 4-input NAND gate
IC19,IC28,IC30,IC42—4049 hex inverting buffer
IC20—74LS191 synchronous up/dpwn counter
IC22—74LS73 dual J-K flip-flop
IC25—74LS174 hex D-type flip-flop
IC26,IC39—74LS123 dual retriggerable monostable multivibrator
IC29 IC31—74C00 quad NAND gates
IC32—74LS30 8-input NAND gates
IC33—7402 quad NOR gate
IC34—74LS169 4-bit synchronous up/down counter
IC35—7473 dual J-K flip-flop
IC36—MM5321 TV camera sync generator (National)
IC37—74LS365 hex bus driver
IC38—74LS93 4-bit binary counter
IC40—LM318 op-amp
IC41—74LS08 quad AND gate
IC43—LM340T5 5-volt regulator, T0-220 case
IC44—LM340K5 5-volt regulator, TO-3 case
IC45—LM340T12 12-volt regulator, TO-220 case
IC46—LM320T12 12-volt negative regulator, TO-220 case
Q1,Q4—2N2222A
Q2,Q3—MPS918
Q5—MPSAO5
D1,D3–D18—1N914 or 4148
D2—1N746A
S1—7-position rotary switch (Allied 7471001 or similar)
S2—pushbutton switch, normally closed
S3—SPDT toggle switch
S4—SPST toggle switch
LED1—standard red
T1—Transformer (Triad F-166XP or similar), primary: 117 volts; secondary: 24 volts, center-tapped, .125 amps; 9 volts, center-tapped .5A
BR1,BR2—bridge rectifier, 1.5 amps
L1—0.071–0.082 mH adjustable coil (J.W. Miller 48A778MPC or similar)
L2—7–12 µH adjustable coil (J.W. Miller 23A105RPC or similar)
XTAL1—14.31818 MHz crystal
F1—fuse, 1 amp, pigtail leads
J1—BNC jack
J2—type N jack
J3–J5—standard tip jacks

Miscellaneous—Heat sinks, cabinet (Pactec CM86-225), power cord, strain relief, T0-3 mounting kit, IC sockets, etc.

The following are available from Jengco, 3232 San Mateo, Suite 75, Albuquerque, NM, 87110: Complete kit including PC boards, all components, cabinet (no IC sockets), $295; Etched, drilled, and silkscreened PC boards (boards A and B), $49.50; Complete test generator, assembled and tested, $395. Please add 5% for postage and handling, New Mexico residents add 4.25% sales tax, allow 6–8 weeks for delivery.



color-bars signal can also be used to check chroma demodulators.

Interfacing the generator

A standard 34-pin card edge is available at the back of the unit. Refer to Table 2 for the pinout configuration. Numerous sync-family signals are provided as TTL level outputs (horizontal drive, vertical drive, composite sync, composite blanking, and colorburst gate). Those signals are useful in a variety of applications such as driving switches. The vertical-drive and horizontal-drive signals are handy for driving two or three video cameras (for example: in a security system), thereby synchronizing them for input to a simple switcher or VCR. That avoids the loss of sync which usually causes picture roll. A composite sync at video levels can also be derived from the generator by using the gray-level signal adjusted for blanking (gray level = 0) and taking the output from the front-panel BNC VIDEO OUT connector.

continued on page 109

CPU'S & SUPPORT CHIPS

8035	6.95	8259	5.95
8080A	2.75	8275	24.50
8085A	7.50	8279-5	6.95
8086	22.50	8288	25.00
AMD 2901	8.95	8355	12.95
8156	8.95	8755	19.95
8202	19.95	Z80A CPU	4.75
8205	6.50	Z80B CPU	12.95
8212	3.50	Z80A CTC	6.75
8214	4.50	Z80A DART	9.00
8216	3.50	Z80A S10	10.95
8224	4.50	Z80A P10	4.95
8226	3.50	TMS 9927 NL	9.95
8237	14.00	6502	5.75
8238	3.95	6803L	12.95
8250	10.95	6809	6.95
8251	4.50	6810	3.50
8253	5.95	6821	4.60
8257	7.95	6845	13.95
		6850	3.95
		8875	4.50
		68000L8	39.50

INTER FACE & DRIVERS

1488	1.50
1489	1.50
3341A	2.95
8130	2.50
8830	2.50
8833	2.50
8834	2.00
8837	2.00
8838	2.50
AY3-1015D	5.75
AY5-1013A	3.75
AY5 3600	9.95
BR1941L	8.95
CRT5037	18.95
MM5307	7.95
MM5369	2.50
TR1602B	3.95

SHIFT REGISTERS

MM1402	1.75
MM1403	1.75
MM1404	1.75
MM5013	2.50
MM5055	2.50
MM5056	2.50
MM5057	2.50
MM5058	2.50
MM5060	2.50

DISC Controllers

1771	16.50
1791	25.00
1793	35.00
1795	45.00
1797	45.00
D765C	35.00

RAM's

2101A-4	1.50
21L02-3	.90
2111A	2.50
2114-2	1.40
2147-3	2.50
3242	6.00
TMS3409	1.75
MK4027-3	1.75
TMS4050NL	2.95
MK4096-11	1.25
4108-3	1.50
4116-15	1.50
4118-4	5.50
4164-15	7.25
MK4802	5.95
5101E	2.95
Z6104-4	2.50
6116-3	6.75
8118-12	4.95

ROM's

2532	7.95
2708	3.50
27128	22.50
2716 + 5V	4.95
2732	7.95
2764	9.95
3628A-3	3.00
6331	1.95
TPB18S42	3.50
TPB28S166	9.50
74S474	3.95
7643-5	3.95
82S23	2.50
82S126	1.95
82S130	1.95
82S181	6.95
82S191	9.50

NO. 30 WIRE WRAP WIRE SINGLE STRAND 100' . . . $1.40

CRYSTALS

1.843	6.000
2.000	6.144
3.000	8.000
3.579	10.000
4.000	18.000
5.000	18.432
	20.000

3.50 ea.

EPOXY GLASS VECTOR BOARD

1/16" thick with 1/10" spacing
4½" x 6½" $1.95

SCR's

	1.5A	6A	35A
100	.35	.40	1.40
200	.40	.50	1.80
400	.60	.70	2.40
600		1.00	3.60

TRIAC's

PRV	1A	10A	25A
100	.35	.60	1.40
200	.50	.80	1.90
400	.70	1.00	2.60
600	1.00	1.20	3.60

C/MOS

4001	.40	4028	.80	4077	.50	74C14	.70
4002	.40	4029	1.00	4081	.40	74C20	.40
4006	.80	4030	.60	4082	.40	74C32	.80
4007	.40	4034	1.75	4093	.80	74C42	1.00
4008	.70	4035	1.00	4099	1.75	74C76	1.00
4009	.50	4040	1.00	4501	.95	74C83	1.25
4010	.60	4042	.90	4503	1.50	74C86	.70
4011	.45	4043	.90	4510	1.00	74C154	2.50
4012	.45	4044	.90	4511	1.00	74C157	1.75
4013	.60	4046	1.20	4514	1.25	74C160	1.20
4014	.70	4047	1.50	4515	1.50	74C161	1.15
4015	.60	4049	.60	4516	1.40	74C163	1.15
4016	.60	4050	.60	4518	1.00	74C173	.75
4017	1.00	4051	1.00	4520	1.20	74C174	1.15
4018	.70	4052	1.00	4528	1.00	74C175	1.19
4019	.70	4053	1.00	4539	1.25	74C193	1.75
4020	.80	4060	1.00	4583	.90	74C901	.60
4021	.80	4066	.70	4585	.75	74C902	1.00
4022	1.00	4068	.50	74C02	.40	74C914	1.75
4023	.40	4069	.50	74C04	.50	74C921	3.95
4024	.70	4070	.50	74C08	.50		
4025	.40	4071	.50	74C10	.40		
4026	.95	4072	.50				
4027	.60	4076	.65				

74S SERIES

74S00	.40	74S85	1.10	74S174	1.40
74S02	.40	74S86	.90	74S175	1.40
74S03	.40	74S89	2.20	74S181	2.20
74S04	.70	74S112	.85	74S182	1.75
74S05	.50	74S124	2.00	74S194	1.10
74S08	.50	74S133	.50	74S195	1.50
74S10	.40	74S135	1.10	74S240	1.00
74S11	.45	74S138	1.25	74S241	1.50
74S15	.50	74S139	1.10	74S257	1.30
74S20	.45	74S140	1.70	74S260	1.50
74S30	.40	74S151	1.25	74S373	2.25
74S32	.80	74S157	1.25	74S374	1.75
74S43	.85	74S158	1.25		
74S51	.70	74S161	1.75		
74S74	1.10	74S163	1.40		

50 PIN EDGEBOARD CONN.	3.95
40 PIN EDGEBOARD CONN.	3.00
34 PIN EDGEBOARD CONN.	3.00
26 PIN EDGEBOARD CONN.	2.50
60 PIN RIBBON CABLE CONN.	4.00
50 PIN RIBBON CABLE CONN.	3.50
40 PIN RIBBON CABLE CONN.	3.00
34 PIN RIBBON CABLE CONN.	2.75
26 PIN RIBBON CABLE CONN.	2.50
20 PIN RIBBON CABLE CONN.	2.00

TRANSISTOR SPECIALS

2N1307 PNP GE TO-5	$ .40
2N404A PNP GE TO-5	3/$1.00
HEP G6014 — PNP GE TO-3	$ .85
TIP 111 $ .50 TIP 145	$1.35
2N6233 NPN SWITCHING POWER	$1.95
MRF-8004 CM RF TRANSISTOR NPN	$ .75
2N4908 PNP Si TO-3	$1.00
TIP 2955 PNP Si	$ .70
2N2222 NPN Si TO-18	7/$1.00
2N2907 PNP Si TO-18	7/$1.00
2N3055 NPN Si TO-3	$ .60
2N3904 NPN Si TO-92	7/$1.00
2N3906 PNP Si TO 92	7/$1.00
2N6109 PNP Si TO-220	$ .55
TIP 31B NPN Si TO 220	$ .40
TIP 32B PNP Si TO-220	$ .40
TIP 34 PNP Si	$ .95
TIP 121 PNP Si U84	$ .80
TIP 141 NPN Si U97	$1.00
BU206	$1.75
DPS2000 — DUAL POWER DARL.	$3.95
MJE3055T	$ .60

TTL IC SERIES

7400	.35	7474	.50	74164	.80
7401	.30	7475	.50	74165	.80
7402	.35	7476	.45	74166	.90
7403	.30	7480	.45	74170	1.60
7404	.50	7483	.50	74173	.75
7405	.50	7485	.70	74174	.80
7408	.40	7486	.55	74175	.70
7409	.40	7490	.50	74176	.75
7410	.30	7491	.55	74180	1.90
7411	.30	7492	.55	74181	1.90
7412	.30	7493	.55	74182	.90
7413	.45	7494	.60	74190	.80
7414	.75	7495	.55	74191	.80
7420	.30	7496	.60	74192	.80
7425	.30	74107	.50	74193	.79
7426	.30	74116	1.50	74194	.85
7427	.30	74121	.45	74195	.45
7430	.30	74122	.50	74196	.75
7432	.60	74123	.95	74199	1.25
7437	.50	74125	.60	74221	1.00
7438	1.10	74126	.45	74273	.85
7440	.30	74145	.60	74279	.60
7442	.60	74148	1.10	74298	.65
7445	1.00	74150	1.10	74365	.80
7446	.80	74151	.60	74367	.80
7447	1.10	74153	.60	74390	.90
7448	.80	74154	1.60	75325	1.50
7450	.30	74155	.60	75492	1.05
7472	.40	74157	.60	9601	.75
7473	.45	74160	.85	9602	.75
		74161	.65	8T26	1.40
		74162	.70	8T28	1.40
		74163	.70	8T98	1.10

74LS SERIES

74LS00	.50	74LS109	.70	74LS241	1.50
74LS01	.40	74LS112	.60	74LS242	2.00
74LS02	.50	74LS113	.60	74LS243	2.00
74LS03	.40	74LS114	.65	74LS244	2.25
74LS04	.70	74LS126	.60	74LS245	2.25
74LS05	.70	74LS132	.90	74LS246	.95
74LS08	.70	74LS136	75	74LS247	1.50
74LS09	.50	74LS137	96	74LS248	1.50
74LS10	.50	74LS138	1.25	74LS251	.70
74LS11	.50	74LS139	1.30	74LS253	.70
74LS12	.40	74LS147	1.95	74LS257	70
74LS13	.55	74LS151	.70	74LS258	80
74LS14	90	74LS153	.70	74LS259	2.00
74LS15	.50	74LS155	.80	74LS260	1.75
74LS20	.40	74LS156	.80	74LS266	.70
74LS21	.40	74LS157	.80	74LS273	1.60
74LS22	.40	74LS158	.80	74LS279	.60
74LS26	.55	74LS160	.90	74LS280	1.80
74LS27	.60	74LS161	.90	74LS283	80
74LS28	.50	74LS162	90	74LS290	1.20
74LS32	1.10	74LS163	.90	74LS293	.90
74LS37	.50	74LS164	.90	74LS298	1.20
74LS38	.50	74LS165	.90	74LS320	2.00
74LS40	.40	74LS166	1.90	74LS323	3.50
74LS42	.70	74LS169	2.50	74LS365	.90
74LS47	1.10	74LS170	1.90	74LS366	90
74LS51	.40	74LS173	.90	74LS367	1.25
74LS54	.40	74LS174	90	74LS368	90
74LS73	.80	74LS175	.90	74LS373	2.00
74LS74	1.20	74LS181	1.95	74LS374	2.30
74LS75	1.25	74LS190	.90	74LS377	2.00
74LS76	80	74LS191	.90	74LS386	60
74LS83	80	74LS192	.90	74LS390	1.10
74LS85	.90	74LS193	.90	74LS393	1.10
74LS86	.60	74LS194	1.00	74LS398	2.50
74LS90	.90	74LS195	.90	74LS446	2.00
74LS92	.70	74LS196	.90	74LS625	1.75
74LS93	.70	74LS197	.90	74LS668	1.50
74LS95	.90	74LS221	1.50	74LS670	1.20
74LS96	.80	74LS240	1.50	81LS97	1.50
74LS107	.55			81LS98	1.50

MULTI TURN TRIM POTS

50 OHM		5K
100 OHM	3/$2.00	10K
1000 OHM		50K

LINEAR CIRCUITS

		LM370	1.60		
DAQ08EQ	3.75	LM377	1.60	798CT	.60
TL062 CP	.96	LM380	1.20	LM1310	1.60
TL064 CN	1.50	LM384	1.60	LM1391	1.00
TL072	1.25	LM386	1.50	1456	.80
TL082	1.50	LM387	1.25	1458	.50
LM201	.75	LM393	.75	LM1808	1.75
LM301/748	.50	LF398A	3.50	AD2700LD	4.95
LM307	.50	LM555	.50	LM2901	.95
LM308	.65	LM556	.90	CA3018	1.95
LM310	1.10	558	1.25	CA3078AT	1.50
LM311	.80	565	1.25	CA3080	1.00
LM319	1.30	566	1.25	CA3086	.75
LM324	1.25	567	1.75	CA3089E	1.75
LM339	.90	709C	.80	CA3130	1.00
LM348	.90	LM710	.60	CA3140	1.00
LF351	.80	711CH	.40	3900	.50
LF353	.95	733	.95	LM3909	.80
LF355	.90	741CV	.40	4136	.85
LM358	.50	747	.50	N5596A	1.50
LM361	1.75	CA758	1.75	8700CJ	5.95
				LM13080	.95

4164-2 — $6.25
4164-15— 100/$660.00
4116-3 — 100/$100.00
2114-3 — 100/$100.00

2N3820 P FET	$ .45
2N5457 N FET	$ .45
2N2646 UJT	$ .45
ER 900 TRIGGER DIODES	4/$1.00
2N 6028 PROG. UJT	$ .65

DISC CAPACITORS

.1UF 16V	10 $1.00	100/$8.00
.01UF 35V	16 $1.00	100 $5.00

PRINTED CIRCUIT BOARD

4" x 6" DOUBLE SIDED EPOXY BOARDED 1/16" THICK $.60 ea. . . . 5/$2.60

TOGGLE SWITCHES

106D — SPDT — 1.00
206D — DPDT — 1.40
206P — DPDT — CENTER OFF 1.80

IN4148 (IN914) 15/1.00

L1411-IR DETECTOR	3/$1.00
FP 100 PHOTO TRANS	$ .50
RED LED's .2"	8/$1.00
YEL, GREEN or AMBER LARGE LED's .2"	6/$1.00
RED-GREEN BIPOLAR LED	$ .90
RED-YELLOW BIPOLAR LED	$ .90
MLED92 IR LED	$ .40
MRD14B PHOTO DARL. XTOR	$ .50
MCT2 OPTO ISOLATORS	$ .60
1 WATT ZENERS: 3.3, 4.7, 5.1, 5.6, 6.8, 8.2, 9.1, 10, 12, 15, 18, or 22V	6/$1.00

FULL WAVE BRIDGE

PRV	2A	6A	25A
100			1.40
200	.80	1.30	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

12VDC RELAYS [illegible]
S.P. 1200 ohm coil [illegible]
D.P. 400 ohm coil [illegible]

SILICON POWER RECTIFIERS

PRV	1A	3A	12A	50A	125A	240A
100	.05	.14	.35	.90	5.00	6.00
200	.06	.17	.50	1.30	7.00	9.00
400	.09	.25	.65	1.50	10.00	12.00
600	.11	.30	.80	2.00	13.00	15.00
800	.13	.35	1.00	2.50	16.00	18.00
1000	.20	.45	1.25	3.00	20.00	26.00

DIP SWITCHES

CTS 206- 4	4 POSITION .75
CTS 206- 7	7 POSITION .95
CTS 206- 8	8 POSITION .95
CTS 206-10	10 POSITION 1.25

REGULATORS

LM338K	$5.75	323K (LA1405)	$1.75
LM317T	$1.35	LM305G	$ .75
78L05, 78L12	$ .40	340T-5, 6, 8, 9, 12, 15, 18 or 24V	$ .75
723	$ .50	LAS1412 + 12V 3A	$3.95
320T 5, 12, 15 or 24	$ .85		
LM 337T	$1.95		

DIP SOCKETS

8 PIN	.10	22 PIN	.25
14 PIN	.15	24 PIN	.25
16 PIN	.18	28 PIN	.35
18 PIN	.20	40 PIN	.40
20 PIN	.25		

TANTALUM CAPACITORS

.22UF 35V	5/$1.00	15UF 16V	3/$1.00
.47UF 35V	5/$1.00	30UF 6V	5/$1.00
.68UF 35V	5/$1.00	33UF 15V	$ .50
1UF 20V	5/$1.00	47UF 20V	$ .85
2.2UF 20V	5/$1.00	68UF 16V	$1.00
3.3UF 20V	4/$1.00	120UF 6V	$ .75
4.7UF 35V	4/$1.00	200UF 20V	$1.75
6.8UF 20V	4/$1.00	150UF 16V	$1.30
10UF 20V	— $ .40	330UF 10V	$1.75
22UF 10V	— $ .30		

WIRE WRAP SOCKETS

14 PIN	— .45
16 PIN	— .50
18 PIN	— .65
20 PIN	— .90
24 PIN	— 1.10
28 PIN	— 1.25
40 PIN	— 1.80

20KV DIODES 250 ma. **$1.95**

DB CONNECTORS

DB9P	$2.00	DB25P	$2.40
DB9S	3.00	DB25S	3.20
HOODS	1.10	HOODS	1.10

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POCKET PAIN FIELD GENERATOR — IPG50
Assembled $59.50
IPG5 . . . Plans . . . $7.00 **IPG5K** . . . Kit/Plans . . . $39.50

PHASOR PAIN FIELD CROWD CONTROLLER — PPF10
Assembled $250.00
PPF1 . . . Plans . . . $15.00 **PPF1K** . . . Kit/Plans . . . $175.00

BLASTER— Provides a plasma discharge capable of puncturing a can.
BLS10 . . . Assembled . . . $79.50
BLS1 . . . Plans . . . $10.00 **BLS1K** . . . Kit/Plans . . . $59.50

SHOCKER/PARALYZING DEVICE — Very intimidating and effective.
SHG60 . . . Assembled . . . $99.50
SHG6 . . . Plans . . . $10.00 **SHG6** . . . Kit/Plans . . . $79.50

LASERS

RUBY LASER RAY GUN — Intense visible red beam burns and welds hardest of metals. **MAY BE HAZARDOUS.**
RUB3 *All Parts Available for Completing Device* $15.00

CARBON DIOXIDE BURNING, CUTTING LASER — Produces a continuous beam of high energy. **MAY BE HAZARDOUS.**
LC5 . . *All Parts Available for Completing Device* . . $15.00

VISIBLE LASER LIGHT GUN — produces intense red beam for sighting, spotting, etc. Hand held complete.
LGU3 . . Plans . . $10.00 *(Kit & Assembled Units Available)*

IR PULSED LASER RIFLE — Produces 15-30 watt infra-red pulses at 200-2000 per sec.
LRG3 . . . *All Parts & Diodes Available* . . . $10.00

BEGINNERS LOW POWER VISIBLE LASER — Choice of red, yellow, green — provides an excellent source of monochromatic light.
LHC2 . . . Plans . . . $5.00 **LHC2K** . . . Kit . . . $29.50

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MFT1 . . . Plans . . . $7.00 **MFT1K** . . . Plans/Kit . . . $39.50

WIRELESS TELEPHONE TRANSMITTER — Transmits both sides of phone conversation over one mile, shuts off automatically.
VWPM5 . . . Plans . . . $8.00 **VWPM5K** . . . Plans/Kit . . . $34.50

TALK & TELL AUTOMATIC TELEPHONE RECORDING DEVICE — Great for monitoring telephone use.
TAT20 . . . Assembled . . . $24.50
TAT2 . . . Plans . . . $5.00 **TAT2K** . . . Plans/Kit . . . $14.50

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2304 MOD 3 (Hi-Gain Pre-amp) (Includes case & fittings)	$39.95

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Two independent memories of 512 words (horizontal dots) with 8-bit vertical resolution let users capture information about events ranging from 2 μs to 1-hr in duration. Five selectable trigger points (0, 25%, 30%, 75%, and 100%) give users options as to how much data is stored before and after the triggering event.

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