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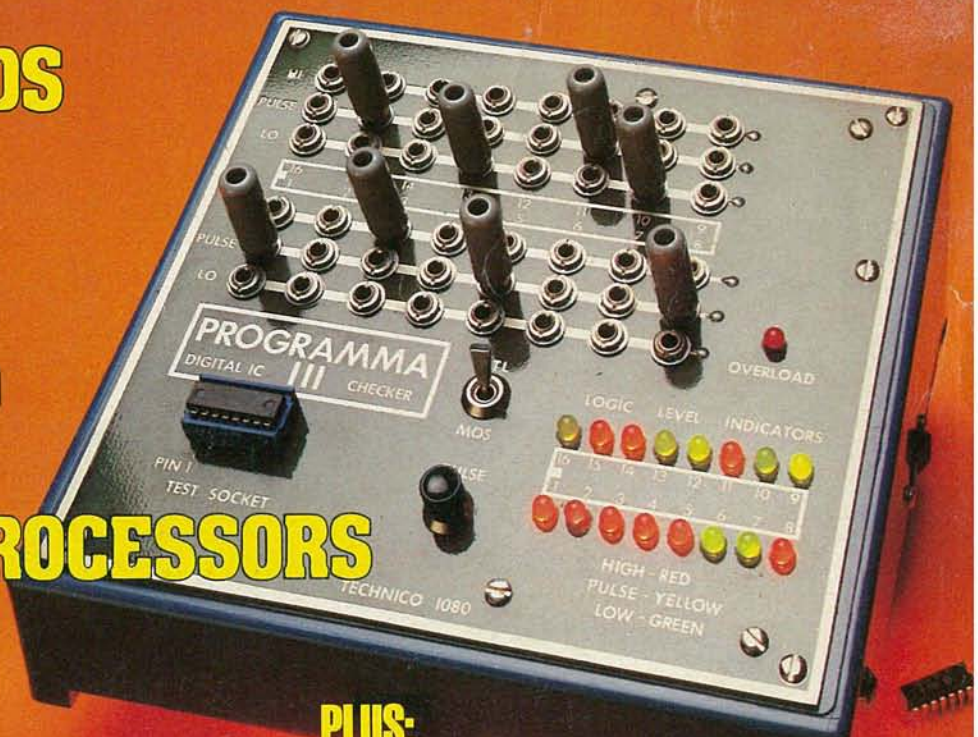


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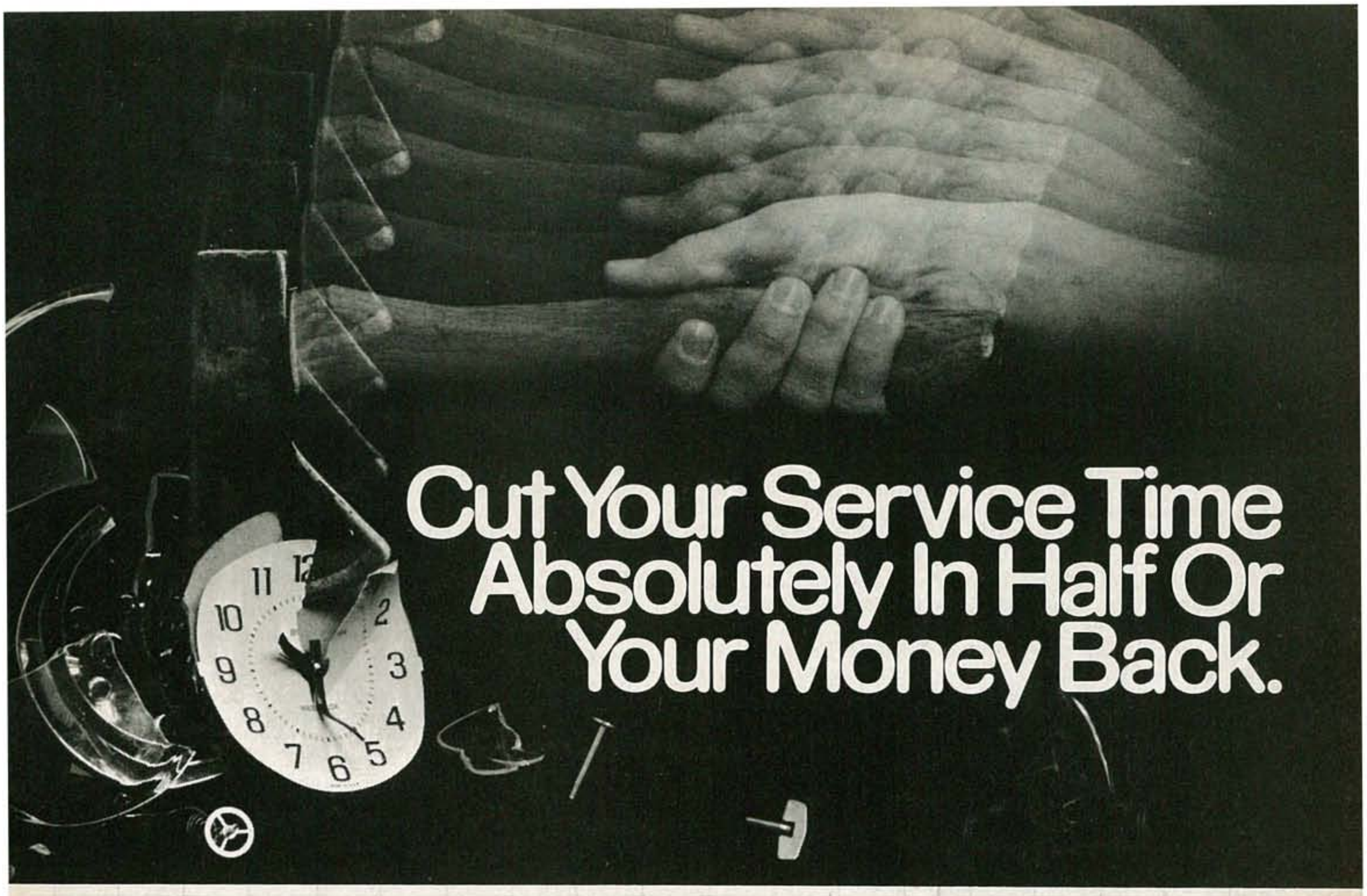

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## ON THE COVER

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## ANNUAL INDEX JANUARY—DECEMBER

## 1982

To present the maximum number of articles to our readers, we have not published the Annual Index as part of this issue. A 4-page brochure containing this index is available for those who need one. To get your free copy, send a *stamped self-addressed envelope (legal size) to:*

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Any requests postmarked on or before April 30 are free. After that date there is a 50¢ fee. Questions and comments about anything other than the Index that are included with your request cannot be handled. Send them separately to our Editorial Offices.

**Because of space restrictions, the second part of the "Automatic Commercial Editor" will not appear in this issue. It *will* appear next month.**

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# VIDEO ELECTRONICS

**DAVID LACHENBRUCH**
CONTRIBUTING EDITOR

## KODAK'S VIDEOPLAYER

At the recent Photokina exposition in Cologne, Germany, Eastman Kodak demonstrated a prototype of a home-video product that it may be planning to produce—and it turned out to be very similar to the possible Kodak product described in this space last February. It's an accessory that permits the viewing of Kodak's Disc camera pictures on the home-TV screen. It permits "electronic cropping," or the ability to zoom in on any portion of the picture so it fills the screen. Those cropping instructions are automatically recorded on a magnetic stripe on the film disc, so that the same portion of the photo shows up every time it's projected on the TV screen after the first cropping. The instructions placed on the magnetic stripe by the user can also be used by photo processors' automated equiment to produce custom prints or enlargements. Kodak employs a CCD solid-state imager in its videoplayer, with a definition of 350,000 picture elements—almost twice as much as the first solid-state color TV cameras from Japan. Any segment of the picture can be enlarged by as much as four times.

## TV STEREO TESTS RESUME

Members of the EIA subcommittee exploring multichannel sound for TV (including stereo) have gone back to their drawing boards, despite the FCC's attitude that it won't wait for a recommendation before proposing to permit multi-audio with television (see **Radio-Electronics,** December 1982). The industry-wide committee, composed of engineers from TV stations and networks, receiver manufacturers, and cable-TV interests, is re-testing two proposed systems that have been modified since tests were started nearly four years ago. It will also determine what modifications will be necessary in cable-TV equipment for accommodating multichannel sound, and will test various companding systems, such as CX, Dolby, dbx, and Telefunken.

The subcommittee now has a goal: completing the tests, and recommending one multichannel system and one companding system by May, which probably would make stereo telecasting possible early in 1984. The FCC is expected to go ahead simultaneously with its proposal for multichannel TV without specifying any standard. The subcommittee is seeking legal opinions on whether it can complete its work after the Commission starts deliberating on the issue. Some members feel that that could be interpreted as an antitrust-law violation and may resign from the standards group unless they can get some assurance that they won't be prosecuted for that activity.

## TV-CABLE INTERFACE

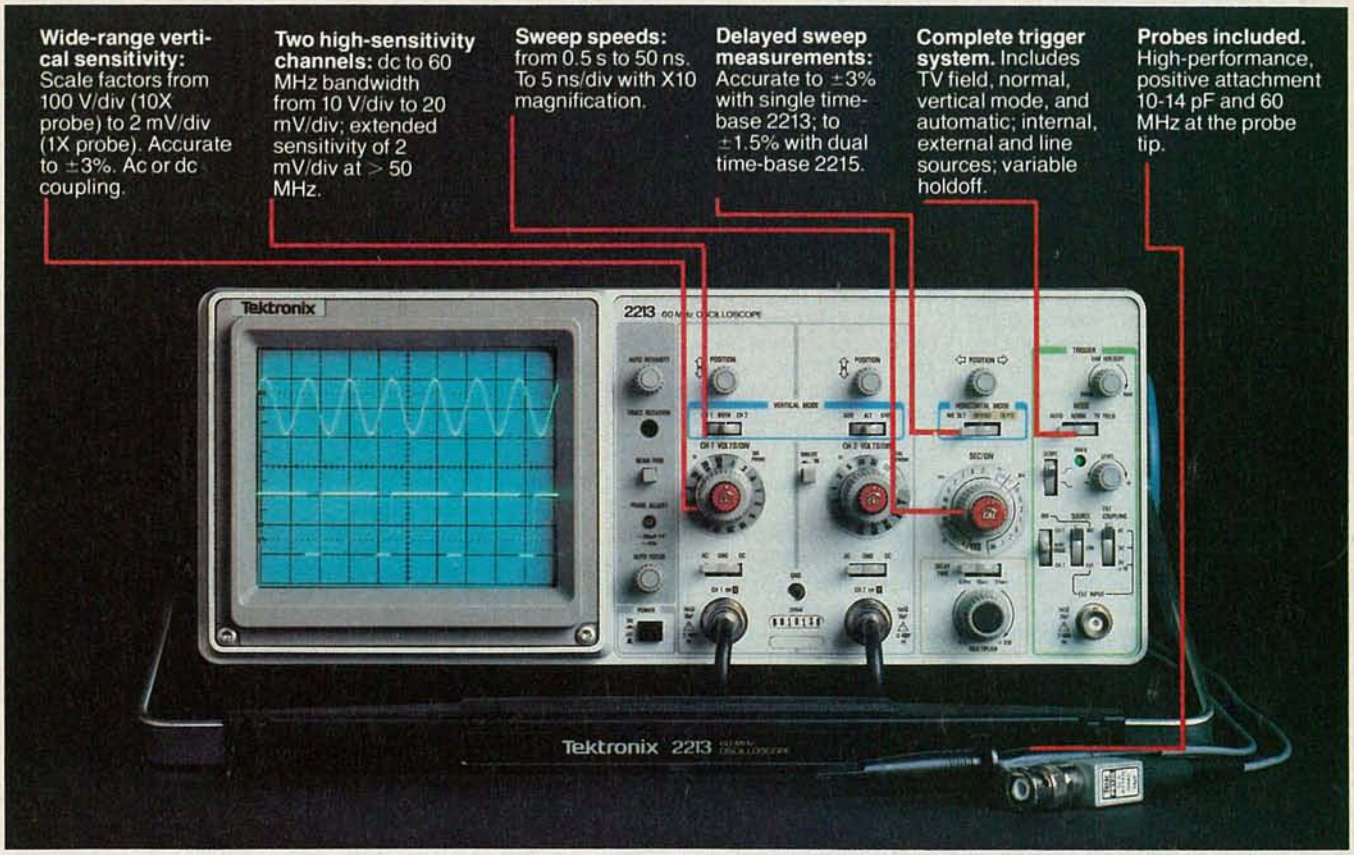
Another standards-setting group, this one jointly sponsored by EIA and National Cable TV Association (NCTA), is tackling the problem of compatibility between CATV systems and television receivers to eliminate the cable converter box and make TV sets truly "cable-ready." The first issue considered by the committee was standardizing cable channels and their identification. Although details are still to be worked out, there was general agreement that the cable channels should be numbered—perhaps from 1 to 99—rather than using the current informal lettering scheme.

The tougher problem of interface is expected to be solved by recommending that future TV receivers be built with a "port" or receptacle to accommodate a circuit board that would interface the specific cable system with the set. The card could contain pay-TV or pay-per-view decoders as well as various converters or connectors for the standard "non-pay" cable channels. Each port would be flexible enough to accommodate a wide variety of plug-in cards for various cable systems or services. In addition, the TV ports might also be designed for interface with other video equipment, such as computers, VCR's and videodisc players. Although there is general agreement on the two approaches—numbering channels and the provision for an interface port—working out details is expected to be a time-consuming process.

## WATCHMAN

Sony's little two-inch flat-tube portable TV set now has an official name—*Watchman,* inspired by you-know-what. It is now scheduled to show up in the United States shortly at a suggested list price just below $300. And if Sony wants to call its little hand-held TV "Watchman," that's probably all right with Japan's watchmaker Seiko, which plans to introduce next year a combination watch, TV, and radio, with 1.4-inch LCD displays for TV and time, at about $400. It has earphones for audio and a wallet-sized pocket battery pack. **R-E**

# Tek's most successful scope series ever: At $1200-$1450, it's easy to see why!

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# WHAT'S NEWS

## Rooftop terminals to take over by 1990?

More than 15 million rooftop dishes for direct-broadcast satellite reception will be installed on U.S. homes by 1990, states a 187-page report by International Resource Development Co., a Norwalk, CT, research firm. The report also predicts that the rooftop terminals, intended for Ku-band frequencies (between 15 and 17 GHz approximately) will render present backyard terminals all but obsolete. Those terminals operate on C-band frequencies, around 4 to 6 GHz. One exception will be the cable networks and operators, already firmly established with heavy investments on the C band.

## Record industry wants to tax tapes, recorders

In two separate bills, one in the House of Representatives and the other in the Senate, audio interests propose an indirect tax on home recording. That move appears to have been inspired by the proposal of some video interests to tax home-video recording. Until the introduction of those bills, private audio recording had been accepted without challenge for several decades.

The bills (H.R. 5705 and Senate Amendment 1331) are careful to provide that no tax shall impose a direct liability on the individual who uses recording devices or media in the home for private purposes. (The clause comes immediately after a statement that such home recording constitutes infringement of copyright.)

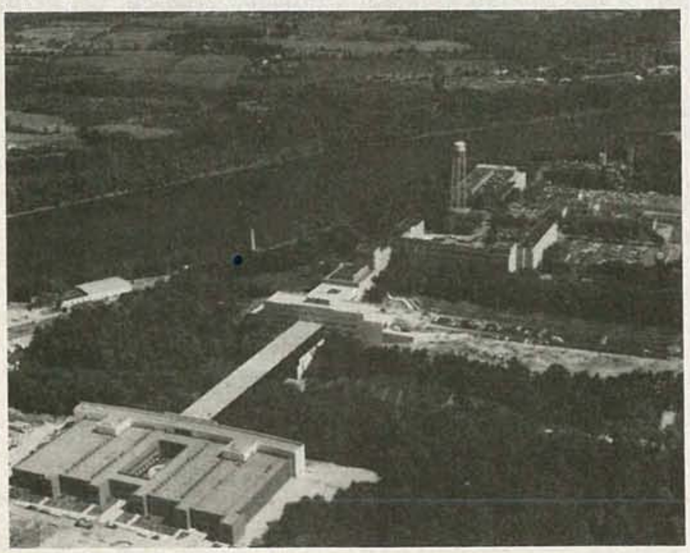
The bills, instead, propose a tax on all recorders and blank recording media (tapes, etc.) at point of import or manufacture. The proceeds would be distributed by a Copyright Royalty Tribunal among copyright owners whose works might be copies with the machines and tapes.

The proposed tax, while called a "royalty," would be imposed equally on all equipment whether or not the equipment would be used for personal recording purposes or for copying a friend's album or a radio program. The manufacturer or importer would be free of the tax for as much of his sales that a "fair estimate" would show to be used for purposes other than home recording.

Difficulties loom (should such a law be passed) in distribution of the "royalties." The Tribunal is supposed to "determine fair compensation to copyright owners," but provides for "proceedings" in case of disagreement between and among royalty claimants.

In view of the technical difficulties of enforcement, the likely unconstitutionality of such a law, and the probable effect on the tape and tape recording industry the tax might have (if it were large enough to guarantee what copyright owners might consider "fair compensation") the passage of the bills seems doubtful.

## GENERAL ELECTRIC EXPANDS RESEARCH CENTER



**NEW ELECTRONICS AND COMPUTER SCIENCE LABORATORIES, among the world's most advanced, are seen in the foreground. Midway along the span is a new two-story office building, and at the end of the span structure a five-story commons/services building. All are part of the General Electric Research Center's expansion program, which has increased the size of the Center by 50 percent over the past three years, with an investment of more than $130 million.**

## Security by cable Installed in St. Louis

Warner Amex Cable Communications introduced security service in the St. Louis area early in September, making St. Louis the sixth major city where 24-hour fire, burglary, and medical alert services are provided by Warner Amex. The others are Pittsburgh, PA; Cincinnati and Columbus, OH; and Dallas and Houston, TX.

The new service will be available to 25 communities in the metropolitan St. Louis area. It can be made available to all residents in the area, including non-cable TV families and businesses.

To demonstrate the new service, Mr. Miklos B. Korodi of Warner Amex tripped a burglar alarm before a group of guests that included mayors, police and fire chiefs, and other civic dignitaries from the 26 communities. The alarm was received immediately by the Warner Amex security center and flashed to police headquarters. Control units arrived less than five minutes after the alarm.

## Typesetting service for computer users

Two prominent companies, Type Share and CompuServe, have joined forces to offer a low-cost, high-quality typesetting service to users of micro- (and other) computers. Users need to have only a computer and an editor or word-processor program that can produce sequential ASCII files and store them on either a tape or disc.

Also needed are a modem and transmission software that ca communicate as a terminal an transmit the previously store material over the phone. A Typ Share manual that provides eas to-follow instructions—with exter sive examples—for every step i the typesetting process is also re quired.

Users, says Steve Westmorlan of Type Share, have the fu capability of a commercial type setting establishment at their fir gertips. Their files are processe on modern computerize phototypesetting equipment tha produces headlines and body cop in a wide assortment of styles an sizes. The cost is as little as $4.0 per foot on 4-inch wide paper c $6.00 per foot on 8-inch wid paper.

The user simply enters th material into a computer, alon with the easy-to-use code (according to the instructions the Type Share manual) to speci style, size, column width, etc. A jobs are completed, they are save on disk or tape. Then, at his co venience, the user dials a loc phone number and transmits th work to CompuServe. Use receive—usually within tw days—the same kind of galle they would get from a commerci typesetter.

Type Share is a typesetting se vice that specializes in producir typeset material from user file CompuServe is a leadir computer-services company ar information network. "Marryir these two services," sa Westmorland, "has made natio wide time-shared typesetting reality for the first time."

## AM stereo broadcasts begin in Atlanta

WQXI, Atlanta, GA, signed last August 6 with its first stere broadcast program. The equi ment, supplied by Harris Broa cast Division, was installed the d before, when Harris Corp. w granted FCC type acceptance the STX-1 AM stereo Exciter. T STX-1 was installed at WQXI about four hours.

WQXI operates on 790 kHz w 5,000 watts. During the daylig hours, the transmitting pattern nondirectional—at night a rectional array is used. F

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During the past year, your magazine, RADIO-ELECTRONICS, posted a tremendous total of 1,023 pages of advertising...representing a huge linage gain of 23% over 1981. This is one of the largest increases reported by any publication. It ranks RADIO-ELECTRONICS among an elite group of supremely successful publications in the media marketplace, for which we are both proud and grateful.

And these added advertising pages you helped us get brought additional *editorial* pages for you! *We invested substantially and ran 120 more pages of exciting articles and features throughout 1982...for an average of 10 extra editorial pages per issue!*

As we close 1982 and reflect upon our leadership position in electronics publishing, we acknowledge in full our responsibilities to you, our readers. We pledge to strive even harder to provide the most incisive editorial at the cutting edge of the field. We will exert every effort possible to continue to earn your esteem, justify your faith in us and enhance your enjoyment of electronics.

Season's Greetings from all of us at RADIO-ELECTRONICS and best wishes for health, happiness and prosperity for the coming year.

The Staff of
**Radio-Electronics**®

# EDITORIAL

## Committing suicide—FCC style

I'm sure that many of you are wondering about the recent rash of aparently absurd decisions that has been coming forth from the FCC. I know that I have. Well, FCC Chairman Mark Fowler has let the cat out of the bag. Chairman Fowler has proposed a sweeping deregulation of the broadcasting industry, including an end to licensing requirements.

In Chairman Fowler's mind, the regulations that apply to radio and TV stations should be "indistinguishable" from newspapers. Chairman Fowler feels that the broadcasters "... should be as free from regulation as the newspapers you share the press table with and compete with for advertisers."

"No license-renewal filings, no ascertainment exercises, no content regulation, no ownership restrictions beyond those that apply to the media generally, free resale of properties, no petitions to deny, no brownie points for doing this right, no finger wagging for doing that wrong," Fowler said.

Those statements certainly put an end to any questions regarding the FCC's sanity. It's no longer a question! I could explain at this point why the FCC was born in the first place and explain its purpose for existing; but if Chairman Fowler doesn't already understand that, I can see no purpose it would serve. Instead, I will await the day that I can build my own broadcast transmitter out of junkbox parts and play DJ for a day. I will await the day that I will finally find out what is it really like to tag a 1 kilowatt linear to the output of my CB. Then I will crawl away and hide because there will be 200 million other people in this country finding out the very same things.

**ART KLEIMAN**
**Editor**

**Radio-Electronics**



Cover photo by Robert Lewis

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# INTRODUCING the sophisticated

# SATELLITE/TELETEXT NEWS

**GARY ARLEN**
CONTRIBUTING EDITOR

## MORE ORIGINAL PROGRAMMING

The ever-increasing number of cable/satellite programming networks are emphasizing original shows, rather than relying on a dwindling supply of Hollywood movies and other program sources. Home Box Office, Showtime, the cultural, sports, and special-interest channels have all revealed extensive plans for innovative schedules of newly-created shows.

For example, HBO is working with Muppets creator Jim Henson to develop a weekly series called "Fraggle Rock" that will feature a whole new breed of Muppets. HBO's upcoming line-up also includes a new series of "short story" programs, plus an original National Geographic Society series. Showtime will offer a few soap-opera-type series, plus a hefty roster of flashy stage performances. ESPN has made a deal with the new United States Football League to telecast two prime-time games per week during the USFL season, which begins in March, 1983.

In addition, the recently launched Cable Health Network includes 25 original series, ranging from science and health news to healthcare advice and fitness programs. And entirely new channels—including UTV and Satellite News Channels—add to the viewing options. Moreover, there are new strategies for packaging satellite programs. For example, Tele-Communications Inc., one of the largest national cable-TV companies, is grouping a number of existing satellite program channels as a standard package of shows which it will offer on all of its cable systems.

## NEW PRODUCTS

**Channel Master** has introduced a new generation of satellite-reception equipment, including redesigned devices from dishes to LNA's. The new CM earth stations are available in 8 different models; each system includes a 10- or 12-foot dish, polar mount, 100° or 120° low-noise amplifiers, scaler feed with automatic polarizer, and 24-channel receiver-downconverter. The prime focus feed-assembly and downconverter are supported above the dish by aluminum struts. Correct polarity is automatically chosen by a special integral polarizer according to the channel selected by the receiver. Several of CM's new packages start in price under $4500. (Channel Master, Ellenville, NY 12428.)

**Pico-Savac** has introduced a 100% reflective RF metal film which can be applied to existing and installed satellite antennas to improve contrast and gain. The company says the film covering will also increase noise rejection. The film, in effect, "remetalizes" the exposed surfaces on casted antennas, which often have bumps and other surface imperfections affecting reception. The RF films are available in 25-foot rolls, and Pico-Savac says that a 10-foot antenna can be remetalized in an hour at a cost of less than $90. (Pico-Savac, 7165 30th Avenue N, St. Petersburg, FL 33710.)

## MORE TEXT SIGNALS ON THE AIRWAYS

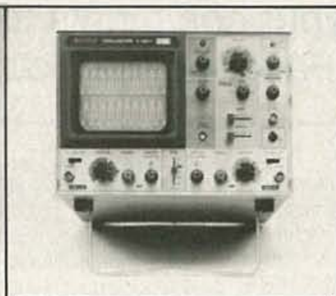
KPIX-TV, Channel 5 in San Francisco, has launched its *DirectVision* teletext experiment, using conventional Antiope technology to transmit a package of three different "magazines" of text and graphics. KPIX, owned by Group W Broadcasting, is testing the service until early 1983, at which time it will consider going ahead with a commercial service—possibly using the enhanced North American Broadcast Teletext Standard. For the test, *DirectVision* offers a group of electronic ads, a section of fast-breaking news, sports, business, and weather information, plus a section with classified ad listings supplied by a local newspaper chain. For the service, KPIX has introduced a section called *DirectVision Extra Messages.* Whenever a program or commercial appears which has a text supplement, teletext receivers automatically flash DV in the corner of the screen; viewers can then switch from the TV show to *DirectVision* for additional pertinent information.

Meanwhile, public-TV stations are delving deeper into text services—in this case special-interest data for farmers and ranchers. Public Broadcasting Service and the U.S. Department of Agriculture are testing a farm-news service using closed captioning facilities, and transmitted via PBS stations in Denver, Tampa, Fresno, Springfield, MO, and Fargo, ND. If the one-year test is successful, PBS may eventually distribute the farm-data service via satellite to public-TV stations nationwide; for this year's test, data travels via phone lines from USDA to participating PBS stations via satellite. To view the timely data, farmers, commodity brokers, and others in the agribusiness must buy a Sears *TeleCaption* decoder for their TV sets in order to pick up the signal. R-E

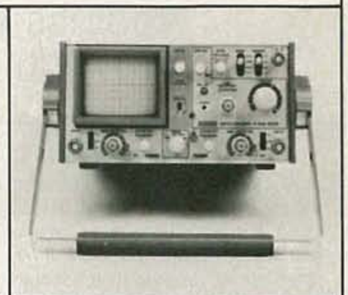
# "When will someone introduce high-performance scopes without the high prices?"

**V-152F — 15 MHz**
# $595

**V-202F — 20 MHz**
# $695



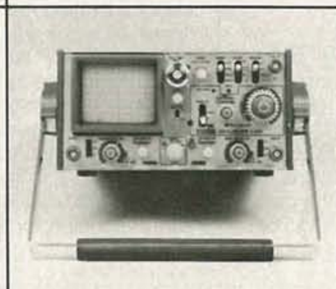
**V-302F — 30 MHz**
# $799



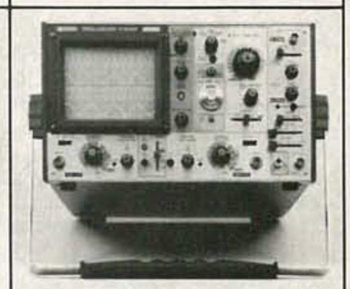
**V-209 — 20 MHz**
# $945

**V-353F — 35 MHz**
# $949

**V-650F — 60 MHz**
# $1,195



**V-509 — 50 MHz**
# $1,650



**V-1050F — 100 MHz**
# $1,980

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We call them our F series. They range from 15 MHz to 100 MHz and can be used for all types of bench and field work. There are dual-trace and quad-trace models. Several have delayed sweep. All are lightweight. Compact. And feature functionally grouped operating controls and bright, easy-to-read CRTs. Here's a closer look at each model:

**V-152F.** A 15 MHz, dual-trace scope, sensitive to 1 mV/div at 7 MHz. It has a 5″CRT. **$595.**

**V-202F.** A 20 MHz, dual-trace scope, sensitive to 1 mV/div at 7 MHz. It has a 5.5″CRT. **$695.**

**V-302F.** A 30 MHz dual-trace scope, sensitive to 1 mV/div at 7 MHz. It features signal delay and a 5″CRT. **$799.**

**V-353F.** A 35 MHz, dual-trace delayed sweep scope, sensitive to 1 mV/div at 7 MHz. It features a 5.5″square CRT. **$949.**

**V-209.** A 20 MHz, dual trace, mini-portable scope, sensitive to 1 mV/div at 5 MHz. It features AC/DC operation and has a 3.5″CRT, and weighs only 10 lbs. Battery included. **$945.**

**V-650F.** A 60 MHz, dual-trace scope, sensitive to 1 mV/div at 10 MHz. It features delayed sweep and a 6″CRT. **$1,195.**

**V-509.** A 50 MHz, dual-trace, mini-portable scope with optional battery pack, sensitive to 1 mV/div at 10 MHz. It features delayed sweep and a 6″CRT, and weighs 11 lbs. **$1,650.**

**V-1050F.** A 100 MHz, quad-trace scope, sensitive to 0.5 mV/div at 5 MHz. It features delayed sweep and a 6″CRT. **$1,980.**

There they are. High-performance scopes without the high prices. And all are backed by Hitachi's reputation for quality. To learn more, write or call us today. Hitachi Denshi America, Ltd., 175 Crossways Park West, Woodbury, NY 11797. Phone: (516) 921-7200. Offices also in Atlanta, Chicago and Los Angeles.

CIRCLE 83 ON FREE INFORMATION CARD

# LETTERS

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

### AGREEMENT

Just had to send you a little note after reading Mr. Paul T. Kelly's letter in the September 1982 **Radio-Electronics**. *Audio Amateur* and **Radio-Electronics** are the only magazines in their field worth subscribing to. There may be an occasion to pick up another publisher's magazine for a specific article, but the aforementioned periodicals are the only ones to read on a constant basis.

GARY A. NACHMAN
*Oak Park, MI*

### ROAD-INFORMATION SYSTEM

The letter by Mr. Charles Koontz titled "Road-Information System" (**Radio-Electronics,** July, page 22) states: "...due to the wrong transmitting-antenna design, the reliable fringe reception of FM stations beyond 65 miles is almost a thing of the past." The implication is that the coverage was better at some other time in the past. That statement is clearly incorrect and may mislead your readers.

The far-distant normal reception from an FM station is a function of transmitted power and antenna height above the terrain. Weather conditions affecting refraction also play a part in the signal level beyond about 35 miles from the transmitter. Since the mid-60's, FM stations have been converting to circularly polarized (CP) antennas; that has vastly improved the signal level of FM stations received in automobiles. As one holding a patent on CP antennas presently manufactured for use by FM stations, I could not let that statement go unchallenged. Ninety-nine percent of the U.S. FM stations use CP transmitting antennas!

Mr. Koontz also states that FM transmitters using his KQ2 system "...will be broadcasting high detail full-color pictures over FM stations broadcasting on mono, stereo, and quadraphonic, with and without SCA." That is simply not true, unless Mr. Koontz has discovered a new law of physics! As is well known, TV picture definition is simply a function of bandwidth. FM broadcasting bandwidth is limited by FCC allocations to ±100 kHz. Our 525-line TV video requires an RF bandwidth of 4.5 mHz. Koontz simply cannot squeeze that into 200 kHz!

On another subject, Mr. Koontz feels that the older tube FM exciters and transmitters were much better in technical response than the current state-of-the-art solid-state exciters and RF drivers with singe-tube 1, 5, 10 kW final RF amplifiers. I suggest that he read the specifications of any current FM transmitting equipment available from the manufacturers. He will learn that such current equipment is at least two orders of magnitude

*continued on page 20*

# New from NRI...

# Industrial Electronics with color computer.

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Here's the training that gets you into the heart of American industry's rebirth. Over $5 billion a year will be spent in automation alone... $2.3 billion in computerized control systems... $600 million in industrial robots and robotics is only just getting underway! To help meet the soaring demand for people to operate, maintain, repair, and design these control systems, NRI has created the only complete training in Industrial Electronics for Instrumentation and Control Technicians.

**Your training includes the TRS-80 color computer, the NRI Discovery Lab, interfacing breadboard, digital multimeter, frequency counter, computer-assisted training programs, audio instruction tape, and 46 profusely illustrated lessons.**

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NRI training is more than lessons... it's experiences. You learn by doing, using the TRS-80™ color computer to learn about control systems, programming, and troubleshooting. It comes with special computer-aided instruction programs to speed learning, is expandable for business and personal computing, and is yours to keep. And that's just the beginning.

NRI's exclusive Discovery Lab® is designed to interface with your computer and special breadboarding card so you build demonstration circuitry, "see" inside your computer, and follow its operation. You also get professional quality instruments, including your own digital multimeter and CMOS frequency counter. You'll use them during your hands-on training, keep them to use in your work.

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Your NRI training is thorough and complete. Starts you with the fundamentals, builds step-by-step up to the most advanced concepts. You learn about automatic control and feedback systems, control motors, numerical control systems, lasers and optoelectronics, robotics, microprocessors, instrumentation, computer peripherals, and much more. NRI keeps you up with technology to make the most of the big demand for control and instrumentation technicians.

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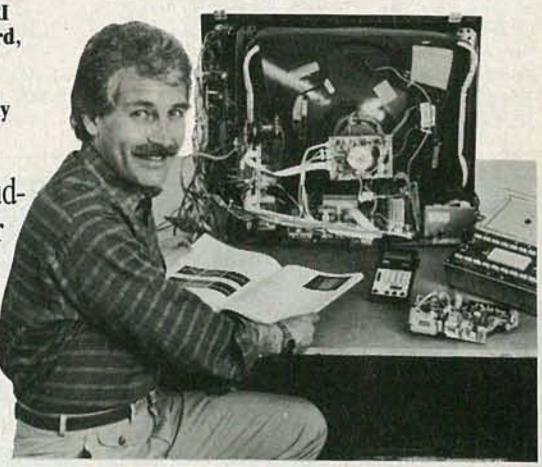
Send the postage-paid card for NRI's big electronic careers catalog. There's no cost or obligation, and no salesman will call. In it, you'll find complete lesson plans, equipment descriptions, and career opportunities in this exciting field. You'll also get information on almost a dozen other electronic courses including Microcomputers, Electronic Design, TV/Audio/Video Servicing, Digital Electronics, and more. Act today and get on with your future. If card has been used, write to us.



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## LETTERS

*continued from page 14*

better than the ones manufactured in the 50's and mid-60's, when comparing improvements in distortion, AM and FM noise levels, stereo separation, and also intermod distortion.
PETER K. ONNIGIAN
*Sacramento, CA 95822*

### ENERGY MISER

There were some errors in the editing of my article, "Energy Miser" in the August **Radio-Electronics.**

The following information may be helpful to your readers.

Temperature Fahrenheit = 1.8 × temperature Kelvin − 459.67°.

The output of IC12 (555) terminal no. 3 will go low when the voltage at terminal no. 6 is ⅔ $V_{CC}$ or 4 volts.

The output will go high when the voltage at terminal no. 2 is ⅓ $V_{CC}$ or 2 volts.

Relay RY1 contacts must be normally open.

A 1000-ohm resistor must be inserted in series with the base of Q1 (276-2017) and connected to D9 (IN1202). Without that resistor in the circuit, LED1 will not function.

Also, in the interest of ease of construction, perforated board was used for power-supply construction, and Radio Shack #276-170 PC boards for the IC circuitry. Multi-turn potentiometers were used for R1, R3, R6, R9, R11, R27, and R34 (PC type).
ROLAND GIBSON

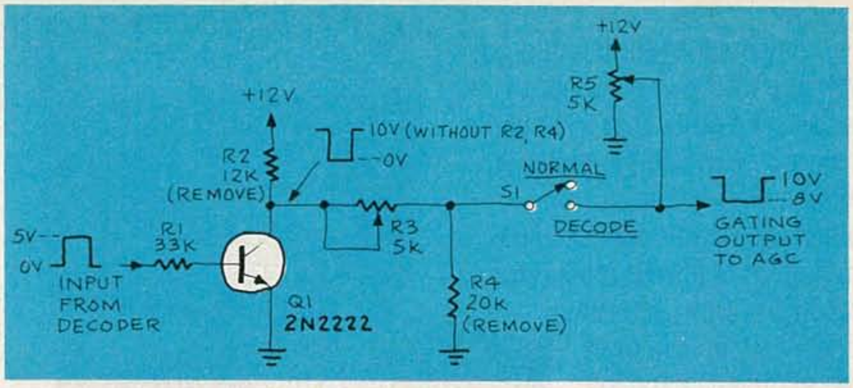



FIG. 1

### PAY-TV DECODER ADD-ON

I enjoyed reading about the add-on for improving pay-TV decoders in the June 1982 issue of **Radio-Electronics.** Fortunately, a problem I found in the interface can be solved by removing two resistors (see Fig. 1).

Step two of the alignment procedure asks us to connect the input (R1) to ground and, in effect, adjust R3 so that the voltage to S1 is the same as the voltage from R5 (about 10 volts). That is clearly not possible, because the voltage to S1 (S1 open) can be at maximum only 7 volts (12V × 20K/32K). Removing R2 and R4 stops the action of R3 on the 0-dB gain adjustment, and eliminates the need for the second step in alignment. The circuit will function as described with R3 adjusted to about 2.8K.

I suspect that R2 and R4 are leftovers from an earlier version of the circuit, because they serve no apparent function.
BILL STRUVE,
*Memphis, Tenn.*

### ON NIKOLA TESLA

It is fascinating that there have been so many readers commenting on Nikola Tesla's work in the last few months. Alfred C. Powell, and most recently George de Lucenay, come to mind. Something needs to be done here to revive and *re-examine* some of the amazing work that Tesla did.

I'd be willing to act as a collection point for information and comments on Tesla's work as uncovered by your readers. Perhaps I could afford to print a "newsletter" type of publication occasionally, covering such things as little-known facts about Tesla's work and reviews of books relating to his life and accomplishments.

If I receive enough interesting items, maybe even a magazine column or two might be produced.

Here are a few of the more interesting items about Nikola Tesla that I have encountered over the years:

1. Supposedly, a re-creation of Tesla's biggest coil has been observed to create *ball lightning* from time to time. That obviously needs further investigation.

2. When a child, I saw the mushroom-shaped tower that Tesla used for an antenna. That antenna was said to be able to transmit a usable amount of *power* to a boat out in the Atlantic Ocean.

3. Tesla apparently had at least an intuitive knowledge of the ionosphere and its importance in his radio-power experiments. He even suggested that one might derive power from atmospheric ionization—an idea that is fascinating even now.

Let's hear about whatever other little-known facts or insights anybody may have. I'll make every effort to reply to all who write to me at the address below.
PETER LEFFERTS,
*1640 Decker Ave.,*
*San Martin, CA 95046*

## TV ANTENNAS

I have just finished reading "How To Select The Best TV Antenna," by Gary J. Arnold, in the August 1982 **Radio-Electronics.** Although I agree with most of the points in this article. I want to point out to you a glaring error, which appears on page 85.

Mr. Arnold stated, "...generally, every ten feet of height, starting from forty feet from ground level will actually double the signal strength of weak, distant signals."

I believe that if Mr. Arnold will consult a qualified antenna or frequency-transmission expert, he will find that he is in error. I believe that the generally accepted theory states that your signal-level will increase approximately 3 dB each time you double your height above the ground, starting at approximately the 30-foot level. That means that if your signal-level 30 feet off the ground is 0 dBmv, then at 60 feet your signal would be approximately +3 dBmv; at 120 feet it would then be +6 dBmv, and at 240 feet it would be +9 dBmv, etc.
MELVIN SHANK,
*President, Master Antenna Systems, Inc.,*
*Orange, CT*

## UHF-TV RECEPTION

I think that your UHF-TV reception articles are the best that you have run during the past year. In fact, they are the main reason why I subscribed to your magazine.

Nevertheless, I find a glaring neglect of the *specifics* of the lead-in wire. I live in a valley, which leaves me 700 feet from a decent antenna site. For that reason, line-losses form a major part of my problem. I have installed slotted twin-lead for its low insertion loss, but I do lose all UHF signals during wet weather. In dry weather, the line does carry enough UHF signal to get a fine picture on at least one channel. To get that signal, I am using a 5-foot parabolic antenna and the Radio Shack preamp mentioned in your July 1981 article. That article gave me the nerve to try this system, and I thank you for it.

When I was planning my system, I could have used a lot more information about wet/dry attenuation vs. price for various types of lead-in. All of your authors have presumed that their readers have short down-leads! How about some articles for those of us who must use long stretches of cable?
DAVID CUSICK
*Huntington, WV*

## MAIL-ORDER SOURCE

I wish to bring to your attention the omission of the Sintec Company from your list of mail-order sources following the article on the subject in the November 1982 **Radio-Electronics** (pages 51, 53).

We have been an advertiser in **Radio-Electronics** for some time, and Sintec has been supplying many of your readers with quality electronics parts by mail through your ads and our free catalog. Please let your readers know that our free catalog is available by writing to: SINTEC CO., Drawer Q, Milford, NJ 08848.
FRANK FOLMSBEE, President

## THE CASIO COMPUTER

I just purchased your October 1982 issue and noticed that you missed one in the section titled *Your Own Computer—92-page Buyer's Guide*. Missing is Casio's model *FX-9000* personal computer.

I sell those computers and I feel that they are excellent-quality machines. The Casio computer is not often recognized in surveys such as yours.

The Casio *model FX-9000* features (1) an Option Board OP-1. The board attaches to the lower rear part of the main frame and contains a graphic-printer interface, a character-printer interface, a cassette-tape interface, and a clock, alarm, and calendar logic with power backup; and (2) an Option Box-2. That contains 2 single-sided double-density floppy disk drives (including operating-system software) and RS-232C interface together in a single unit that connects to the OP-1 with a cable (that last unit is available *now*!).

Casio will have more computers coming out the first of the year.
MICHAEL VAUGHAN
*Knoxville, TN*

### CAN ANYONE HELP?

Perhaps you can help me. I have a telephone-answering set that needs repair. I also need an owner's instruction manual for the operation of the set.

The trade name of the set is Zegna; it was manufactured by Hung Nien Electronics, Ltd., Hong Kong. I would appreciate the name and address of the company that distributes them in the United States.
H. L. GRAY
*114 Elmwood Drive,*
*Lafayette, LA 70503*

*We are giving Mr. Gray's full address so that any reader who knows the address he is seeking can write to him directly.*—Editor

### 8-BITS VS. 16-BITS

The article "8-Bits Vs. 16-Bits" in the October 1982 **Radio-Electronics** contained a few misconceptions that I'd like to straighten out.

The article described the 8088 (the microprocessor used in the IBM personal computers) as a 16-bit processor; the error appears elsewhere in the issue, and I've seen it in other publications. The Intel 8088 is an 8-bit device; the Intel 8086 is a 16-bit device. Both processors execute an identical instruction set, and have the same internal register structure. When the 8088 wants to get a 16-bit memory word, however, it has to fetch two 8-bit bytes. In the time it takes to fetch one of those bytes, the 8086 can fetch the entire word.

The misconception presumably arises because the 8088's internal architecture is 16 bits wide. There's some justice in the idea, but to be consistent the honor could be extended to other 8-bit processors with elements of 16-bit architecture. The Motorola 6809 is an example.

I hasten to note that a significant achievement of the 8086/8088 design is the independence of instruction fetching as opposed to execution (program instructions are obtained before the processor actually needs them—during "spare time"), so that the 8088's performance, in this respect, should be as good as the 8086's in many cases. (The fetching of operands—data—is another story.) The 8088, however, is still an 8-bit processor, at least if we're referring to the width of the data path, which would seem to be the only reasonable use of the term.

The article also asserts that 16-bit processors can address more memory than 8-bit processors. While that is true of most of the actual products available in the marketplace (which is probably what the author had in mind), it is not a universal truth and is related to marketing factors rather than to anything dictated by digital logic.

In a similar confusion, it is suggested in the next paragraph or so that the larger address space is one factor responsible for the increased speed of 16-bit processors over 8-bit processors. That is not a direct relationship; a wider address bus means that the processor can deal with more memory, which might in some cases make a particular computer running a particular program faster, but in other cases might have no such effect at all. The major inherent speed advantage of a 16-bit computer over an 8-bit computer is in the width of the data path: the 16-bit computer can move twice as much data in the same time as an 8-bit computer. (16-bit processors usually have more powerful instruction sets and architectures than 8-bit processors, which also tends to improve speed; but that, like memory-addressing capability, is a marketing/historical phenomenon.)
J.G. OWEN
*Port Jefferson Station, NY*

### AM STEREO

I would like to see in your magazine an article (or series of articles) on AM stereo—a project for converting your current FM stereo/AM mono tuner into an AM stereo/FM stereo. I realize that the IC's for such a project might not yet be available, but I would like to see an article on the subject as soon as possible. Station CKLW—Detroit, MI, has just gone to AM stereo, as has Station WLS, Chicago.

I would also like to see articles on telephone projects—hold buttons, extension lights, etc.

Keep up the good work on your very fine magazine.
JOHN PAVLICA, JR.
*Toldeo, OH*

### EASE OFF COMPUTER ARTICLES

I am a loyal reader and subscriber, and I most enjoy your "Build This" features and the video sections.

Please ease off the computer articles. You don't need them. I am not a diehard or an oldtimer; I fix the 32-bit long monsters for a living. But there are enough sources of computer information already.

You probably would do a good job of covering both component-level electronics *and* computers, but I doubt that you could better the great job you're doing now.
JOSEPH W. MILLER
*Reading, PA*

### UHF PREAMP

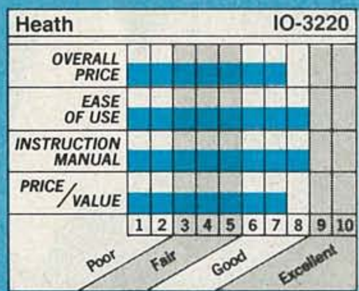
Just a quick note to tell you that I built the UHF preamp from your May, 1982 issue. That is one project which was well worth the money. I live in the Smokie Mountains of North Carolina, about 45 miles west of Asheville, with the Education Channel #17 translator hidden behind a mountain about nine miles as the crow flies. I first installed a new UHF antenna from Radio Shack. Used Channel Master RG-59 foam with aluminum foil.

I can say truthfully that my signal improved on a scale of 1 to 100—95%. No snow, color excellent, better than my former best channel, which was CBS. Also, I am using a 12-inch Sony.

Thank you for a good project that worked. I got my kit from Quest Electronics PDQ.
BURRELL M. RHODES, K4BVJ
*Whittier, NC* **R-E**

# EQUIPMENT REPORTS

## Heath Model IO-3220 20-MHz Dual Trace Portable Oscilloscope




CIRCLE 101 ON FREE INFORMATION CARD

THE HEATH COMPANY'S (BENTON HARbor, MI 49022) first electronics kit was an oscilloscope (its *very* first kit was an airplane). With the *model IO-3220* 20-MHz dual-trace portable oscilloscope, Heath continues its tradition of supplying quality test equipment in kit form.

The scope, smaller than standard bench units (it measures 5½ × 13 × 18 inches and weighs about 22 pounds with its optional battery pack), is intended primarily for use in the field. Its size even allows it to fit under an airplane seat.

With portability a prime consideration, Heath has made the *IO-3220* extremely flexible in its power requirements. It will operate from standard 50 or 60-Hz AC line current over a range of 105 to 270 volts. The unit also operates from a variety of DC sources. A rechargeable 12-volt battery pack is available; it fits into a compartment inside the scope. The batteries are recharged from the scope's power supply, and LED's are provided on the front of the unit to indicate that charg-

ing is taking place, and also to show when the battery charge is getting low. A minimum of two hours of operation is provided by a set of fully charged batteries.

Recharging (and trickle charging) are automatic when the scope is operated from an AC supply. The unit can also be operated from any external 11–24-volt-DC source. Power-supply options are switch selectable from the rear panel. Power consumption is approximately 34 watts.

### Features

The dual-trace scope has a DC bandwidth of from DC to 20 MHz (−3 dB) and an AC bandwidth ranging from 3 Hz to 20 MHz (−3 dB). Sensitivity is given as 2 mV/cm, and the maximum permissible input is 400 volts. Vertical rise time is on the order of 18 ns—a necessity when troubleshooting many of today's digital circuits.

Each channel has 12 calibrated voltage-ranges, from two millivolts/division to 10 volts/division. An algebraic-add function is available, which combines the values of signals fed to the scope's two inputs into one waveform. In addition, the second input can be inverted so that, when in the ADD mode, the scope can display the difference between two signals.

Timebase ranges go from 0.1 second/division to 100 nanoseconds/division in 19 steps, and are switched in a 1-2-5 sequence. Any sweep speed can be expanded by a factor of five. The 3-inch (diagonal) CRT offers a high-brightness display, and has an 8 × 10-division built-in graticule.

Switches for TRIGGER SELECT and LEVEL allow precise triggering of the timebase at any point along the positive or negative slope of the trigger signal. Various trigger signals can be selected. Trigger-input bandpass can also be selected to cut off unwanted DC signals and trigger only on fast AC signals. A baseline can be automatically displayed, even when there is no trigger signal.

Other features of the *IO-3220* include a Z-axis input on the rear panel that varies the brightness of the trace over an input range of 0–5-volts. A one-volt P–P squarewave is available at a front-panel connector for calibration purposes.

The probes for the kit come with a variety of tips and are switch-selectable for ×1 or ×10 operation. Capacitance compensation is adjustable over a range of 15 to 50 picofarads. A pouch to hold the probes can be attached to the oscilloscope's case.

Finally, a front-panel dust cover is provided to protect against dirt (and worse!) and the carrying handle also functions as a multi-position stand.

### Construction

Building the *IO-3220* is not for the beginner, but it is not likely to be a beginner's first project.

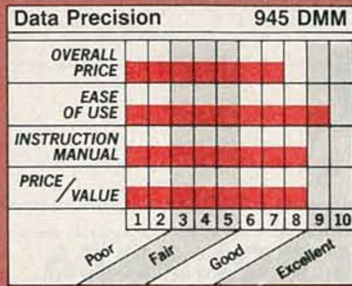
As usual, Heath supplies an extremely detailed construction manual. Because of the complexity of the kit—it uses eight circuit boards—a separate book of assembly diagrams is provided to supplement those in the main manual. And, in addition to that manual, two more smaller ones also come with the kit. The first of those covers calibration and applications of the scope; the second provides illustrations for the other.

The kit features a multitude of calibration adjustments and, to do the job properly, a precision source of squarewaves, such as Heath's *IG-4505* oscilloscope calibrator will be required.

The design and construction of the *IO-3220* make for a rugged device, and it should be able to take the kind of abuse, and deliver the performance, it was intended for. To use Heath's words, it really is "...a versatile tool for the hobbyist, professional, or service technician."

The *IO-3220* is $689.95 in kit form and $995.00 for the assembled, tested, and calibrated version. The *IOA-3220-1* probe and pouch set sells for $59.95, the *IOA-3220-2* rechargeable battery pack for $44.95, and the *IG-4505* calibrator for $57.95. **R-E**

## Data Precision Model 945 DMM




CIRCLE 102 ON FREE INFORMATION CARD

WE'VE OWNED SEVERAL DIGITAL MULTI-meters that came from Data Precision (Electronics Ave., Danvers, MA 01923) and have always found them to be highly-accurate, sturdy little meters. The latest model, the *945*, is no exception.

That flat, oblong meter is designed for one-handed operation. The LCD readout is at the top, and all of the range- and function-selection switches are in a row down the left-hand side. The case is compact enough to fit comfortably in the palm of your hand; just curl your fingers around it and then you can switch to any desired range or wanted function instantly.

The DMM measures AC and DC volts, and AC and DC current, over five ranges; and resistance over six ranges. What's really impressive here, however, is the resolution that the meter is capable of. Differences of as little as 10 μV, 10 nA, and 10 milliohms can be read. Such readings are possible because the meter uses a 4½-digit readout instead of the more-or-less standard 3½-digit one. Thus on the lowest ranges, readings of 199.99 rather than 199.9 are possible.

Polarity switching is automatic on all DC ranges and is indicated on the display by a plus sign for voltages positive with respect to the common test-lead, and minus sign for those that are negative. An out-of-range reading is indicated by a blinking 0000 display. A LO-BAT annunciator on the display is used to indicate a low-battery condition (less than 20% of useful life remaining). We checked that out by installing a weak battery and found that the annunciator worked, but what was interesting was that the meter readings remained accurate despite that weak battery.

I like the design of this meter. The switches are spaced far enough apart so that a human finger can get at only one at a time. Regrettably, a large number of instruments I've seen use tiny buttons that are spaced so closely together that hitting just one at a time is difficult. The test leads plug into "safety" jacks at the bottom of the panel so that no bare metal is exposed. The whole instrument meets UL's safety standards, with panel markings to indicate shock hazards, etc.

The DMM uses a 9-volt rectangular-type battery for power. An AC adaptor, the model *BE-9* is also available for the meter; it plugs into the right side of the case. The instrument comes with sturdy test leads with slip-on alligator clips, an instruction manual, and a battery.

The panel markings are very readable, and for the resistance ranges, the actual current used by the meter for the tests is shown. Incidently, on the higher resistance ranges, the current supplied can be used to test semiconductor junctions, while on the lower ranges, the current is low enough to allow you to test semiconductor circuits without turning on the junctions. Also, the positioning of the two function switches is plainly indicated.

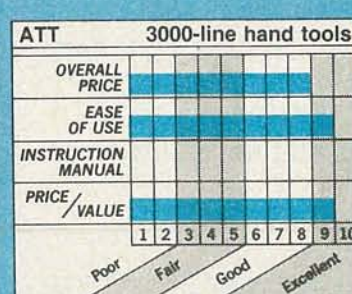
The AC rejection on DC-voltage ranges is very good. On the 200-volt DC range, for instance, plugging the test prods into a 117-volt AC outlet produced no reading at all! Some of the early digital meters had problems in that area.

The instruction manual is very complete. It covers fully the setup and operation of the meter. Recalibration data is included in case it's ever needed. The manual also provides complete diagrams and a parts list, as well as very clear explanations of how each function works.

In summary, this is a high-quality, very-accurate, and easy-to-use little meter. The accuracy is good enough for lab work or for use on a shop bench, and yet it can fit in your shirt pocket. The *945* lists for $265.00; the optional *BE-9* AC adaptor lists for $20.00. They are available from your local distributor. **R-E**

## Advanced Tool Technology Inc. Hand Tools

CIRCLE 103 ON FREE INFORMATION CARD

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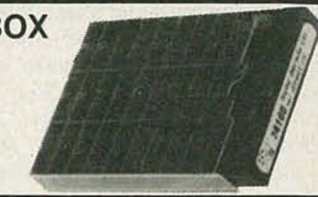
| ANTI-STATIC | |
| BLX-002BAS (2 Boxes) | $8.49 |

## BUG BOX

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|---|---|
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| ANTI-STATIC | |
| BGX-002BAS (2 Boxes) | $6.55 |

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|---|---|---|
| 30001 | National CMOS | $ 7.95 |
| 30003 | National Linear | 12.95 |
| 30005 | National TTL Logic | 10.95 |
| 30008 | National Memory | 7.95 |
| 30009 | Intersil Data | 10.95 |
| 30013 | Zilog Micro | 8.95 |
| 10400 | Intel Data | 15.95 |

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| Part No. | Description | Price |
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| DE9P | 9 Pin Plug | $1.95 |
| DE9S | 9 Pin Socket | 2.49 |
| DA15P | 15 Pin Plug | 2.49 |
| DA15S | 15 Pin Socket | 3.29 |
| DB25P | 25 Pin Plug (Meets RS232) | 3.79 |
| DB25S | 25 Pin Socket (Meets RS232) | 4.49 |
| DC37P | 37 Pin Plug | 5.49 |
| DC37S | 37 Pin Socket | 6.49 |
| DD50P | 50 Pin Plug | 6.49 |
| DD50S | 50 Pin Socket | 7.49 |
| | **Accessories** | |
| DE-9H | Hood for DE-9 Series Connectors | $1.39 |
| DE-15H | Hood for DA-15 Series Connectors | 1.49 |
| DB25H | Hood for DB25 Series Connectors | 1.79 |
| DB37H | Hood for DC37 Series Connectors | 1.59 |
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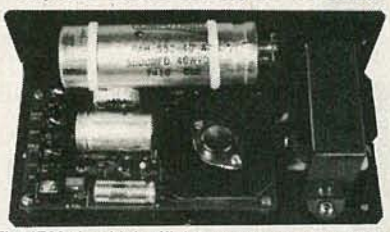
## JE224 Adjustable Switching Power Supply Kit

**4-24VDC REGULATED, UP TO 5AMP**



The JE224 is a high-efficiency power supply utilizing a LH1605 5 amp switching regulator. The LH1605 provides high current output while maintaining a small physical configuration. Open frame type to allow mounting into restricted areas.

**FEATURES:** Adjustable 4-24VDC: 5VDC @ 5A, 6VDC @ 4.8A, 9VDC @ 4.1A, 12VDC @ 3.3A, 18VDC @ 1.9A, 24VDC @ .5A. Overvoltage protection. Input: 115VAC 50/60Hz. Output variations within 20mV. Size: 8.24"L x 4.25"W x 2.25"H. Weight: 3.25 lbs.

**JE224 KIT ......... $79.95 each**

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## Muffin-Style Fan

- 105cfm free air delivery
- 4.68" sq. x 1.50" depth
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- 115V 50/60Hz 14W
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- 36cfm free air delivery
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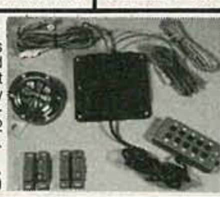
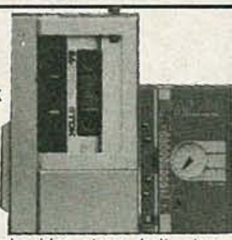
## Anti-Theft Auto Alarm System

• Audible horn is activated when door or trunk is opened • Alarm sounds for 3 min. — unless turned off by secret 3-digit code. • Wire cutting will not deactivate alarm. • Code set by owner. • Uses only 0.01mA power. • System complete w/one black-box control unit; one personal coded keyboard; 2 sets of sensors; one audible horn; & wiring (incl. one 10A fuse).



**CA-06** Auto Alarm ............ **$59.95**

## Stereo Cassette Player with FM Stereo Tuner Pack



- Lightweight Headphones
- Cr02/Metal/Normal Tape Selector
- Anti-Rolling Mechanism

FEATURES: • Blue carrying case, shoulder strap, belt strap, lightweight headphones, FM stereo tuner pack & instruction manual • Talkline • Tone selector • Cr02/Metal/Normal tape selector • LED operation indicator • Built-in microphone • Stop/eject, play, rewind/review, fast forward/cue, tape/radio selector functions • Vol. control • Ext. power input jack • Headphone jack • Auto-stop mechanism (shuts off player when tape ends) • Anti-rolling mechanism (prevents sound from quivering when walking, jogging, etc.) • Weight: 13 oz. • Requires 4 AA batteries (not included) • Size: 6"L x 4"W x 1-1/8"H

**Model TWF-802 ................ $69.95**

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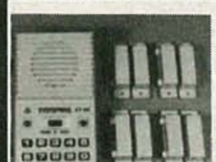
• Coded door alarm. • Instant or 7-second delay system. • Alarm activated as door is opened. • Can be de-activated by pressing personal code. • Power: One 9V battery (not incl.). • System includes one personal coded keyboard and one magnetic sensor.

**ES-07** Door Alarm ............ **$29.95**

## Home Alarm System



• Self-Installation • Presettable w/individual 3-digit code — no key nec. • Instant or 10-sec. delayed warning system • Alarm system incl. window & door contacts • One 9V battery required (not incl.) Low power consumption (0.01mA) • Loud audible alarm (90db) • Delayed exit feature • System complete w/one control station with built-in siren and test button; 4 magnetic contact sets & connecting wires for entire system

**ST-05** Home Alarm System ...... **$59.95**

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**WITH HEADPHONES For Joggers, Cyclists, Skaters & Sports Events**

**FEATURES:** Lightweight headphones. Left/right balance control. Full fidelity stereo sound. Additional black soft carrying case & shoulder strap. Belt-clip (hands-free). Uses 3 AA cell batteries (not included). Compact size: 3-1/8"H x 4-7/8"L x 1"D. Wt. 6 oz.

**MODEL 2830 .................. $29.95**

CIRCLE 9 ON FREE INFORMATION CARD

the tools you use. The quality of those tools, as well as how appropriate they are for the task at hand, often mean the difference between success and failure. At the very least, the use of a high-quality tool can make a job considerably easier.

With that in mind, let's take a look at one of the nicest lines of hand tools we've ever used. Those tools, known as the *3000* line, are manufactured by Advanced Tool Technology, Inc. (18217 Parthenia St., Northridge, CA 91325); they are not inexpensive, but they are most certainly worth their price.

What is it that sets those tools apart? For one thing, they are almost totally hand-made out of drop-forged steel and thus are extremely durable. But what is even more important is their use of box joints. Most tools use scissors-type joints in which the two halves of the tool are mounted next to each other on a pivot. In box joints, the two halves of the tool are still mounted on a pivot, but one half passes completely *through* the other. That greatly increases the cost of manufacturing the tool, but offers several important advantages. For one thing, the tool is much more resistant to breakage. In addition, box joints help eliminate the jaw misalignment and wobble that almost all tools suffer after prolonged use. In other words, those tools should be usable long after most others must be thrown away.

Another important thing about the tools is their size. Designed for use by production-line workers, especially for the manufacturing of PC-board circuits, the tools are sized to fit comfortably in the palm of your hand to minimize fatigue. That's important for the hobbyist, too, as anyone who's ever built a larger project, such as a stereo amplifier, is sure to know. Some of the tools' other features include adjustable tension springs and cushioned, insulated handles.

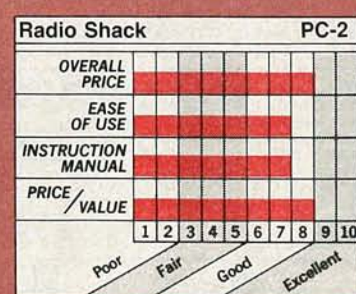
Included in the line are a variety of pliers and cutters. Among those are flat-nose, bent flat-nose, long-nose, curved needle-nose, round-nose, and bent round-nose pliers, and diagonal, slant-edge, angle and angled flush cutters. We found the angle cutters to be particularly nice. Designed again for use on a production line, that tool is great for quick, close clipping of leads or wires on a PC-board, even on tightly packed boards.

All-in-all, we like the tools. They have a quality feel to them that's hard to describe. Suggested list prices for them range from $22.50 to $30.00. Certainly not the least expensive on the market, but not that bad either. And you definitely get what you pay for. **R-E**



## *Radio Shack TRS-80 PC-2 Pocket Computer*

**CIRCLE 104 ON FREE INFORMATION CARD**




FIFTEEN YEARS AGO, IF SOMEONE HAD told you it would one day be possible to slip a powerful computer into your jacket pocket you probably would have laughed at him. After all, the introduction of hand-held calculators was still a couple of years away, and even the smallest computers couldn't be considered portable, let alone pocket sized.

All of that has changed dramatically in the time since, and nearly two years ago the first "pocket-sized" computers were introduced. Yes, there were some computer-like, programmable calcula-

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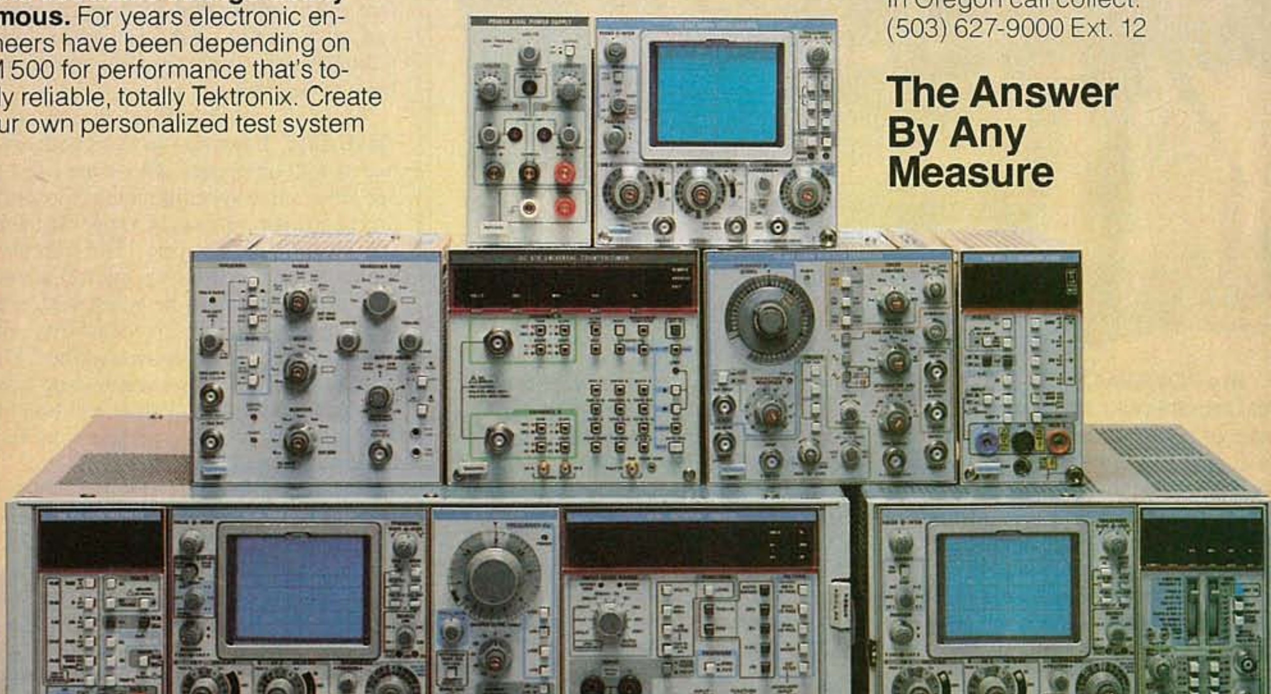

**Tektronix**
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tors on the market before that, but they were meant for arithmetic calculations and couldn't make use of a true programming language such as BASIC.

The first pocket computers were offered by Radio Shack and Sharp, although Panasonic and Quasar were soon offering their own models. Those early machines were fairly simple, and while they could be programmed in BASIC, the version of the language used was very limited. Also, the early pocket computers were driven by relatively slow four-bit microprocessors and offered only limited memory capacity.

That also has been changed, however, with the introduction of a new generation of pocket computers, including the Radio Shack (One Tandy Center, Ft. Worth, TX 76102) *PC-2*. That unit is driven by a proprietary eight-bit CMOS microprocessor and is quite powerful even in its most basic configuration. The CPU is more than capable of handling all functions, including the keyboard and display I/O. In the earlier Radio Shack pocket computer, two CPU's were required—one to handle the actual computations and another to handle the BASIC interpreter and key in.

The computer itself, without peripherals, weighs about one pound and measures 1¹⁄₁₆ × 7¹¹⁄₁₆ × 3⅜ inches. It features a 65-key keyboard that is laid out in typewriter fashion (although don't expect to be able to touch-type on the tiny keyboard, of course) as well as a 10-key numeric pad for rapid data entry. In addition, the unit offers 18 programmable key-functions and 18 user-definable keys. Cursor movement keys as well as insert and delete keys simplify program editing. The keyboard can also be used to input both upper- and lower-case characters. The unit also has a 24-character 7 × 156 dot-matrix LCD display. That display can handle upper- and lower-case alphanumerics, and graphics.

As far as memory goes, the basic unit has 16K of system ROM (for the monitor, BASIC, etc.) and 2.6K of RAM. A single plug-in slot on the unit is intended for memory expansion. That slot will accept a plug-in module with up to 16K of RAM, ROM, or a combination of RAM and ROM. As of this writing, however, only 4K and 8K RAM modules are available from Radio Shack.

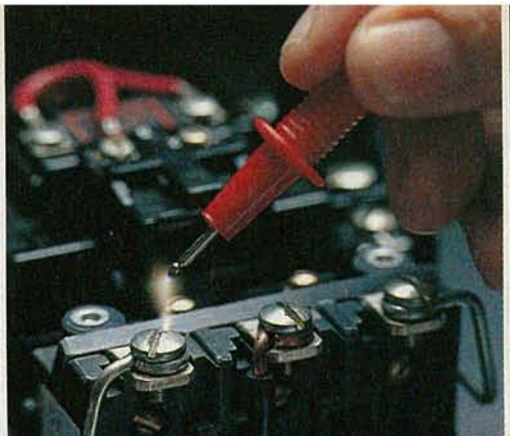
The version of BASIC supported by this machine is rather powerful. It is called Extended Pocket BASIC and can handle long, complex arithmetic computation and advanced string manipulations. Among the string handling features are variable length (from 1 to 80 characters) and two-dimensional array capability. An important point for those who already own a Radio Shack *PC-1* is that programs written for that computer can often be run on the newer machine, although some minor modifications may have to be made.

There is one significant drawback to that BASIC, however—it lacks both PEEK and POKE commands. Those are used to see what's in a specific memory location and to change contents of a specific memory location respectively. Their absence prevents the user from taking full advantage of the system as he is left with only sequential programming capability and no direct access to the power of the CPU. Also note that as only cassette-tape mass storage is currently available, random file access and handling is not possible; files must be accessed sequentially.

One area where this unit does shine is in its graphics capability. Available as an accessory is a combination multi-color printer and a dual cassette-tape interface. That unit is supplied with a built-in rechargeable battery and an AC adapter/charger; both can also be used to power the computer itself. Otherwise, the computer requires 4 AA batteries for operation. Getting back to the printer, it is capable of generating alphanumeric characters and graphics in red, blue, green, and black. Use of the printer/interface adds 25 commands to the computer's Extended Pocket BASIC; those commands are used to simplify plotting and for the creation of even complex graphics. Furthermore, the printer uses

*continued on page 80*


Drop-proof


Overload-proof


Contamination-proof

# Oops proof.

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.


## Drop Proof

Constructed of double-thick thermoplastics, the HD100 series DMMs resist damage even after repeated falls. All components are heavy-duty and shock mounted.

## 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.

## Accidental Overload Protection

All DC voltage inputs are protected up to 1500 Vdc or 1000 Vrms. Current ranges are protected to 2A/600V with resistance ranges protected to 600 Vdc. Transient protection extends up to 6KV for 10 microseconds.

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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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# If you have put off learning more electronics for any of these reasons, act now!

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- ☐ High school was hard for me and electronics sounds like it may be hard to learn.
- ☐ I can't afford any more education.
- ☐ I have a family now.
- ☐ I'm here. You're there. I've never learned that way before. I'm not sure it will work for me.

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BUILD THIS

# Digital IC TESTER

*Need to identify unmarked IC's? Check out "defective" ones? Learn how digital-logic circuits work? The Programma III, which you can build for about $100, will do all that and more.*

UNTIL RECENTLY, IC TESTERS HAVE BEEN a rarity in electronics labs, and that is unfortunate because they can be so helpful—in identifying unmarked IC's, in checking for defective ones, as training devices, etc. Sad to say, they are frequently expensive, and often require other test equipment to perform their functions. But meet the Programma III digital-IC tester! It allows you to check IC's at a breakthrough low cost, and replaces several pieces of test equipment—all in one neat package.

The device was originally designed for use in identifying unknown IC's, but it seems as if every day a new use pops up for it. For example, a cable was made up using a 16-pin IC test-clip and DIP header. The header is plugged into the test socket on the IC tester, and the clip snapped over a suspect IC in another piece of equipment. The result is a low cost "logic anayzer," or a device that will display many logic states at once. That can speed up troubleshooting immeasurably in many cases. Commercial logic analyzers cost thousands of dollars, while ours costs a tiny fraction of that. More on applications later!

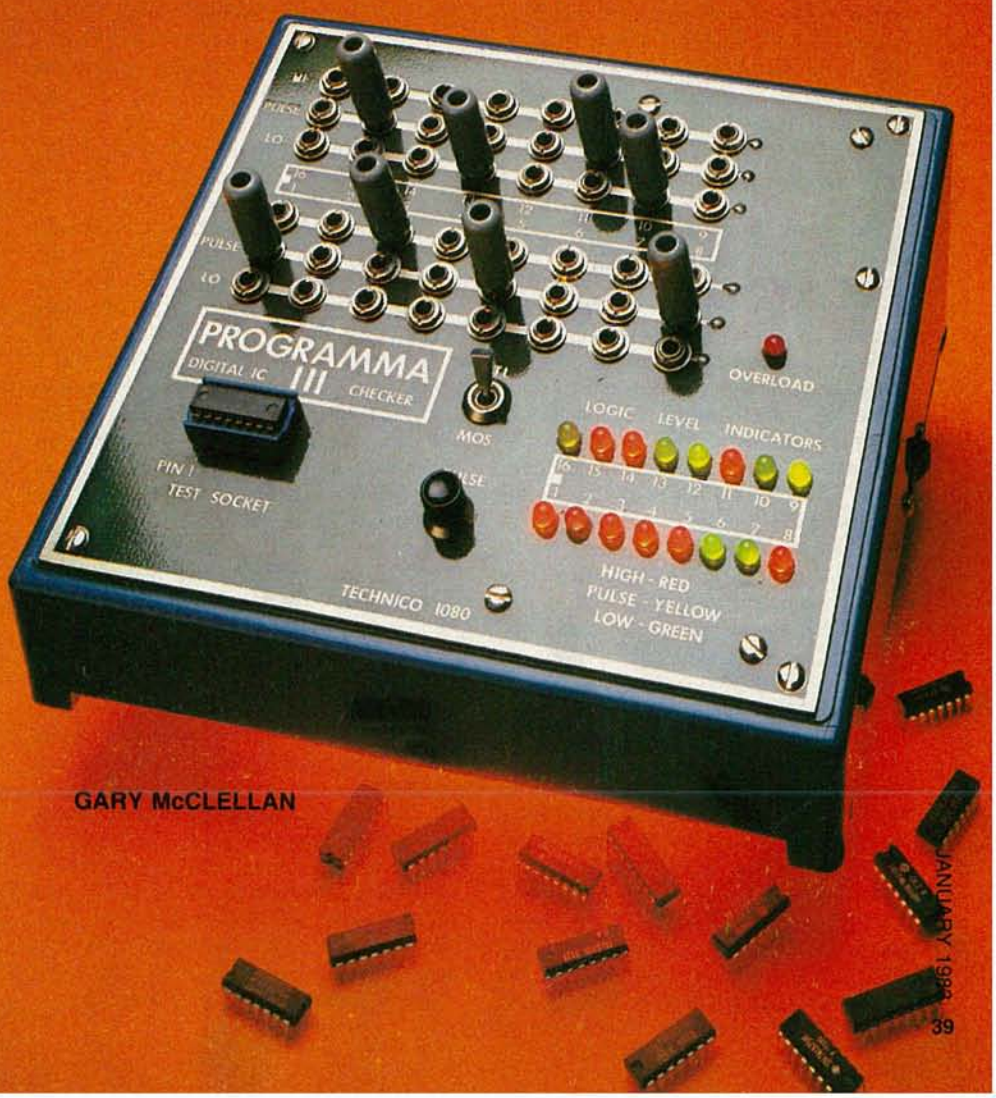
The Programma III has many novel features that help to make it versatile as well as low-cost. A "zero insertion force" (ZIF) test-socket is used so that components can be easily inserted and removed without bending or breaking leads. That's important—you know how easy it is to break a pin.

Connections to each pin of the test socket are made via an array of jacks. For each pin there is a jack that can be connected either to ground, a pulse signal, or +5 volts. Standard miniature phone-plugs, similar to those used on transistor radios, are plugged into the jacks, applying the desired signal or voltage, or shorting the IC-pin to ground. As a bonus, components may be wired to the plugs, allowing you to build up actual circuits for testing parts. (Good examples would be the NE555 timer, and any one-shot.) The pulse signal just mentioned can be used to increment counters or registers. It is produced by pressing the PULSE button.

Finally, the logic-level display is unique. It uses tri-color LED's to show the status of each IC pin, with red indicating a logic-high, yellow indicating a pulse condition, and green indicating a logic-low. Those features combine to make the Programma III a device that is invaluable in your work with digital IC's.

The construction of the Programma III is something special. The front panel is a PC board! That gives you a finished project that looks just like the one shown in the photographs, and there is no tedious lettering of the jacks required. In addition, the lettering on the board resists wear far better than any transfer-type lettering can. The "panel-board" concept makes project building easier, and the final result looks first rate. Inside, the panel-board greatly simplifies the wiring, as all wire connections are made directly to the jacks.

The display electronics are also something special. You'll be surprised to dis-




GARY McCLELLAN

cover that there are only seven IC's in the whole unit! They are all standard, low-cost parts, which makes them easy to find. In addition, this is probably one of the first projects you've seen that uses a VMOS power FET. It does a superior job in the pulse-generator section, and allows pulses to swing the full five-volt range. The display electronics mount on a separate PC board, and simply plug into the panel-board, further simplifying construction.

### How it works

The Programma III owes its unique features to some clever applications of standard IC's. Let's look at the circuit before starting construction.

The device is built on two PC boards, which we'll call the panel board and the display board. The larger board, which contains the IC test-socket and the jacks, is the panel board; the smaller board, which contains the LED's and IC's, is the display board. Be sure to keep those distinctions in mind as you read the circuit theory and assemble the project.

### Display board

This is the smaller board, but since it contains the active circuitry, it will be discussed first. Refer to Fig. 1, and the schematic in Fig. 2, for details as you read about it. The display board contains a power supply, pulse generator, and a set of comparators. Figure 1 shows that circuitry in its basic form, but note that the IC socket, jacks, and switches are all on the panel board. You'll be surprised to discover that the display-board isn't much more complicated than its block diagram!

The power supply is simple, but has a clever twist. The IC tester may be powered by an unregulated 12–18-volts-DC source. That voltage runs the comparators and an IC audio amplifier, IC6. Now you may be wondering what a power amplifier is doing in a power supply—especially since nothing is connected to its input! But that IC has what the manufacturer calls a "self-centering output stage." That means it will effectively divide the power supply voltage by two, providing the LED's with the proper voltage. That neat little problem-solver replaces two power transistors and an op-amp, reducing the parts count...and cost.

Power for a standard five-volt regulator, IC5, is supplied through a resistor. The IC supplies regulated power for the pulse-generator circuit and for the IC being tested. Since it is possible to short the five-volt supply with a bad IC, or by misusing the tester, overload protection is built in; that's the job of the series resistor. You can draw up to 100 mA without affecting the five-volt power, but exceed that by much and the output voltage drops quickly. That voltage drop protects the unit from damage by overloads and the OVERLOAD LED lights up to indicate that there's a problem.

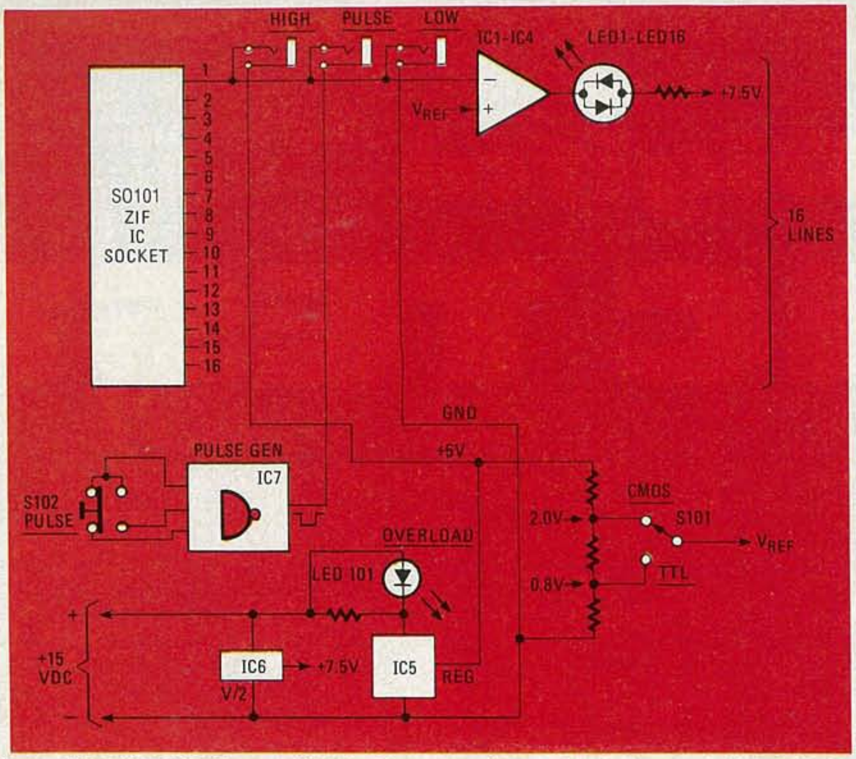



FIG. 1—SHORTING PLUGS inserted in jacks (shown at top) determine whether a logic-high, logic-low, or pulse is applied to each IC pin.

Finally, the five-volt output is tapped to provide two reference voltages; those drive the comparators, which will be discussed shortly. The voltages correspond to the thresholds for TTL (0.8 volt) and CMOS (2.0 volts) devices. We want to know when the outputs from the IC being tested go above or below those values; if they don't, the part is defective.

The pulse-generator circuit is simple, and also a bit unusual. Refer to the schematic for details. It consists of NAND gates IC7-a and IC7-b, and Q1. The gates are wired as a "bounceless pushbutton"—a circuit that generates a single pulse each time the PULSE button is pressed. That's necessary because switch bounce can cause many pulses when the switch is pressed, and that makes checking flip-flops, counters, and registers impossible! The output from one of the gates switches a new device-type called a VMOS power FET, which features high input-impedance and high output-current. It is used to advantage in the circuit because it can bring the pulse line to within a few millivolts of ground. That insures more reliable switching of the IC under test, as conventional transistors may come as only close as 0.6 volt of ground.

The comparator circuit is as simple as the block diagram makes it out to be. It contains sixteen op-amp comparators, and each is driven by an IC test-socket pin. Type LM324's—with four comparators in each IC—are used, so the circuitry is contained in just four packages. The $V_{REF}$ input goes to all comparators.

#### PARTS LIST—DISPLAY BOARD

**All resistors ¼ watt, 5%, unless otherwise noted**
R1, R2—10,000 ohms
R3—470 ohms
R4–R19—100,000 ohms
R20–R35, R40—1000 ohms
R36—68 ohms, 1 watt
R37—8200 ohms
R38—3300 ohms
R39—2200 ohms

**Capacitors**
C1—1000 µF, 25 volts, axial-lead electrolyic
C2–C7—0.1 µF, 25 volts, ceramic disc

**Semiconductors**
IC1–IC4—LM324N quad op-amp
IC5—MC7805 5-volt regulator
IC6—LM380N audio amplifier (14-pin package)
IC7—CA4011 quad CMOS NAND gate
Q1—VN10KM (Siliconix) VMOS power FET (Radio Shack 276-2070)
LED1–LED16—tri-color LED (see text)
SO1—16-pin IC socket

**Miscellaneous:** PC boards, 14-pin IC socket, solder, etc.

**The following is available from Technico Services, PO Box 20HC, Orangehurst, Fullerton, CA 92633: set of two etched & drilled PC boards (IC-1), $30.00. Available from ABC Electronics, 2033 W. La Habra Boulevard, La Habra, CA 90631 is a set of all parts, *excluding PC boards* (IC-1P), $85.00. CA residents please add sales tax; foreign orders please add $3.00 for postage & handling.**

That voltage is equal to the IC threshold-voltage, and comes from resistors connected across the five-volt power supply.

In operation, the comparators compare the voltages on the IC pins to $V_{REF}$. If the IC-pin voltage is greater, the output of the comparator will snap high. That connects the LED (through a current-limiting resistor) to + 15 volts, causing the red diode in the package to glow. On the other hand, if the IC-pin voltage is less than $V_{REF}$, the comparator output snaps to ground, causing the green diode in the package to glow. Just think of the comparator output as an SPDT switch; all it does is to switch one side of the LED to ground, or to + 15 volts. The other side of the LED stays at 7.5 volts. If the IC pin is pulsed rapidly, the two diodes in the LED package will turn on and off in turn and the colors blend to form yellow. A simple, but neat and elegant way to indicate logic levels, don't you think?

## Panel board

The panel-board circuitry is restricted to just a few components. They include a switching matrix made up out of jacks, and a few switches. The arrangement for pin 1 is shown in Fig. 1. The wiring for the other pins from the IC socket are arranged in the same manner, with jacks from the HIGH, PULSE, and LOW lines connecting to it. Although it looks like quite a bit of wiring, the PC board simplifies things considerably. Furthermore, the connections to the display board are made using just two connectors. That makes construction, testing, and troubleshooting simple.

## Assembly

We'll assemble the display board first. It isn't difficult, but it is important to follow instructions. The LED's, for example, must be installed *last*. They mount a fixed distance off the display board, and if you install them incorrectly, you won't be able to install the panel board! If you follow the directions, there should be no problem with assembly.

The first step is to obtain the parts. Since the display board is double sided, and tough to make, you may want to buy it from the source in the Parts List. Of course you may make your own using the artwork provided in Figs. 3 and 4. (The same goes for the panel board, which will be shown in the next part of this article.)

The IC's should be no problem, but be sure to use first-quality parts. If you scrounge the IC's from the junkbox, be sure to test them in an active circuit to make sure they are good. It's embarassing to build an IC checker and discover it won't work due to a bad IC! Actually, since the IC's this project uses are so inexpensive, I can't imagine why you wouldn't use factory-fresh IC's anyway. The extra cost of new parts is a lot less

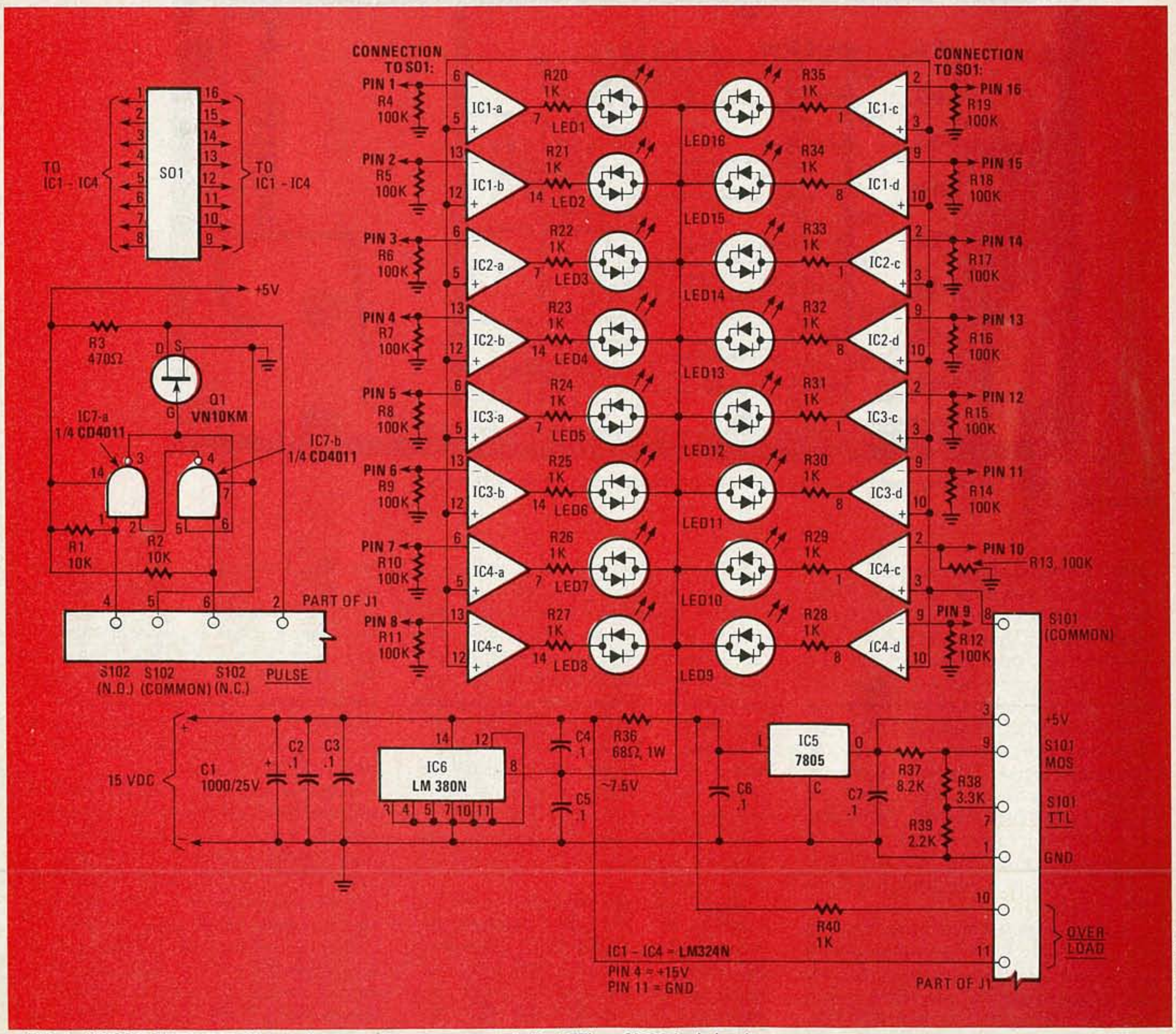



FIG. 2—VMOS POWER FET, Q1, permits test voltages to approach ideal TTL or CMOS logic levels.

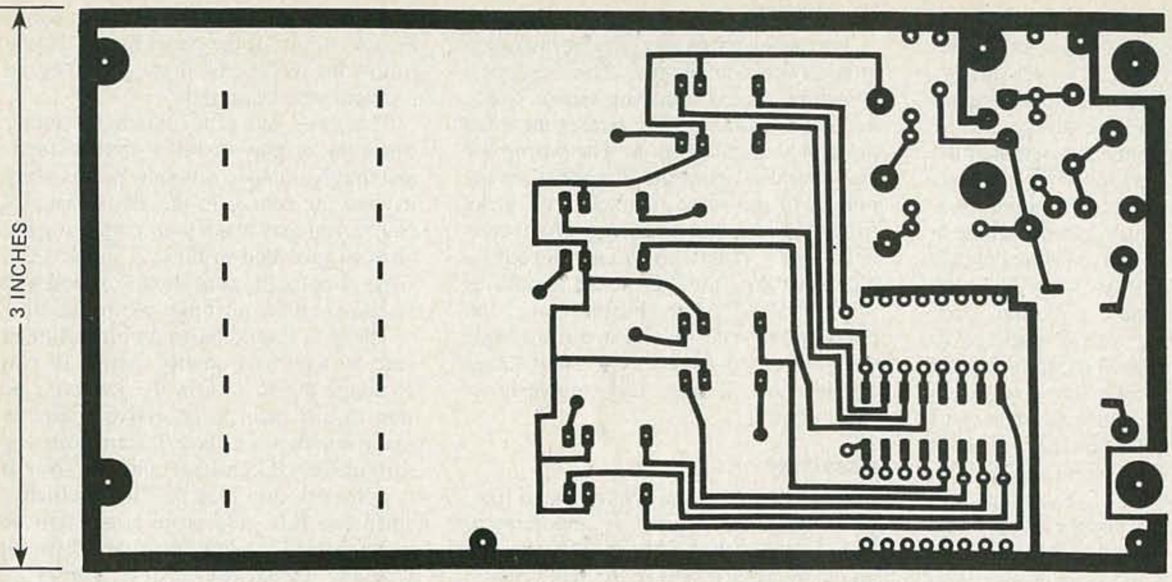


FIG. 3—THIS SIDE OF IC TESTER's display board is the one on which most components are mounted.

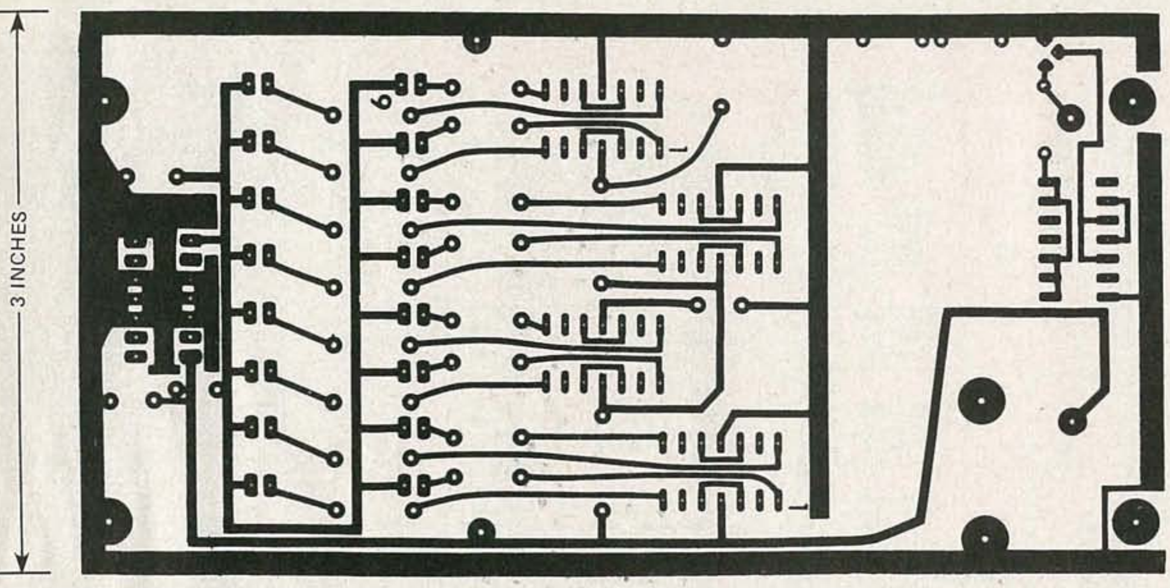


FIG. 4—"FOIL-SIDE" of display board. Note that, while board is double-sided, holes need not be plated-through.

bother than troubleshooting later on.

The LED's are important, too. There are several types of tri-color LED's on the market. The Programma III uses the kind with the two diodes in parallel, and as a result, the package has *two* leads. Another type of tri-color LED has the diodes in series, and the package has *three* leads. Stay away from that one; you want the two-leaded device. If you want to save money, you can substitute standard red LED's for the ones called for. The display won't look as elegant, because logic-low states won't be indicated, but you'll still get the information you need, and that's what counts.

Keep those tips in mind when shopping for parts. Since it is important to control costs today, keep them low by reading the ads in this magazine, comparing prices, and then buying from the best suppliers.

Once you have the boards and parts, it's time to get started. Refer to Figs. 5 and 6 for details for this phase of construction. Study Fig. 5 for a moment, and orient your board so it faces the same way. **Note that the parts-placement diagrams show the board from the side on which the components are mounted but that the foil pattern you see in the diagrams is on *the other side* of the board**. Now you are all set to install the parts, which consist of IC's, jumpers, resistors, and capacitors. The LED's—LED1–LED16—and the wires to SO1 won't be installed yet; *don't* rush and put them in first!

Begin with the IC's and insert an LM324 at IC1. Normally I would recommend using sockets for the IC's, but since the some of the IC pins have to be soldered on both sides of the board, it's better to solder the IC's directly to the board. Use gentle heat, and don't cook anything. Press the IC in place with your fingers, then flip the board over and solder all 14 leads to the foil. Then return to the *component side* of the board and carefully solder pins 2, 5, 6, 9, 19 and 13 to the foil. Use solder sparingly, and watch out for shorts. If you accidently create a solder bridge between two terminals, heat it , and push away the solder with a toothpick or X-ACTO knife.

Continue by installing another LM324 at the IC2 position. Solder it in as you did with the first IC. After that, install two more LM324's at the IC3 and IC4 positions. When you're done, check for missed connections and shorts, and correct any errors before going farther.

Moving to the left of the board, install an LM380 at IC6. (You may use a socket for this device, if you like.) Orient it as shown in Fig. 5 and solder the pins to the foil on the reverse side of the board. Move

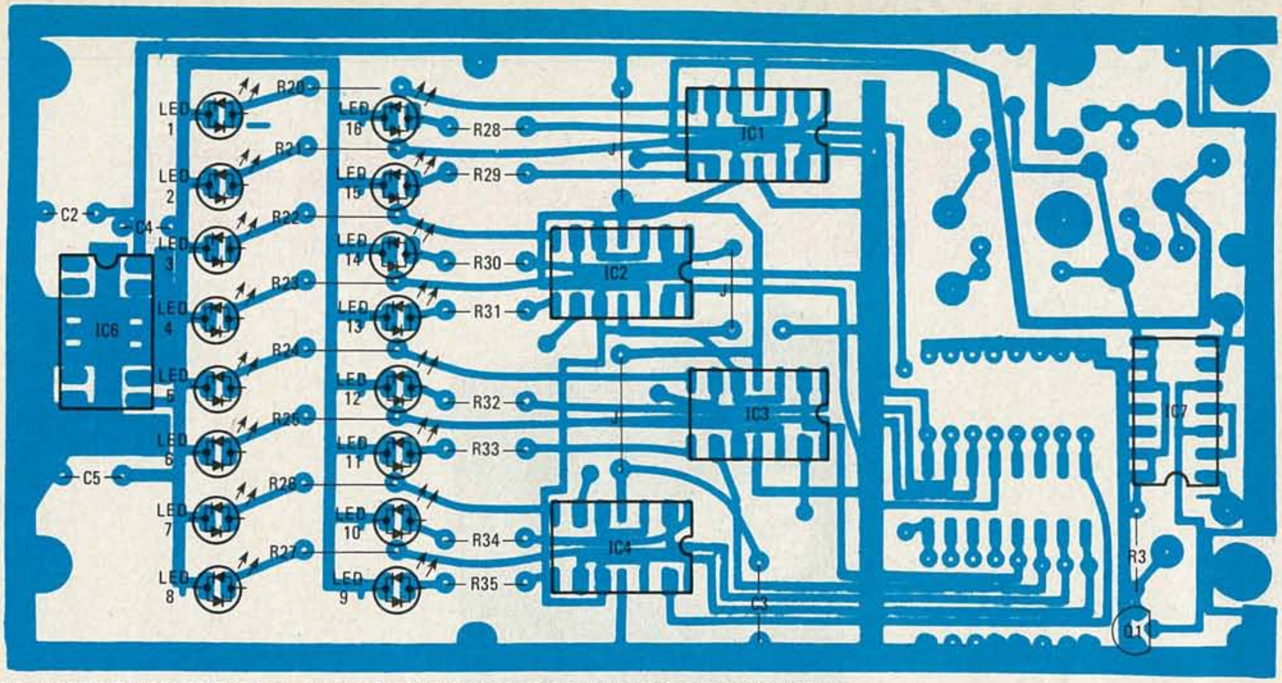



**FIG. 5—PARTS PLACEMENT on "component-side" of display board. Note that foil pattern shown is on side of board *opposite* the one on which components are mounted.**

to the right of the board and install a CD4011 at IC7. Press it in place with your finger, then turn the board over and solder the pins to the foil. Flip back to the component-side of the board and carefully solder pins 1, 6, and 8 to the foil on *that* side of the board. Be careful not to bridge pin 6 and pin 7; they are close together because of the foil trace nearby. That takes care of the IC's. Check your work again for shorts and errors, fix any problems, and you can continue.

There are three jumpers, and they come next. They are by IC1, IC2, and IC3, as indicated in Fig. 5. You can make the jumpers from short pieces of hookup wire, or short lengths of resistor lead. Install the first jumper to the left of IC1 and solder the leads to the foil on the other side of the board. Move across IC2, and install another jumper to the left of IC3. Position it so that it can't touch the foil that runs nearby—in fact, you should slip a piece of insulated tubing over the jumper if you used bare wire. Move to pin 1 of IC3, and install the third jumper. Note that it runs between the two IC's, and parallel to them.

The resistors come next. Note that these are all 1K units except for R3 (470 ohms), which is off in a corner by itself and which should be installed first. Solder its leads to the foil on the other side of the board. Move to the left of the LM324's and start installing the 1K resistors—note that there are 16 of them—as shown in Fig. 5. Then turn the board over and solder the leads to the foil. Be sure to clip off the excess lead lengths.

Now for the capacitors. Note that they are all of the same value—0.1 $\mu$F. Either ceramic disc or Mylar types may be used. Starting at the far left of the board, install 0.1 $\mu$F discs at C2, C5, and C4. Solder the leads on the other side of the board, and clip off the excess. Position the capacitor bodies so that they stand straight up. Then move along the bottom of the board, and install C3. Press its body flat against the board before soldering the leads; we don't want this part to stand up in the air. Clip off the excess leads, and you are finished with the capacitors.

For the time being, the last part to be installed on the component side of the board is Q1, the VMOS power FET. It goes in the bottom right corner, next to the 470-ohm resistor. Install the device as shown, with the flat in the case pointing toward the right edge of the board. Solder the leads on the other side of the board, and clip off the excess. That completes the component installation on this side of the board for now, though we still have to install the LED's and wire SO1.

Next time we'll complete the display board and wire it to the panel board. We'll also finish up construction and put the IC tester into operation. **R-E**

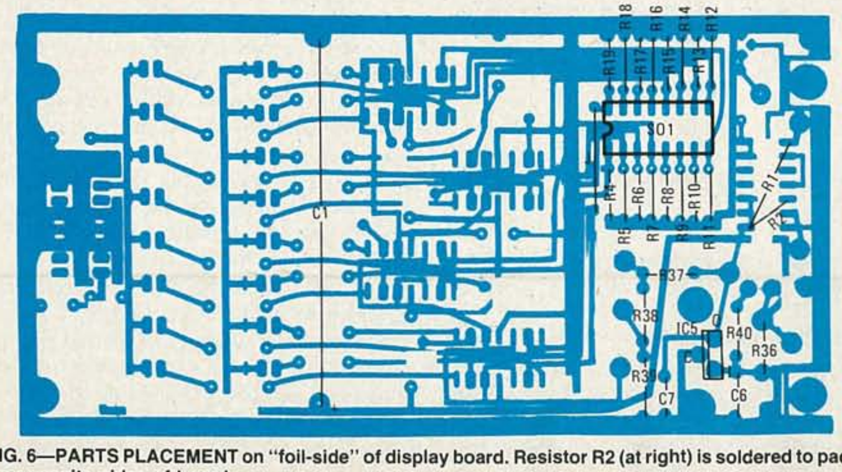
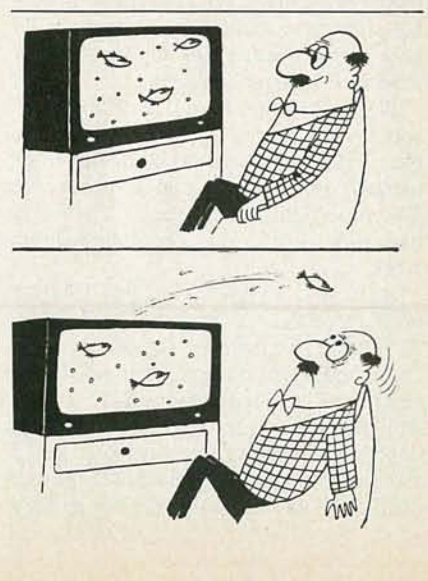



**FIG. 6—PARTS PLACEMENT on "foil-side" of display board. Resistor R2 (at right) is soldered to pads on opposite sides of board.**



# ALL ABOUT PAGERS


*Pocket pagers keep you from missing important calls, even when you're miles away from your phone. Here's a look at how pagers and paging systems operate.*

PETE DeHAAN

YOU'RE IN A CROWDED RESTAURANT, there's talk and laughter all around you, when suddenly a *BEEP, BEEP, BEEP* fills the room. The roar subsides as curious heads turn to find the source. *"Mr. Jones,"* says a disembodied voice, *"please call your office."*

As Mr. Jones gets up and heads toward a phone, the talk at your table turns to the merits of pocket pagers—beepers, as they are sometimes called. You start to add your opinion, when you stop short. What exactly *is* a pager, anyway?

If you look about you, you're sure to spot them—carried by doctors, salespeople, maintenance crews, computer technicians, and others. Even your favorite TV crime-fighter may "pack" a pager on occasion. Let's examine how pagers work.

Basically, a pager is an FM receiver with a tone decoder and audio amplifier. In order to activate or set off a pager, some additional equipment is needed: a transmitter to signal the pager, a controller to turn on the transmitter and encode the signaling information, and a means for input to the transmitter. Before we discuss paging equipment, let's take a fast look at the radio frequencies used by paging services.

## Frequencies used

The FCC (*F*ederal *C*ommunications *C*ommission) permits paging within several bands of frequencies in the RF spectrum. Those bands, however, are used for other purposes in addition to paging. The bands are divided and allocated by the FCC for such diverse functions as public safety, industrial communications, land transportation, public radio, etc.

One group of frequencies where paging is permitted is in the VHF (*V*ery *H*igh *F*requency) range and is commonly referred to as "low band;" it covers 30 to 50 MHz. Also in the VHF area is the "high band," with a range of 147 to 175 MHz. Farther up the frequency spectrum are the UHF (*U*ltra *H*igh *F*requency) band segments allocated for for paging: 406 to 420 MHz, 450 to 512 MHz, and areas in the 800-MHz band. Also being considered for paging are frequencies in the 900-MHz range. Again, those bands are not used exclusively for paging; many other types of transmissions are FCC-authorized for those frequencies.

As you can easily see, there are many frequencies that can be used for paging, and there are a number of different paging systems as well. They range from private business in-house systems to the offerings of RCC's (*R*adio *C*ommon *C*arriers), which are available to the public. Even though private users (industry, business,

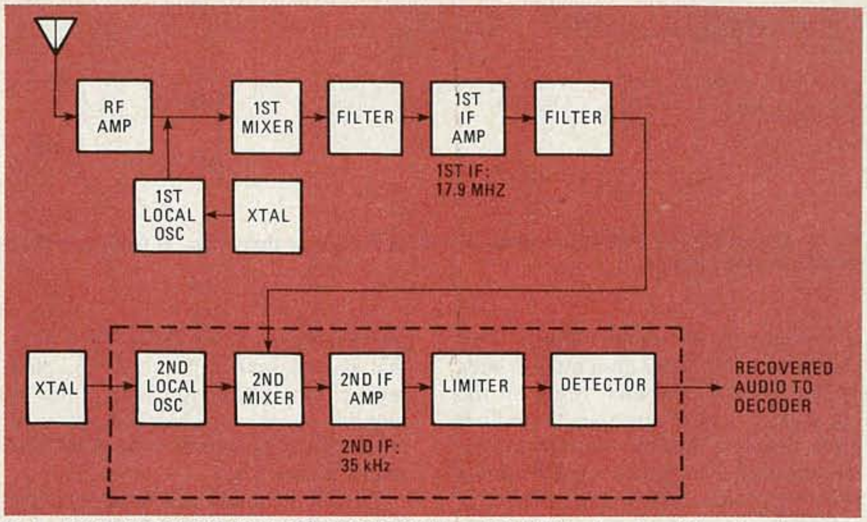



**FIG. 1—RECEIVER USES TWO IF-STAGES (17.9 MHz and 35 kHz) to step signal down to a frequency where it can easily be limited and demodulated.**

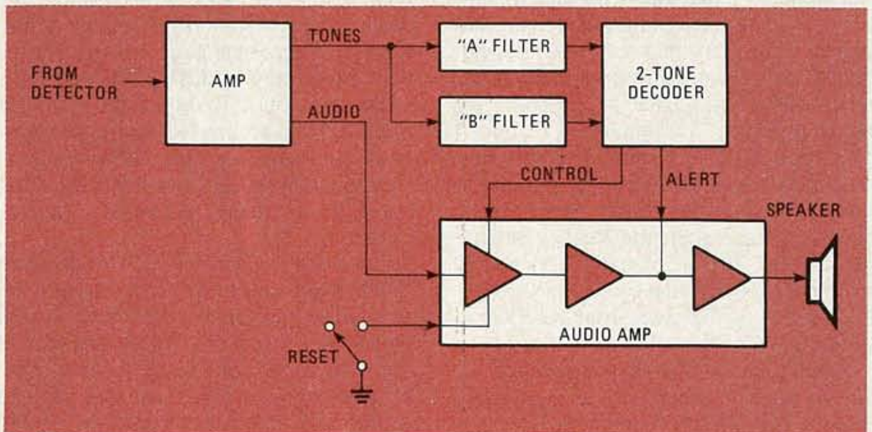



**FIG. 2—TWO-TONE DECODER uses two sharply tuned bandpass filters to isolate tones required to activate pager. First stage of audio amplifier is not keyed unless tones are successfully decoded.**

etc.) are permitted to own their own paging systems, they often choose not to. The reason is that they must file for, and be granted, a license by the FCC. They must also purchase and maintain their own equipment. Since that is both expensive and time consuming, many potential private users have, instead, sought the services of a local RCC. In that case, the user generally pays a fixed monthly rate to the RCC, which is, in turn, responsible for all equipment and licensing. For that and other reasons, independent RCC's across the country serve about 85% of the paging market. The most common frequencies of the RCC's are two VHF high-band frequencies referred to by the industry as P-5 and P-6—152.24 and 158.7 MHz, respectively.

Because of its widespread use, we will concentrate on the RCC format and examine the operation of a typical VHF high-band pager.

### The pager receiver

As stated earlier, a pager is simply an FM receiver with a tone decoder and audio amplifier. The receiver portion is a dual-conversion FM receiver. It must not only be very sensitive, to provide wide-range coverage, but must also be highly selective to reject unwanted and interfering signals.

Figure 1 shows a block diagram of a typical pager. When a signal arrives at the pager's antenna, it is coupled to the input of the RF amplifier. The RF amplifier must have a high gain-factor because, at times, the RF signal level at its input may be only slightly higher than the noise level. The RF amplifier will amplify both the wanted and unwanted signals; however that stage's high gain will greatly increase the difference between them. The relationship of the two signals within the receiver is referred to as its signal-to-noise ratio, and is an indication of the receiver's sensitivity. The output of the RF amplifier is fed to a stage called the *first mixer*.

Also fed to the first mixer is the output of the *first local oscillator*. Its frequency is established by a crystal, and is 17.9 MHz lower than the frequency the receiver is tuned to (also crystal-controlled). The purpose of the mixer is to combine the two input frequencies. The result is four signals at the mixer's output; one is the original input signal, another the local-oscillator signal, and the others the sum and the difference of those two.

Both the sum and the difference signals contain the same modulation information as the original signal, but it is only the 17.5-MHz difference signal that is needed for the *conversion* process. (The signal is converted to a lower frequency because it is easier to work with there than at a higher one.) A crystal filter is used in a bandpass configuration to attenuate the three unneeded signals and pass the modulated 17.9-MHz difference-signal. That leaves a signal having a lower frequency, with the original modulation intact, and accomplishes the first (or high) conversion of the dual-conversion process.

The difference-frequency of 17.9 MHz is referred to as the *first intermediate-frequency* (first IF). The signal is then further amplified by the first-IF amplifier and filtered a second time to further improve IF selectivity (the rejection of the three unwanted signals).

The conversion process is then performed a second time. That step is referred to as *low conversion*. The amplified and filtered first-IF signal is fed to the second mixer, along with the output of the crystal-controlled second oscillator. The second mixer produces a difference frequency of 35 kHz, which is amplified and fed to the limiter. That stage limits the amplitude of the signal to a constant level, as required by the detector. The detector removes the 35-kHz second-IF carrier, recovering from it the modulated audio. The recovered audio is then passed on to the decoder and audio-amplifier circuitry. The process of recovering the audio from the modulated second-IF signal is called *demodulation*.

### Decoder operation

The decoder, shown in block form in Fig. 2, must check for a series of received and demodulated audio tones. Each pager in a system will respond to one, and only one, specific group of tones. Not only does the decoder check for a particular series of tones, but it also looks for them to appear in a specific sequence.

Since the audio recovered from the FM signal is low in level, it must be amplified before being fed to the decoder filters and the audio amplifier. If the pager is in its normal (STANDBY or RESET) mode, it is waiting for the audio tones that will enable it and cause it to "sound off." In the case of the decoder shown in Fig. 2, only two tones are needed to make it decode successfully.

In the RESET mode all of the audio (tones and speech) may be present at the inputs of both the audio amplifier and the two filters. The filters, which are highly selective bandpass arrangements, will not pass any speech, since they require steady tones at the frequencies to which they are tuned in order to produce an output from the decoder.

The first stage of the audio-amplifier IC is normally off. When a tone matching the frequency of the "A" filter is received, that filter passes the signal to the decoder. The decoder is then enabled. If the proper "B" tone follows, the "B" filter will pass it on the decoder. The decoder will recognize the "match" and will produce an "alert" signal that is fed to the last amplifier-stage of the audio IC. That amplifier, which is always on, will drive the speaker, and the familiar *"beep, beep, beep"* will be heard. Once the alert has sounded, the CONTROL line enables the first section of the audio-amplifier IC and the voice message is received. When the caller has finished speaking, the amplifier is reset to mute the speaker. The pager is then back in the RESET or STANDBY mode, awating another page.

Some pagers, known as *tone-alert* pagers, do not have the capability of handling a voice message. They merely output an alert tone that informs the user to call some pre-arranged number, such as his office, answering service, home, etc. The tone-alert pager circuitry is similar to that of the tone-plus-voice model, but the audio amplifier is configured differently to handle only an alert tone and there is no provision for processing a voice signal.

A second decoding method, the *five-tone* format, uses five distinct audio tones transmitted as a rapid pulse-train. There, the decoding process can be compared to the two-tone format, though the circuits are much more complex. There are two advantages to the five-tone format. The first is that there are more than a million unique encode/decode combinations. The other is that the decoding information can be transmitted in approximately half a second, while the two-tone format requires up to four seconds. That adds up to quite a time saving for systems that are heavily used.

## The paging process

Now that we know what's inside a pager, let's see how paging works. Refer to Fig. 3 as we discuss just what is involved in the paging progress.

In most cases RCC customers can reach a pager on a direct-dial basis (although sometimes a dispatcher must be called; he will, in turn, manually process the paging). A person wishing to page someone merely has to dial a telephone number; each pager is assigned its own, along with the unique set of audio tones required to activate it.

The phone call is channeled through the phone company's central office and then on to the RCC's paging-control equipment. The controller searches its memory for the frequencies of the audio tones required to activate the pager associated with the number dialed. That information is found within milliseconds and the paging controller turns on the transmitter. It also generates the proper tones, which it sends to the transmitter. The transmitter modulates its RF carrier with those tones, transmitting the page-signal.

If the pager is within range of the transmitter, it decodes the signal and emits an alert tone. At the same time, the paging controller "answers" the line and returns to the calling party a short beep tone, which is a signal to the caller to begin speaking. The length of his message can vary from system to system, but is usually about ten seconds. Although that seems short, it is really quite adequate to repeat a short message or phone number two or three times. It is just a matter of seconds from the time a number is dialed until the pager user receives a message.

Some pagers—the tone-alert models—are not able to handle voice messages; instead, they merely beep. With that type of system, the caller hears a beep tone that indicates that the page has been processed, and then receives an interrupted busy tone.

## Pros and cons

A pager can be a great time and money saver to its user. A page can prevent a wasted trip, or ask the user to make an extra stop before returning home or to the office. It is also invaluable to someone who may be away from the office when an important customer, or a patient needing immediate attention, calls.

In these days of economic downturn, pagers are enjoying an increase in popularity. Businesses have been forced to cut costs and to search out and eliminate inefficiencies. Many firms have found that pagers save time—and, therefore, money amounting to many times the monthly pager-rental fee. I'm sure you'll agree that an investment with that kind of return is rare today.

One shortcoming of pagers is their relatively short range—typically 15 to 25 miles. Range can vary with transmitter power, terrain, and atmospheric conditions, and is sometimes related to the number of times the pager has been dropped! Pages may be difficult to receive in some rural areas. To reduce the problem, many RCC's are, or soon will be, simulcasting their pages from several strategically placed transmitters. That naturally increases a device's useful range.

For instance, many RCC's in the state of Michigan and from nearby areas have devised an inexpensive manual wide-area paging system. While the details are too involved to go into here, you can now have a pager in Michigan that will be useful and effective over most of the state.

Finally, a preliminary agreement has been reached to form a national radio-paging system using geosynchronous satellites. The participating companies are National Public Radio and Mobile Communications Corporation of America. Under the proposed system, users would phone pages into their local paging companies as usual. Those companies would then relay the pages to National Public Radio's Washington D.C. control center. From there, they would be uplinked to Westar IV and downlinked to the appropriate ground station. The ground station would then relay the page to the appropriate local paging company which transmits it in the usual manner. **R-E**

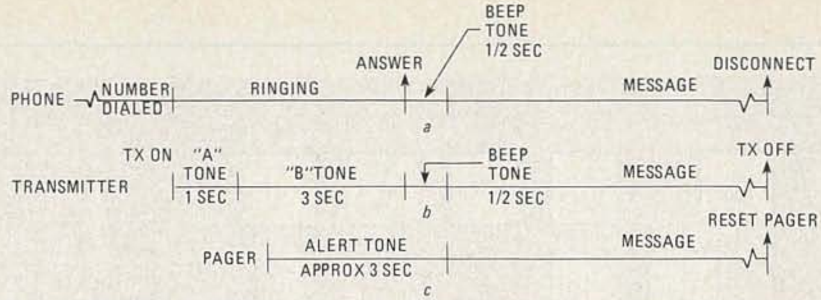
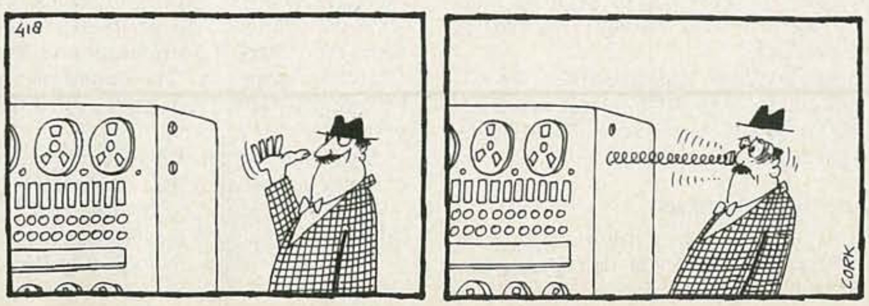



**FIG. 3—SEQUENCE OF EVENTS involved in making a page as they occur at (*a*) telephone, (*b*) transmitter, and (*c*) pager.**



# LOW-BAND CONVERTER


*There's a world of interesting activity on the frequencies below the AM broadcast-band. Here's a description of what happens down there, and instructions for building a converter for your receiver so you can listen in.*

STAN GIBILISCO

THOSE OF US WHO HAVE SHORTWAVE communications receivers have heard, and are familiar with, the range of the radio spectrum between 535 kHz and 30 MHz; that is the extent of coverage of most of today's shortwave receivers. Some receivers have a "longwave" band with a low-frequency limit of around 200 kHz. There aren't many receivers that operate lower than that; the ones that do are rather expensive. This article is concerned with the relatively-little-known part of the electromagnetic spectrum below the standard AM broadcast-band. In particular, we will be looking at the VLF (*V*ery-*L*ow-*F*requency) and LF (*L*ow-*F*equency) bands, ranging from 3 to 300 kHz. (The VLF band extends from 3 to 30 kHz, and the LF band from 30 to 300 kHz.)

It is not difficult or expensive to receive signals in those frequency ranges. A simple converter can be built from easy-to-find parts for a moderate price, allowing VLF and LF reception with a shortwave communications receiver.

### What's below the broadcast band?

There is plenty of activity below 535 kHz, all the way down to 10 kHz in the VLF spectrum. Table 1 shows the frequency allocations below 535 kHz on a worldwide basis. Below 10 kHz, there are no allocations—those frequencies are considered essentially useless, for reasons we will discuss later.

Especially toward the lower part of the LF band (below 150 kHz), and throughout the VLF band, voice-modulated signals will not be found. Such transmissions require too much bandwidth to be used in a part of the spectrum where bandwidth conservation is extremely important. An AM signal takes up at least 6 kHz, and the whole VLF band is only 27 kHz wide! An AM signal at 15 kHz would have to be at least 40 percent as wide as its carrier frequency! Because of those factors, all signals in that frequency range are modulated by means of narrow-bandwidth techniques, such as CW (Morse code) or frequency-shift teletype.

**TABLE 1**

| Frequency—kHz | Service |
|---|---|
| Below 10.00 | Not allocated |
| 10.00–14.00 | Radio location, radio navigation |
| 14.00–19.95 | Fixed, maritime mobile |
| 19.95–20.05 | Standard frequency |
| 20.05–70.00 | Fixed, maritime mobile |
| 70.00–90.00 | Fixed, maritime mobile, maritime radio navigation, radio location |
| 90.00–110.0 | Fixed, radio navigation, maritime mobile |
| 110.0–130.0 | Fixed, maritime mobile, maritime radio navigation, radio location |
| 130.0–160.0 | Fixed, maritime mobile |
| 155.0–281.0 | Broadcasting (Europe, N. Africa, and Middle East) |
| 160.0–200.0 | Fixed |
| 200.0–285.0 | Aeronautical radio navigation, aeronautical mobile |
| 285.0–325.0 | Maritime radio navigation, aeronautical radio navigation |
| 325.0–405.0 | Aeronautical radio navigation, aeronautical mobile |
| 405.0–415.0 | Maritime radio navigation, aeronautical radio navigation, aeronautical mobile |
| 415.0–490.0 | Maritime mobile |
| 490.0–510.0 | Mobile (distress and calling) |
| 510.0–525.0 | Mobile, aeronautical radio navigation |
| 525.0–535.0 | Mobile, broadcasting, aeronautical radio navigation |

### Propagation below 535 kHz

Radio signals at VLF and LF travel by three basic long-distance modes: surface-wave, sky-wave, and waveguide propagation. Particularly below about 100 kHz, the characteristics of radio-signal travel are alien to the short-wave listener; there is no rapid fading, backscatter, or selective distortion such as commonly occurs at high frequencies.

### Surface waves

At VLF and LF, radio signals can travel along the surface of the Earth for great distances, without relying on the ionoshpere for propagation. This mode of propagation (sometimes mistakenly referred to as 'ground-wave' propagation) gets better and better as the frequency decreases. At 535 kHz, surface waves can be heard out to distances of 200 to 300 miles when conditions are good. But, since the Earth is a poor conductor at that frequency, and the return circuit for surface-wave travel is the Earth, the useful range is limited. Most of the energy gets used to heat up the ground.

As the frequency decreases, the ground becomes a better and better conductor. At frequencies around 100 kHz, it is not unusual to hear surface-wave signals from more than a thousand miles away. In the VLF range, surface propagation combines with ionospheric propagation to allow worldwide communications, provided that huge antennas and high-power transmitters are used.

Since the ionosphere plays no role in surface-wave propagation, VLF and LF communications may someday prove useful on planets with no ionosphere to support other modes of over-the-horizon links.

## Sky waves

All radio waves having frequencies below 535 kHz are dramatically affected by the earth's upper atmosphere. There are three layers of ionized gases high above the surface of our planet; those regions are called the D, E, and F layers. Figure 1 shows the arrangement of those layers during the day and at night. Typical altitudes in miles are shown.

The D layer, at a height of 37 to 57 miles, returns VLF signals to the Earth during the daytime, but absorbs energy at higher frequencies. At night, that layer disappears, and the E and F layers are responsible for VLF and LF sky-wave propagation. The E layer varies in altitude from about 62 to 71 miles and the F layer may be anywhere between about 130 and 261 miles up. The F layer is generally higher at night than during the day.

VLF and LF energy is almost totally reflected by the ionosphere, and hardly any of it escapes into space; furthermore, no VLF or LF signals from outer space can penetrate to the Earth's surface. That creates a "trap" for such energy, and insures that over-the-horizon communication is always possible.

Sky-wave and surface-wave modes, acting together, don't always reinforce each other. If, at a certain distance from the transmitting station, the surface-wave and sky-wave signals are equally strong but opposite in phase, they will cancel each other, and no signal will be heard. That effect becomes more common as the frequency increases.

Also, as frequency increases, the D layer gets more and more absorptive. That reduces the effectiveness of sky-wave communications during the daylight hours. But the D layer disappears at night, and that is why we usually hear LF stations from farther away at night. The same effect occurs throughout the AM broadcast band, and no doubt you have observed the difference between daytime and nighttime propagation there.

## Waveguide effect

The ionospheric D layer and the Earth's surface both form almost perfect reflectors of VLF energy. At VLF, the waves are so long that the distance between the ground and the D layer is only a few wavelengths. (For example, a 10-kHz signal has a wavelength of 18.6 miles, but the D layer is 37 to 57 miles high—just two or three wavelengths.) That gives rise to a daytime condition where VLF energy travels within the chamber between the Earth and the D layer as if that space were a waveguide transmission-line.

Waveguide propagation is an extremely reliable means of communication at VLF, with no fading or "dead zones." Waveguide propagation is best during daylight hours, since the D layer disappears at night, leaving only the E and F layers, which are too far above the Earth to serve as good waveguide reflectors.

Since all waveguides have a high-pass frequency response, there is a lower limit on the frequencies that can be used for long-distance propagation. If the wavelength is too great, the Earth-to-D-layer waveguide will be too small to support propagation. The frequency at which attenuation begins to increase rapidly is about 10 kHz. Below that, especially during the daylight hours, the waveguide effect is of little use for long-distance communications. So severe is the loss, in fact, that frequencies below 10 kHz are not allocated for communications.

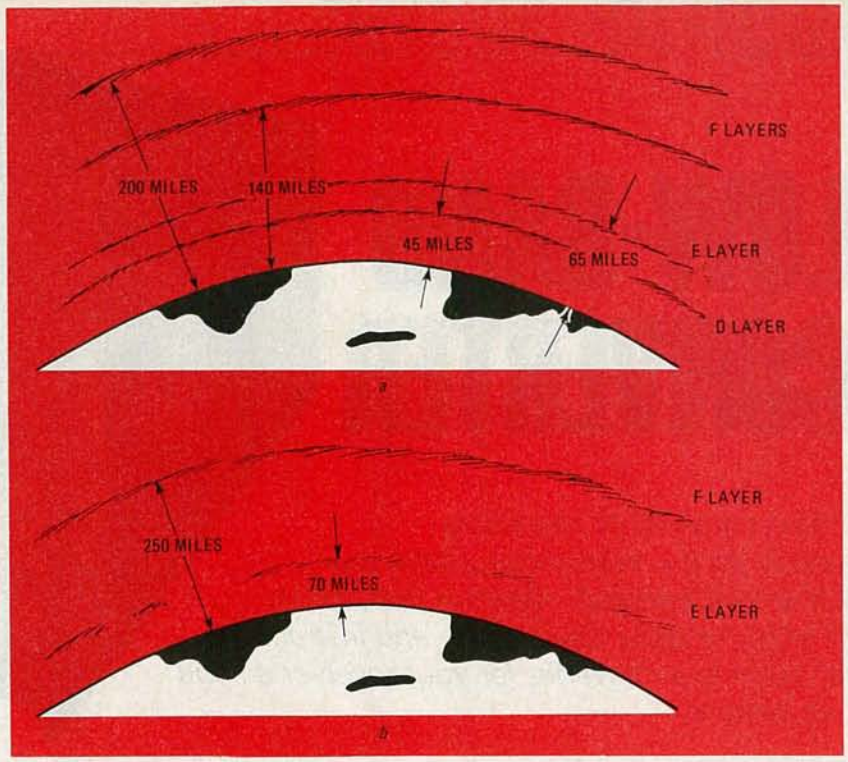



**FIG. 1—"D," "E," and "F" LAYERS of the ionosphere assist in LF and VLF propagation. Typical daytime configuration is shown in *a*; "D" layer disappears at night (*b*).**

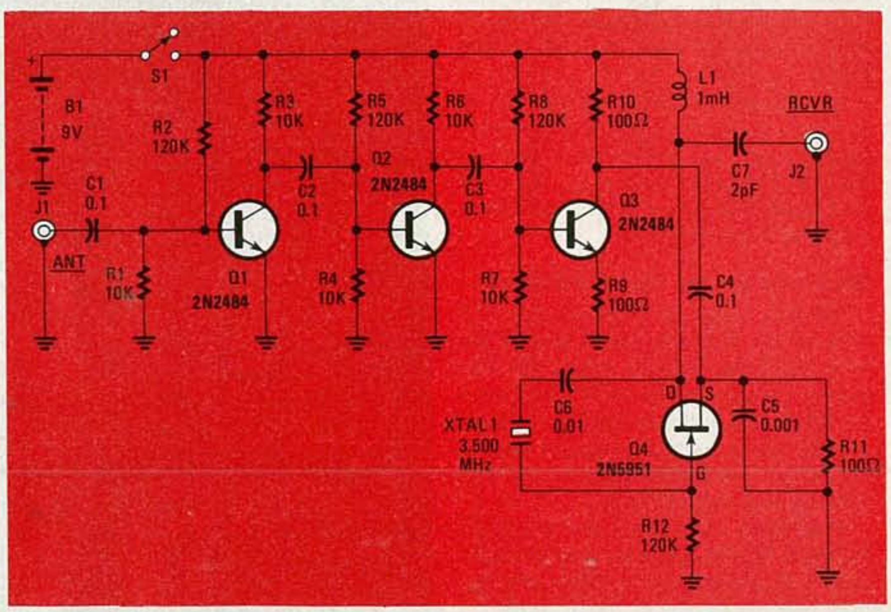



**FIG. 2—COMPONENTS USED IN LOW-BAND CONVERTER are readily available. Crystal may be ordered from companies advertising at back of magazine.**

### Methods of reception

Building a complete, self-contained, receiver that covers 10 to 535 kHz is not easy. The top frequency is more than fifty times greater than the low one; that's equivalent (in terms of percent) to the range from the middle of the AM broadcast-band to TV channel 2! The only practical way in which you can obtain reception over such a wide band is to build a converter for an existing high-frequency receiver.

The converter described here "moves" the 10-to-535-kHz band to the 3.510-to-4.035-MHz range for reception on shortwave receivers. That output range was selected so as to be compatible with amateur-band equipment. The converter's output falls nicely into the 80-meter ham band (3.5–4.0 MHz).

What kind of receiver should you use? It must have a BFO (*B*eat- *F*requency *O*scillator). It should be frequency-stable (as drift-free as possible) and have good selectivity. A ham receiver is ideal, especially if it has a narrow-bandwidth filter for CW reception. It also helps to have a noise blanker or limiter, because man-made impulse-noise is a problem at VLF and LF. Other than those requirements, any sort of receiver with fairly accurate dial-calibration is alright: solid-state or tube-type, battery-powered portable or a 50-pound boat anchor from the pre-World-War-II era!

### A simple converter

Figure 2 shows the a schematic diagram for a low-band converter. Three stages of broadband amplification (Q1, Q2, and Q3) are used. The crystal oscillator/mixer, Q4, provides an amplitude-modulated (AM) signal, with the carrier at 3.500 MHz. That signal is fed to the antenna input of the receiver. The VLF and LF signals appear as sidebands above and below the carrier. The upper sideband (3.510 to 4.035 MHz) is easier to use because the signal frequency is easier to determine—just subtract 3.500 MHz from the receiver dial readout. (If you use the lower sideband the reception will be just as good, but the band will come out "upside down" in the receiver, and frequency determination will be tricky.)

The parts for the converter are inexpensive and easy to find. Most, if not all, should be available from advertisers in **Radio-Electronics**. Parts for antenna construction will be described in the text, and are not included in the Parts List.

### Construction

The converter circuit can be built on perforated construction board or on an "experimenter board" such as those available from Radio Shack and others; I used the latter.

If you use an "experimenter board," note that the holes are interconnected by foil on the underside of the board in groups of four. The 20 × 20 matrix of holes is labeled on each axis by the numbers 1 through 20 and the letters A through T printed on the underside of the board. It helps to place a piece of adhesive paper on top of the board, punch out all the holes with a sharp instrument, and label the rows and columns for easy reference.

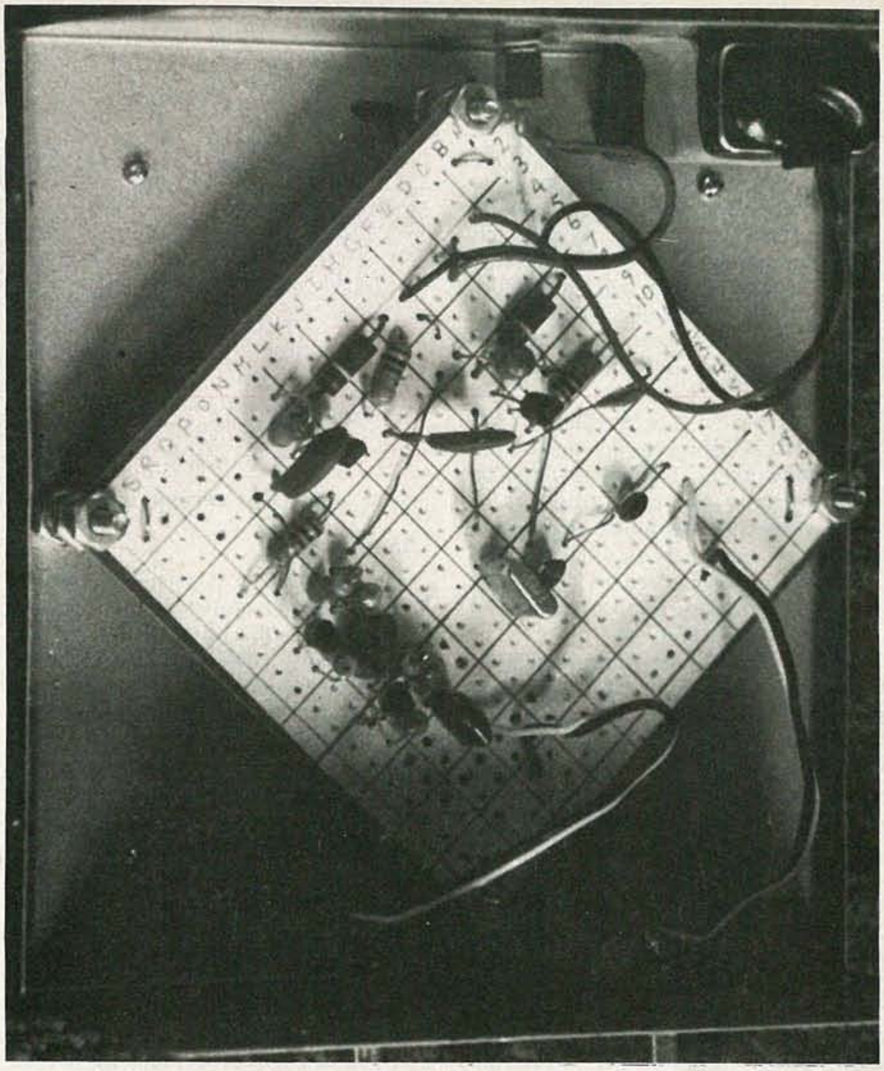


FIG. 3—COMPONENT PLACEMENT is not critical. Letters and numbers at edge of board simplify design work.

The parts layout I used is shown in Fig. 3. Install the jumper wires first. Then install the resistors, capacitors, crystal, and choke. Resistors should be mounted vertically when the holes are adjacent (as is the case with R1 through R6). Install the transistors and external-connection wires last. Be careful not to use too much heat when soldering the transistor leads.

Drill two ¼-inch holes in the rear panel of the metal cabinet, and one ¼-inch hole in the front panel. Also drill four ⅛-inch holes at the corners of a 3¼-inch square (assuming you're using the same type of board I did) on the bottom of the chassis. (It's not critical how the square is oriented, but the holes should be well away from the rubber feet on the underside of the chassis.) Mount the SPST switch on the front panel and the two female phono-jacks on the rear panel. Don't forget solder lugs for the ground connections to the phono jacks.

The four corner holes on the circuit board must carefully be enlarged with a drill to ⅛-inch before mounting. After that's done, put four 6-32 screws into the chassis mounting-holes from the outside of the enclosure, and secure them with one nut apiece. Put a second nut on each screw and move it down until it is ⅜-inch from the end.

Push the circuit board down into the screws and, once the board has been pushed down to the middle nuts, screw on the last four nuts to keep it there.

Connect the SPST switch and the input and output jacks to the board; label the jacks to avoid possible confusion later. Connect the 9-volt battery, and secure it in a convenient place with a battery clip or double-sided tape. Be sure none of the wires short to any other circuit point.

### Preliminary testing

Now you're ready to test the converter. Use a shielded cable to connect the output of the converter to the antenna terminals (or jack) of the shortwave receiver. Tune the receiver to 3.500 MHz. When you switch the converter on you should hear a strong unmodulated carrier on or near that frequency. Turn the receiver's BFO on (or switch the receiver to the USB position), and tune in the carrier until you get a zero beat (the tone pitch gets too low to hear). Set the receiver's dial to read exactly 3.500 MHz. If your receiver has both "main-tuning" and "bandspread-tuning" controls, set the bandspread control to 3.500 MHz and tune the main-tuning knob for zero beat. Leave the BFO on, or leave the MODE switch in the USB position.

What if you don't hear anything around 3.500 MHz? That means that the oscillator is not working. The problem may be improper wiring, including solder bridges or cold-solder joints; an incorrect component-value; a bad crystal; a faulty component; or a dead battery. (I had a lot of trouble getting my oscillator to start up until I replaced the crystal.)

To check the amplifiers and modulator, plug a piece of wire about 20 feet long into the input of the converter. You should hear a loud buzz at VLF frequencies, and possibly well up into the LF band. You may also hear a lot of carriers. If you don't, there is something wrong with one of the amplifier stages. Again, check for improper wiring, an incorrect component value, a faulty component, or a weak or dead battery. Once you are sure that the circuit is working, you're ready to put up an antenna.

Not just any old wire lying on the ground, or thrown up into a tree, will work well at VLF and LF. Unless the right kind of antenna is used, all you'll hear is an overwhelming conglomeration of interference including AC-line buzz and cross-modulation products from the AM broadcast band.

## Antenna systems

The importance of a good ground system cannot be overemphasized for low-band reception. Preferably, the house utility-ground should be used; look for a pipe running down the electric meter into the ground. Cold-water pipes will also work fairly well, but don't try hot-water or heating-system pipes. The ground connection should be made to the shield at the antenna-end of the coaxial cable used to connect the antenna to the converter.

For low-band reception, a loop antenna generally works best. It should be in a vertical plane, since VLF and LF signals tend to be vertically polarized. Such an antenna can easily be tuned to the desired frequency, and has a narrow bandwidth, which is a necessity for rejection of noise and cross-modulation distortion products. There are two possible configurations for a loop-type receiving antenna: the open loop and the ferrite loopstick. Both are shown schematically in Fig. 4.

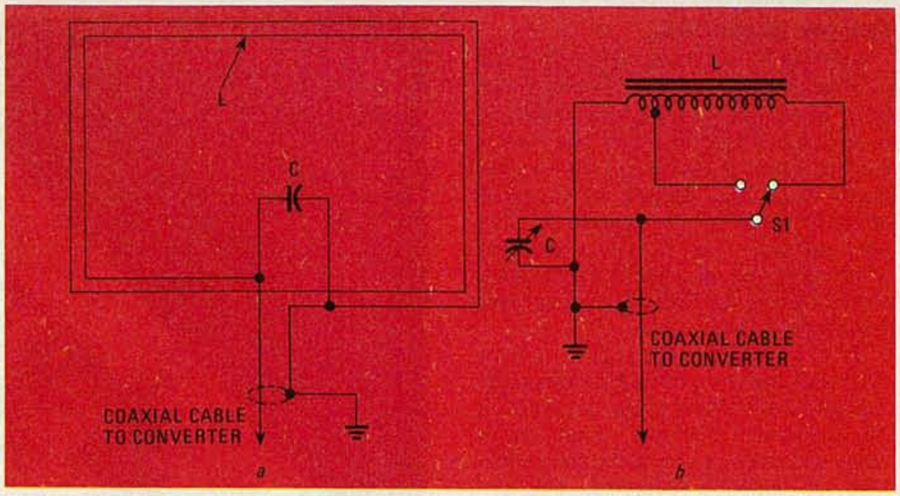



FIG. 4—OPEN-LOOP ANTENNA is shown in *a*; ferrite loop at *b*.

## An open loop

An open loop consists of eight to twelve turns of insulated wire, mounted in the shape of a square, rectangle, or circle against a non-metallic wall, or between two non-metallic supports. The loop should have a radius of at least two feet. The larger the enclosed area of the loop, the better the signal pickup will be; reception also improves with the number of turns used. Excessively large loops, however, will pick up a great deal of AC buzz and appliance noise, so there is a practical maximum size-limit. That limit will depend on the amount of noise in your area, and will have to be determined by experimentation. The loop should, of course, be placed as far away from AC wiring as possible.

The loop should be tuned to, or close to, resonance at the desired frequency by means of a capacitor connected in parallel with it. The resonant frequency for a given capacitance C depends on the loop inductance L. Assuming that the loop is at least several feet away from large metallic objects, its inductance can be found from the formula:

$$L = \frac{N^2\sqrt{A/\pi}}{9000}$$

where L is in millihenries (mH), A is the enclosed area of the coil in square inches, and N is the number of turns. If the coil is a perfect circle of radius r inches, then:

$$L = \frac{N^2 r}{9000}$$

Once you know the inductance of the loop, you can determine the amount of capacitance needed for a given frequency *f*, according to the formula:

$$C = \frac{1000}{4\pi^2 f^2 L}$$

where L is again in mH, *f* is in kHz, and C is in microfarads ($\mu$F).

The capacitance values generally required to tune an open loop to resonance range from about 100 pF at 535 kHz to as much as 0.5 $\mu$F for small loops at VLF. It is impractical to use variable capacitors for tuning an open loop over a wide range of frequencies, simply because they don't make them big enough! That means you will have to switch among several fixed capacitors to obtain wide-band coverage. The easiest way to do that is to use a decade capacitance-box. Ceramic, Mylar or mica capacitors are best; don't use electrolytics.

It is important that the tuning capacitors be placed at the antenna, and not at the converter end of the feed line because the line capacitance will have a detrimental effect on selectivity toward the upper end of the LF band. That will allow more cross-modulation distortion from the AM broadcast-band and give the illusion of LF signals where there are none.

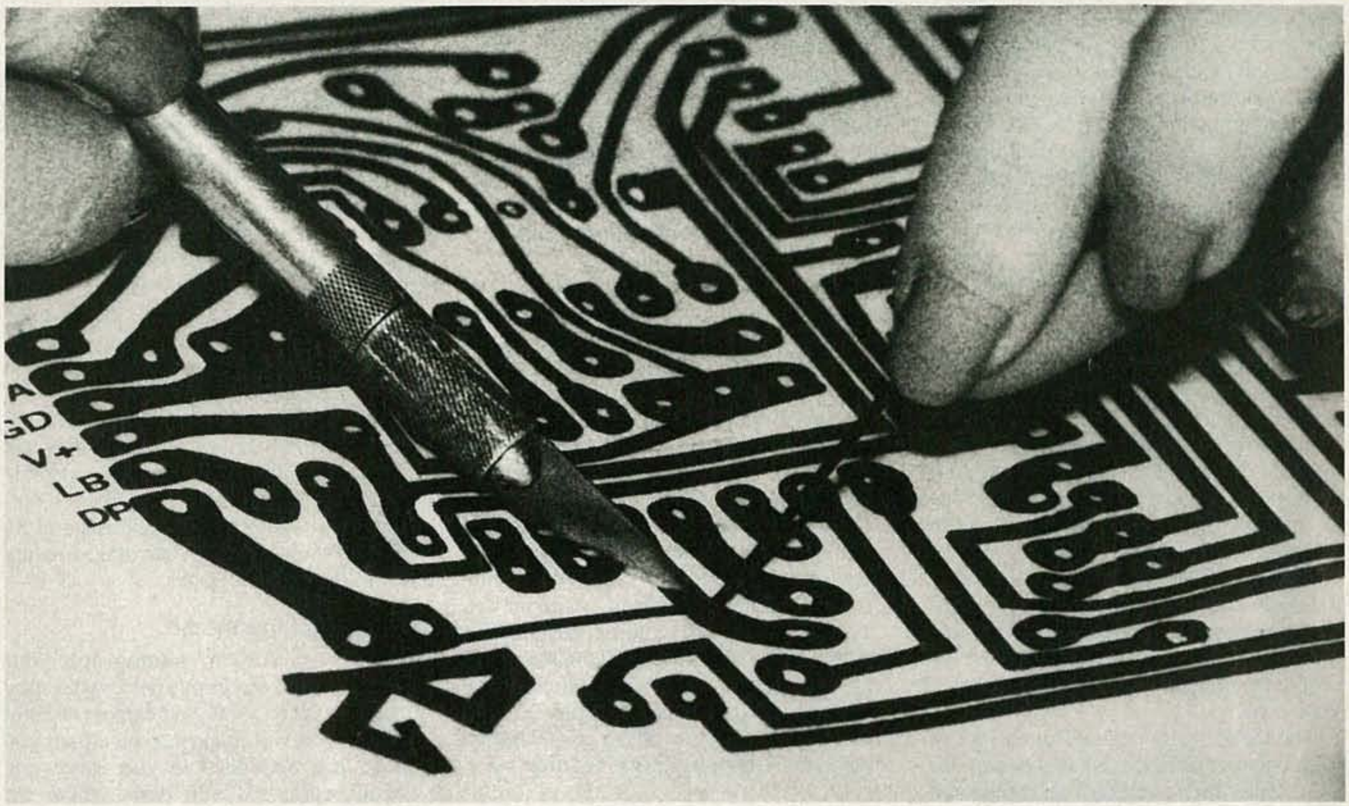
### PARTS LIST

**All resistors ¼-watt, 5%, unless otherwise specified**
R1, R3, R4, R6, R7—10,000 ohms
R2, R5, R8, R12—120,000 ohms
R9–R11—100 ohms
**Capacitors**
C1–C4—0.1 $\mu$F, ceramic disc
C5—0.001 $\mu$F, ceramic disc
C6—0.01 $\mu$F, ceramic disc
C7—2 pF, ceramic disc
**Semiconductors**
Q1–Q3—2N2484 or equivalent
Q4—2N5951 or equivalent N-channel JFET
XTAL1—3.500 MHz, parallel-resonant, 20 pF (if necessary, a crystal of another frequency may be used)
L1—1 mH
J1, J2—RCA phono jack, chassis mount
S1—SPST toggle switch
B1—9-volt transistor battery
**Miscellaneous:** "experimenter board" (see text), wire, battery clip, metal enclosure, antenna materials (see text)

## A ferrite loopstick antenna

The inconvenience of having to switch among fixed capacitors for frequency adjustment can be overcome by the use of a ferrite loopstick antenna. (That's the kind of antenna that you find in most

*continued on page 102*




# ETCH YOUR OWN PC BOARDS

*Now that you've drawn your layout, what's the best way to transfer it to the board? Do it the easy way–photographically!*

ROBERT GROSSBLATT

**Part 2** LAST TIME, WE SHOWED you a step-by-step method for developing a PC-board layout from your working prototype circuit. The first thing we'll do this month is finish that layout.

At the risk of sounding monotonous, recheck all the connections against your schematic once again—and it's not a bad idea to check the schematic against the breadboard, either.

This is the last chance you'll have to make any changes in the pattern easily. Get out the straightedge and calipers again and make sure that the pads at the top and bottom of the boards are in register. Count squares from the middle center line and use the straightedge to verify everything. Finding a pad that's off by a sixteenth of an inch when you're drilling holes can really ruin your day.

If you're sure—really sure—that everything is correct you can go on to the window dressing. It's always a good idea to label things. If you have edge connections on the board, you'll usually find it helpful later on if you number them. The same is true for pin 1 of each IC. You can do all that, and include any descriptions you want on the board, using transfer type as shown in Fig. 6. It's nice to indicate different sections of the board, which way polarized components should be inserted, IC numbers, and so on. After all, the whole purpose in making printed-circuit boards is to make life easier and more reliable. Use transfer type that is at least ⅛-inch wide; any smaller and you run the risk of having it thin out and disappear somewhere along the line.

Your drawing should be finished now. The pattern should be completely blacked in and you should be able to see the components drawn in blue on the component side of the board. Check everything over a final time and then mark off as long a segment as possible on the center line. Label the length in black as shown in Fig. 7. The longer the segment you can mark, the more accurate your measurement is going to be when you shrink it down to half size. Once that is done you're ready to begin making the etching mask.

### Transferring the pattern

There have been lots of methods devised to get a foil pattern transferred from paper to circuit board. They have been as simple as drawing directly on the copper or as involved as cutting out patterns in copper or tape. All those methods were developed because there's a myth that the photographic process is too difficult to be done at home—some claim that the equipment is too expensive; others that the materials are too exotic. In any event, when I made the decision to make prototype boards at home I read all that propaganda and, (perhaps like you?) believed it all. I tried every method I could find. I cut, drew, pasted, taped, and scraped—and unless the pattern was an exceptionally simple one, the results were usually disappointing. Then I decided to do it the hard way—photographically.

I was amazed—the results were perfect, the process was easy, and the amount of detail that could be reproduced on the copper was astounding. Now, if all you need is a few traces on a single-sided board and you want to make only one board, you're better off taping directly on the copper and letting it go at that. But if you're making a board of any complexity, if you want several copies of the board, or if the board has to be double-sided, there is no method simpler, safer, or more secure than the one everyone else told you to avoid—the photographic method.

### Photo masks

Preparing a photographic mask is like most other things in life—if you have the right tools and use them correctly you won't have any problems. Don't automatically dismiss the idea of making your own masks. There's nothing mysterious or difficult about the process, and it can be done easily with a bare minimum of equipment. Of course you can have the masks made by a professional photographic house, but the cost of having that done once or twice will be more than the cost of the materials you have to buy to do your own.

The mask itself is made from a special high-contrast film called *ortho* or *litho* film. That film is very slow and requires a lot of exposure, but it produces the kind of negatives that are ideal for printed-circuit work. When the film is developed, the image is either completely opaque, or completely clear; there are no in-between shades of gray. There is no secret to using it properly and it's very tolerant as far as exposure and processing are concerned.

To keep things simple, we will proceed under the assumption that you have a basic knowledge of darkroom techniques and terminology. If you do not, it would be a good idea to get hold of a basic book on the subject, either from your public library or from a photography store, and look through it.

### What you'll need

Although ortho (litho) film is manufactured by several different companies, it is most readily available from Kodak. Their brand name for the film is *Kodalith* and it comes in a variety of shapes and sizes, ranging from 35mm roll film to sheets of film that measure more than 20- by 24-inches (see Fig. 8). That film is available from most well-stocked camera stores; if they don't ordinarily carry it they usually will special order it for you. If you can't get it locally, the film is also available from many mail-order firms; their ads can be found in almost any photography magazine.

Very little equipment is needed to make your own masks—a 35mm camera, some reusable 35mm cassettes, and a slide projector. The unexposed *Kodalith* must be handled under a safelight, but a red light-bulb will also work well. Any hardware store can supply you with a 15-watt red bulb, and even a 25-watt one will do.

If you do decide to order by mail, be aware that there is often a minimum-order requirement—typically $35.00 or so. But for that amount of money, you can get enough supplies (excluding the camera and projector, of course) to make more than 50 negatives, even allowing for the mistakes you're bound to make while learning. That works out to considerably less than $1.00 a negative, and that's not bad.

You're going to have to find someplace in your home that can be made reasonably light tight. That doesn't mean that it has to be hermetically sealed—a closet, etc. will do fine. Make sure there's some way of running electricity into it for the safelight. You'll also need enough space to lay out the three chemical trays. Mind you, if you do all your work at night, the whole business can be done in the bathroom—even if it has a window (which you should cover up to play it safe).

If you're going to work during the day, however, and you're not sure whether your work area is dark enough, or whether your safelight is safe enough, there's a simple test. Working under the safelight, take a piece of the film and lay it flat on a surface, emulsion side up. The emulsion side is lighter in color than the base side and the difference is easily seen, even under a safelight (see Fig. 9). If the film tends to curl at the edges, tape it flat with masking tape.

Put a key or a couple of coins on it and wait about five minutes. Then put the film in the developer and agitate it gently for about three minutes. After that, give it a quick dunk in the stop bath and then put it in the fixer. The film will start to clear and when you see that it has become transparent give it a quick rinse in water and take it out into the light. If you see any shadow on it from the coins, your "darkroom" isn't dark enough. Check carefully for light leaks, seal them, and try the test again.

Once your darkroom has passed the coin test, load about four-and-a-half feet of the 35mm film into one of the reusable cassettes. Leave about three inches outside the cassette and cut the edge at an angle as shown in Fig. 10 to make loading it into the camera easier.

### Photographing the art

The best way to photograph your artwork is to use a copy stand. All a copy stand does is to point your camera straight down toward a flat surface on which you place the artwork. If you have one already, great; if you don't, there are several ways of going ahead without it.

You can, for example, tape the artwork to a wall and put the camera on a tripod. If you don't have a tripod, rest the camera on a table and line it up with the artwork. The important thing is to find some way to hold the camera steady during the long (at least one second) exposure time required because of the extremely slow speed (lack of sensitivity to light) of the film. If you have a shutter-release cable, use it; the steadier you keep the camera, the better.

You'll also need to make sure that the camera is pointed *directly* at the artwork; if isn't, the image on the film will be distorted and the negative will be useless. Use two 250-watt bulbs to illuminate the artwork, placing them as shown in Fig. 11. For best results, position the camera

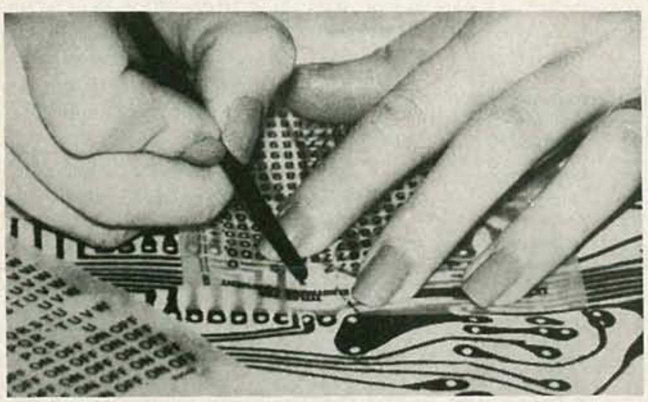


FIG. 6—IT IS OFTEN HELPFUL if you identify IC pin numbers, edge connectors, and the like for later reference. Using transfer type for that, as shown, can give your project a professional appearance.

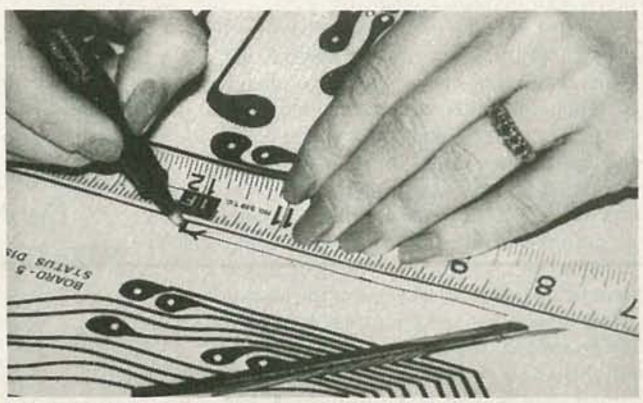


FIG. 7—MARKING OFF a segment of the center line. That segment gives you a useful reference when you make your full-sized mask from your double-sized layout.


FIG. 8—ORTHO (LITHO) FILM, such as Kodak's *Kodalith*, is best for making the mask.

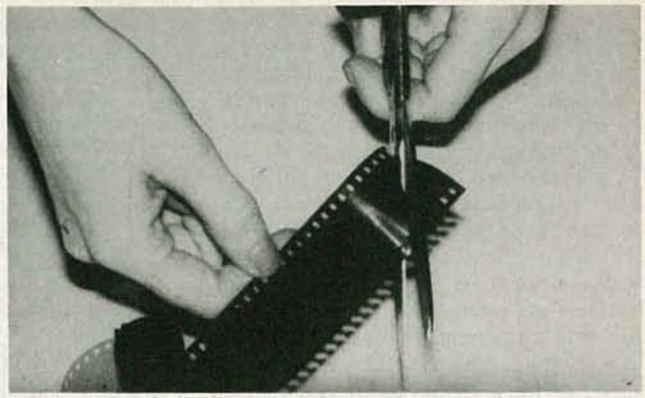


FIG. 10—CUTTING THE FILM at an angle makes loading it into your camera a lot easier.

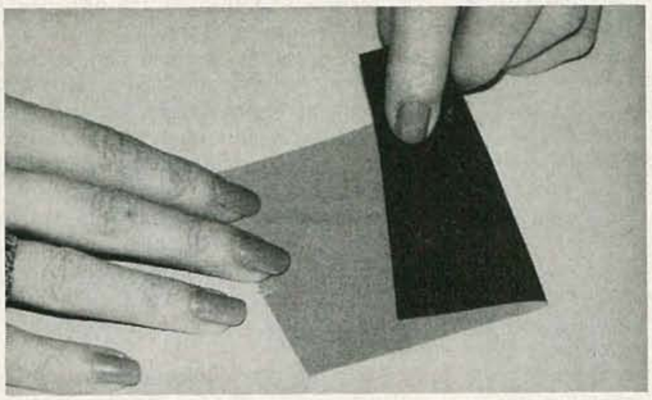


FIG. 9—THE DIFFERENCE between the film's emulsion side and base side is easy to see, even when working under a safelight.

With the safelight on, open the back of the camera and cut off the film you've exposed, about three inches from the cassette (that will allow you to trim a new leader and use the remaining film). Place the film, emulsion side up, in the developing tray and agitate it gently; if you fit it in diagonally, you can get about 12 inches of film into an 8 × 10-inch tray. The film will probably tend to curl, so hold it under the developer or weight the edges down with paper clips. If air bubbles form on the emulsion, tap the film with your finger to remove them; if you don't, you'll wind up with undeveloped spots.

The image should start to appear within thirty seconds. Watch it carefully and when the artwork is clearly visible on the film (as a negative, of course), take the film out of the developer and put it in the stop bath.

That solution, as its name implies, will stop the development. The film should be

so the artwork is as large as possible in the viewfinder.

If you're doing a double-sided board, you can photograph the art for each side separately since you'll be checking the registration of the two negatives later on in the process. Be sure to keep the camera in the same position for both shots; that will eliminate one possible registration problem.

The exposure you use will depend on a number of factors, but a good starting point is one second at $f5.6$. If your camera doesn't have a shutter speed of one second, turn off the lights, set the shutter speed to "B," and turn the lights on for one second. Remember to close the shutter after you turn the lights back off. Since you have four-and-a-half feet of film in the camera, it's a good idea to make several exposures and "bracket" them—use shutter speeds longer and shorter than one second. Making several exposures at each speed won't hurt, either; the film is cheap enough and it's good insurance.

### Back to the darkroom

Many companies make film-processing chemistry. One of those chemicals, called the developer, comes in both powder and liquid form. Each has its good and bad points—for instance, the powder will keep much longer but the liquid is easier to use—the choice is up to you. Follow the mixing directions and pour enough in your developing tray to fill it to a depth of about ½ inch. If you use a 8 × 10-inch tray (which should be large enough), you will need about 16 ounces of developer. Of the remaining two trays, one is for the stop bath and the other for the fixer. Pour enough chemical into each to fill it to a depth of about ½ inch.

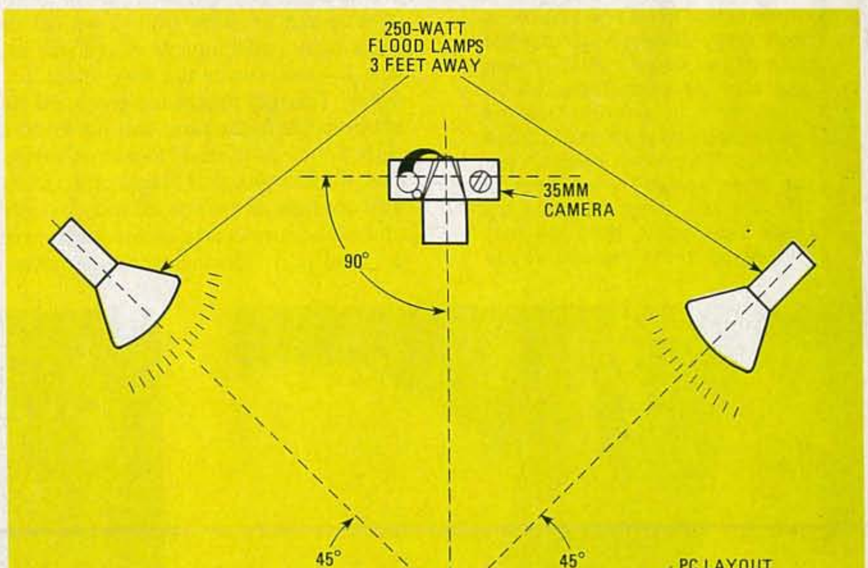



FIG. 11—IF YOU DO NOT HAVE A COPY STAND, you can photograph your layout using the setup shown here.

left in the tray for about 20 seconds and, as before, the tray should be gently agitated. Kodak makes a stop bath called *Indicator Stop Bath* that turns purple when it's exhausted. It's easy to use and is a good choice to use with the *Kodalith*.

The next step is to transfer the film to the third tray containing the fixer, which makes the image permament. After a bit of gentle agitation, you'll see the unexposed areas of the film (in between frames and around the sprocket holes) become transparent. When that happens, it's safe to go back to regular room-light. Take the film into the kitchen and wash it under running water (around room temperature) for five minutes. Hang it up to dry in a location where there's a minimum of dust; you can speed the drying up a bit by using a hair dryer **set on low**, but the film will dry all by itself in about 30 minutes.

I haven't really gone into detail about the film processing because it's virtually foolproof if you follow the directions that come with the chemicals and the film. Let me now, however, give you a few hints that can make things a lot easier:

1. You can test the developer under ordinary light. Take a piece of film and put it in the tray of developer under room light. It should turn completely opaque in less that thirty seconds (see Fig. 12). If it doesn't, your developer is exhausted and you should mix a fresh batch.
2. You can test the fixer the same way. Take a piece of film and immerse it directly in the fixer. (Don't put it in the developer first!) It should turn transparent in about a minute as the fixer removes the silver. If it doesn't, you need fresh fixer.
3. An easy way to tell when the film is completely developed is to make one or two exposures of a plain piece of the same paper you've used for your artwork. Use the same exposure you're going to use to shoot the artwork. Keep an eye on those frames as you develop the film and, when you think it's fully developed, hold the test frames up to the safelight. If you can still see the filament of the bulb, you need a bit more development. If the film is completely opaque, it's ready for the stop bath. If you have any doubts, it's better to underdevelop slightly than to go the other way. Remember, the lines you want to reproduce are very thin and any appreciable amount of overdevelopment will cause them to disappear.

Although you can use a photographic enlarger for the next steps, you probably don't own one. Therefore, I'll tell you how to use a slide projector to make your blowups. The first step is to prepare a slide. When the film is dry, pick the frame with the best exposure. The black areas should be dense, and all the lines in your artwork should be completely transparent. Cut the frame from the roll and put it in a slide mount. The best mounts to use are glass mounts; they'll hold the film absolutely flat and the heat from the projector won't cause the film to pop and buckle. There are several varieties of glass mounts, and your local camera store (or the company from which you ordered your other supplies) should have one or more of them in stock.

Just as with the camera, you need to make sure that the projector is pointed directly at the wall; any angle is going to distort the image somewhat. You'll most likely have to move the projector around to get the image to the correct size. One easy way to get the size right is to use a piece of graph paper as a screen. Use paper that has a 1/10-inch grid and adjust the projector's position until the IC pads line up with the grid. Since those pads also use 1/10-inch spacing, that method will allow you to adjust the size precisely.

When you have that all taken care of you're ready to make your positive on a larger piece of ortho film. Turn off the room lights, take a piece of red gel, and tape it loosely over the lens of the projector. That gel makes the projected image invisible to the film; you'll leave it in place until you're ready to make the positive. Tape a piece of black paper to the wall and tape an unexposed sheet of ortho film of the correct size on the paper, with the emulsion side facing the projector. Remember that this image is going to be actual size so the piece of film you use needs to be large enough to allow at least a ½-inch border around the foil pattern. The black paper is used to keep the light from reflecting from the wall onto the back of the film and causing a double exposure. With the red gel still on the lens, turn on the projector and check the size and focus once again. If you think that's being a bit too careful, remember that the more care you take at each step, the less chance you have of making a mistake.

When everything is exactly the way it should be, turn off the projector and take the gel off the lens. Make sure you don't move the projector or change the position of the lens. The film on the wall is exposed by turning the projector on. The correct exposure time can vary greatly, but 15 seconds is a good length of time to begin with; the precise exposure time will have to be found through trial and error. After the film has been exposed, turn the projector off and develop the film as before. In this case, the foil pattern will appear as a black-on-white image. When the black lines are nice and dense, the film is adequately developed. Finish the processing, and wash and dry the sheet of film.

Lay the film emulsion-side-up on a clean piece of white paper and examine the pattern. All you want to concern yourself with here is the areas between the traces—the clear areas. Make sure there aren't any unwanted lines or spots of black. Get rid of the spots and smears by scraping them off with an *X-ACTO* knife as shown in Fig. 13. Don't worry if the traces appear too thin or if some of the black lines are broken. All you're worrying about now is the spaces between the traces. When you have that taken care of, you're ready for the next step—producing the actual foil mask.

When we continue, we'll show you exactly how that's done, as well as some inexpensive substitutes for the equipment that you'll need. We'll then finish up our discussion by showing you the easiest part of the whole procedure, etching the board itself. **R-E**

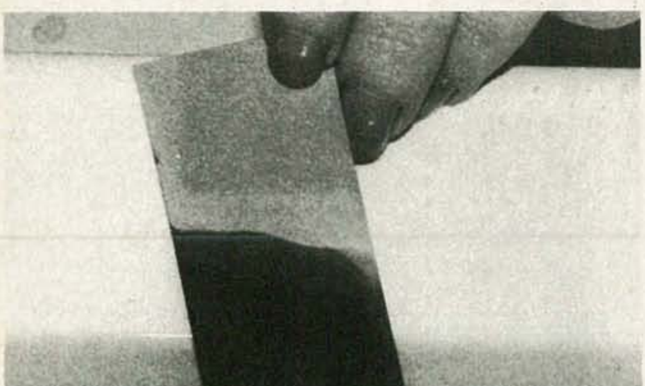


**FIG. 12—TO TEST THE DEVELOPER, follow the directions in the text. If it is good, it should turn the film completely opaque.**

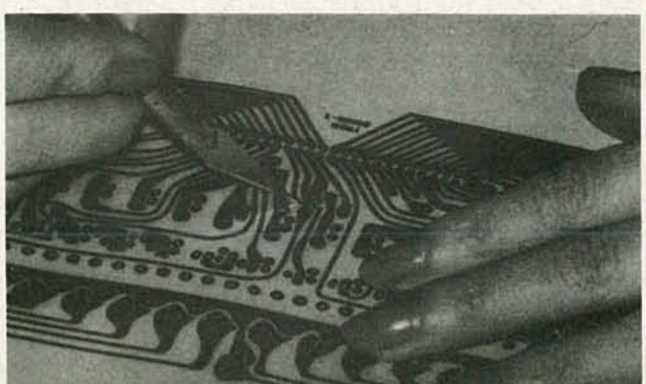


**FIG. 13—WHEN THE POSITIVE mask is developed, remove any stray black lines or spots using an X-ACTO knife or similar tool.**

# Faster Than Light?

*We have always been taught that nothing can exceed the speed of light. Evidence exists, however, to the effect that this may not always be the case. Here's a description of several experiments that seem to disprove the theory of relativity, and an explanation of what may—or may not—be taking place.*

By
**HAROLD W. MILNES, Ph.D**

I'VE RECENTLY BEEN ENGAGED IN EXperimentation with transmission lines and, in discussing my work with other scientists, if I casually happen to mention—which is sort of fun to do—that I'm interested in electrical impulses that propagate faster than the speed of light, I'm met with a variety of reactions.

The most usual is derision—ranging from skepticism or incredulity to outright rejection. On the other hand, there are a few people who say that the phenomenon is all old hat, and well known.

The word ''well'' might be disputed, but it is true that in the first decade of this century it was already known that electric waves *do* propagate in wires at velocities in excess of *c* (the velocity of light in free space, equal to $2.998 \times 10^{10}$ cm/sec). That fact seems to have been obscured by our acceptance of Einstein's theories of relativity so that very few people—even senior graduate electrical engineers—are aware of it. We are much more familiar with idea that the velocity of light has *c* as its upper limit and that the velocities of both matter and energy are similarly limited; and that no intelligible information can be propagated faster.

Since there is some dispute as to whether the speed-limit postulate of the relativity theories originated with Poincare or Einstein, we'll avoid taking sides and simply refer to it as the *c*-hypothesis. It is recognized by relativism (the science of relativity) that the so-called wave velocity of electricity—that is to say, the velocity at which the crest of a sinusoidal, continuously emitted, electrical signal moves through a conductor—can sometimes exceed the velocity of light. That forms an exception to the *c*-hypothsis.

### Properties of electricity

Maxwell's equations seem to describe the properties of electricity best. They predate the theories of relativity by 25 years, and were not the only set of equations proposed in the late nineteenth century to explain the behavior of electricity. But they were the ones supported by the influential Cambridge school, which was predominant in science at the time.

Though Maxwell's equations are very good where there is a continuous current-flow, they are known to be subject to certain errors, particularly in describing phenomena involving moving isolated charges. It is precisely when treating the behavior of those discrete charges that it is best to modify the equations to agree with relativity as we currently understand it.

When derived directly from Maxwell's unmodified equations, the velocity, $v$, of sinusoidal waves in transmission lines is given by the following formula: $v = 1/\sqrt{LC}$. The values of L and C are not the total inductance and capacitance of the line, but represent its specific inductance and capacitance—that is to say, its inherent inductance and capacitance determined on a per-centimeter basis—in henries and farads, respectively.

If L and C were both in the micro-micro ($10^{-12}$) range, then $v$ would be greater than $c$, and a condition would arise where either the unmodified Maxwell equations would fail, or the $c$-hypothesis would no longer apply, for the two are mutually contradictory. It's not hard to find a conductor whose inherent capacitance is in the range of micro-micro farads (picofarads) per centimeter, to position it so that its inherent inductance is in the range of micro-micro henries (picohenries) per centimeter, and then run a series of experiments to see which theory holds water. That's what I've been doing.

### Basis for experiments

The experiments described below show that there are a number of ways to get the results needed to reach a conclusion. They can be performed by anyone with a little knowledge of electronics, and do not require a large cash outlay—all you need are an oscilloscope and a squarewave generator. You will be able to see for yourself that electric pulses do, indeed, propagate in conductors at velocities faster than $c$, but you are also warned that the results do not establish the validity of the equation $v = 1/\sqrt{LC}$ (though it is more likely to be true than would be the $c$-hypothesis, if it were applied to the speed of propagation of electrical wave-trains). In many cases I've observed the speed of propagation of squarewave trains to be greater than $100c$—one-hundred times the speed of light. In most instances the speeds have been beyond the capabilities of my equipment to measure.

### Requirements

In experiments relating to the velocity of electrical signals, it is essential to use squarewave pulses or trains of pulses. Doing so makes it easy to determine the starting and ending points of a particular signal, and to measure the time delay—if any—introduced. Also, a transmission line can distort the signal it carries. It is possible, however, to avoid such difficulties by using a line long enough so that the delay predicted by the $c$-hypothesis would exceed the time period of a single cycle. On the face of the oscilloscope, the trace of the output signal from the line would then be displaced at least one full wavelength with respect to the trace of the input signal. For a 1-MHz pulse, that means using a wire at least $3 \times 10^4$ cm long, which would give a delay (under the $c$-hypothesis) of at least one $\mu$s; I use lines about 400 meters (1200 feet) long, which allows for pulses somewhat longer than a microsecond. Since too long a line can distort a waveform, the shorter a line you use, the better, just as long as you can get measurable results.

If precise measurements are to be made (beyond just determining that something is taking place), it is necessary to define exactly where waves begin and end. The falling and rising edges of squarewave pulses—particularly the former—make good reference-points that can be easily traced through progressive stages of deformation induced by line-distortion. That is illustrated in Fig. 1-b, where $\alpha'$ and $\beta'$ are images of the falling and rising edges $\alpha$ and $\beta$ of the original wave, shown in Fig 1-a. Thus, a squarewave pulse is considered from one successive falling (or rising) point to the next similar point, and waves that have been generated from it as the waveform that exists between the images of those points. The marking points are nearly always accompanied in the output waveform by sharp overshoot spikes immediately following them, as shown.

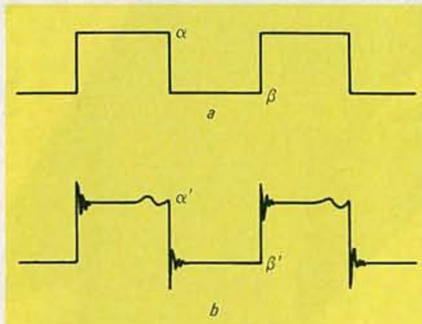



**FIG. 1—ORIGINAL SQUAREWAVE (*a*) and its image (*b*). Pulses are measured from one rising (or falling) edge to the next.**

The hookup for studying the delay is shown in Fig. 2. Resistor R is used to provide a signal at B. A dual-trace oscilloscope is not an absolute necessity, since the input and output points can be monitored separately by transferring a probe from one to the other. If the delay were 1⅓ $\mu$s, as a line 400 meters long would imply under the $c$-hypothsis, and the oscilloscope's maximum sweep-rate was .1 $\mu$s/cm, then you would obtain an easily discernable displacement of 1 mm on the screen.

The delay circuit should be constructed so that the values of L and C are quite small. The procedure used in the first experiment shows one way to accomplish that. A very fine wire is selected, so as to keep the surface area, and, hence the inherent capacitance, small. Number 40 copper wire is the finest generally available, but it is so fragile that I prefer use No. 35 steel sound-recording wire (available from Fidelitone, 3001 Malmo Dr., Arlington Heights, IL 60005) which is quite satisfactory, despite its high resistance of one-ohm-per-cm.

As shown in Fig. 3-a, a hundred notches were cut, one cm apart, in two insulating boards, and the boards were separated from one another by 99 cm. The wire was strung tightly back and forth, forming a series of 100 parallel lines, each one meter long (when the turns at the end are taken into account). The total length was exactly 100 meters.

The value of L was kept quite small because the wires are noninductively wound, and the direction of current flow in any one line the reverse of that in the two adjacent lines.

A second, similar, plane was constructed and placed beneath the first, but with its wires running perpendicular to the first's. An air gap of one cm separated the two planes. Then a third and fourth plane were stacked beneath those, with the direction of the wires alternating. The planes were connected to one another, forming a continuous transmission line 400 meters long.

The capacitive effect of the planes is illustrated in Fig. 3-c and depends on the proximity of the wire surfaces to one another. I am aware of no practical way to measure inherent capacitance, but a crude upper estimate can be made by noting that the circumference of No. 35 wire is .025 cm, so that the total exposed surface of the 400-meter line is 1000 square cm. Two plates, each of area 500 square cm, separated by 1 cm of air dielectric, have a capacitance of $4.425 \times 10^{-11}$ farads; the total inherent capacitance must be very much less than that. On a per-centimeter basis it is less than $1.106 \times 10^{-15}$ farads—well below the picofarad range mentioned earlier. Obviously, the capaci-

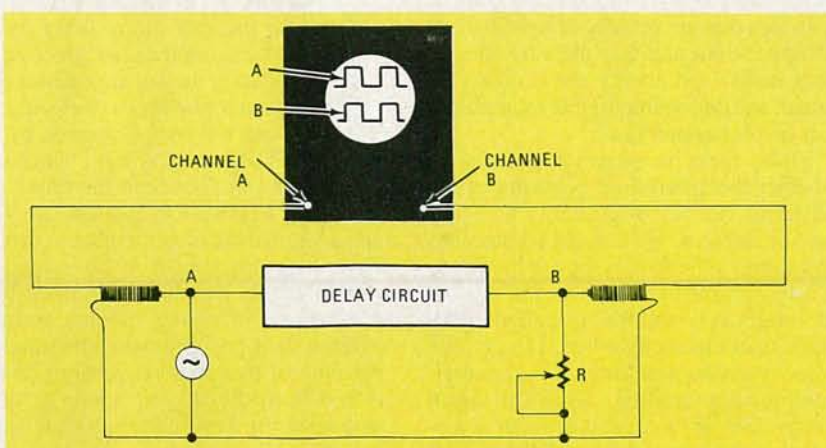



**FIG. 2—DEVICE USED BY THE AUTHOR to compare a delayed signal with the original.**

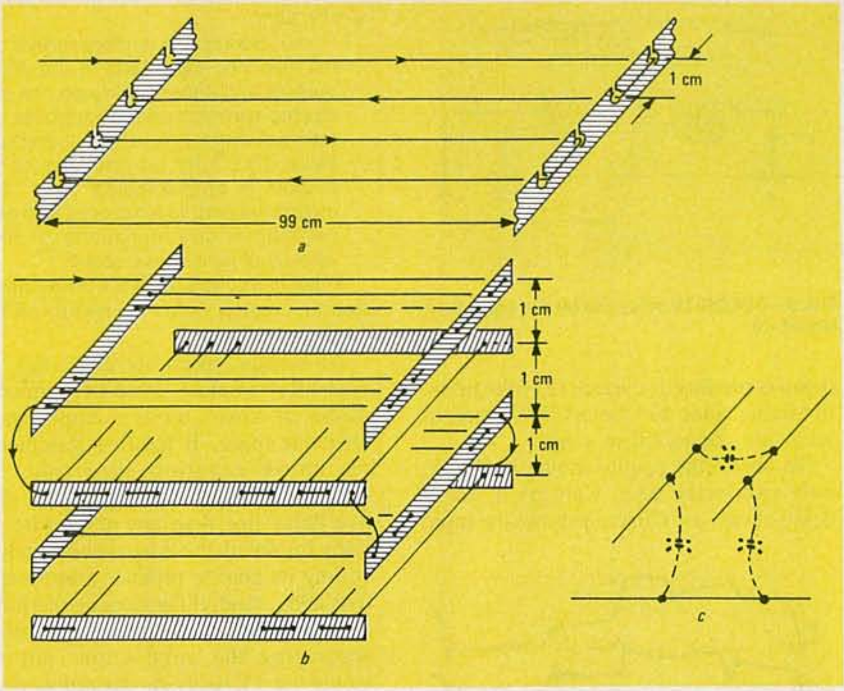



**FIG. 3—APPARATUS USED TO CONSTRUCT a 400-meter delay line is shown in *a* and *b*; equivalent capacitance is shown in *c*.**

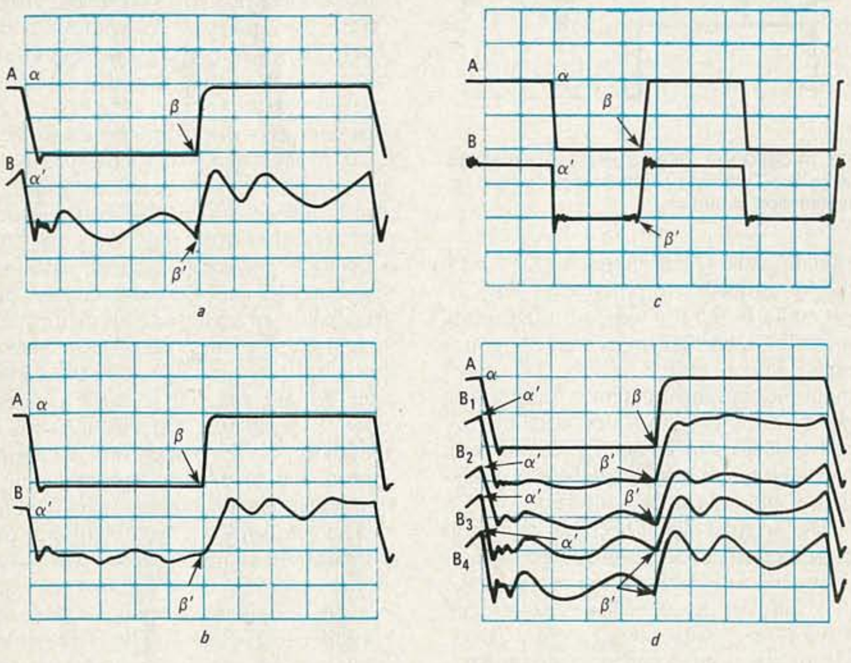



**FIG. 4—ORIGINAL AND IMAGED signals for three different frequencies: 1 MHz (*a*), 0.8340 MHz (*b*), and 0.3579545 MHz (*c*). Fig. 4-*c* shows images probed at 100, 200, 300, and 400-meter points.**

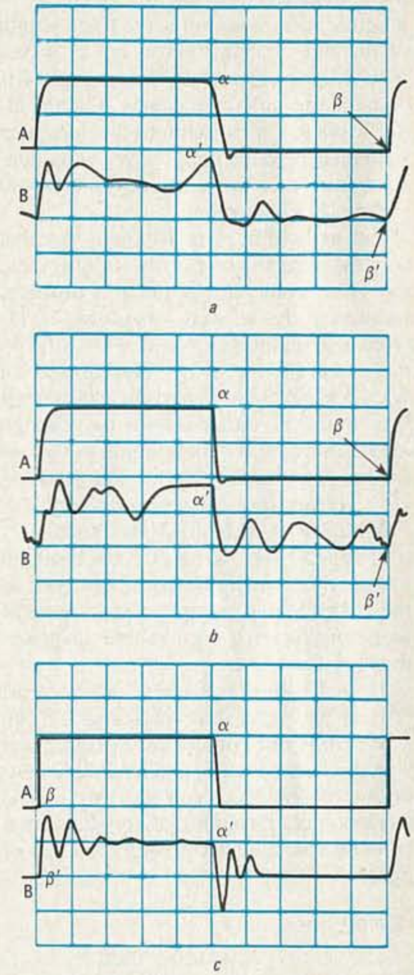



**FIG. 5—SIGNALS, AND IMAGES, returned using 480-meter continuous loop. Frequencies used are the same as those indicated for Fig. 4.**

tance could be further reduced by separating the wires and the planes by more than one cm, but it is unnecessary to do so.

When a squarewave signal is fed to one end of the device, the transit time to the other end is so brief that it is undetectable at the highest sweep-rate of a 15-MHz oscilloscope. According to the *c*-hypothesis, the output waveform should be displaced by at least 13 cm with respect to the input waveform, but the α′ and β′ points match the α and β points to within the precision that the instrument permits.

Typical input and output waveforms are shown in Figs. 4-a–4-d for three different frequencies. In case you feel that the precise alignment of the curves is somehow related to the length of the line, in Fig. 4-d the traces are shown at 0, 100, 200, 300, and 400 meters from the input point; the deformation is continuous in between. The value of R was set at 5000 ohms and the total resistance of the device was 40,000 ohms.

### A second experiment

The apparatus just described is the least cumbersome for laboratory use that I have developed so far. In case you think that the observed effect is dependent on the design of the wire array, I'll describe a second experiment I performed. In that, I ran 480 meters (1600 feet) of No. 35 steel wire in a giant loop once around the city block where I live. The specific inductance of the loop can be considered so small as to be negligible, and the inherent capacitance even less than that in the first experiment.

The results were essentially the same, and the waveforms are shown in Figs. 5-a–5-c for three different frequencies. In that experiment, the value of R was 3500 ohms, and the resistance of the line 48,000 ohms. The displacement of the signals should have been at least 16 cm if the waves propagated at velocity *c* through the line. There was considerable difficulty in obtaining clean signals because of noise interference; the line could not be shielded or terminated without altering its essential L and C characteristics. Furthermore, shielded cables are well-known delay lines and their cores are frequently coiled on themselves to enhance the delay effect, depending on the design of various manufacturers. The line picked up so much random noise from broadcast signals that even the input squarewave was fuzzily indistinct on the oscilloscope. To obtain the clean signals shown, I found that it was necessary to perform the experiment between 3 AM and 4 AM on a Sunday morning when the local TV stations and airport beacon were off the air.

It was impossible, of course, to lead the output probe along the loop as had been done in the previous experiment. However, the fact that the input and output waves corresponded may be deduced by using some elementary arithmetic and from the fact that no significant displacement occurred at several different, independent, frequencies.

Suppose that, under the *c*-hypothesis, the transit time of the line were $T = length/c$, where length is the fixed length of the line. In that time $n = Tf$ waves would have entered the line, where f is equal to the signal-frequency. For an output wave to appear without displacement with respect to the input wave, a frequency would have to be chosen that would make n a whole number.

Let us assume, for instance, that that was the case for one of the frequencies, say $f_1$. It could not occur at a different frequency, $f_2$, as well, unless $n_2 = Tf_2$ were also an integer. Now, $T = n_1/f_1 = n_2/f_2$, so $f_1/f_2 = n_1/n_2$. The number of waves, in whole or in part, in a 480-meter line would be either one or two, which means that $f_1/f_2$ would be equal to 1, 2, or ½; that is, either $f_1 = f_2$, $f_1 = 2f_2$, or $f_1 = ½f_2$. The test frequencies used were: $f_1$ = 1 MHz, $f_2$ = 0.8340 MHz, and $f_3$ = 0.3579545 MHz; none of them bears an integer relationship to the others, yet, as the corresponding graphs show, none of them produced a measurable displacement of the waves.

I regard this experiment as the most critical one I have so far performed. It can lead to only one conclusion: An electrical signal in a conductor, under suitable conditions of very low L and C values, can be made to pass through that conductor at a velocity considerably greater than that of light.

## Delay lines

The one-μs delay lines used in color-TV receivers are probably familiar to most **Radio-Electronics** readers. One is shown in Fig. 6-a, along with its schematic representation (Fig. 6-b). Of some 15 of the devices I've studied, no two have had precisely the same characteristics. Typically, though, they consist of a coil of fine wire, about 27 meters (80 feet) long, wound as a single layer on a form one cm (0.4-inch) in diameter. Beneath the windings lies a strip of foil covering about a third of the tube. When that strip is connected to ground, the inherent capacitance of the line is increased to the point that, when combined with the small inductance of the winding, a one-μs delay of the signal passed through the line results. If the strip is simply left floating—unconnected to ground—no measurable

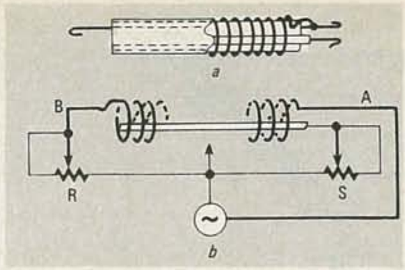



**FIG. 6—COLOR-TV delay line (*a*) and equivalent circuit (*b*).**

delay is produced, even if 15 of the units, involving some 405 meters (1300 feet) of wire, are connected in series.

To obtain the results shown in Fig. 7, only two delay lines were used, for a delay of two μs. Curve A shows the input

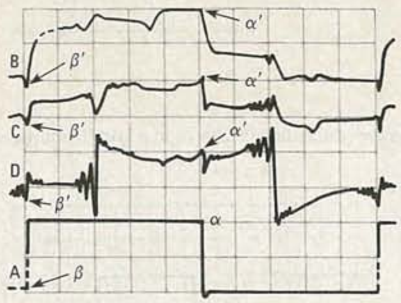



**FIG. 7—ORIGINAL SIGNAL and images returned using two TV delay-lines in series. See text for explanation of curves.**

signal; curve D the output signal—with the foil grounded to produce a delay. To get curve B, the foil was left floating and it can be seen that the α' and β' points match the α and β points. If a one-megohm potentiometer is inserted at point "S" (in Fig. 6-b), between the foil and ground, and its setting varied from one megohm to zero, a continuous gradation of effects can be followed.

The original signal becomes more and more deformed; some of the peaks predominate, as can be seen in curve C, and it is hard to decide where the original wave is, and where the delayed wave is. The α' and β' points identifying the original wave remain evident for a long time but, in due course, they are almost obliterated, although they always remain vestigial, even in curve D. It really becomes a matter of subjective opinion whether the new wave is merely some deformation of the old, or whether a delay of the input signal has taken place.

## Facts vs. literature

The statements made in the literature relating to the velocity of electric signals in conductors are contradictory, misleading, and seem to ignore experimental evidence. How is the $v = 1/\sqrt{LC}$ formula reconciled with the *c*-hypothesis? W.C. Johnson, in *Transmission Lines and Networks* says:

"...the product LC is independent of the size and separation of the conductors and depends only on the dielectric constant and permeability of the insulating medium. The numerical value $1/\sqrt{LC}$ for air-insulated conductors is approximately $3 \times 10^8$ meters/second, which checks with experimental determinations of the velocity of light in free space."

What is free space? It is a mathematical fiction, created to suit the results of Maxwell's equations.

At certain times, its properties conveniently simulate those of conducting media; at others, those of empty and interstellar space. If the first statement of the above equation were true, then coaxial cable would not be a more effective delay line than any other wire similarly insulated; there would be no point in coiling its core to produce a more effective delay. And, if the velocity of electrical pulses were unaffected by the distance separating the conductors, not only would the TV delay-device not work, but other delay devices that depend on an overlay of one substrate of a printed-circuit board upon another would also be ineffective. Inherent capacitance is distinctly dependent on wire size and surface area. The assurance that all is well and checks with the velocity of light, *c*, is just that—an *assurance*, unfounded in fact.

The very analysis that persuades us that $v$ equals $1/\sqrt{LC}$—a result that may be nearly correct—has other consequences that are rather surprising. They are: "the velocity of propagation is independent of frequency," and "a pulse can be propagated down a line without distortion." In real life, the latter is obviously false, as my graphs illustrate. Nor is the former true, for we can find current texts that state "...in matter, velocity depends on frequency." Experimental evidence agrees, but to what extent, my limited equipment cannot measure accurately.

The analyses of both Brillouin and Sommerfeld claim to explain why Maxwellian and relativistic theories both support the *c*-hypothesis, and the phenomenon being discussed. They depend entirely on the effects of dispersion (the dependency of the velocity of electromagnetic waves on frequency) and, if dispersion is not assumed, they are invalid. **R-E**


*"Radio is just like TV—only the picture tube blew."*

# HOW TO

# Interface Microprocessors

WILLIAM BARDEN, Jr.

*You're sure to find the information provided here a great help in designing your own microprocessor-based circuits.*

MICROPROCESSORS ARE BEING USED IN A variety of control applications from lumber grading to automatic bartending devices. State-of-the-art microprocessor IC's are easier than ever to interface to the external world. This article describes how to interface several types of popular 8-bit microprocessor IC's to provide TTL inputs and outputs, or to control relays or high voltage devices. The information you find in this article will be essential if you decide to design your own microprocessor-based projects.

### Microprocessor structure

Figure 1 shows the general structure of an 8-bit microprocessor. The CPU (*C*entral *P*rocessing *U*nit), more commonly called a microprocessor, communicates with external memory and I/O devices along a bidirectional 8-line data bus. Instructions of one to four bytes are entered into the CPU from external memory along the data bus. The CPU decodes the instructions by executing one or more *machine cycles*, which comprise a complete *instruction cycle*. During the instruction cycle, operands (an operand is the quantity upon which a mathematical operation is performed) can be transferred between the CPU and memory or between the CPU and I/O devices. All data transfers are 8 bits, or 1 byte, at a time. The machine cycles are synchronized by a one-phase or two-phase clock generated either outside or inside the CPU IC.

External memory is addressed by a 16-line address bus output from the CPU. At certain times within the instruction cycle, that address bus holds a valid memory address. The address represents the unique memory location to be read for the next instruction or data byte, or the memory location that it is to be written into. External memory will perform a read or write when it receives a *valid memory-address* signal, the 16 bits of memory address, and a signal indicating whether a read or write is to be performed.

Input/output (I/O) devices are addressed by the CPU in two modes: memory-mapped I/O and I/O-mapped I/O. Memory-mapped I/O is used on the 6800 and 6502 microprocessors. In that mode, the I/O device is addressed exactly as a memory location is addressed, and the same signals are used to determine when the data and address output are available. In that method, the 65,536 allowable addresses on the 16 address lines must be divided between memory addresses and I/O-device addresses. Of course, the major portion of the data goes to memory addresses, because there are usually a small number of total I/O devices in the system. In the 6800 and 6502 microprocessors, consideration must also be given to page-zero memory locations, stack-memory locations, and dedicated

Photo courtesy of Intel Corporation

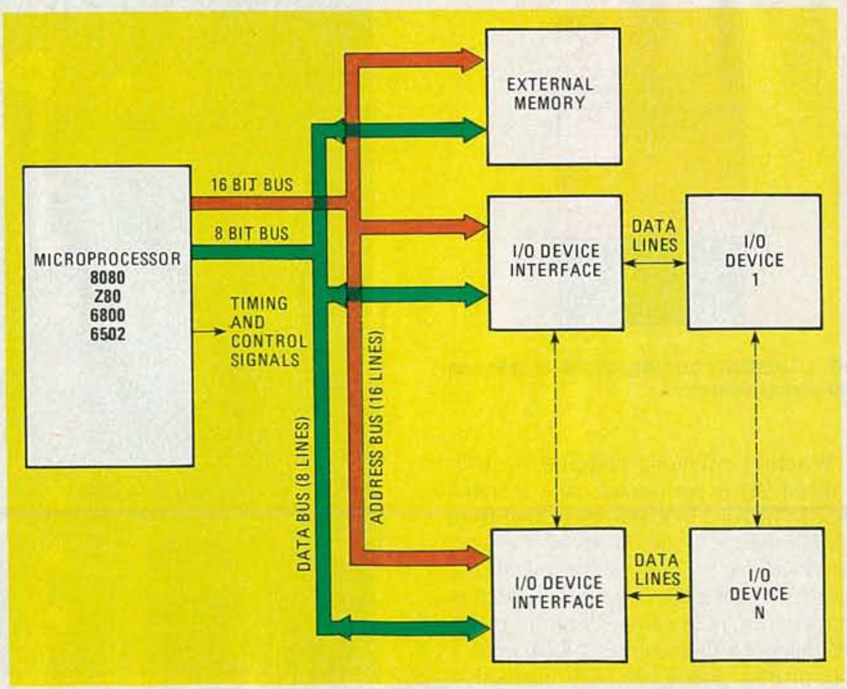



FIG. 1—MICROPROCESSOR system structure.

locations for interrupts and other system functions. Figure 2 shows general memory architecture for the 6800 and 6502.

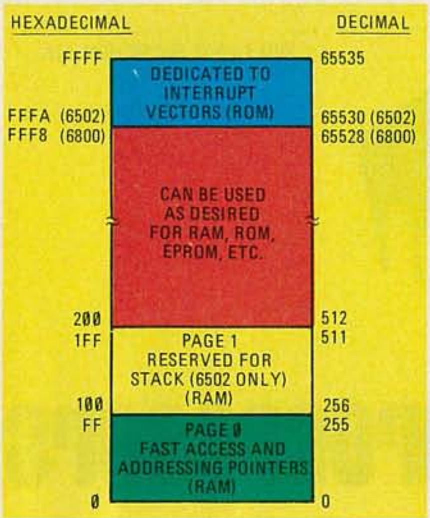



**FIG. 2—MEMORY ARCHITECTURE of 6800 and 6502 microprocessors.**

The I/O-mapped I/O mode is used on the 8080 and Z80 microprocessor IC's. Memory-mapped I/O can still be used on those systems, but both the 8080 and Z80 have special instructions to address I/O devices for input and output. Those instructions allow use of up to 256 different I/O addresses while retaining the 65,536 address combinations for external memory only. As in the 6800 and 6502, certain memory addresses are reserved for system functions, as shown in Fig. 3.

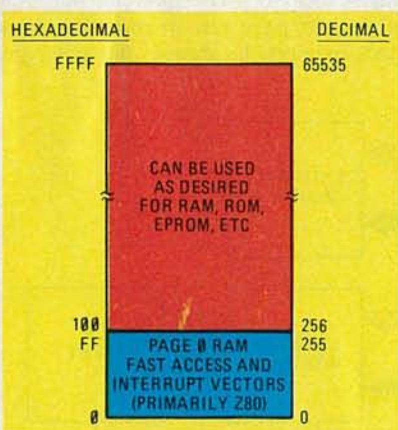



**FIG. 3—MEMORY ARCHITECTURE of 8080 and Z80 microprocessors.**

Whether memory-mapped or I/O-mapped I/O is performed, data is transferred 8 bits or 1 byte at a time either from a CPU register to an I/O device, or from the I/O device to a CPU register along the data bus. Each input or output instruction (STORE A or LOAD A instruction for memory-mapped I/O ) requires transferring 1 byte of data. Since one such instruction takes approximately 2 ms, and since associated instructions in an I/O loop add about another 8 ms, data-transmission speeds of up to 100,000 bytes-per-second can be accomplished be means of using register I/O of that type. Direct-money-access, which bypasses CPU registers, is a faster I/O method that allows data transfer to be limited only by

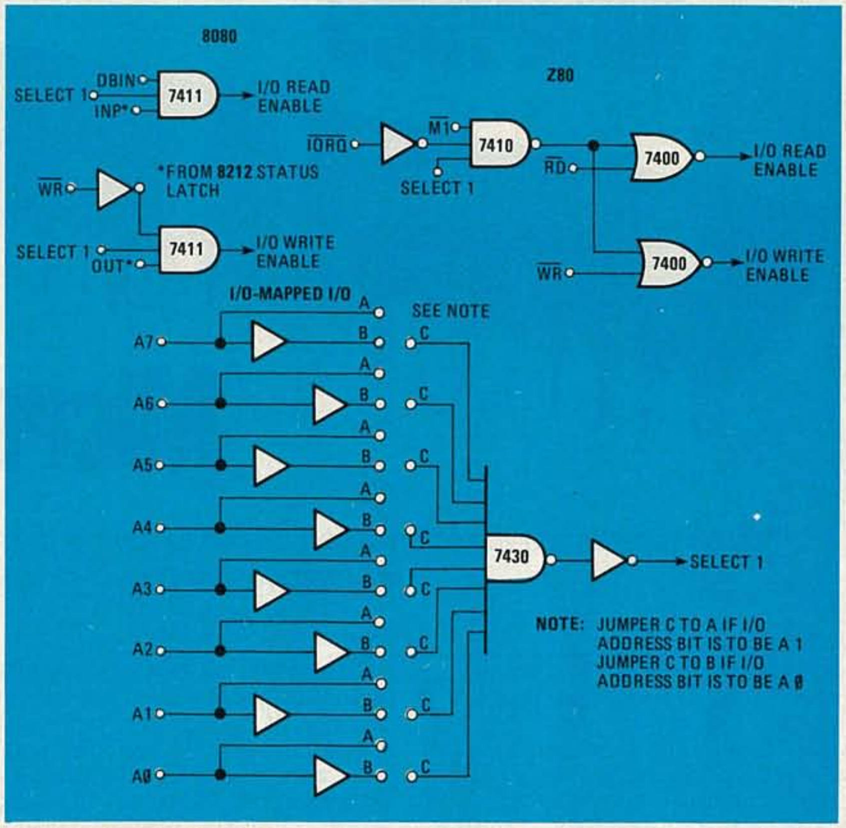



**FIG. 4—I/O DECODE for the 8080 and microprocessors.**

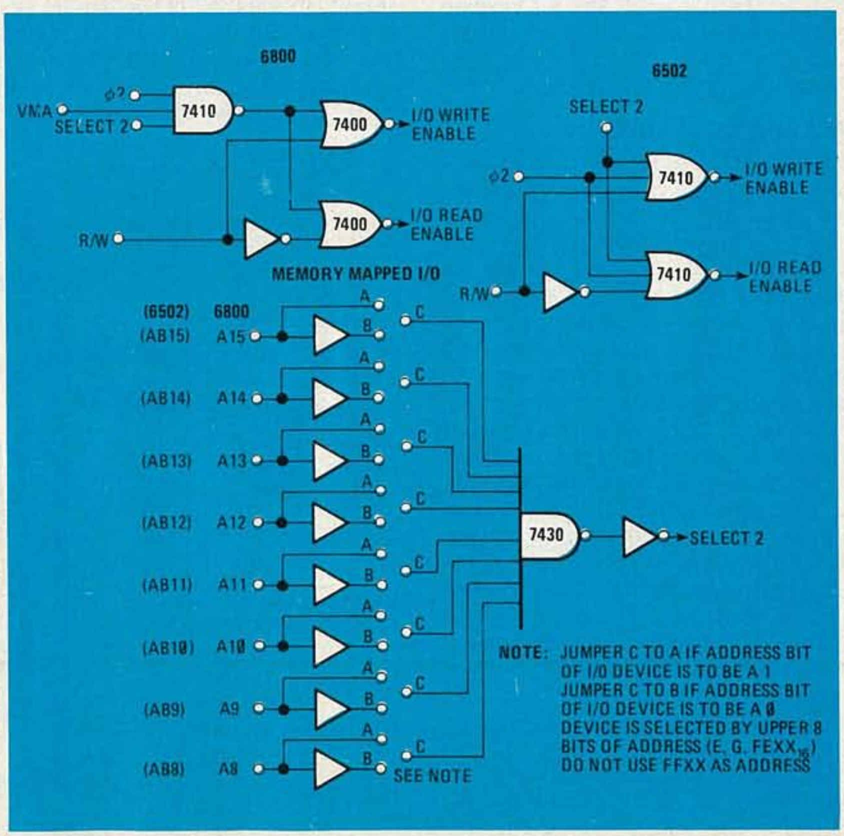



**FIG. 5—I/O DECODE for the 6800 and 6502 microprocessors.**

memory cycle times. In this article, however, we will consider only the simpler register I/O implementation.

In the I/O-mapped method, each I/O device has a unique device code. The microprocessor selects the I/O device by placing that code on the address bus. To transfer data between the CPU and external I/O devices requires a programmed I/O instruction, detecting the I/O-device code by decoding the address lines, and detecting control signals from the CPU that indicate when the output data is available, or when the input data should be made available. Figure 4 shows logic that is required to implement I/O reads and writes for the 8080 and Z80 microprocessors. Figure 5 shows the same logic for the 6800 and 6502 microprocessors.

### Discrete I/O lines

The simplest type of interfacing consists of reading discrete-line inputs or writing discrete data into latches. Discrete data represents "on" or "off" digital data. Reading 8 data-inputs is easily accomplished by gating the input onto the data bus at the proper time. The inputs must be TTL-compatible, representing either a logic zero (a nominal 0 volt) or a logic 1 (a nominal 5 volts). If the inputs are not at TTL voltage levels, voltage-level conversion can be performed with a variety of devices, including transistors and off-the-shelf IC's.

Figure 6 shows the general method for reading eight data-inputs. The gate-enable signal is derived from the signals shown in Figs. 4 and 5 and represents the execution of a microprocessor I/O or LOAD instruction. Data on the eight lines is sampled at some time within the 2 ms or so of the I/O instruction. Gating is performed by Tri-state gates whose outputs are at a high impedance (disconnected) state when the gate-enable signal is inactive. Since the data bus is shared by memory, I/O devices and other system logic, Tri-state outputs are a necessity. Because the input data can be sampled approximately every 10 ms by software (allowing for a program overhead of loop maintenance, comparing data, etc.), the scheme can be used to sample such discrete inputs as switch closures for keyboards, burglar alarms and control functions. Switch debouncing can be accomplished by continuously sampling the input until a closure is detected, and then sampling 2 ms later or so by using a software timing loop to reject any false input caused by noise.

Data is output to the external world in similar fashion. Because the output data is present for only several hundred nanoseconds, however, it must be latched into flip-flops. Every time an I/O write instruction (or STORE instruction) is executed, new data is latched into the set of addressed I/O latches. Of course, only a portion of the data may be changed by retaining the same data in the proper bit positions of the CPU register, and changing the remainder. Figure 7 shows the method used for writing up to 8 bits of data. The clock signal that causes the data to be recorded in the latches is derived from the signals of Figs. 4 and 5.

As new data may be written out every 10 ms or so when software overhead is considered, discrete outputs of 0 to 100 kHz can be implemented. The square-wave output of the TTL latches can be used for a variety of audio applications.

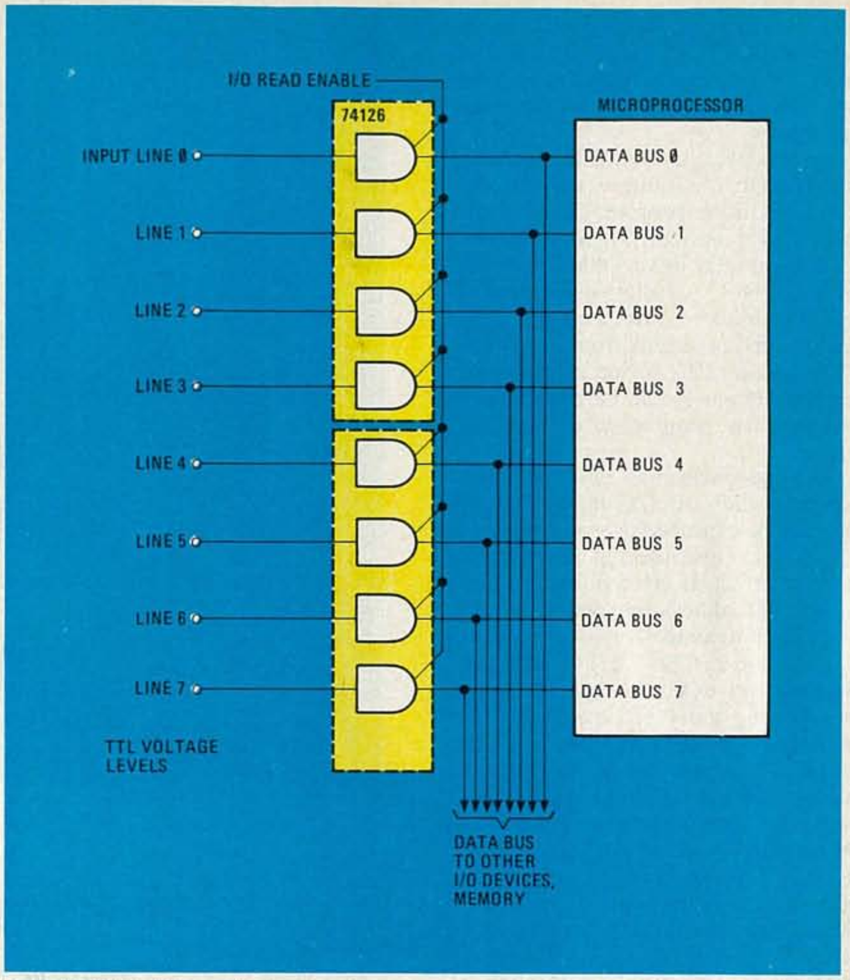



FIG. 6—DISCRETE I/O read logic.

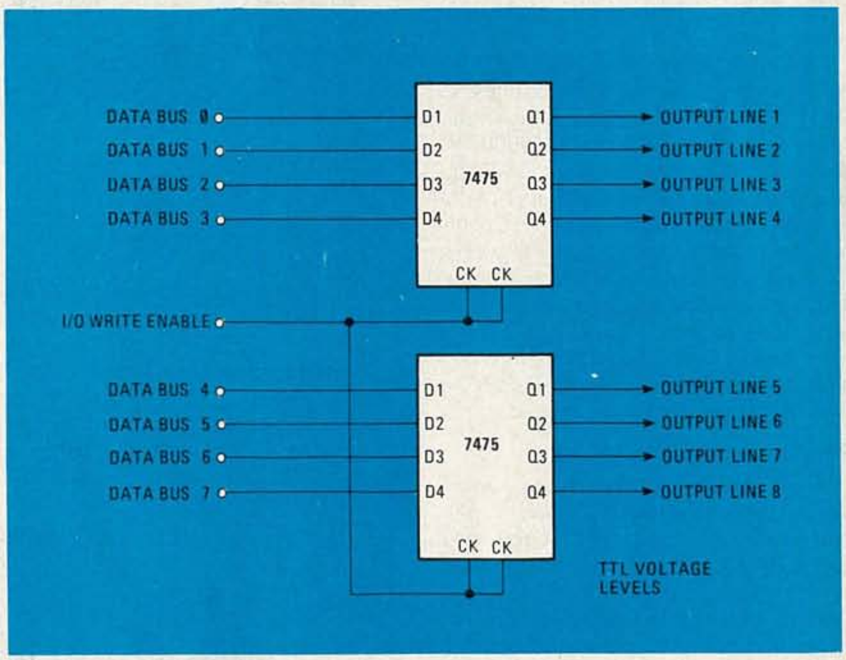



FIG. 7.—DISCRETE I/O write logic.

such as electronic music synthesis (by toggling the flip-flops to produce musical notes), as a software modulator for *Teletype* FSK applications, or for audio warning signals.

Level-conversion from TTL outputs to low-voltage DC outputs can be performed by using peripheral drivers such as LM75451 devices. Figure 8 shows a set of eight relay drivers that will handle 24-volt relays. An alternative approach would be to use 5-VDC reed relays that could be driven directly from some of the higher-current TTL devices. Devices that require AC power can be controlled in two ways—by using relays or by driving triacs.

The implementations described above for controlling external inputs and outputs can be expanded to as many lines as required by multiplexing sets of eight lines at a time. Each eight-line set has a unique I/O address assigned to it. It is convenient to assign the complete set of I/O lines to a block of I/O addresses. Suppose, for example, that 32 discrete input lines must be sampled under microcomputer control: The complete block of 32 lines might be given the binary address 11111110000000XX, where XX represents binary values from 00 through 11. Input data from lines 0 through 7 would be transmitted by executing a LOAD instruction from location FE00 (base 16) for a memory-mapped scheme. Lines 8 through 15, lines 16 through 23, and lines 24 through 31 would be addressed by LOAD instructions to hex locations FE01, FE02, and FE03, respectively.

The block address would be decoded by logic that looks at address lines 15 through 2. When those lines hold a valid memory address of $11111110000000_2$, the block is being addressed. Address lines 1 and 0 are used as inputs to a 74153 multiplexer that selects one of four inputs to be transmitted to one bit position in the CPU register being used for the input. There are eight multiplexers for the eight input lines, each having inputs of address lines 1 and 0 for set selection. The block address is used to control gating onto the data bus as previously discussed.

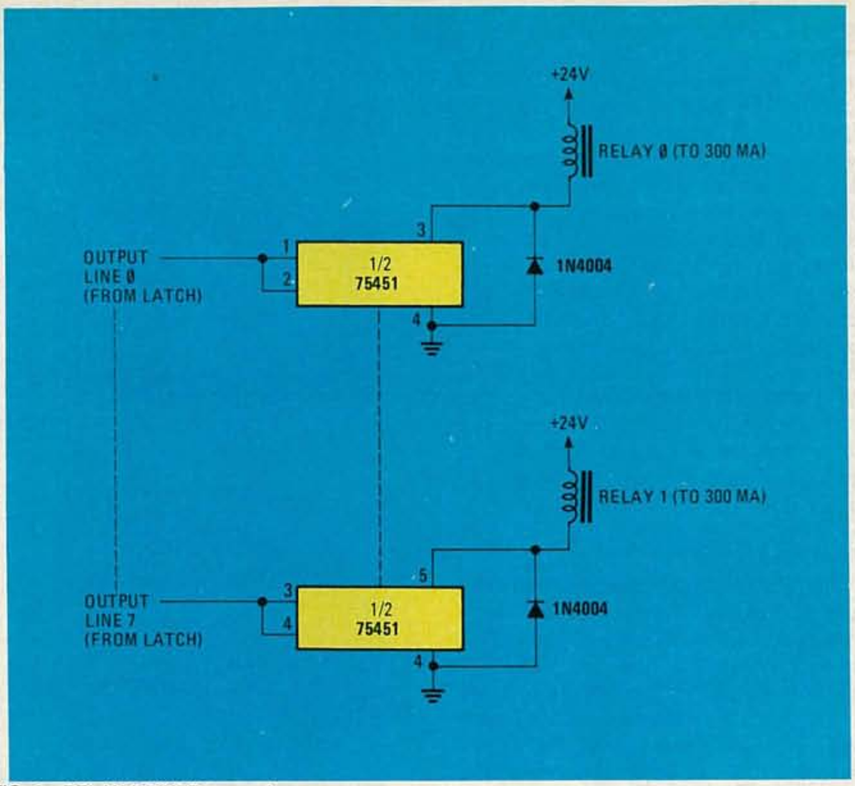



FIG. 8—RELAY DRIVER example.

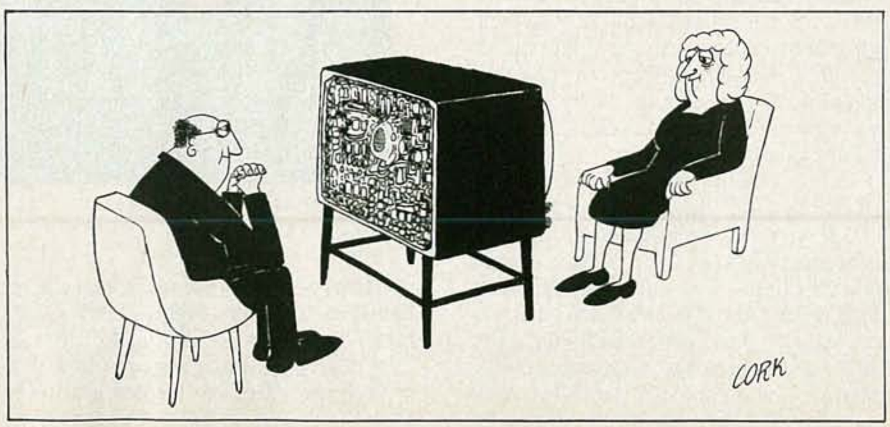
**Table 1—Programmable peripheral interfaces**

| Microprocessor | Peripheral Interface |
|---|---|
| **8080** (Intel) | 8255 Programmable peripheral interface |
| **8085** (Intel) | |
| **Z80** (Zilog) | Z80 parallel I/O circuit |
| **6800** (Motorola) | 6820 peripheral interface adapter |
| **6502** (MOS Technology) | 6520 peripheral interface device |

## Peripheral interface devices

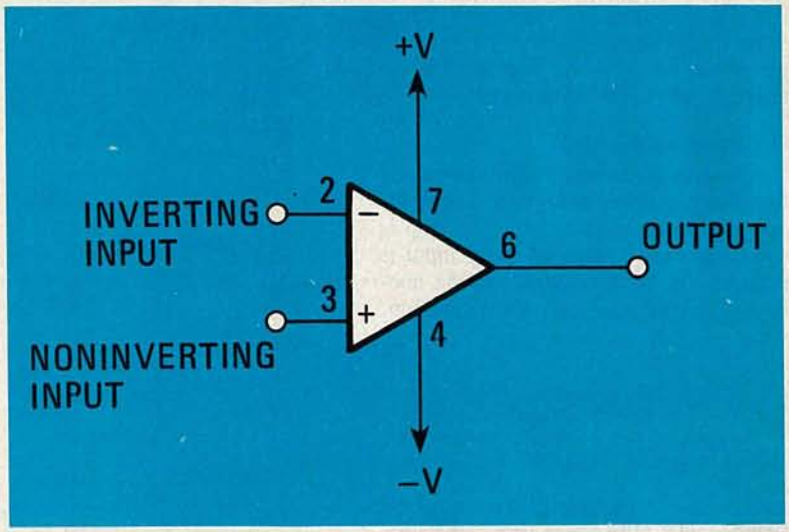
Since most users may require several devices to be connected to their microprocessors, manufacturers have provided decoding, gating, latching and multiplexing capabilities on special-purpose IC's that are designed to supplement the microprocessor IC The more sophisticated IC's interface with floppy disks and video displays, while two general-purpose types are for serial or parallel data I/O. The serial devices are called USART's or UART's (or similar names), and are general-purpose (*U*niversal *S*ynchronous and/or *A*synchronous *R*eceive and *T*ransmit) devices that operate with serial data at a variety of transmission rates and in a variety of communication modes. In this article we'll consider only the type of device that provides parallel I/O since it lends itself more readily to control applications.

The parallel interface device is called a PIO or PIA (or a similar name), and Table 1 lists several. The PIA provides a set of discrete lines, ranging from 16 to 24, that can be programmed as inputs or outputs. Various other functions, such as simple hand-shaking and interrupt logic, may also be provided. The peripheral interface IC is inexpensive (typically one-half the cost of the microprocessor) and adaptable, and it provides all functions in one convenient package. Programming usually consists of resetting the device, sending out a mode-control command to prepare the device for the I/O communication mode desired, and then performing the usual I/O instructions to transfer data between the external discrete lines and the CPU register. **R-E**



# How to Design Analog Circuits —Operational Amplifiers

MANNIE HOROWITZ




*This month we'll discuss one of the most useful integrated circuits—the operational amplifier. Even though they may seem complex, using them is not.*

PERHAPS THE MOST WIDELY USED AMPLIfier circuit is the operational amplifier (op-amp). Commonly available as an integrated circuit, the op-amp can be configured with external components to perform a wide variety of circuit functions, including amplification, non-inverting amplification, addition, subtraction, differentiation, integration, etc.

An operational amplifier is characterized by high gain, high input impedance, and low output impedance. Additionally, the input stage of an op-amp consists of a differential amplifier. In that type of amplifier the output signal is proportional to the difference between two input signals. Let's take a closer look at how a differential amplifier works.

### The differential amplifier

A basic differential-amplifier circuit is shown in Fig. 1. All the corresponding components in the two transistor circuits of that amplifier are assumed to be identical. That would not be a good assumption if you were using discrete components but, as the transistors used for differential amplifiers in op-amp IC's are made on the same substrate, they are essentially identical. Because of that, and because of the symmetry of the circuit, the currents through both transistors are identical when idling. But, if different signals are present at each input, then the collector currents through each transistor will be different. Despite that, however, the total current through Q1 and Q2 will remain constant, and be approximately equal to $V_{CC}/R_E$. The output of the differential amplifier is the difference between the voltage developed on the collector of Q1 and the voltage developed on the collector of Q2.

### Common mode inputs

If identical signals were fed to each input of the circuit of Fig. 1 (that is referred to as common-mode operation) there would be no output. That is because the voltages at the collectors would be equal due to the circuit symmetry. In real circuits, however, there is always some output due to dissimilarities between the two halves of the amplifier. The ratio of that output signal to the input signal is called the common-mode gain. The ratio of the normal gain (when different signals are fed to the two inputs) to the common-mode gain is referred to as the CMRR (*C*ommon *M*ode *R*ejection *R*atio). The CMRR is often expressed in decibels and called the CMR (*C*ommon-*M*ode *R*ejection). ($CMR = 20\log_{10}CMRR$.) It is de-

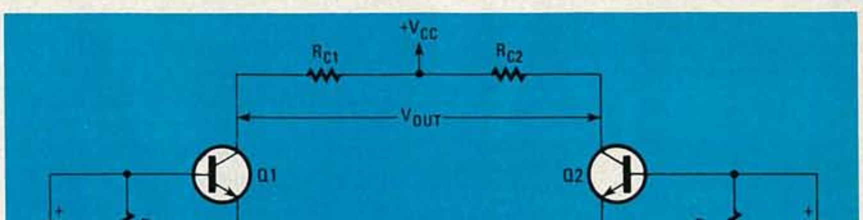



FIG. 1—IN A DIFFERENTIAL AMPLIFIER, the values of $R_{E1}$ and $R_{E2}$ are often equal to zero.

sirable that the CMRR be large so that the circuit will be immune to common-mode disturbances. Such common-mode disturbances include noise, changes in circuit operation due to temperature changes and power-supply voltage variations, and other factors that affect both halves of the amplifier.

### Differential mode inputs

When two different signals are applied to the input terminals ($V_{IN1}$ is not equal to $V_{IN2}$), the currents through each transistor are different, and a signal will be seen across the output terminals. If we apply a signal $V_1$ to Q1, the output signal will be equal to $A_V V_1$, where $A_V$ is the voltage gain of the amplifier. That input is referred to as the non-inverting input. If that same signal were applied to Q2, the output would be $-A_V V_1$. That input is referred to as the inverting input.

### Op amps as devices

An op-amp can be thought of as a differential amplifier with a very large voltage gain. The symbol for an op-amp is shown in Fig. 2. The inverting input is marked with a minus sign and the non-inverting input is marked with a plus sign.

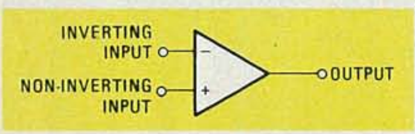



**FIG. 2—THE STANDARD OP-AMP SYMBOL.** Note that not all of the device's leads are shown.

To analyze an operational amplifier, it is easier to first consider it as an ideal device. The analysis can then be expanded to take into account the limitations of a real one. The model we will use for the ideal operational amplifier is shown in Fig. 3. One very important assumption is that the input resistance, $R_{IN}$, is infinite. The voltage gain of the op-amp, $A_V$, as well as the bandwidth, are also assumed to be infinite. The output impedance, $R_{OUT}$, and response time can be considered to be equal to zero. These assumptions make analysis of op-amp circuits relatively easy. Obviously, though, no op-amp will fulfill any of the ideal characteristics, but the closer we come to them, the better our results will be.

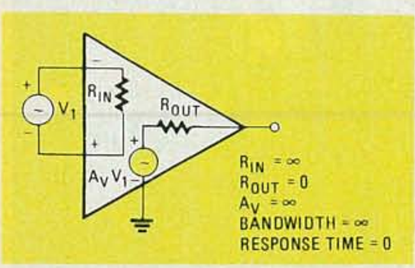



**FIG. 3—USING THIS MODEL** of an ideal op-amp will make studying the device much easier.

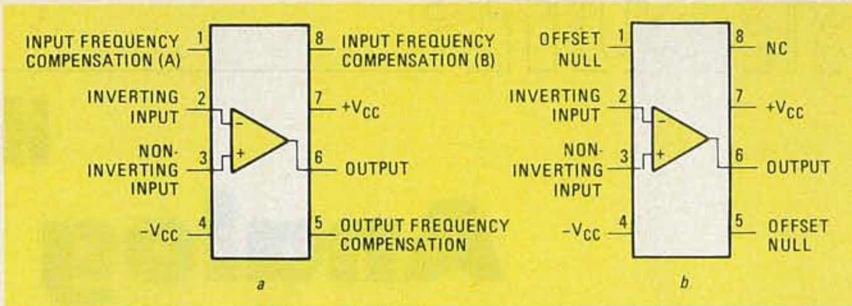



**FIG.4—SOME EARLY OP-AMP IC's such as the 709 (shown in *a*) did not have as much circuitry as later IC's. That's why it had pinouts for such things as input-frequency compensation. Later IC op-amps, such as the 741 (shown in *b*) have that circuitry built in.**

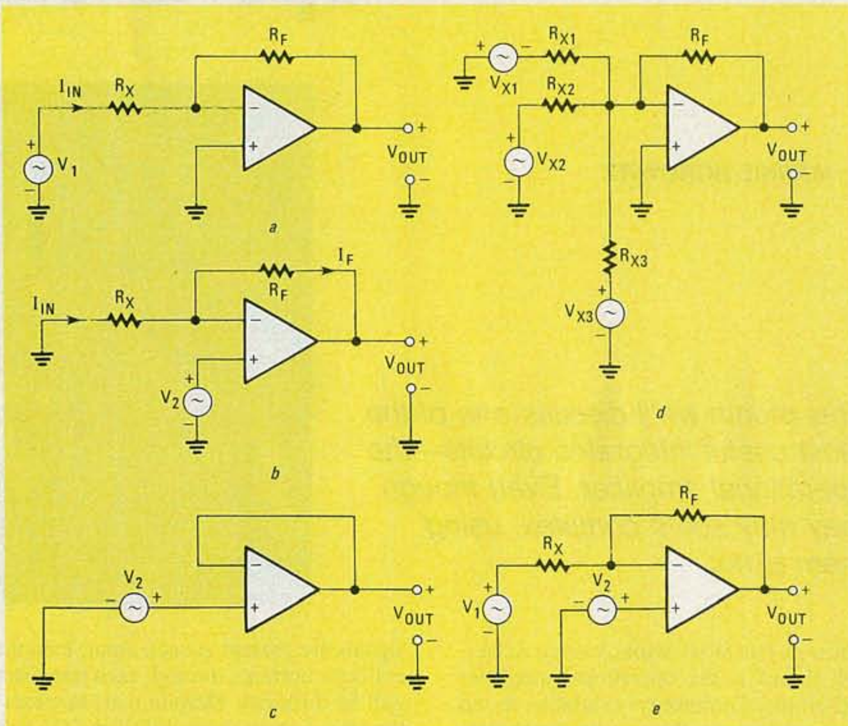



**FIG. 5—THE FIVE BASIC op-amp circuits that use feedback are the inverting amplifier (*a*), the non-inverting amplifier (*b*), the voltage follower (*c*), the adder (*d*), and the subtractor (*e*).**

Figure 4-a shows one of the early popular op-amps, the 709. It has several leads or terminals that were not shown in the diagram of the ideal IC. First, there are leads for the positive and negative supply voltages, $+V_{CC}$ and $-V_{CC}$, respectively. Also, there is a terminal to which a frequency-compensating circuit is connected. That circuit's function is to stabilize the op-amp and keep it from oscillating. The capacitor-resistor network required is usually specified by the manufacturer of the IC. If there are no terminals for that purpose on the op-amp you are using (as on the more recent 741 op-amp shown in Fig. 4-b), the compensation network may already be included on the chip. The 741 also has offset null or balance terminals that allow you to adjust the idling output voltage to 0-volt DC when both inputs are grounded.

### Feedback

Feedback is often used in op-amp circuits. In feedback circuits, a portion of the signal from the output of an amplifier is fed back to the input. If that signal causes the output level to be reduced, the circuit is said to have *negative feedback*. Should the opposite be true and the output level be increased, the circuit is said to have *positive feedback*. Negative feedback can be used to improve certain characteristics of a circuit. Positive feedback, however, can often make the circuit unstable and cause it to oscillate. Also, it can cause an output signal to be generated even when no signal is input.

### Basic op-amp circuits

If any of the op-amp circuits we will discuss are to work properly, the properties of the IC should be as close as possible to the ideal characteristics discussed above. Also, the inputs of the op-amp must be balanced when no signal is applied to the circuit. That means that the impedance between each input and ground should be identical. In the inverting amplifier shown in Fig. 5-a (we'll be discussing that circuit in depth shortly), for example, the inverting input terminal sees a resistance equal to the parallel combination of $R_X$ and $R_F$. A resistor of that value should be wired between the non-inverting terminal and ground to keep both halves of the op-amp in balance. The balancing resistor will not be shown in any of the figures that follow, but nonetheless should be included.

### Voltage comparator

When an op-amp is used in its simplest form, without feedback, it can serve as a voltage comparator, as shown in Fig. 6. Because of the very high gain of the op-amp, the output of that circuit will either be a positive- or negative-going spike. The value of $V_1$ that causes the output of the op-amp to switch polarity is equal to the voltage input to the non-inverting terminal. For example, let's assume that $V_2$ equals zero (which sets the non-inverting input at ground potential) and that $V_1$ is a sinewave. The signal at the inverting input ($V_1$) is then compared to the signal at the non-inverting input (again in this case it is zero), and when it is greater than zero, the op-amp's output will be negative, and vice versa.

Let's now assume that $V_2$ is at +3 volts. In that case, the output will not switch polarity and become negative until the amplitude of the sinewave at the inverting input exceeds +3 volts. Conversely, the op-amp's output will go positive when the voltage at the inverting terminal drops below +3 volts. The same principles apply no matter what voltage is applied to the non-inverting inputs, even if that voltage is chosen to be negative.

Voltage comparators can be used for a variety of applications. One of those is turning a logic circuit in a D/A (*D*igital-to-*A*nalog) converter on or off.

### Inverting amplifier

In addition to the comparator, there are other basic circuits in which the op-amp is used. Five of those circuits are shown in Fig. 5. Note that, unlike the comparator, the circuits shown all use feedback.

Let's turn our attention once again to the inverting amplifier circuit shown in Fig. 5-a. There, an input signal, $V_1$, is fed through $R_X$ to the inverting input. It is amplified and appears at the output as $V_{OUT}$. A portion of the output voltage is fed back through $R_F$. That is done to reduce the gain of the circuit so that the output will be of the same waveform type as the input. What we mean by that is that if the input to the circuit is a sinewave, the output, too, will be a sinewave. (You'll remember from our discussion of voltage comparators that although the input was a sinewave, the output consisted of a series of spikes.)

In the inverting amplifier, no current can flow into the inverting input (because of its assumed infinite impedance). Therefore, $I_{IN}$ must flow only through $R_X$

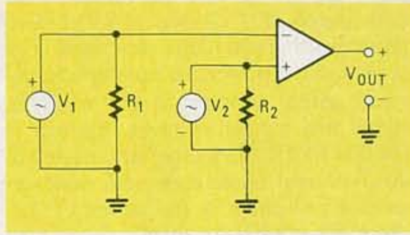



FIG. 6—IF THE INPUTS ARE TO BE BALANCED, $R_1$ should be equal to $R_2$.

and $R_F$ to $V_{OUT}$ and the current through $R_X$ must equal that through $R_F$. And, since no current can flow into the inverting input, it is at the same voltage as the non-inverting input. As the non-inverting input is in this case grounded, the inverting output under these conditions is said to be at *virtual ground*.

The next step is to calculate the gain of the circuit. By definition, the voltage gain of any circuit is the ratio of the output voltage to the input voltage, or $A_V = V_{OUT}/V_{IN}$. Taking that one more step, since (from Ohm's law) we know that $V = IR$, we can rewrite that previous expresion as $A_V = I_{OUT}R_{OUT}/I_{IN}R_{IN}$. Next, since from our previous discusion we know that $I_{IN} = I_{OUT}$, we can write $A_V = R_{OUT}/R_{IN}$. Finally, subsituting the circuit variables from Fig. 5-a for the general terms, we can write:

$$A_V = -\frac{V_{OUT}}{V_1} = -\frac{R_F}{R_X}$$

The negative sign that appears in the equation indicates that the circuit's output will be inverted with respect to the signal at the non-inverting input.

Now, let's look at a practical example. Suppose you have a 0.25-volt signal at the input and you need 2.5 volts at the output. The required gain is then 2.5/0.25 = 10. Using the above equation, we can see that to get that gain, $R_F$ must be ten times $R_X$. A good choice would be 100,000 ohms for $R_F$ and 10,000 ohms for $R_X$.

### Non-inverting amplifier

The non-inverting amplifier circuit in Fig. 5-b is almost identical to the inverting amplifier. Again, the signal from $V_2$ is amplified and appears at the output of the circuit as $V_{OUT}$. Also as before, the output waveform is of the same type as that at the input. The difference, however, is that in this case the output is not inverted.

Using Kirchoff's current-law and assuming that the voltage at the inverting input equals the voltage at the non-inverting input, we can determine the voltage gain. First of all, we can state that $I_{IN} = V_2/R_X$. Second, since $I_F$ must equal $I_{IN}$, we know that $V_{OUT} = I_{IN}(R_X R_F)$. And finally, we can now rearrange terms and write:

$$A_V = \frac{V_{OUT}}{V_2} = \frac{R_X + R_F}{R_X} = \frac{R_F}{R_X} + 1$$

If we short $R_F$ in the circuit, and omit $R_X$ we get the circuit shown in Fig. 5-c. As that circuit's gain can still be described by equation 2, we can state that the gain is equal to $R_F/R_X + 1$. But, since the circuit changes we've made will cause the first term in that expression to drop out, the gain simply becomes equal to 1. That type of circuit is called a *voltage follower*. Once again, the output is not inverted with respect to the input.

### Adder

Figure 5-d shows a circuit with multiple input circuits at the op-amp's inverting terminal. Each of those circuits affect the overall gain of the entire amplifier. Using the principle of superposition and what we know about the inverting amplifier, we can determine the output of the adder. (Incidently, the principal of superposition states that if several voltages are applied to a circuit or network at the same time, the current that flows is the same as the sum of the currents that would flow if the voltages were applied one at a time.) That output $V_{OUT}$ is equal to:

$$-\left[\left(\frac{R_F}{R_{X1}}\right)V_{X1} + \left(\frac{R_F}{R_{X2}}\right)V_{X2} + \left(\frac{R_F}{R_{X3}}\right)V_{X3}\right]$$

If all the $R_X$ input resistors were equal, that equation could be simplified to:

$$V_{OUT} = -\frac{R_F}{R_X}\left(V_{X1} + V_{X2} + V_{X3}\right)$$

That last equation makes it clear that the output is proportional to the sum of the input voltages.

You'll note that the output from the adder is inverted with respect to the input. It's possible, however, to use a non-inverting amplifier configuration to get an adder where the output is not inverted. Just connect the input voltages and their associated input resistors to the non-inverting terminal of the IC. Now the output of the circuit will be:

$$V_{OUT} = -\frac{R_X + R_F}{2R_X}\left(V_{X1} + V_{X2} + V_{X3}\right)$$

That assumes, of course, that $R_{X1} = R_{X2} = R_{X3} = R_X$.

### Subtractor

Operation of the subtractor, or difference amplifier, shown in Fig. 5-e can also be understood with the help of the superposition principle. The output due to a signal at $V_1$ is $V_{OUT} = -A_V V_1$. The output due to $V_2$ is $V_{OUT} = +A_V V_2$. The total output is the difference of $V_1$ and $V_2$. Referred to as $V_{OUTD}$, it is equal to:

$$A_V V_2 - A_V V_1 = \left(1 + \frac{R_F}{R_X}\right)V_2 - \left(\frac{R_F}{R_X}\right)V_1$$

$$= V_2 + \frac{R_F}{R_X}\left(V_2 - V_1\right)$$

As you can see, $V_{OUTD}$ is related to the difference between the the voltages applied to the inverting and non-inverting inputs of the op-amp.

### Filters

One of the properties of capacitors is that they pass high frequencies while attenuating low frequencies. Thus, if you place a capacitor in series with a signal source as shown in Fig. 7-a, it will let only the high frequencies pass from $V_{IN}$ to $V_{OUT}$. That circuit is called a high-pass filter.

Similarly, if you place a capacitor across a circuit as shown in Fig. 7-b, it will bypass, or short, the high frequency signals to ground and let only the low frequencies pass from $V_{IN}$ to $V_{OUT}$. That circuit is called a low-pass filter.

If you properly combine both filters into one circuit, the extreme high and extreme low frequencies will be attenuated and only the mid-range frequencies will pass from $V_{IN}$ to $V_{OUT}$. That, of course, is a bandpass filter. Conversely, if the resistor and capacitor in the circuits are chosen carefully, a circuit that will attenuate only a small band of frequencies can be designed. That circuit is referred to as a band-rejection or notch filter.

Those filters can be built using op-amps as well. For instance, if only a resistor is placed in the feedback circuit, all frequencies will be passed back to the input. However, if a capacitor is used there, only high frequencies are passed. That, in turn, causes the high frequency part of the input signal to be attenuated by the op-amp itself, but allows the low frequency part to pass unattenuated from the input to the output. Thus, that circuit behaves just like a low-pass filter. If, on the other hand, a resistor is used in the feedback circuit but a capacitor is used at the input, the circuit behaves just like a high-pass filter. It is possible to design many different types of active filters using resistors, capacitors, and op-amps.

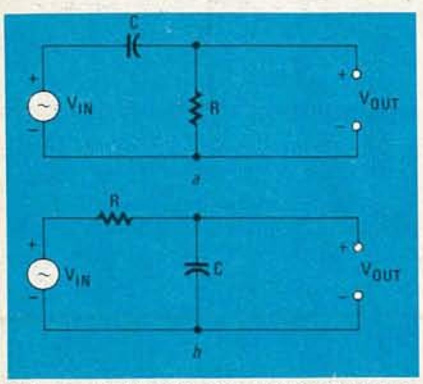



**FIG. 7—A PASSIVE HIGH-PASS FILTER is shown in *a*, a low-pass filter in *b*.**

### Practical circuit considerations

Several op-amp characteristics must be considered if a device is to perform properly in the circuits described. One is how much power the op-amp can dissipate safely. Another is the maximum signal and supply voltages that can be applied to the device before any breakdown occurs. Those maximum values are usually indicated in the op-amp's data sheet. We must also consider factors such as offset voltage, slew rate, and frequency response/stability. Let's now take a look at those last three factors.

### Offset voltage

When we discussed the differential amplifier we noted that if both halves of that circuit were not identical there would be a voltage at the output even with no input signal. Since an op-amp is made up mostly of differential amplifiers, that also holds true for that device. However, there are ways to overcome the problem.

Op-amps should be adjusted for a 0-volt output with no signal applied. Some op-amps have terminals for nulling out any offset voltage. If the device you are using doesn't, a voltage divider like the one in Fig. 8 can be used. Potentiometer R1 should be 10,000 ohms. The exact value of R2 is not critical, but it is a good idea to keep it below 1000 ohms.

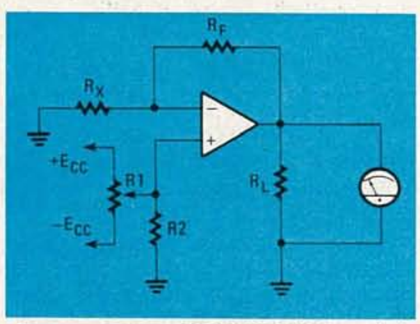



**FIG. 8—IF OFFSET-COMPENSATION terminals are not provided, offset nulling can be done using a voltage divider. Here, that divider is connected to the non-inverting input.**

### Slew rate

The maximum possible rate-of-change of an op-amp's output is called the *slew rate*. If the frequency of an input signal is too high, the output will not follow the input faithfully. An example of that is shown in Fig. 9. If the maximum undistorted sinusoidal output voltage required from the op-amp is $V_{OUTMAX}$, the maximum sinusoidal frequency ($f_{MAX}$) it will reproduce properly is related to the op-amp's rated slew rate by the formula:

$$f_{MAX} = \frac{\text{SLEW RATE}}{6.28\ V_{OUTMAX}}$$

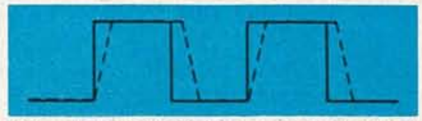


**FIG. 9—DISTORTION (shown by dotted lines) will result if the input signal's frequency exceeds the op-amp's slew rate.**

### Frequency response and stability

Op amps can have very narrow bandwidths. Typical open-loop frequency-response curves are frequently supplied by the manufacturer of the device. For example, the open-loop frequency response for a National LM118 op-amp can be approximated from the curve in Fig. 10. We can see that at the 110-dB level (a voltage gain of 300,000) the gain is flat to 100 Hz, at least as far as the open-circuit response is concerned.

Now, let's say that we want to find the response at a different level of gain. In the inverting amplifier of Fig. 5-a, the gain can be reduced each time feedback is increased simply by reducing the resistance of $R_F$ with respect to the resistance of $R_X$. If, for example, $R_F$ were 100,000 ohms and $R_X$ were 10,000 ohms, voltage gain, $A_V$ would be 1000 or (20log1000 =) 60 dB. Returning to Fig. 10, if a horizontal line is drawn at the 60-dB level, it will intersect the sloping line of the open-loop frequency-response curve at 30,000 Hz. Thus, at that gain level, the frequency response of the op-amp is flat to 30,000 Hz.

The bandwidth of an op-amp circuit can also be found from the gain-bandwidth product of the IC. For instance, if the op-amp's open-loop gain is 300,000 and its bandwidth is 100 Hz, its gain-bandwidth product is the product of the two numbers—300,000 × 100 = 3

*continued on page 93*

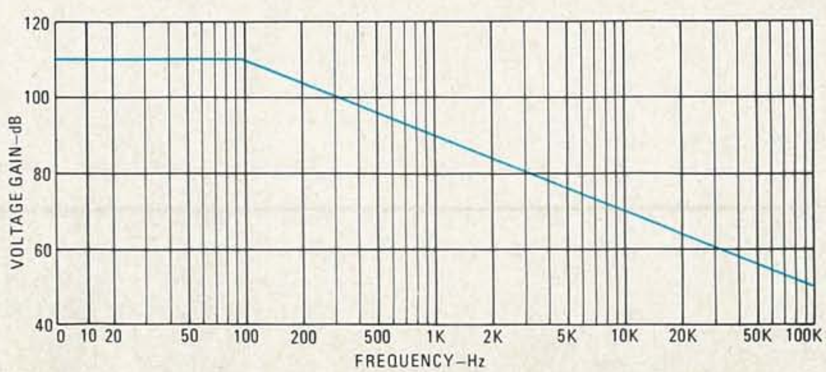
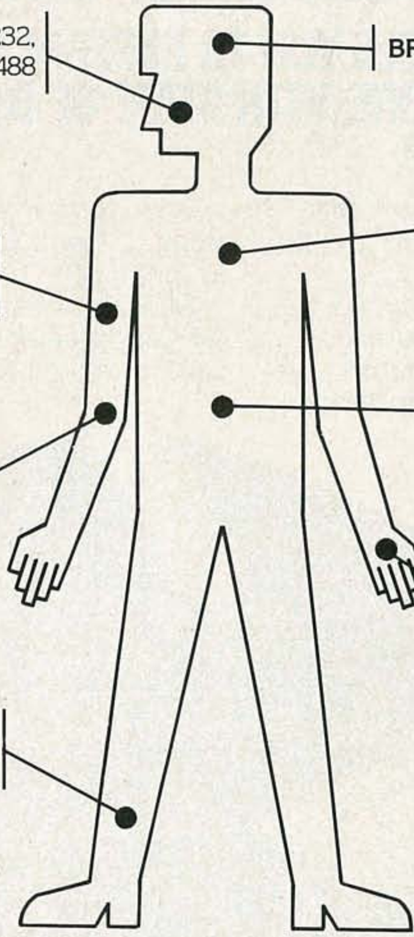


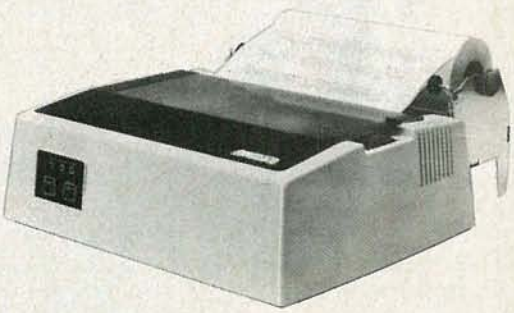

**FIG. 10—A FREQUENCY-RESPONSE CURVE, such as the one shown here, can be used to determine the bandwidth of an op-amp. Such curves are often provided on the device's data sheet.**

## The COEX

# Anatomy of a Printer




## The EPSON Alternative



### SPECIFICATIONS:

| | |
|---|---|
| **CHARACTER FORMATION PROCESS** | Serial, impact dot matrix |
| **STANDARD FONT** | 9 x 7 (7 needles), 6 x 6 for graphics printing |
| **PRINTING DIRECTION** | Bi-directional |
| **NUMBER OF COLUMNS** | 80, 96 or 132. (40, 48 or 66 for enlarged characters) |
| **CHARACTER SIZE** | 2.57 mm (.101″) x 2.0 mm (.079″) for standard 80-column line |
| **CHARACTER DENSITY** | 5 CPI for 40 column, 10 CPI for 80 column, 12 CPI for 96 column and 16.7 CPI for 132 column |
| **LINE SPACING** | 1/6″, 1/8″ and 1/12″ |
| **PRINTING SPEED** | 80 characters per second |
| **NUMBER OF COPIES** | 2 (original plus 2 copies for cabonless sets) |
| **PAPER WIDTH** | 8″ to 10″ for friction-fed paper and 3″ to 10″ sprocket-fed paper |
| **INKED RIBBON** | Standard Underwood spool type 1/2″ (13 mm) wide by 11.5 yards (10.5 m) long |
| **DIMENSIONS** | 387 mm (15.3″) wide by 309 mm (12.2″) deep by 124 mm (4.9″) high. With tracto-feed assy, height is 171 mm (6.7″) |
| **POWER CONSUMPTION** | 90 watts maximum operation 25 watts standby |
| **WEIGHT** | 8.5 Kg (19 lbs.) |

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# SERVICE CLINIC

## Which way does current flow?

**JACK DARR,** SERVICE EDITOR

AT TIMES, WE COME ACROSS SITUATIONS where we need to know the polarity of the voltage at a certain point in a circuit. Finding that polarity presents few problems if we remember some of the basic laws of electronics and current flow. Although there is only one type of current, there are (to cause confusion) two ways to describe it. One way is in terms of electron flow, which describes current by the actual direction that electrons move in a circuit. The other way is in terms of conventional flow. Conventional flow came about because the early experimenters arbitrarily said of their batteries, "This pole is positive and that pole is negative, and current flows from positive to negative."

Actually, those experimenters knew that *something* flowed in a circuit, but they had no idea as to what! The invention of the vacuum tube cleared that up. They found that a stream of electrons flowed from the hot cathode to the anode (plate). Also, they found that electrons had a negative charge. By putting a high positive voltage on the plate, "current" flowed. Stubbornly they insisted that current flowed from plate to cathode! So, that was the "plate current." That didn't cause too much trouble until the invention of the diode and transistor.

When they made up the symbols for semiconductor devices, they hung on to the old conventions. Every junction (in a diode, transistor, etc.) is marked by an arrow and a bar. The convention was to say that current flowed out of the point of the arrow. Actually electrons flow *into* the arrow! Figure 1 shows a sketch I made up that helps me when I get confused. I have three copies of it: one over my bench, one in my wallet and one over the desk where I am now! Electrons flow into the point of the arrow, leaving the device with the polarity shown.

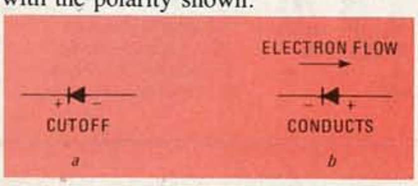


FIG. 1

When you run into any kind of problem where you need to know the polarity of the voltage at a given point, go back through the circuit until you come to a point with a tube, transistor, or other device where you know the current direction for certain.

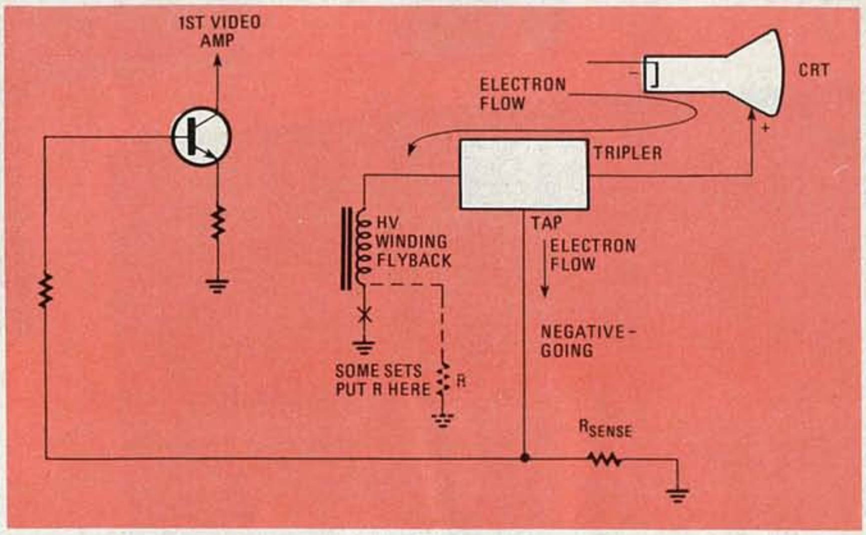


FIG. 2

Here is an example of where that method can be used: A while ago I came across a set with a problem in the automatic-brightness-limiter circuit. In that model, the beam current is monitored by a tap in the high-voltage return circuit. A resistor from the tap to ground develops a voltage that is fed to the automatic-brightness-limiter circuit. You need to know the polarity of that voltage to troubleshoot the circuit, but the schematic doesn't show it. But, by going back to a point in the circuit where the direction of the current flow is known, the polarity can be determined. That point is the CRT, which is just a big tetrode vacuum tube. Figure 2 shows a basic diagram of the circuit.

In that circuit, electrons flow from the "plate" (CRT screen) to ground through the high-voltage tripler and the flyback. The resistor ($R_{sense}$) to ground develops the control voltage. Electrons flow into the resistor, so that one end has a surplus of electrons and becomes negative. The higher the beam current, the higher that negative voltage. If the beam current increases (thus increasing the brightness of the picture on the CRT screen) more electrons flow and the voltage drop across the resistor increases. That voltage reverse-biases the first video stage, thus reducing the beam-current and maintaining a constant picture-brightness.

### A word about grounds

The chassis is the common (usually called ground) in practically all TV circuits. Older sets have only one ground. In some new sets, you'll find two. One is the earth ground of the AC power line. The other is an isolated ground, which is the common for all the TV circuits. Incidentally that common is always *hot* with respect to an earth ground. When servicing such a set, an isolation transformer *must* be used because your test instruments are almost always grounded to the AC line. **R-E**

# SERVICE QUESTIONS

### VTVM METER PEGGED

I asked you why the meter needle pegged to the left on an old Knight VTVM, and you suggested checking resistors (in the meter). I thought I had, but I found a 22K resistor (R33) in the power supply that read over 80K. I replaced it and everything's fine now. Thanks.—*G.R., Key Largo, FL*

### GOOD COLOR, WRONG PLACE

***I got this set to fix (flood damage) after it had been to another shop. I fixed several***

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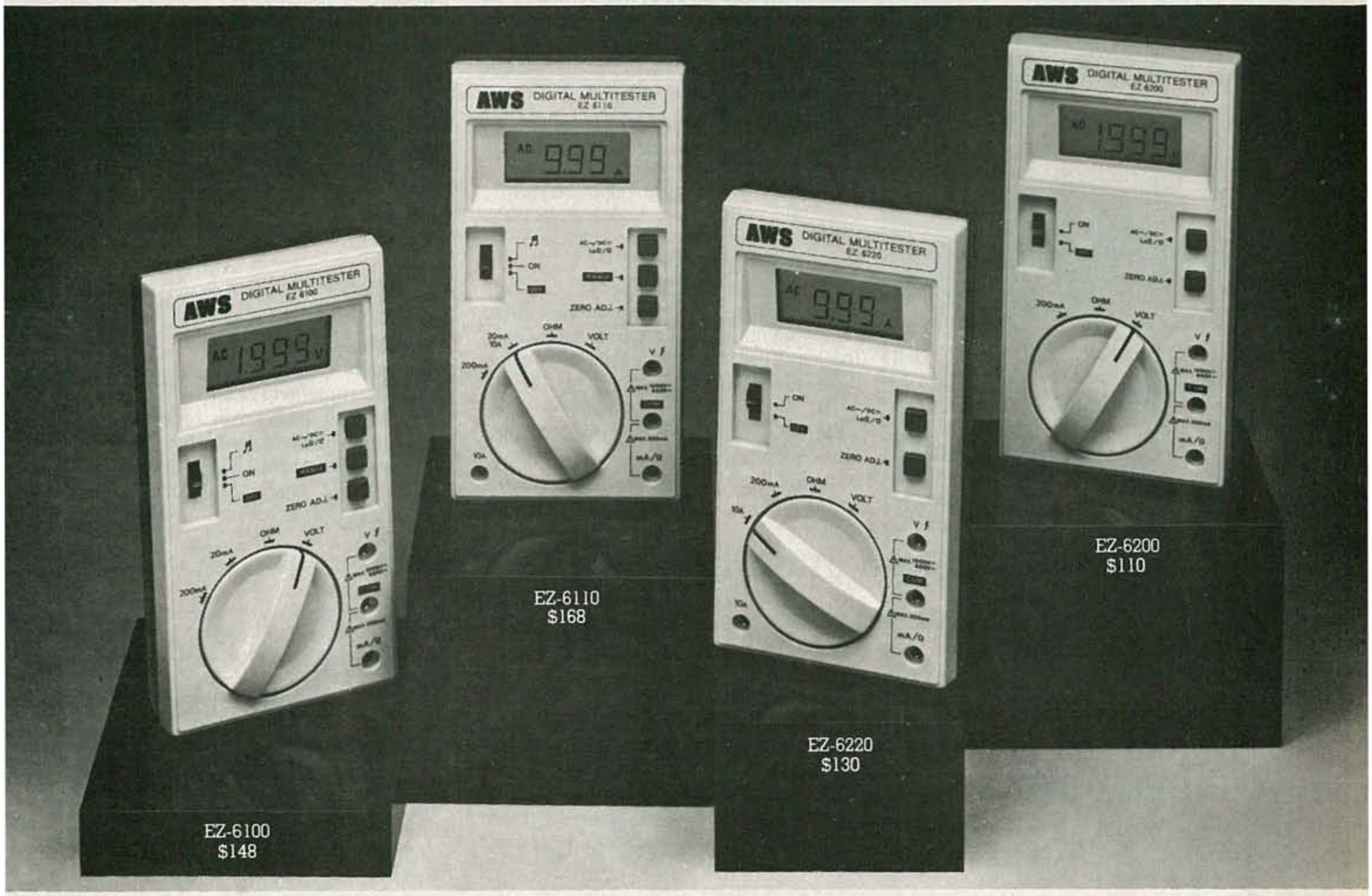


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| ACV 0-600 | 4-Autoranges | ACV 0-600 | 4-Autoranges |
| AC/DCA 0-10 | 1-Range (EZ-6110) | AC/DCA 0-10 | 1-Range (EZ-6220) |
| AC/DCMA 0-200 | 2-Ranges | AC/DCMA 0-200 | 1-Range |
| Ω 0-2000KΩ | 5-Autoranges | Ω 0-2000KΩ | 5-Autoranges |
| Low Power Ω: 0-2000KΩ | 4-Autoranges | Low Power Ω: 0-2000KΩ | 4-Autoranges |
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***things, and now it produces good colors...but they're in the wrong places. When I connect it to a color-bar generator, the red bar shows up at the right, and the blue one at the left. They're locked in solid, too! I ran a full setup on the TV and everything reacted OK...but the colors still lock in in the wrong places! I've run out of ideas; maybe you have one.—H.S., Austin, TX.***

I have a couple of them. I've had the same thing happen to me and the factory once told me to "check and replace the AFPC (*A*utomatic *F*requency *P*hase *C*ontrol) and color-killer diodes." Also, a Magnavox man told me some years ago never to reinstall those diodes after removing them—always to use new ones (perhaps the heat of unsoldering them ruins them). Anyway, that's probably where your problem is: unbalance in the AFPC diode unit. Try new ones (factory replacements) and, just to play it safe, heat-sink them by holding the leads with a pair of long-nose pliers when you solder them in.

To see whether they're working properly, measure the DC voltages on the two diodes; they should be exactly the same, but of opposite polarities. A ball-park figure is −55 and +55 volts.

### NO SOUND, NO PICTURE

***I've got a Magnavox T931 with no sound and no picture. I found shorted diodes in the full-wave bridge in the DC power-supply, and a bad flyback transformer. I replaced them, and got good sound, but no picture.***

***The DC source voltage is OK, as are the tubes, but I found that the plate voltage on the horizontal oscillator was only +20 volts instead of the normal +225 volts. The plate dropping-resistors check out OK. I'm a bit lost.—R.B., St. Albans, NY***

When you find a condition like that—where the resistors and tubes are good, but there's very low plate-voltage—there's one answer: the tube is drawing far too much plate *current*, causing an excessive voltage drop.

Check the control-grid voltage; if it's too far positive, you've probably found the cause of your problem. The normal DC voltage on that grid is only +0.2 volt. I see (on the schematic) a small capacitor between the grid and the plate circuit of the oscillator section; make sure it isn't leaky. If it is leaky, it will pass a high positive voltage to the grid and cut off the picture.

Double check: turn the set on cold, with a DC meter on the plate of the tube. If the voltage comes up to normal, and then drops very rapidly as the tube warms up, that capacitor is certain to be at fault.

### DIODE PROBLEM

A while back I wrote to you about a Quasar with a low-DC-voltage problem. You were right—it was the power supply; I think the transformer was bad. I got a rebuilt panel from a tuner-repair service and it worked fine...except for one little thing.

The raster would appear at turn-on, and then go out. The cause turned out to be a bad diode, D16 on the replacement front panel. The raster would come on (because of the "instant-on" transformer) and then go right out. Replacing the diode fixed that and, now that the DC voltages are back to normal, the transistors run cooler and everything seems to be OK. Thanks a lot.—*J.G., Newton, IA*

### LOW CRT HEATER-VOLTAGE

***I installed a new CRT in a Magnavox T982 chassis (-08 run) and now the voltage reads 1.4-volts AC. The field fix for that has something to do with a capacitor and resistor installed in series with one lead of the heater transformer, T301. How do you make that fix, and where are those parts?—E.M., Washington, DC***

I see that R–C network in Sams 1509-3. It looks like a 100K resistor and 4 $\mu$F capacitor in parallel, with the combination in series with one of T301's primary leads. The Sams parts list shows no fewer than *seven* T301's! (The one you should have is a 300310-4; check it.)

As a crystal-ball guess, it looks to me as if the R–C network is in series with the primary to provide a small voltage-drop. If the capacitor is *open*, the voltage drop would be across the 100K resistor, and the CRT's heater voltage would be very low. Considering your symptoms, that's where I'd look first. You should find T301 just behind T300, on the left side of the chassis at the back.

### FOUR-LEGGED CAPACITOR

I asked you about a no-high-voltage/everything-OK problem in a Magnavox T982-13. You suggested several things to check. It turns out that one section of the four-legged capacitor in the horizontal-output stage was open; it looks like that was the problem.—*M.B. Danish, Aberdeen Proving Ground, MD*

*Thanks for the feedback. Those capacitors are designed so that if one lead opens, it breaks either the emitter or collector circuit of the horizontal-output transistor.*

### TUBE EATER

***This one has some good people stumped, including the distributor's technician. It's a Zenith 16Z7C19Z that eats up 6HV5's. I've changed the VDR's, but that didn't help. The high-voltage adjust has no effect on the high voltage, which is too high, as is the focus voltage. The high-voltage-adjust pot is OK. The grid voltage on the 6HV5 is +340 volts; the cathode voltage only +105 volts. Help!—J.U., Beaverton, OR***

The only thing I see wrong here is the bias on the 6HV5, but that's enough.

There should be +340 volts on the grid, and +390 volts on the cathode, for a net bias of − 50volts. You've got a net bias of +285 volts—no wonder the tubes won't last! They must be drawing a tremendous amount of current!

My crystal ball tells me that the series diode from the B+ to the cathode is probably breaking down under the load. Replace it with a suitably rated diode and see what happens. That diode should cut off completely, with a positive voltage on its cathode. The high-voltage adjust control should (*must!*) vary the grid voltage; the high bias is probably keeping it from doing that.

### 25-INCH REPLACEMENT CRT

***I have a ten-year-old 25-inch Magnavox that I'd like to hold on to. The problem is that the picture tube is going out. I get conflicting advice about replacing it: some people tell me I can use a rebuilt tube, others say they're no good, and still others say that 25-inch tubes are no longer available! I'm really confused.—J.E.H., Longwood, FL***

Age really isn't a problem; you should see what I use—a 20-year-old RCA. I haven't heard any rumors about 25-inch CRT's being discontinued. As for rebuilt tubes, yes—it *is* possible to get a bad one. However, if you get a factory-rebuilt one, it will carry a warranty almost as good as the new ones do. Lines like RCA's, Sylvania's, and others' offer such warranties, and we've had good results with them.

From long experience I'd say that, if the set has been working well this long, the possibility of catastrophic failure is small. Most of the problems have already shown up and been fixed. Replace the tube and keep the set.

### INDEPENDENT REMOTE CONTROL

***I have an RCA CTC68 with remote control, and it's got a dandy problem. It turns itself on at odd times, usually in the middle of the night...and even with the REMOTE switch in the OFF position! I've changed Q104, which was what RCA suggested, but it didn't help. Any ideas?—H.L., Newport, OR***

Since you've changed Q104, which controls the opto-coupler switch, the problem must lie somewhere else. Check the remote, especially Q11, which is the relay-control transistor. If it's leaky, it could cause that kind of problem.

(*Feedback: That was it. I* had *replaced Q11, but evidently the replacement was as bad as the old one. A second replacement cured the problem. Thanks.)*

### STICKY PROBLEM

I developed an interesting problem in my RCA MR-419R (CTC-111 chassis): neither the remote control nor the switch on the set would turn it off. I had to unplug the line cord to shut it down. When I plugged it back in, two more problems showed up: the volume shot up to maximum, and the remote volume control wouldn't work.

All those functions are controlled by a remote receiver. Checking the switch showed relay K1 stuck in the ON position. Freeing the relay and cleaning it brought *all* the functions back to normal.

The unexpected thing here (remember your column "Expect the Unexpected" in the July 1982 issue?) was that a shop technician might never know that the original fault was just in the on/off switch, and the symptoms pointed to the decoder when the only problem was in the relay.

I haven't figured out why this happened (*neither have I*—J.D.). Maybe someone out there has some ideas.—*R.S., Poway, CA*

### LOST PICTURE

When I reported a no-picture symptom, you told me to try a new video-driver transistor to find the cause. I did, but it didn't help. When I checked for continuity between the collector of that driver and the base of the next stage, though, I discovered that something was open. It turned out to be a lead on the delay line; I resoldered that and things came back to normal. Thanks, ever so much.—*A.V., Miami, FL* R-E

# COMMUNICATIONS CORNER

## Ensuring privacy in communications

**HERB FRIEDMAN,** COMMUNICATIONS EDITOR

THE NEED FOR "SECURITY" IN COMmunications has grown along with advancements in technology, population increase, and lack of spectrum space. Today, we can manufacture reasonably priced receivers for almost any frequency, and almost everyone can afford a "monitor radio" that will let him listen in to government and business frequencies, radiotelephone conversations, and the like. Normally, if there are a few hobbyists "reading the mail" on communications frequencies it's not much of a problem. But when everyone and his brother (and sister) can listen in, it becomes another story.

As for the airwaves, they are so crowded that we have shared-use of the VHF/UHF channels, and we must often provide some way to keep shared-channel users from being disturbed by calls and conversations not intended for them.

Even the amateur radio operators have their own problems caused by technology and population. Two-meter repeater activity is so heavy in some areas that many clubs have been forced to restrict access to their repeaters, particularly when that repeater provides a "phone patch" service.

Finally, we come to the "people on the go"—people who are constantly on the move, running down hospital corridors, driving from one computer-repair site to another, or relaxing at the pool or theater but always "on call." They use radio paging systems to inform them that they must phone in for a message or special instructions.

A convenient, low-cost, way to prevent unauthorized VHF/UHF monitoring, use of a repeater, signaling, etc., is through the use of audio tones of specific frequencies transmitted before, along with, or instead of voice transmissions. Sometimes a subaudible (below the lower frequency-limit of the receiver's audio-output stage) tone is transmitted along with the audio, and only those receivers with a squelch circuit tuned to that subaudible frequency receive the transmissions. At other times, a specific tone or sequence of tones prior to a voice transmission will open the squelch.

Precision-frequency tones also provide signaling through radio pagers—those "beepers" you see clipped to the belts or shirt pockets of nurses, doctors, service technicians, and others who have to be contacted, no matter where they may be. Each beeper is a miniature radio receiver whose audio output is keyed by a different tone or sequence of tones, so that a single radio-frequency can be used to page hundreds of individual subscribers, or groups of subscribers. When the beeper sounds, the subscriber phones in to his office or the paging service to receive his message.

**TABLE 1**
**EIA SUBAUDIBLE TONES**

| | | | | | |
|---|---|---|---|---|---|
| 67.0 Hz | XZ | 100.0 | 1Z | 146.2 | 4B |
| 71.9 | XA | 103.5 | 1A | 151.4 | 5Z |
| 74.4 | WA | 107.2 | 1B | 156.7 | 5A |
| 77.0 | XB | 110.9 | 2Z | 162.2 | 5B |
| 79.7 | SP | 114.8 | 2A | 167.9 | 6Z |
| 82.5 | YZ | 118.8 | 2B | 173.8 | 6A |
| 85.4 | YA | 123.0 | 3Z | 179.9 | 6B |
| 88.5 | YB | 127.3 | 3A | 186.2 | 7Z |
| 91.5 | ZZ | 131.8 | 3B | 192.8 | 7A |
| 94.8 | ZA | 136.5 | 4Z | 203.5 | M1 |
| 97.4 | ZB | 141.3 | 4A | | |

### EIA tones

The tones used for signaling, paging and squelch-opening must be highly precise, and the filters in the receiving equipment are very sharp (high-Q) with filter-bandwidths of $\pm 1.5$ Hz being common. As shown in Table 1, there are 32 standard EIA tones just in the narrow range of 67.0 to 203.5 Hz, yet the frequencies are easily separated by modern receiving equipment. Also note that each frequency is assigned an alphanumeric identification code. That EIA frequency-group consists of subaudible tones; they are below the minimum frequency normally reproduced by receiving equipment and are sent simultaneously with the voice transmission. A receiver's audio-output stage is turned on by the tone, and goes off when the tone ceases. (The full range of EIA tone-frequencies extends to 2109.4 Hz.)

### Other tone-systems

General Electric and Bramco each have their own standard tone-groups for two-tone sequential signaling. Depending on the tone frequency(s) used, either a group of pagers or an individual pager can be signaled. To illustrate how far the signaling-tones concept can be carried, Motorola alone has six groups of eleven frequencies, giving a total of 66 frequencies between 288.5 Hz and 1433.4 Hz. G.E. has three groups of eleven tones, and Bramco two groups of eleven. Some of the frequencies are used by all three companies, others are not. And, if you find you need other frequencies, you can use "non standard" tones in the range of 268.5–3906.0 Hz.

As a general rule, tone encoders can be easily added to almost any equipment such as amateur radio HT's (handie-talkies) and transceivers. The encoders

| LOW GROUP-Hz | | | | |
|---|---|---|---|---|
| 697 | 1 | 2 | 3 | A |
| 770 | 4 | 5 | 6 | B |
| 852 | 7 | 8 | 9 | C |
| 941 | * (SPARE) | 0 | # (SPARE) | D |
| HIGH GROUP-Hz | 1209 | 1336 | 1477 | 1633 |

FIG. 1

"Mobile antenna mounting and cable routing on today's cars are a nightmare"

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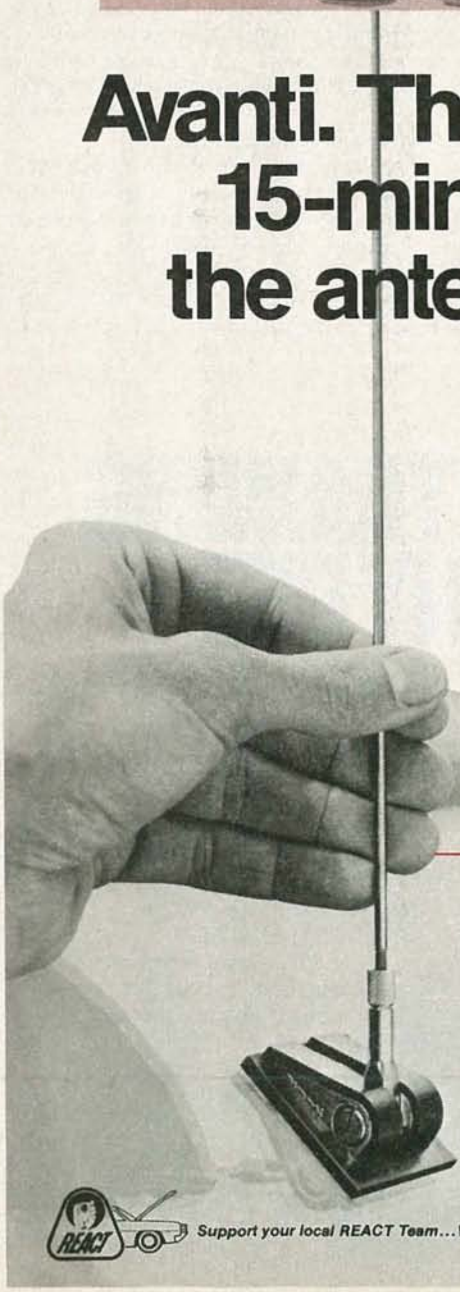

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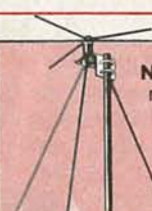

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are available as small printed-circuit assemblies not much larger than a postage stamp, and are connected directly into the microphone circuit or the input to the transmitter's modulator stage. Similarly, printed-circuit tone decoders are also available; they are about the size of two postage stamps. The operating frequencies of the encoder and decoder are selected by the user. Sometimes they are crystal controlled; some recent devices are programmable by means of DIP switches.

### DTMF encoders

Perhaps the most popular, best known, tone group is the set of DTMF (*D*ual *T*one *M*ulti *F*requency), or *Touch-Tone* frequencies used in telephone circuits. Those tones are also used for everything from computer control and data entry, to control of amateur-radio repeaters, to remote control of industrial devices.

The DTMF tones consist of two groups of four frequencies—called the low and high groups—arranged in a matrix as shown in Fig. 1. Depressing a key or button causes two tones to be transmitted simultaneously. For example, depressing the "4" key transmits both the 770- and 1209-Hz tones. For conventional *Touch-Tone* signaling only twelve combinations are used and only twelve keys are provided on the keypad, usually numbered "0" through "9" with two spares that are generally identified by the "*" and "#" symbols. Note that the 1633-Hz column is not normally accessed. There are 16-key pads available, though, for special applications; they make use of that 1633-Hz column. That provides four additional tone-combinbations in addition to the standard twelve. The four new keys, together with the two "spares" on the standard pad provide six "free," or non-numeric keys that can be used for additional control functions. Sometimes, for example, they are labled "A," "B," "C," "D," "E," and "F," and are effectively used to provide a hexadecimal keypad for computer input.

Audio tones presently provide relatively inexpensive telephone signaling, selective paging, and communications security. However, one must wonder whether the cost and complexity can be reduced even farther by digital encoding using microprocessors. Even today, a single integrated ciruit can generate all the DTMF tones. In a future column we'll go into selective digital encoding. **R-E**



## EQUIPMENT REPORTS

*continued from page 32*

standard cash-register-type paper, is capable of printing upper- and lower-case characters in nine type-sizes, and can scroll freely up-and-down or side-to-side. That last feature is very important and is what makes the printing of graphics realistic. About the only problem I found with the printer was that the pen tips dried out rather quickly—I would suggest keeping the pens capped when not in use. The operation of the *PC-2* and its printer-interface is rather straightforward, but a first-time user should take care to follow the instruction manual closely.

Turning to that instruction manual, we find that it is clear and concise, and leads the user through each phase of start-up and operation. However, toward the end it seems to lose its tutorial flavor and simply provides brief instructions on use. I think the manual would have been even better if more tutorial help had been offered there. But on the whole it is probably one of the better computer-instruction manuals around.

Altogether, the Radio Shack *PC-2* pocket computer is an impressive and powerful unit as it offers true computing capabilities in a nearly pocket-sized package; it sells for $279.95. The cassette interface/printer sells for $239.95. **R-E**

# COMPUTER CORNER

## Computerizing your office

LES SPINDLE*

YOU'VE FINALLY DECIDED TO TAKE THE plunge. Business associates and friends have long extolled such benefits of office computerization as increased productivity, quick and convenient access to information, and higher profits. The pressure is on to jump on the bandwagon, and you've decided to give in. But where do you begin?

Do you buy an office system, or hook up with a timesharing service? Do you consult with your local computer store, or take the less expensive mail order route? Do you go for a turnkey (ready-to-run) system, or do you opt for having the system configured to fit your specific needs? The beginner has a mind-boggling maze of options to sift through before making the switchover. The only way to make any intelligent decision is to know all of the options—and the pros and cons of each.

### Buying vs. timesharing

Once you have determined that some office functions are to be computerized, you have to decide whether it is better to buy a computer system or to hook into a timesharing service such as Tymshare or Comshare. We will first study the options of two timesharing methods—batch processing and actual on-line usage.

In the batch-processing approach, the entire keypunching (data entry) and data manipulation procedures are performed outside the office by a service bureau. After your initial consultations with the bureau staff, all data to be processed is turned over to them on a regular basis. The data is then fed into the service's main computer, processed, and the printed output is delivered to you.

With on-line timesharing, the keypunching function is performed at a terminal in your office that communicates via modem hookup (over telephone lines—see Fig. 1) with an off-site mainframe unit shared by a number of different companies. You access the portion of the mainframe's memory that is reserved for your application programs, and your staff carries out any data storage, retrieval, or manipulation functions.

Which of the two timesharing methods is better for you can be determined by your office requirements. For smaller operations, where bookkeeping is minimal and various files do not have to be accessed constantly throughout the workday, batch processing may be the better choice because the service is less expensive. That's because the overhead involved in shopping for the proper terminal, modem, and software—as well as the expenses of maintenance and repair, and the upgrading and replacement of equipment—are not necessary.

FIG. 1

On the other hand, while the actual service cost is less—and the incidental costs detailed above are not present—the process is scarcely as automatic as on-line usage. It imposes a greater workload on the employees who go through the daily routines not accomplished by the computer. Traditional bookkeeping and file-cabinet activities are necessary while the material is being assembled to turn over to the service bureau.

Also, the standardized software packages available from a service bureau are not very adaptable to individual needs. Unlike the on-line method, batch processing requires you to adapt your office procedures to the system—rather than the other way around. The loss in flexibility of operation may offset the savings of the service.

As with service bureaus, consultation with the timesharing service will determine which software programs in its data bank serve your needs best. Then the programs are fine-tuned to your specific office requirements.

The obvious benefit over batch processing is greater—and more constant—control. Rather than keeping records manually to turn over to the service bureau, the data is fed directly into the computer. Information can be added, deleted or manipulated at any time. For larger businesses whose daily (or even hourly) transactions require fast data-manipulation, timesharing may be the only answer.

There is one frustration that can occur with timesharing that should be pointed out. Depending upon the number of users sharing the service, access may not always be instantaneous. If your local access node is overbooked you may have to wait until it clears—or pay for a long-distance call to the next access point. The possibilty of "crashes" also exists—resulting in inconvenient "downtime" or even the loss of data.

All things considered, batch processing will prove cost-effective for some smaller companies, while it may be too inconvenient and unsophisticated for others. Only by comparison-shopping and careful analysis of your work-flow requirements can you determine which method of timesharing is best for you.

### A computer of your own

Perhaps you require more sophisticated capabilities than the timesharing services can offer. You might, in that case, consider purchasing an office microcomputer. As costs of hardware and software continue to drop—while capabilities continue to increase—an in-house system is a good investment for many businesses.

An important consideration, though, is all the "hidden" costs that must be taken into account: hours of planning and consultation, program customization, upgrading and maintaining equipment, and staff training. The busy office manager, already overloaded with day-to-day concerns, may find it necessary to hire a DP (*D*ata *P*rocessing) specialist just to coordinate all of these headaches.

While on-line timesharing does not require the programmers or computer technicians that are necessary to handle a complete office system, it does require DP skills on the part of at least a few employees—a staff with skills separate from those of basic bookkeepers or file clerks. However, while on-line timesharing does require a terminal and basic communications hardware, it is much less complicated than implementing a complete system. The shopping, maintenance, software integration, and plan-

*Managing Editor, *Interface Age* magazine

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ning processes involve fewer man-hours.

However, as the rush to office automation escalates—and the number of non-technical users along with it—more and more firms are designing software and hardware that are well documented, user-friendly, and English-language oriented (rather than communicating in "computerese"). Turnkey hardware systems (pre-assembled and software-integrated) and simple-to-operate software are the rule; "do-it-yourself" is becoming the exception.

While the initial costs of purchasing a system may appear high, the cost-effectiveness may make such a purchase worthwhile in the long run. Even more important, having the system on hand—and learning to use it—will prepare you and your staff for the oncoming computer blitz. Timesharing may leave you behind while technology races ahead.

### Shopping for a computer

Assuming that you've chosen to go the purchase route, where do you buy? Are you more attracted to the cost savings of a computer-by-mail transaction—or the step-by-step support offered by a local retail outlet?

Mail-order vendors are able to offer substantial software and hardware discounts because they do not have the overhead involved in operating coast-to-coast retail outlets. However, they seldom offer any after-sale support. The tasks of planning and customizing the system are left totally up to the purchaser.

That can present insurmountable problems, because there are light years of difference between buying a computer and buying an electrical appliance that you can take home and plug in. The process involves analyzing your work-flow requirements, installing the system software and any utility packages, as well as properly connecting and operating the peripherals and learning to work with the idiosyncracies of operating systems and programming languages. The value of a qualified sales-person who is willing to work with you in the crucial purchase-and-implementation phase can make the difference between success and failure in establishing a cost-effective office system.

So, the answer is simple, right? Despite the initial cost savings of a mail-order house, it's usually better to buy from your local dealer. Not always. Though there are rapid improvements occurring in the after-sale support area, horror stories still abound of computer stores not offering adequate service, not employing qualified salespeople, and not offering the necessary after-sale hand-holding.

The only way to avoid the problem is to rely on the word-of-mouth technique. If you've decided to buy from a computer store rather than a mail-order firm, make sure it's a reputable one with some satisfied customers. Another caution: since usually the vendor's warranty is only as good as the manufacturer's policy, make sure that you stick with a company that other users have endorsed as standing behind its products.

Nevertheless, for the adventurous, the electronically-inclined, or those with experienced friends willing to help them over the rough spots, the savings offered by a mail-order purchase may be worth the extra effort.

The keyword in computerization is patience. Switching to automation is not an overnight process. Since there is a wealth of alternatives—each with its own advantages and disadvantages—plan your moves wisely. With cautious investigation, the pitfalls will be easy to avoid. **R-E**

*"But, Gloria, I* do *excel in sports. I have electronic football, electronic basketball, electronic hockey ..."*

# HOBBY CORNER

## Battery backup for digital clocks

**EARL "DOC" SAVAGE, K4SDS,** HOBBY EDITOR

A while back, L. V. Clifford asked for some help in making a back-up, short-term, power supply for his AC-operated digital clock (see the May, 1982 issue of **Radio-Electronics**). He wanted to avoid the problem of having to reset his clock when the AC power just flickers.

Many readers advised putting a larger-valued capacitor on the low-voltage power-supply line. The larger value will maintain the voltage a bit longer when the AC fails.

Budd Webb (Santa Maria, CA), and others, suggested the approach shown in Fig. 1. It uses a battery and diode to keep the clock running if the AC power should fail. If the battery voltage is just a bit lower than the clock's operating voltage (as it should be under normal conditions), the battery is, in effect, disconnected from the circuit. When the AC power fails, the clock's operating voltage drops below the battery's voltage. Thus, the bias on the diode is reversed and power is supplied to the clock. Battery life should equal its shelf life unless it is called upon to run the clock frequently.

Wayne Ingram of Marietta, GA was the first of several who suggested an improvement on that circuit. As shown in Fig. 2, a second diode is added so that the battery power is not "wasted" in running anything but the clock module itself. Note that the power for the display, which requires much more current than the module, is taken off the line ahead of the second diode. The clock module runs on battery power but you cannot read the time because that second diode keeps the display off.

Other readers sent more complex circuits that also provide a 60-Hz pulse in case the clock depends on the AC line for timing pulses. Robert Otis (Cincinnati, OH) sent one using a 555 oscillator and William Otto, Jr. (Jupiter, FL) uses the gates of a CD4001 to form an oscillator. If there is space later, I'll pass along those circuits.

Thanks to those readers, and all the rest of you that responded to L.V.'s call for help. I hope you will continue to be as cooperative in the future. **R-E**

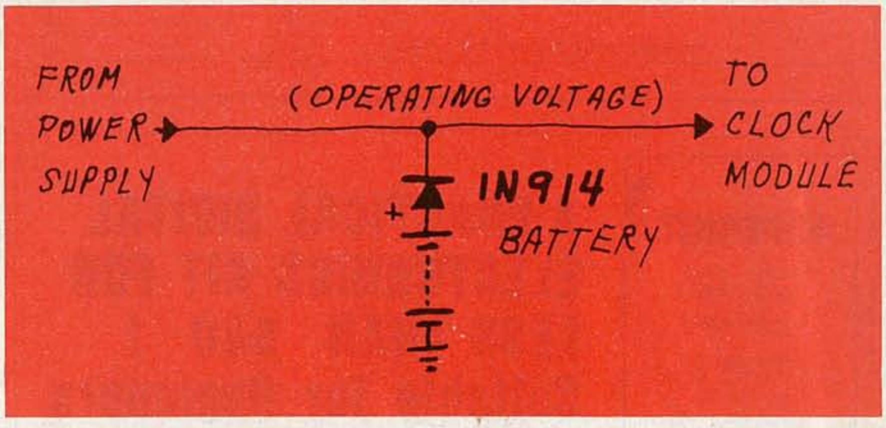


FIG. 1

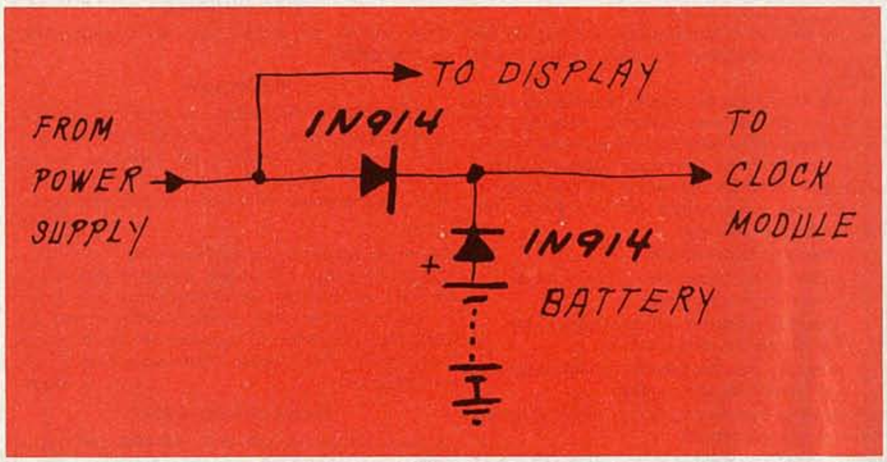


FIG. 2

**AN INVITATION**

To better meet your needs, "Hobby Corner" will undergo a change in direction. It will be changed to a question-and-answer form in the near future. 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:

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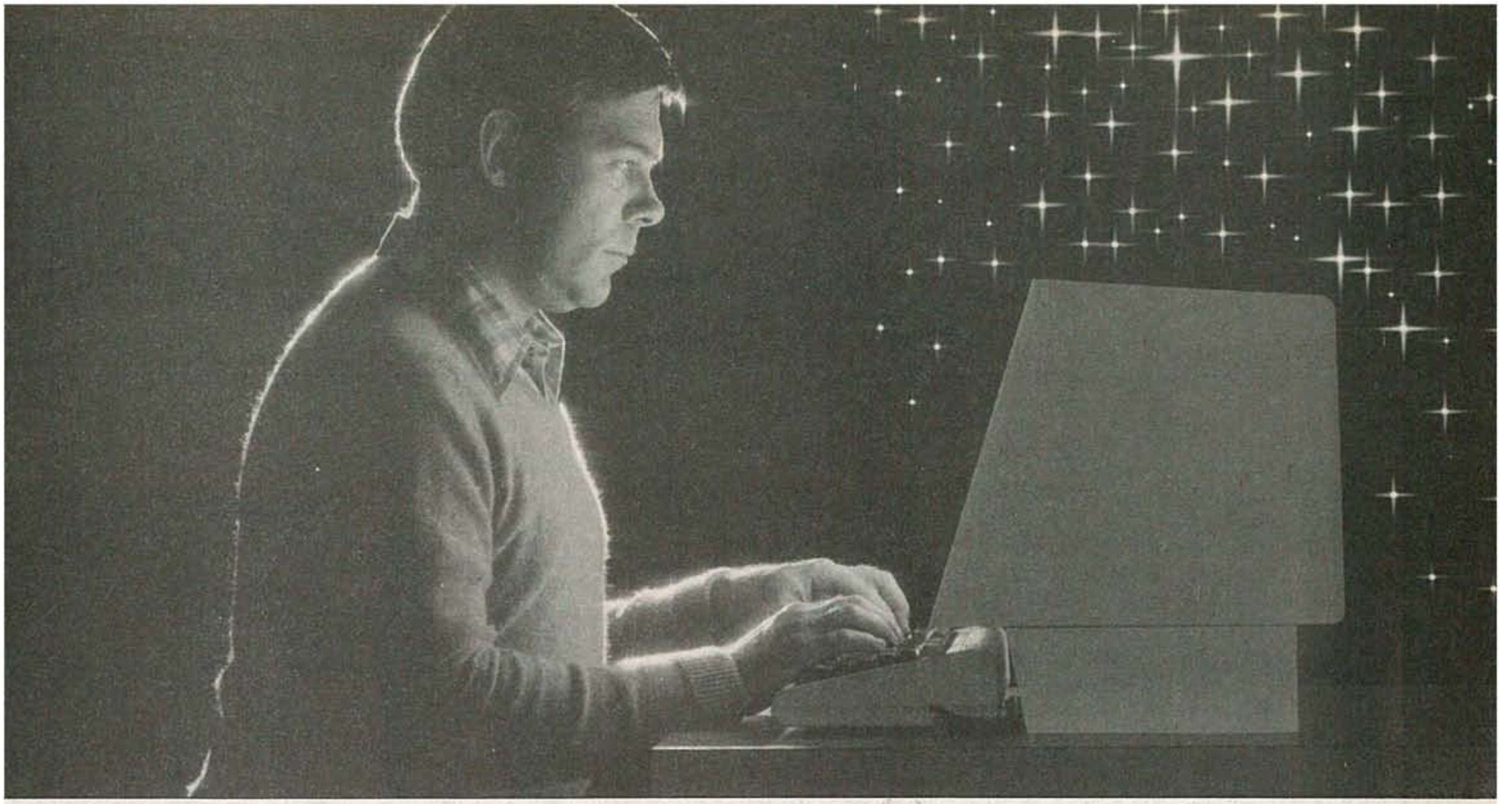

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# STATE OF SOLID STATE

## Digital lock circuit

**ROBERT F. SCOTT,** SEMICONDUCTOR EDITOR

ONE OF THE MOST INTERESTING IC'S TO come to my attention in the last few weeks is the LS7220 digital-lock circuit from LSI Computer Systems, Inc. (1235 Walt Whitman Road, Melville, NY 11747). It is a monolithic PMOS keyless combination-lock designed especially for automotive security applications. It includes sequential logic for reading correct key-closures and detecting out-of-sequence entries. In addition, the circuit includes a "save" input that stores the states of all outputs so that the driver can leave the security system disabled to allow the car to be driven by parking lot and garage attendents. Other features include:

- Stand-alone lock logic
- 5040 possible 4-digit combinations
- Out-of-sequence detection
- Automatic chip enable (for automotive use)
- Programmable convenience time-delay
- Low current consumption (40 μA @ 12 VDC)
- Single power supply (+5 to +18 VDC)

Output voltage specifications are given in Table 1.

**TABLE 1—OUTPUT SPECIFICATIONS**

| | | | Source Current | | |
|---|---|---|---|---|---|
| | **VSS** | **Min** | **Typ** | **Max** | **Units** |
| Lock Control | 5 VDC | 2.40 | 3.75 | 6.30 | mA |
| Output Pin 13 | 9 VDC | 7.20 | 9.75 | 14.70 | |
| On (Logic "1") | 12 VDC | 10.80 | 14.25 | 21.00 | |
| $V_{OUT} = V_{SS} - 2$ | 15 VDC | 14.40 | 18.75 | 27.30 | |
| | 18 VDC | 18.00 | 23.25 | 30.00* | |
| Convenience | 5 VDC | 0.20 | 0.29 | 0.50 | mA |
| Delay Pin 12 | 9 VDC | 0.55 | 0.75 | 1.13 | |
| On (Logic "1") | 12 VDC | 0.83 | 1.10 | 1.60 | |
| $V_{OUT} = V_{SS} - 2$ | 15 VDC | 1.10 | 1.44 | 2.10 | |
| | 18VDC | 1.40 | 1.80 | 2.30 | |
| Lock Indicator | 5 VDC | .40 | .60 | 1.00 | mA** |
| Output Pin 8 | 9 VDC | 3.00 | 4.30 | 6.90 | |
| On (Logic "1") | 12 VDC | 6.10 | 8.50 | 13.00 | |
| $V_{OUT}$ Clamp to | 15 VDC | 10.40 | 14.00 | 21.00 | |
| 1.7V | 18 VDC | 15.80 | 20.00 | 30.00* | |
| Save Indicator | 5 VDC | .80 | 1.20 | 2.00 | mA** |
| Output Pin 10 | 9 VDC | 6.00 | 8.60 | 13.80 | |
| On (Logic "1") | 12 VDC | 12.20 | 17.00 | 30.00* | |
| $V_{OUT}$ Clamp to | 15 VDC | 20.80 | 28.00 | 30.00* | |
| 1.7V | 18 VDC | | | 30.00* | |

*Indicates maximum allowable current drain of 30 mA.
Note: Limit output current to 30 mA max.

**Current drive balanced for equal brightness on red and green indicators.

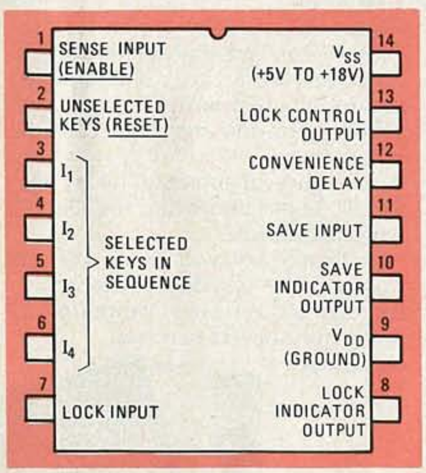


FIG. 1

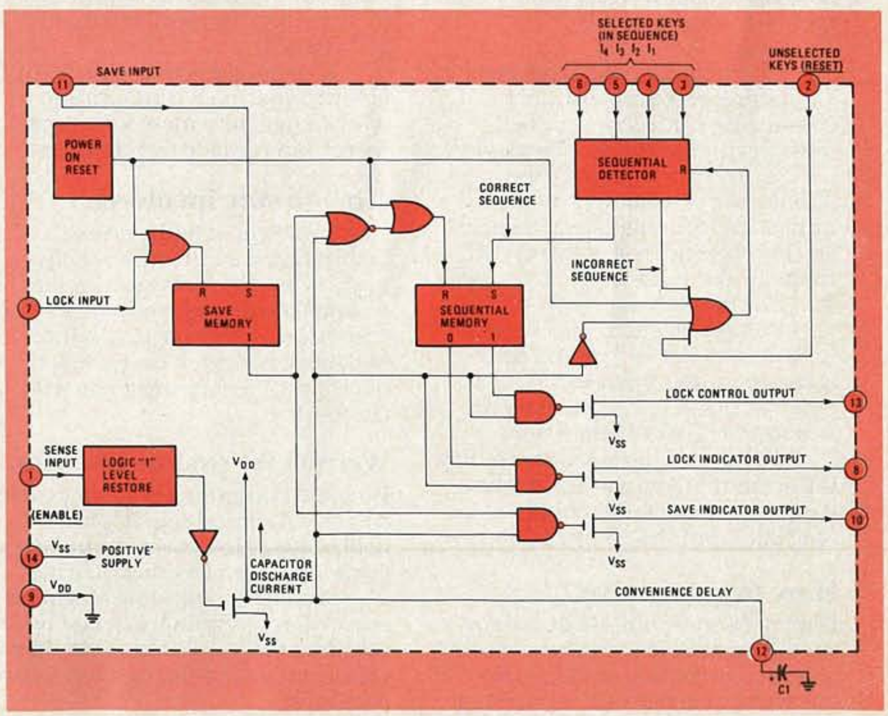


FIG. 2

Figure 1 shows the pinout of the LS7220, and Fig. 2 shows a block diagram of the IC.

### Using the IC

A practical circuit for an automobile anti-theft lock is shown in Fig. 3. When the car's ignition switch is turned on, the SENSE INPUT pin goes high and readies the SELECTED KEYS inputs (pin 3 through 6) to accept the unlocking sequence at input

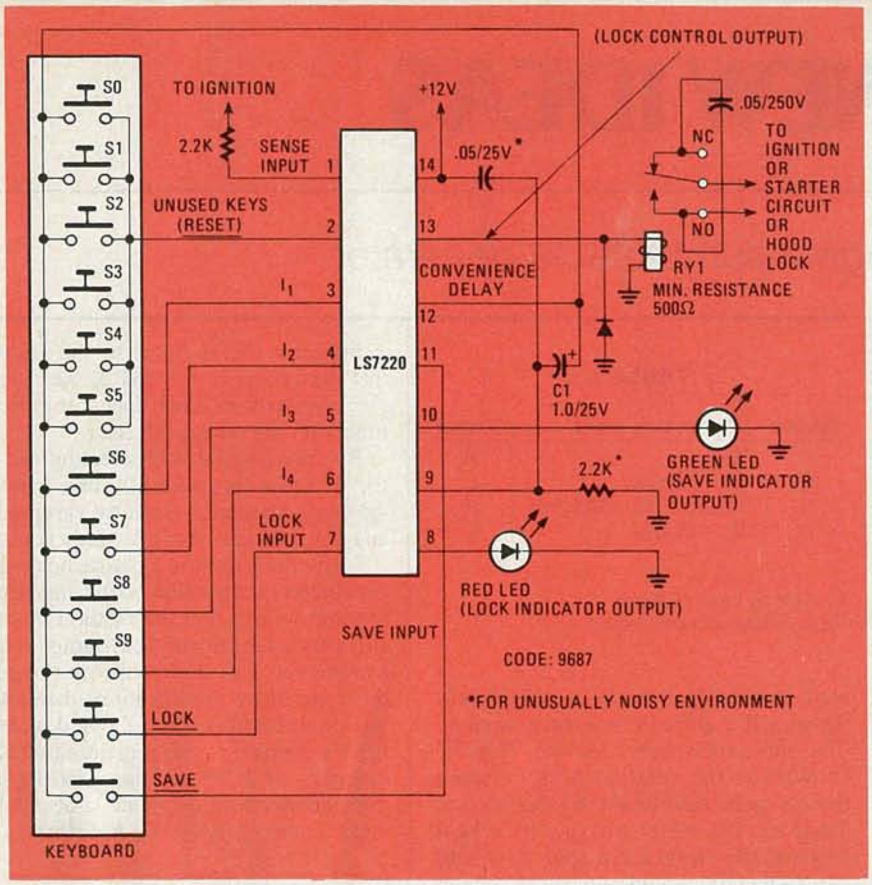


FIG. 3

terminals $I_1$, $I_2$, $I_3$, and $I_4$. If the keys associated with those inputs are pressed in exactly the right sequence, the LOCK CONTROL output goes high and lock relay RY1 is energized. At the same time, pin 8 goes low, turning off the red LED to indicate that the circuit is unlocked. If the keys are pressed in any sequence other than that of $I_1$, $I_2$, $I_3$ and $I_4$, the internal sequential detector will reset and the entire keying sequence must be repeated.

At the moment that the sense input (ENABLE) pin goes high, the convenience-delay capacitor, C1, charges and delays any change in the states of the outputs when the state of the sense input changes from high to low. The delay is a function of the value of C1 and the supply voltage. When C1 is 1 $\mu$F, the delay ranges from about 3 seconds with $V_{ss}$ at 5 volts to 12 seconds when $V_{ss}$ is 18 volts.

Normally, when the ignition is turned off, the sense-input pin goes low and the lock relay opens. The next time the ignition is turned on, the red LED LOCK indicator is turned on and remains on until the correct key code is punched in. The LOCK indicator goes out when lock relay RY1 is energized.

However, to hold or "save" the "unlocked" state when the ignition is turned off, even though the device is in the off or unlocked state, the driver first presses the SAVE key. That puts a logic "1" on pin 11

*continued on page 98*

# NEW IDEAS

## Budget sound-effects generator

HERE IS A NOVEL USE FOR THE TEXAS Instruments TL507C analog-to-digital (A/D) converter (available from Radio Shack as part No. 276–1789). Although intended for use with 4- and 8-bit microprocessors, this IC provides the "brain" for an incredible sound effects generator. It is relatively easy to build—only a clock and an audio amplifier need to be added. A wide assortment of sounds can be produced—race car, dog's bark, airplane, lion's roar, and more.

The sound effects circuit is shown in Fig. 1. A variable clock-pulse generator is made up of two sections of IC1 (a 4069 CMOS hex inverter), R1, S1, and capacitors C1–C6. By adjusting R1, and switching one of the capacitors into the circuit, the clock's pulse rate can be varried over a wide range. That pulse rate can be determined by the formula: Pulse rate = 1/1.4RC, where R is in ohms, and C in *farads*.

The TL507C (IC2) converts analog signals (in this case the output of IC3, an LM386 audio amplifier) into digital signals at a conversion rate that can be determined from the formula $T = 2N/f$ where T is the conversion time, $f$ is the clock frequency, and N is the 7-bit output of the binary counter contained in the IC.

The conversion is accomplished using the single-slope method. In short, that involves comparing an internally generated ramp signal to the analog input-signal and a 200-mV reference voltage. The application notes for the TL507C show how the relationships between those signals determines the output (see Table 1). The RESET pin (pin 8) is held low and the ENABLE pin (pin 1) is held high. That allows continuous conversion operation at a rate determined by the clock frequency and analog input.

**TABLE 1**

| Enable | Analog input | Output |
|---|---|---|
| L | X | H |
| H | $V_I < 200$ mV | L |
| H | $V_{RAMP} > V_I > 200$ mV | H |
| H | $V_I > V_{RAMP}$ | L |

$V_I$: Analog input to pin 5
$V_{RAMP}$: Internal ramp signal

The squarewave output from the A/D converter is fed to IC3 through a network consisting of R2, R3, and C7. Resistor R2 controls the amplitude of the pulses. Resistor R3 and capacitor C7 form a variable tone-control filter and a differentiator circuit that converts a squarewave into a spiked waveform. That waveform is amplified by IC3, and the resulting output is fed back into the analog input of IC2 as well as to an eight-ohm speaker.

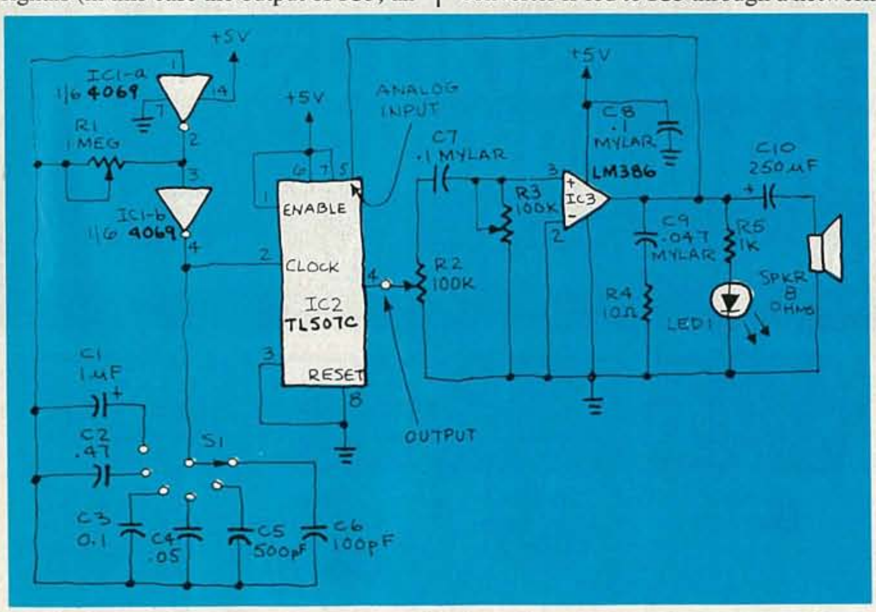


FIG. 1

Indicator LED1 lights to inform you that the power is on, and at the slower clock frequencies it will appear to pulse in time with the sound effects.

By adjusting R1 and selecting one of the six capacitors with S1—thus varying the clock frequency—and by varying R2 and R3, you can produce many sounds.

I built the circuit in a plastic box using perforated construction board and point-to-point wiring, but the method of construction is not critical. I encourage you to experiment with the circuit as I'm sure there are many modifications that could add more fun to it. Those could include LED's coupled to the remaining unused inverters of IC1, additional analog-to-digital converters, different values for R1 and C7, etc.—*Jeffery C. Nickerson*

**NEW IDEAS**

This column is devoted to new ideas, circuits, device applications, construction techniques, helpful hints, etc.

All published entries, upon publication, will earn $25. In addition, Panavise will donate their *model 333*—The Rapid Assembly Circuit Board Holder, having a retail price of $39.95. It features an eight-position rotating adjustment, indexing at 45-degree increments, and six positive lock positions in the vertical plane, giving you a full ten-inch height adjustment for comfortable working.

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## ANALOG CIRCUITS

*continued from page 66*

$\times 10^7$. If the gain is reduced to any other level, let's say to 60 dB or 1000, the gain-bandwidth product must remain constant. That indicates that the bandwidth times 1000 must be equal to $3 \times 10^7$, or that the bandwidth is equal to $3 \times 10^7/1000 = 30{,}000$ Hz.

To improve stability of the overall circuit, R-C networks are frequently added. However, the use of excessively large capacitors will affect the device's response. The manufacturer frequently indicates just what resistors and capacitors should be used in the circuit for stabilization purposes. Also, many op-amps already have stabilizing circuits built in.

### Power amplifiers

Small- and medium-signal amplifying devices have so far been described. One job of such a device may be to supply gain for a meter movement. In other cases, small-signal devices can fill different circuit requirements in a radio or record player. To drive a loudspeaker in a hi-fi or PA system, power devices are required, however. In the next part of this series we'll look at power amplifiers. **R-E**

# NEW PRODUCTS

For more details use the free information card inside the back cover

**VIDEOCASSETTE RECORDER,** *model NV-8950,* completely eliminates noise and blurring in slow and stop-action, and provides clear, bar-free pictures in high-speed playback modes as well. Its high-speed playback operates both forward and reverse directions when the tape was recorded in normal (SP) or extended slow (SLP) modes. The *model NV-8950* features program access, front loading, two-track audio with Dolby, direct portable color-camera connection capability, and it is operated by a 13-function wireless remote control.

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Four video heads are used to eliminate the noise and blurring that occur when a tape is played back at a different speed from its recorded speed. The two new heads in the *model NV-8950* are designed specifically for fast, slow, and still-field playback to assure perfect tracking at any speed.

The *model NV-8950* is priced at $1995.00.—**Panasonic,** One Panasonic Way, Secaucus, NJ 07094.

**FIELD-STRENGTH METER,** *model FSM-8,* is a solid-state UHF/VHF meter for professional installers and technicians. It operates on any of three different battery combinations. The battery pack is located in the cover, and batteries can be changed without removing the meter.

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The *model FSM-8* reads directly in dBmV and has a digital delay circuit to shut the meter off automatically at a preset level. The meter is lightweight (7 pounds) and is housed in an impact-resistant case with a heavy-duty shoulder strap and hanging loop. The *model FSM-8* (stock number 4138) is priced at $862.50.—**Blonder-Tongue Laboratories, Inc.,** One Jake Brown Road, Old Bridge, NJ 08857.

**DIP SQUEEZERS,** *model DS299*, is a versatile hand tool suited not only for DIP IC removal and insertion, but for discrete parts handling, lead straightening, wire-bundle holding, and many other applications where

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items must be held in place temporarily for soldering or other work. Its unique handle can slide up or down along the gripper shafts to change the gripper opening, allowing for the firmest grip. The handle also swings out to accommodate the operators's needs.

The *model DS299* is priced at $14.95.—**Edsyn,** 15958 Arminta Street, Van Nuys, CA 91406.

**DESOLDERING BRAID,** the *Chem-Wik,* is safe and effective because it is manufactured with pure copper braid, which permits the user to see the absorption of solder as it travels up the wick. Another characteristic of the *Chem-Wik* is its pure rosin, water-white flux. That coating is completely free from halogens and corrosive chlorides that can leave harmful desposits on the work. The rosin is ultrasonically applied to impregnate the wick with a perfectly uniform and smooth flux, for more rapid and efficient wicking ac-


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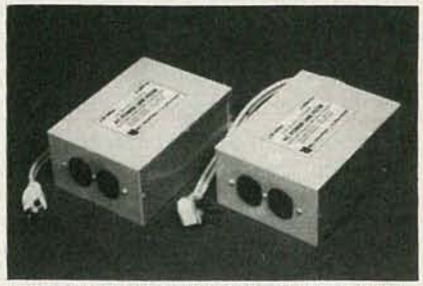
tion. That results in minimal flux residue and instant solder absorption with less heating of sensitive components.

The *Chem-Wik* is available in 5 gauges: .025-inches, .05-inches, .075-inches, .10-inches, and .15-inches for all desoldering operations. It is priced at $1.27–$1.68 for 5-foot spools.—**Chemtronics, Inc.,** 681 Old Willets Path, Hauppauge, NY 11788.

**LINE FILTERS,** *model C-517-L1* and *model C-518-L2,* are heavy-duty powerline filters with Varistor high-voltage/high-energy transient protection.

The *model C-517-L1* (110–120 volts AC) and the *model C-518-L2* (220–240 volts AC) both handle up to 15 amps, and each has a 5-section L-C network filter that provide 50-dB of attenuation or better from 500 kHz to 300 MHz. Those filters are ideal for protecting



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minicomputers and other noise-sensitive instrumentation from virtually all interference produced by copying machines, appliances, transmitters, and other noise sources.

The *model C-517-L1* and the *model C-518-L2* both have the same price: $69.75.—**Bell Industries,** J.W. Miller Division, 10970 Reyes Avenue, P.O. Box 5825, Compton, CA 90224.

**POWER HEAD AND HOLDER,** AUTO-VAC *model DS317,* is a low-static-potential, simple, easy-to use, power desoldering system designed for use with all electronic circuit components, but specifically MOS-LSI semiconductor devices sensitive to static electricity. The AUTO-VAC system requires only an automatic vacuum-controlled source to be-

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come operational; it comes with a combination tip cleaner and tool holder.

The *model DS317* is priced at $60.55.—**Edsyn, Inc.,** 1598 Arminta St., Van Nuys, CA 91406.

**POWER SUPPLY,** *model 515*, is dual-tracking and designed for modern solid-state applications where both linear op-amp and digital IC circuits are encountered. The output voltage is variable from ±5-volts to ±15-volts DC, and each output is rated at 1-amp continuous to comply with power requirements of complex digital and analog devices.

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All outputs feature automatic current limiting and short-circuit protection, as well as reverse-voltage protection. The *model 515* is manufactured with controlled tracking to within 20 mV and has a load regulation better than 3% from no-load to full-load on all outputs. Engineers, students, experimenters, and hobbyists will appreciate the large meter for easy voltage calibrations.

The *model 515* is priced at $160.00.—**HF Signalling, Inc.,** PO Box 17510, Kansas City, MO 64130.

**THERMOSTAT CONTROLLER,** the *Telestat*, is used to conserve energy while providing extra comfort for the user. The *Telestat* allows the user to close the heating/cooling vents in those areas which are not being used, and automatically control the temperature in occupied areas. In most cases, those areas are remote from the central forced-air


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thermostat. A simple regulator control is built into the remote unit to provide the user with the convenience of raising or lowering the room temperature remotely from the central thermostat. The battery-operated, portable *Telestat* continuously monitors and controls the temperature of the area where it is placed.

The *Telestat* is a two-part remote thermostat controller. The portable remote unit monitors the room temperature and transmits a digitally encoded radio signal to the receiver, which controls the central forced-air furnace/air conditioner. The transmitter is powered by a standard 9-volt battery, and the receivers obtains its power from the original wall-mounted thermostat.

The *Telestat* is priced at $150.00.—**Communications Research Corporation,** 1720 130th Avenue NE, Bellevue, WA 98005.

**FUNCTION GENERATORS,** *model 190, model 191,* and *model 192* present the following features:

The *model 190* function generator's outsignal frequency is from 0.002 Hz to 20 MHz with amplitudes up to 30 volts peak-to-peak (15 volts P-P into 50 ohms). Waveform selection of sine, triangle, and square are available with DC offset control up to $\pm 10$ volts ($\pm 5$ volts into 59 ohms). Variable symmetry provides sawtooth ramps and variable duty-cycle pulses with symmetry ratios of up to 19:1. Mode selection provides continuous, triggered, or gated operation. Those characteristics are also applicable to both the *model 191* and *model 192*.

The *model 191* pulse/function generator uses its versatile pulse capability as an internal burst generator to trigger the main function generator. When in the pulse mode, the *model 191* provides pulse delay and width control from 50 ns to 500 sec and 20 ns to 100 ms respectively. Pulse rise and fall times are less than 15 ns at full amplitude. In the burst mode, the pulse delay and width circuits become an internal burst generator which gate the main generator on and off to create a

*continued on page 100*

## STATE OF SOLID STATE

*continued from page 91*

(SAVE INPUT) and sets the "save memory" flip-flop, preventing the sequential memory from resetting as the ignition is turned off. A logic "1" appears at the SAVE INDICATOR output pin (pin 10) and turns on the green LED. If the ignition is turned off while the green LED is on, all output states are preserved in the IC's memory and it won't be necessary to go through the input keying-sequence the next time the car is started. In effect, the "save" feature disables the security system so the car can be operated by valet parking and garage attendents. The security system can be switched out of the SAVE mode by pressing the LOCK key and then turning off the ignition for a time period longer than the convenience delay. That resets the save-memory flip-flop and arms the security system.

The LS7220 digital lock IC can be ordered directly from the manufacturer. The devices cost $2.70 each in lots of 1 to 24. Include $5.00 for handling and shipping. New York State residents must include sales tax.

### High-speed analog switch

The Harris HI-201HS is a monolithic CMOS analog switch featuring very fast switching speeds and low on-resistance. It consists of four independently selectable SPST switches in a 16-pin DIP package. The device offers improved performance over earlier CMOS analog switches. Switching speed is 50 nanoseconds maximum and maximum on-resistance is 50 ohms. The wide analog-signal range of ±15 volts makes the device ideal for sample-and-hold circuits, digital filters, op-amp gain-switching networks, and just about any other application where improved switching performance is required.—**Harris Corp.,** P.O. Box 883, Melbourne, FL 32901.

### 40-ampere plastic SCR

A new line of TO-220 plastic-packaged SCR's (*S*ilicon-*C*ontrolled *R*ectifiers) with forward-current rates of 40 amperes—15 amps higher than previously available plastic devices—has been introduced by Motorola. The new devices have a surge-current rating of 400 amperes. That makes these SCR's particularly suitable for industrial applications.

The new MCR264 series includes four devices with voltage ratings between 200 volts and 800 volts as follows: MCR264-4 (200 PIV), MCR264-6 (400 PIV), MCR264-8 (600 PIV), and MCR264-10 (800 PIV). The devices are priced at $3.90, $4.85, $5.20, and $6.20, respectively in lots of 1–99.—**Motorola Semiconductor Products,** P.O. Box 20912, Phoenix AZ 85036. **R-E**

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# Tiny, powerful electronic "ears" let you hear whispers through walls, conversations 2 miles away.

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It's smaller than a quarter. But DYNA-MIKE will transmit every sound in a room to an FM radio tuned to the proper unused frequency, from 1/3 mile to 2 miles away.

If you're at a neighbor's home a block from your own, you can hear your baby's cry, or you can tell the instant your spouse comes home. If two of you are driving tandem in two cars, one or both of you can communicate with the other even if other cars drive between you.

DYNA-MIKE has as many uses as your imagination can think of. For a business conference, let the tiny microphone sit unobtrusively on the table or concealed on a shelf, and you'll be able to record every word. For businesses, you can put an FM receiver in a warehouse or remote office and "broadcast" instructions or orders to be filled.

Public speakers never had a better friend than the DYNA-MIKE. No wires or setup — just turn on one or more radios and your speech will come through with perfect fidelity. Put one on the front porch. If you hear a suspicious sound, turn on the radio and you'll hear the doorbell or the ring of the telephone.

**Choose Your Model**

New Horizons is introducing three models of the DYNA-MIKE supersensitive broadcast microphone. Model IC-18 is the world's smallest micorphone — it's a miracle of electronic miniature power, with a high-fidelity range of 1800 feet. Introductory price is $129.95 (two for only $119.95 each).

Model X-18 is the longest-range microphone, with an unbelievable two-mile range. Introductory price is $149.95 (two for only $139.95 each).

Model X-3 is the most sensitive microphone. It broadcasts perfect-quality sound even from low-levels or whispers, up to 1,500 feet. Introductory price is $99.95 (two for only $89.95 each).

Each microphone is fully wired, complete with standard HC-1.35v. battery, good for 100 hours of continuous use and easily and inexpensively replaceable.

Of course you're protected by the New Horizon guarantee: use any DYNA-MIKE transmitter microphone for 30 days, with the right to return it for a full refund if you're not delighted.

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Effortlessly, you can hear not just a baby's cries, but quiet breathing, through a concrete wall a foot thick. Put the SUPER-EAR earphone in your ear and place the speaker on the wall. That's all there is to it.

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SUPER-EAR is undetectable from the other side of the wall. The quality of sound has amazing fidelity—good enough to record, and SUPER-EAR has its own built-in recorder jack.

Because SUPER-EAR is the ultimate listening device, you can use it to pinpoint hidden squeaks in your car or the source of mysterious engine noises. Construction experts use it to check for flaws or cracks in buildings.

**It Works Anywhere!**

Ever put your ear to a railroad track to try to hear the train? Try it with SUPER-EAR. You'll hear that train many miles away. Use it as a powerful stethoscope on yourself, a friend, or a pet. You can even hear a bird's breathing.

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The PHONE ANSWERER/RECORDER connects in seconds between any tape recorder and your telephone. When you're away it automatically delivers a message up to 20 seconds to anyone who calls: when you'll return, when to call back, where you are.

When you're there, the ANSWERER/-RECORDER starts any cassette recorder automatically when you pick up the phone and shuts off when you hang up.


It records both sides of the conversation with astonishing clarity, giving you a permanent record of every call, preventing unauthorized use of your phone, and eliminating misunderstandings over what was said. It's specially wired to extend recording time on your tape recorder. Needs no batteries - it's always "alive".

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- ☐ 2 for $119.95 each
- ☐ Dyna-Mike Model X-18, $149.95
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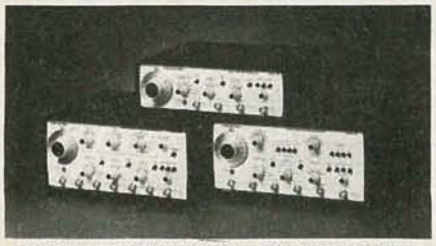
## NEW PRODUCTS

*continued from page 97*

burst of sine, triangle, or square waveforms. The burst rate is variable from 1 Hz to 5 MHz, and provides a burst-width range of 20 ns to 100 ms.



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The *model 193* sweep/modulation generator has an independent auxiliary generator in addition to the main generator that gives you a great variety of waveforms from one instrument. The auxiliary generator can be used as an independent signal source of sine, triangle, and square waveforms with symmetry control, or as an internal source to sweep, frequency-modulate, or amplitude-modulate the main generator. The combination of the two generators in one package makes a versatile signal source to address a wide range of applications.

The *model 190* is priced at $895.00; the *model 191* and *model 193* are priced at $1195.00 each.—**Wavetek,** 9045 Balboa Ave., San Diego, CA 92123.

**NUT-DRIVER SET,** *No. 89904,* has been designed to fill the demand for a set of nut drivers with 6-inch long shafts to accommodate the many applications where added length is needed. This 7-piece, pouched set contains the most popular hex sizes: 3/16, 1/4, 5/16, 11/32, 3/8, 7/16, and 1/2 inches. The nut drivers are packed in a vinyl hang-up pouch for convenient storing and handling.

The drivers have a patented shaft construction that enables them to withstand high torque, even at high temperatures, and their

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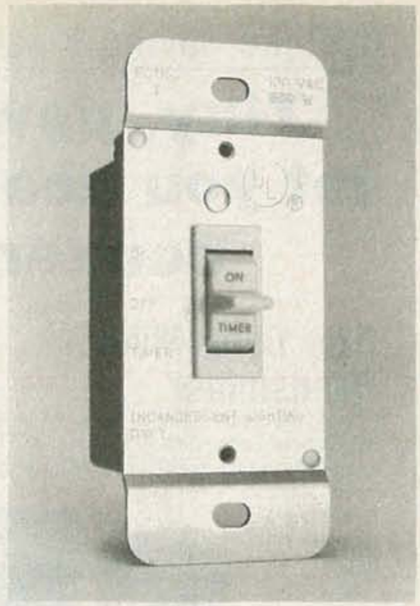
all-hollow shafts will accommodate the longest stud. They are color-coded to hex size for easy identification.

The *No. 89904* Nut-Driver set is priced at $30.00.—**Vaco Products Company,** 1510 Skokie Blvd., Northbrook, IL 60062.

**LIGHT SWITCH,** the *Lites-Off,* is designed for saving energy and has ON, OFF, and TIMER positions. In the TIMER position, lights will turn off automatically after 15 minutes, 1 hour, or 4



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hours depending upon the model. That can be valuable for replacing standard wall switches where lights are frequently left on after they're needed—such as basements, garages, utility areas, closets, bedrooms, and bathrooms. The *Lites-Off* is single pole, 120 volts AC, for incandescent lighting only, 500 watts maximum; it is UL-listed.

The *Lites-Off* is priced at $14.95.—**ECTEC Inc.,** 19138 Old Vineyard Road, Los Gatos, CA 95030. **R-E**



CIRCLE 74 ON FREE INFORMATION CARD

# NEW BOOKS

For more details use the free information card inside the back cover

**INTEGRATED CIRCUITS: Materials, Devices, and Fabrication, by William C. Till and James T. Luxon, Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 462 pages, including index; 6¼ × 9¼ inches; cloth; $32.50.**

This book is intended primarily for junior- and senior-level college students who have had one or more electronic-circuits courses and want to learn more about solid-state materials, solid-state devices, and integrated-circuit fabrication.

It is rooted in the thought that electronic circuits should be taught without a first course in solid-state materials and devices. The intent here is to emphasize the education of integrated-circuit *users*, rather than integrated-circuit makers. With that approach, devices are introduced descriptively, as needed, in electronic-circuit courses. Device characterisitcs and equations are presented and device models are used to predict circuit operation. Device fabrication is also discussed, but briefly, as needed.

After the opening, introductory charter, each chapter is followed by a bibliography for further study, and a list of problems. You will not find the answers to the problems in the back of the book; they are there to test the reader's comprehension of what he or she has just been presented with.

The text develops material science concepts that are fundamental to silicon circuits, derives current-voltage characteristics for the basic silicon devices, and discusses the fabrication techniques that are basic to bipolar and MOS circuits.

CIRCLE 141 ON FREE INFORMATION CARD

**49 EASY TO BUILD ELECTRONIC PROJECTS, by Robert M. Brown & Tom Kneitel, Tab Books, Inc., Blue Ridge Summit, PA 17214; 5 × 8 inches; 112 pages, including index; softcover; $5.95.**

This is a cookbook of economical, easy-to-build gadgets that the reader can assemble using only two types of transistors. The reader is urged to prepare by buying a few standard assortments of resistors and capacitors, and salvaging others from old radio and television chassis. (If the reader doesn't have any of the latter, local repair shops may have discarded chassis, which can be purchased very cheaply. Each component, however, should be checked carefully after removal.)

The projects include a wireless home broadcaster, hand-motion music maker, echo-chamber amplifier, automatic safety flasher, miniature FM radio, CB field-strength meter, supersonic eavesdropper, automatic auto-light reminder, electronic moisture/rain alarm, crazy kiddie toy, personal metronome, blinker, and squarewave audio generator.

All projects in the book are complete with parts lists, descriptive texts, and schematic diagrams in which only standard schematic symbols are used and all capacitors and resistors are standard values. The projects have been designed to make maximum use of certain key parts, many of which are used over and over again.

CIRCLE 142 ON FREE INFORMATION CARD

**SMALL BATTERIES, Volume 1: Secondary Cells, by T. R. Compton. A Halstead Press Book, John Wiley & Sons, Inc., One Wiley Drive, Somerset, NJ 08873; 226 pp including, glossary, a list of suppliers of secondary batteries, and index; 7½ × 10 inches; hardcover; $69.95.**

This book, dealing with rechargeable secondary batteries, is the first of two volumes intended to cover all aspects of small batteries. The types of batteries dealt with cover the ampere chain capacity range from appreciably less than 1 to about 30 ampere-hours. Some batteries of capacity in excess of about 30 ampere-hours are discussed, but only if the manufacturer's range for a particular battery covers from below to above 30 ampere-hours.

This comparative reference source will help designers by making them aware of the types of battery available, and which manufacturers supply them. It will also assist in the selection of the most suitable battery for a particular applicaiton, achieving a compromise between cost and performance.

The companion volume, dealing with primary small batteries, will be published soon.

CIRCLE 143 ON FREE INFORMATION CARD

**MAGNETIC CODE SELECTION FOR TRANSFORMERS AND INDUCTORS: A User's Guide to Practice and Specification (Electrical Engineering and Electronics Series, Volume 13), by Colonel William T. McLyman. Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016. 736 pages including index; 8½ × 11¼ inches; hardcover; $65.00.**

Manufacturers of magnetic cores use a variety of measurement systems to describe their products—a practice that complicates the task of comparing and selecting cores. This new reference book compiles the specifications of over 12,000 cores—all converted to cgs units; that information will help engineers to select quickly the configuration that bests suits their design requirements.

Most of the data is in tabular forms for easy access, and this book illustrates that cores can have the same area product ($A_P$) or core geometry ($K_g$) coefficient, but different size configurations. Using the material presented, the user can tell at a glance whether a particular design or core configuration will work, or what alterations need to be made.

CIRCLE 144 ON FREE INFORMATION CARD

**ELECTRONIC TIMER PROJECTS, by F.G. Rayer, Bernard Babani (publishing LTD, England) available from Electronic Technology Today, P.O. Box 83, Massapequa Park, NY 11762; 88 pages; 4¾ × 7 inches; softcover; $5.00.**

Electronic timing circuits are able to cover many different kinds of needs. They may switch on or off, either at a preset time or after an elapsed time. They may need to have a high degree of accuracy, with quartz control, or they may be quite simple designs, using only a few components.

This book offers a large variety of build-it-yourself timers. The first section covers components and power sources; display hardware, resistors and capacitors, battery operation of timers, and mains PSU (AC power supplies) for timers.

Over 30 timer circuits make up the rest of the volume; they include an easy 5-minute timer; a single numeral timer; second, minute, and hour timers; a precision 1/100th-second timer; a precision 0-9 minute timer; and a visual timer. Also included are such special timer projects as a car windshield-wiper delay unit, darkroom timer, metronome, and many others.

**HANDBOOK OF SEMICONDUCTOR AND BUBBLE MEMORIES, by Walter A. Triebel and Alfred E. Chu, Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 401 pages, including bibliography, answers to selected odd-numbered problems, and index; 7⅛ × 9½ inches; cloth, $24.95.**

Today's electronic memory marketplace represents one of the most dynamic sectors of the digital electronics industry. The state of the art in memory design is changing every day.

For example, new devices, such as the magnetic-bubble memory are being introduced, higher-capacity devices, such as the 128-kilobyte read-only memory, and 64-kilobyte random-access memory, are becoming available; and faster devices are being manufactured, so that MOS memory-devices are now rivaling bipolar memories for high-speed operation.

This book fills the gap between books written on basic digital electronics and those on microprocessors. It represents an extensive study of modern memory technology, including the most widely-used storage devices such as ROM's, RAM's, and shift-registers. There is also a thorough coverage of the newer devices. Those include PLA's, FIFO's, CAM's, CCD's, and MBM's. For each of those memory categories, detailed material is provided on architecture, I/O operation, and switching characteristics. Moreover, extensive coverage of standard IC devices of each type is provided, along with their use in practical applications. R-E

CIRCLE 145 ON FREE INFORMATION CARD

**LOW-BAND CONVERTER**

*continued from page 50*

small, transistorized AM radios.) The arrangement shown in Fig. 4-b can be tuned from 10 to 60 kHz or from 60 to 360 kHz, depending on the amount of inductance that is switched in by S1. The ferrite rod should be as big a one as you can get—5 × ⅜-inches is a good size to work with. The capacitor can be any common 365-pF or 400-pF receiving-type air variable. The exact number of turns needed on the ferrite rod, and the position of the tap, will depend on the size and permeability of the ferrite rod used. The inductance required to tune 10 to 60 kHz is 685 mH, and the inductance required to tune 60 to 360 kHz is 19 mH. Winding data is generally given with ferrite rods; the values can also be found by trial and error. Use fine enameled wire, such as No. 30 or 32, for winding.

One advantage of the ferrite loopstick is that it can be easily positioned to null out man-made noise. Heating pads, electric blankets, vacuum cleaners, and hair dryers are notorious for their ability to saturate the electromagnetic spectrum with noise well up into the VHF range; at VLF and LF, they can be devastating! By turning the loopstick in both the vertical and horizontal planes, that kind of noise, as well as the AC buzz that always seems to hinder VLF reception, can be nearly eliminated. A ferrite loop will also provide you with a sharper degree of selectivity than an open loop. That insures still more noise immunity.

The principal disadvantages of the ferrite loopstick are lower signal-capturing ability because of its smaller physical size, and the difficulty of locating a rod big enough to wind an inductor of 685 mH. A military surplus shop is a good place to look for large ferrite rods. Electronics outlets also may carry them.

My preference is the open loop, primarily because of its superior signal-pickup and ease of construction. At times, someone runs a hair dryer or vacuum cleaner, but my ham-band receiver has an excellent noise blanker, and that is satisfactory under all but the worst conditions.

### Dealing with noise

The tuned-circuit resonance provided by the parallel capacitors, both with the open loop and the ferrite loopstick, give some noise reduction because they cause the antenna to have a narrow-band response. Both antennas can be mounted on azimuth/elevation bearings (although that's very difficult with a large open loop), and positioned for minimum noise. If it cannot be rotated for a null in the noise, the open loop can be used with a noise-cancellation circuit that often works remarkably well. Such a circuit is shown schematically in Fig. 5.

Both the loop itself, and the noise-pickup wire P, receive impulse noise generated by the surrounding appliances and utility wires. But the loop receives far more of the desired signal-energy than wire P. Noise cancellation is obtained by first finding the loop connection (via S1) that causes the noise picked up by the loop to be out of phase with the noise from P. Capacitor C1 is then adjusted until the noise inputs from P and from the loop are equal in amplitude. At that point, there will be a sharp drop in the receiver noise, but the signal level will not be affected.

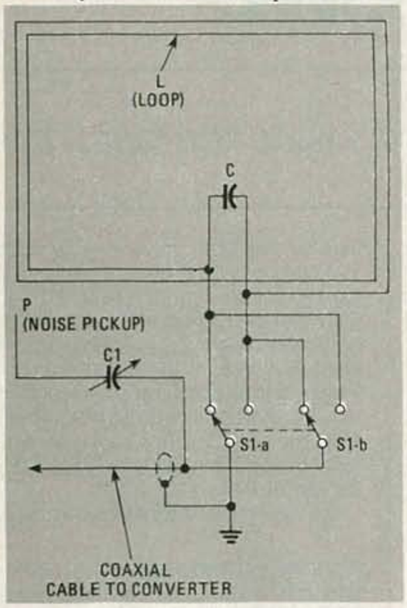


**FIG. 5—OUT-OF-PHASE signals from wire "P" and loop "L" provide noise-cancellation.**

It may be necessary to experiment with various lengths of wire for P. If your receiver has a signal-strength indicator (S-meter), the task can be simplified by noting the noise level with the loop only, and then adjusting C1 for an equal noise level using P only. If the noise level is always lower when using P alone than when using the loop alone, you will have to lengthen P. If the noise level is higher with P alone, you will have to shorten it. Ideally, C1 should be at the middle of its tuning range when the noise pickup is equal from both antennas.

Once the two antennas are tied together, there will be some mutual-coupling effects that will require you to change the setting of C1 somewhat. However, the above method should bring you close to the required length for P and the required setting for C1.

The noise-cancelling circuit just described usually works better at VLF than at LF-or-higher frequencies, and is more effective against some kinds of noise than others. It will be of little value in reducing AM-broadcast cross modulation or atmospheric static. Still, I've found that it allows much better reception in the VLF range, as compared with an open loop by itself. **R-E**

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| AC-1 AC adapter | 3.95 |
| BP-1 Nicad pack +AC Adapter/Charger | 12.95 |
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| External time base input | 14.95 |

The CT-90 is the most versatile, feature packed counter available for less than $300.00! Advanced design features include; three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally; an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

**SPECIFICATIONS:**

| | |
|---|---|
| Range: | 20 Hz to 600 MHz |
| Sensitivity: | Less than 10 MV to 150 MHz<br>Less than 50 MV to 500 MHz |
| Resolution: | 0.1 Hz (10 MHz range)<br>1.0 Hz (60 MHz range)<br>10.0 Hz (600 MHz range) |
| Display: | 9 digits 0.4" LED |
| Time base: | Standard-10.000 mHz, 1.0 ppm 20-40°C.<br>Optional Micro-power oven-0.1 ppm 20-40°C |
| Power: | 8-15 VAC @ 250 ma |

## 7 DIGITS 525 MHz $99.95 WIRED

**SPECIFICATIONS:**

| | |
|---|---|
| Range: | 20 Hz to 525 MHz |
| Sensitivity: | Less than 50 MV to 150 MHz<br>Less than 150 MV to 500 MHz |
| Resolution: | 1.0 Hz (5 MHz range)<br>10.0 Hz (50 MHz range)<br>100.0 Hz (500 MHz range) |
| Display: | 7 digits 0.4" LED |
| Time base: | 1.0 ppm TCXO 20-40°C |
| Power: | 12 VAC @ 250 ma |

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as; three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

**PRICES:**

| | |
|---|---|
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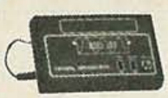

## 7 DIGITS 500 MHz $79.95 WIRED

**PRICES:**

| | |
|---|---|
| MINI-100 wired, 1 year warranty | $79.95 |
| AC-Z Ac adapter for MINI-100 | 3.95 |
| BP-Z Nicad pack and AC adapter/charger | 12.95 |

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat! Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

**SPECIFICATIONS:**

| | |
|---|---|
| Range: | 1 MHz to 500 MHz |
| Sensitivity: | Less than 25 MV |
| Resolution: | 100 Hz (slow gate)<br>1.0 KHz (fast gate) |
| Display: | 7 digits, 0.4" LED |
| Time base: | 2.0 ppm 20-40°C |
| Power: | 5 VDC @ 200 ma |

## 8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

**SPECIFICATIONS:**

| | |
|---|---|
| Range: | 20 Hz to 600 MHz |
| Sensitivity: | Less than 25 mv to 150 MHz<br>Less than 150 mv to 600 MHz |
| Resolution: | 1.0 Hz (60 MHz range)<br>10.0 Hz (600 MHz range) |
| Display: | 8 digits 0.4" LED |
| Time base: | 2.0 ppm 20-40°C |
| Power: | 110 VAC or 12 VDC |

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

**PRICES:**

| | |
|---|---|
| CT-50 wired, 1 year warranty | $159.95 |
| CT-50 Kit, 90 day parts warranty | 119.95 |
| RA-1, receiver adapter kit | 14.95 |
| RA-1 wired and pre-programmed (send copy of receiver schematic) | 29.95 |

## DIGITAL MULTIMETER $99.95 WIRED

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| | |
|---|---|
| DM-700 wired, 1 year warranty | $99.95 |
| DM-700 Kit, 90 day parts warranty | 79.95 |
| AC-1, AC adaptor | 3.95 |
| BP-3, Nicad pack +AC adapter/charger | 19.95 |
| MP-1, Probe kit | 2.95 |

The DM-700 offers professional quality performance at a hobbyist price. Features include; 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

**SPECIFICATIONS:**

| | |
|---|---|
| DC/AC volts: | 100uV to 1 KV, 5 ranges |
| DC/AC current: | 0.1uA to 2.0 Amps, 5 ranges |
| Resistance: | 0.1 ohms to 20 Megohms, 6 ranges |
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|---|---|
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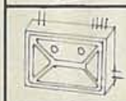

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| 74LS08 | .28 |
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| 74LS11 | .33 |
| 74LS12 | .33 |
| 74LS13 | .45 |
| 74LS14 | .89 |
| 74LS20 | .24 |
| 74LS21 | .24 |
| 74LS26 | .30 |
| 74LS27 | .28 |
| 74LS28 | .32 |
| 74LS30 | .24 |
| 74LS32 | .32 |
| 74LS37 | .50 |
| 74LS38 | .32 |
| 74LS42 | .50 |
| 74LS48 | .70 |
| 74LS51 | .24 |
| 74LS55 | .35 |
| 74LS74 | .35 |
| 74LS75 | .48 |
| 74LS83 | .70 |
| 74LS86 | .38 |
| 74LS90 | .60 |
| 74LS91 | .85 |
| 74LS92 | .65 |
| 74LS93 | .60 |
| 74LS95 | .80 |
| 74LS107 | .38 |
| 74LS109 | .38 |
| 74LS112 | .40 |
| 74LS113 | .40 |
| 74LS114 | .45 |
| 74LS122 | .40 |
| 74LS123 | .85 |
| 74LS125 | .90 |
| 74LS126 | .85 |
| 74LS132 | .70 |
| 74LS136 | .50 |
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| 74LS139 | .65 |
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| 74LS153 | .70 |
| 74LS157 | .70 |
| 74LS158 | .70 |
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| 74LS163 | .85 |
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| 74LS165 | .85 |
| 74LS169 | 1.55 |
| 74LS170 | 1.55 |
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| 7402 | 18 | 7470 | 30 |
| 7404 | 18 | 7472 | 25 |
| 7405 | 21 | 7474 | 30 |
| 7408 | 23 | 7475 | 40 |
| 7409 | 18 | 7476 | 30 |
| 7410 | 18 | 7480 | 55 |
| 7411 | 22 | 7481 | 1 00 |
| 7412 | 28 | 7489 | 3 95 |
| 7413 | 32 | 7490 | 30 |
| 7414 | 45 | 7491 | 35 |
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| 7438 | 25 | 74145 | 50 |
| 7440 | 18 | 74148 | 1 00 |
| 7442 | 45 | 74154 | 1 00 |
| 7443 | 60 | 74157 | 45 |
| 7444 | 60 | 74160 | 80 |
| 7445 | 60 | 74161 | 80 |
| 7447 | 60 | 74166 | 90 |
| 7448 | 60 | 74174 | 80 |
| 7450 | 18 | 74181 | 1 95 |
| 7451 | 18 | 74393 | 1 00 |
| 7453 | 19 | | |

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| | |
|---|---|
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| 74S02 | 38 |
| 74S03 | 38 |
| 74S04 | 45 |
| 74S05 | 65 |
| 74S08 | 40 |
| 74S10 | 55 |
| 74S15 | 55 |
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| 74S51 | 60 |
| 74S65 | 95 |
| 74S74 | 55 |
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| 74S86 | 1 10 |
| 74S112 | 1 45 |
| 74S132 | 1 10 |
| 74S138 | 95 |
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| 8255 | 4 50 |
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| LM565 | 95 |
| LM741 | 25 |
| LM1310 | 2 90 |

EPROMS

| | | |
|---|---|---|
| 1702 | 4 25 | 8/3 95 ea |
| 2708 | 3 25 | 8/2 99 ea |
| 2716(5V) | 3 95 | 8/3 65 ea |
| TMS2716 | 8 95 | 8/8 00 ea |
| 2732(5V) | 8 95 | 8/7 75 ea |
| TMS2532 | 11 50 | 8/10 25ea |

VOLTAGE REGULATORS

7805, 7806, 7808, 7812, 7818 65, 7905, 7908, 7912, 7918

MORE MISC

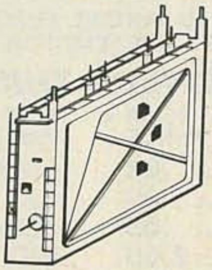
| | |
|---|---|
| 8212 | 1 95 |
| 8216 | 1 80 |
| 1103A | 95 |
| N82S185 | 8 95 |
| AY5 1013A | 3 00 |
| 1488 | 95 |
| 1489 | 95 |
| MC6802 | 9 95 |
| MC6821P | 4 95 |
| MC6850P | 3 25 |

CPU S

| | |
|---|---|
| Z80 | 8 50 |
| Z80A | 6 00 |
| Z80A PIO | 6 00 |
| 6502 | 6 00 |
| 6502A | 12 00 |
| 8085A | 8 50 |
| MC6800 | 7 75 |

CIRCLE 58 ON FREE INFORMATION CARD

## MORE GAIN Than a Mitsumi Tuner DSW10-140 Parts Kit



MODEL ELC 1045
FREQ. RANGE
UHF 470-889 MHZ
CHANNEL 14-83
OUTPUT CHANNEL 3
75 OHM INPUT

| Part No. | | |
|---|---|---|
| DSW10 | Philips UHF Tuner ELC 1045 | $23.95 |
| DSW20 | Printed Circuit Board, Predrilled Glass Epoxy | $15.00 |
| DSW30 | P.C.B. Potentiometers 5-10K, 1-5K | $5.95 |
| DSW40 | Resistor Kit 1/4 watt 5% Carbon Resistors 32 pcs. | $4.95 |
| DSW50 | Panel Mount Potentiometers 2-10K and Knobs | $2.95 |
| DSW60 | IC's 7 pcs., 1 Rectifier, 2 Regulators & 1 Heat Sink | $15.95 |
| DSW70 | Electrolytic Cap Kit, 8 pcs. | $4.95 |
| DSW80 | Ceramic Cap Kit, 33 pcs. | $6.95 |
| DSW90 | Variable Trimmer Kit, 4 pcs. | $3.95 |
| DSW100 | Coil Kit, 2-18 uh, 1 variable 33 uh + 1 - + 37-12 Torold + 26 wire | $1.95 |
| DSW110 | I.C. Sockets 5-8 pins, 2-14 pin | $4.95 |
| DSW120 | Power Transformer PRI-117Vac, SEC 24Vac, 1 amp | $5.95 |
| DSW130 | Speaker, Oval 8 ohm | $3.00 |
| DSW140 | Misc. Parts, Hardware & Hookwire Ant. Term, Switch Dpdt, Fuse, Fuseholder, Line Cord, etc. | $7.95 |
| | When Ordering All Items | |
| DSW10-D140 | Total Price | $99.95 |

## AUDIBLE DIGITAL MULTIMETER MIC-6000Z

NEW

- 3½ Digits
- DC 0.5% Accuracy
- DCA and ACA up to 10A
- OHM up to 20 M OHM
- Audible Continuity Test
- Diode Check
- Leads and Battery Included

The MIC-6000Z is a professional Multimeter at an inexpensive price.

The 6000Z works up to 1000 hours on a common battery, also can withstand 1000 VDC loads. Resistance ranges are protected up to 400 VDC. For your added convenience the MIC-6000Z has a built-in 10 amp current capacity, so you don't need an accessory shunt.

**MIC-6000Z Assembled .......... $89.95**
**Carrying Case .......... $ 9.95**

### R.F. Modulator

Combine both audio and video output onto channel 3 or 4 of your T.V. set.
Single I.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**

### ADJUSTABLE POWER SUPPLY KIT

NEW

- Adjustabl Positive & Negative Supplies
- Positive and negative 1.2 VDC to 15 VDC
- Power Output (Each Supply) 5 VDC @ 500 ma, 10 VDC @ 750 ma, 12 VDC @ 750 ma, 15 VDC @ 175 ma
- Two 3 Terminal Adjustable Regulators with Overload Protection
- LED on indicator
- P.C. Board Construction
- 120 VAC Input

**RM1 Kit .......... $24.95**

NEW KIT

### Digital Multimeter MIC-3300A

- Kit Form • 3½ Digits
- DC .5% Accuracy
- DCA up to 10 Amps • OHM up to 20 M OHM
- hFE measurement • Floating decimal point
- Leads + battery included • Easy instructions

A high quality Digital Meter Kit at an affordable price. Educational and enjoyable to build, the MIC 3300A is a high quality meter for all hobbyists and maintenance work.

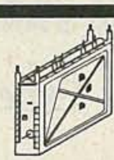
**MIC-3300A Kit Form .......... $59.95**
**Carrying Case .......... $ 9.95**

### UHF T.V. 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.

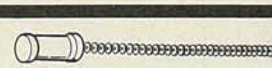
**JH-0** Kit .......... **$22.95**



NEW

### NEW PWD KIT!!!

| Part No. | Description | Price |
|---|---|---|
| PWD10 | Philips UHF Tuner ELC 1045 | $23.95 |
| PWD20 | Glass Epoxy Circuit Board, Predrilled | $16.95 |
| PWD30 | P.C.B. Pots, 4-20K, 2-1K, 2-10K, 2-100K, | $9.95 |
| PWD40 | Resistor Kit 1/4 watt 5% | $4.95 |
| PWD50 | Panel Mount Pots 2-5K | $3.95 |
| PWD60 | IC's 7 pcs., 1 Rectifier, 2-Heat Sinks & Sockets | $11.95 |
| PWD70 | Ceramic Disc Caps — 37 pcs & Misc. Type Capacitors | $11.95 |
| PWD80 | Electrolytic Caps 18 pcs. | $5.95 |
| PWD90 | Variable Trimmer Capacitor 5- 5-35 pF | $4.95 |
| PWD100 | Coil Kit, 2-T37-12 Ferrite cores Torold 4-Prewound Indicators | $2.95 |
| PWD110 | Misc. Parts—Hookup Wire, Ant. Terminals, Fuse, Fuseholder Dpdt Switch, Line Cord etc. | $8.95 |
| PWD120 | Power Transformer Primary-117 Vac, Secondary 24 Vac, 1 amp | $5.95 |
| PWD130 | Speaker, Oval 8 ohm | $2.95 |
| PWD140 | Cabinet, Prepunched & Drilled | $13.95 |
| | When Ordering All Items | |
| PWD10-PWD140 | Total Price | $124.95 |



### Microwave Receiver 1.9-2.5 GHZ

| | | |
|---|---|---|
| PS-1 | Assembled 32 element antenna | $19.95 |
| PS-2 | 20 dB gain microwave receiver kit with variable power supply kit | $50.00 |
| PS-3 | Complete package PS-1 & PS-2 | $65.00 |

**Mounting Hardware Included**

### Video Switch Box Model V-4803

The V-4803 is an electronic switching network capable of switching any six video inputs to any or all three output. Save time and money. Switching of your VCR/VTR, Cable T.V., video games antenna, microcomputer, pay T.V. Boxes. **Hassle Free!!**

**V-4803 .......... $74.95**

### Microwave Preamp!!!

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 .......... $34.95**

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| 238 | 2.25 | HIDIV-3® | 3.75 |

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|---|---|---|---|
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| 2SC1114 | 3.45 | UPC1181H | 1.95 |
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CIRCLE 13 ON FREE INFORMATION CARD

# Now You Can Afford Another 64K...

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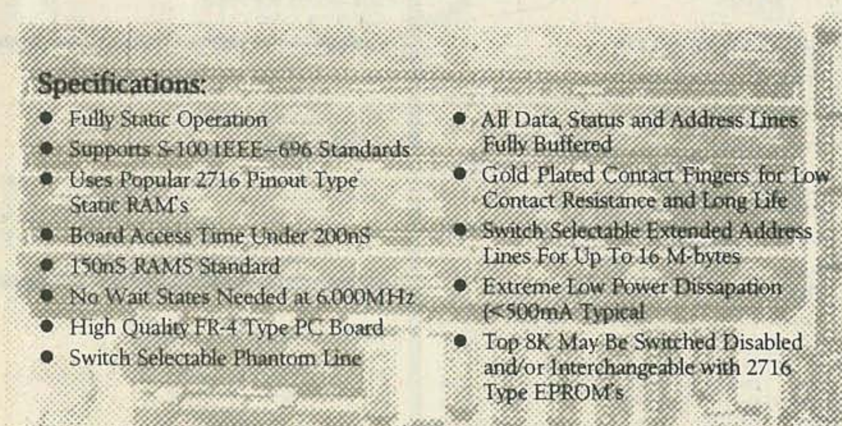

**Specifications:**

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# VIDEO EQUIPMENT
## QUALITY • LOW PRICES
## OFF-THE-SHELF DELIVERY
## from FORDHAM of course.

BUY OF THE MONTH

### BP STABLIZER/IMAGE ENHANCER/RF CONVERTER/ VIDEO FADER/2-WAY DISTRIBUTION AMPLIFIER

MODEL V-1880

OUR PRICE **$135.00** each

Most versatile video processor. Contains five units in one: stabilizer (video guard remover); image enhancer; video to RF converter; video fader; and dual output distribution amplifier.
**Stabilizer** Will correct entire range of copy guard distortion such as jitter, vertical roll or black bar travelling through picture.
**Enhancer** Lets you attain best picture for your own preference.
**RF Converter** Allows your TV set to receive video and audio signals from your image enhancer, guard stabilizer, video camera, computer, VCR, etc. The direct video signal from any video component can be fed into the V-1880 and converted to a usable RF signal that can go to your TV antenna terminals.
**Video Fader** Used to produce professional fade ins and fade outs.

### BP VIDEO GUARD STABILIZER
MODEL V-1875

OUR PRICE **$45.00** each

Has self contained A&B and bypass switch. Many movies, concerts and special programs for sale or rental are copy guarded. This removes copy guard and allows you to make copies. Many TV sets will not play prerecorded tapes because copy guard causes picture to roll and jitter, turn to snow or disappear. Video Guard Stabilizer removes copy guard from signal.

### BP VIDEO GUARD STABILIZER/ RF CONVERTER
MODEL V-1877

OUR PRICE **$69.95** each

Same as above but with a built-in RF Converter that gives the model V-1877 an RF output which can be fed directly to the antenna terminals of a TV set. This enables you to remove the copy guard from a pre-recorded tape and view it on a TV using only a VCR.
**Use as an RF Converter only.** Used in conjunction with your TV, you can feed direct audio and video signals from any video device such as video camera, computer, portable VCR, etc.

### BP VIDEO COMMAND CENTER
MODEL V-4803
OUR PRICE **$59.95** each

A switcher that can accept 6 inputs and direct them to 3 outputs. Utilizes switch similar to one used on home VCR's. You avoid signal loss incurred by using splitters.

### JERROLD 60 CHANNEL CORDLESS TV CONVERTER
MODEL DRX-3-105

OUR PRICE **$110.00** each

• Receive up to 60 TV channels • Remote TV Control • Attach to any age or model TV in minutes. • No tools required. • On/Off button. • Channel selection. • Channel Stepping. • Fine Tuning.

### JERROLD JRX TV REMOTE CONVERTER
MODEL JRX-3C105 (SWITCH)

OUR PRICE **$79.95** each

Consists of two units - a receiver and transmitter. 20 ft. connecting cord is detachable at one end to help you position the unit. May be attached to any age or model TV in minutes. No tools required.
• Receive up to 36 channels. • Remote TV control.

### BP VIDEO CONTROL CENTER
MODEL V-4802
OUR PRICE **$19.95** each

Provides remote control access of all Video, TV or Cable inputs to TV or Big Screen TV from one location by flipping switch.
• One output, your TV set or Big Screen TV
• Four inputs • Completely passive, i.e. no AC power required to operate • Auxiliary input and output provides added flexibility.

### BP UHF CONVERTER FOR TV AND VTR
MODEL V-5736
OUR PRICE **$24.95** each
5 FOR **$100.00**

Use your VCR to its maximum capability. Record VHF, UHF, Cable or Pay TV while watching any other mode.
**FEATURES** • 36 channels
• Allows complete programming of VTR • Super color quality
• Watch or record any combination of selectable channels. • Receives midband, superband/Pay and all VHF channels on UHF.
• For Beta/VHS type recorders or TV set • Record and use TV's remote control.

### BP IMAGE ENHANCER
MODEL V-1860

OUR PRICE **$59.95** each

Dramatically improves performance of video cameras and VCR's (off-the-air or second generation recordings), by compensating for deterioration of detail and sharpness. Includes video distribution amplifier with two video outputs, allowing you to make two copies at once without loss in signal level.

### BP RF CONVERTER/MODULATOR
MODEL V-1885

OUR PRICE **$39.95** each

Allows your TV to receive video and audio signals from image enhancer, guard stabilizer, video camera, computer, VCR, etc.
The outputs of many video components cannot be directly hooked up to the VHF antenna terminals on your TV set. This problem is solved by using the Model V-1885 RF Converter. Converts video signal from any video component to adjustable RF signal at antenna terminals. Allows your VCR output to feed two TV sets at the same time, with virtually no signal loss.

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## LASER POWER SUPPLY

*Includes:* $19^{95}

- (1) Transformer IN 110/220V, OUT 1,300V @ 100ma
- (1) 2MFD @ 3KV DC Cap.
- (4) 1000 P.I.V. Diodes
- (4) Resistors

## MICROWAVE DOWN CONVERTER KIT (HMR II type)

~~$39^{95}~~ $24^{95}

PC Bd., 3-MRF901's, 2-MBD 101's
1 Thermistor, 1 Choke, 3-Chip Caps,
1 "F" Connector, 8 Resistors + Instructions

## Z80 SPECIAL

| | | | |
|---|---|---|---|
| C.P.U. | $4.25 | P.I.O. | $2.50 |
| C.T.C. | $2.25 | S.I.O. | $7.50 |
| 8080A | $3.25 | 8084 | $3.50 |
| 8251 | $3.95 | 8257 | $6.50 |
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| 2716 | $3.50 | 2732 | $5.00 |
| 4116 | $1.50 | TMS4027 | $1.00 |

## DOWN CONVERTER PWR. SUPPLY

$24^{95} NEW! 8-12 V.D.C. or 12-18 V.D.C.

## FLASHER KIT

- (1) LM3909
- (1) LED
- (1) 100 μF Cap

12 Application Schematics

**95¢**

## SPECIAL $1.00 SPECIAL

| | |
|---|---|
| 1N4152 . . 25/$1.00 Similar to 1N914 | 1N5239 . . 20/$1.00 9 V. ZENER |
| 1N4001 . . 15/$1.00 | 1N4007 . . 10/$1.00 |
| TIP 3055 . . 3/$1.00 | 2N3055 . . . 3/$1.00 |
| MJ 3000 . . . . $1.00 Pwr Darlington TO3 | 2N6055. . . . $1.00 Pwr Darlington TO3 |
| TRIAC 200 V. 30A. Stud mnt. . . . . $1.00 | 7 Seg. LED Readout HP 5082-7650 5/$1.00 |
| 4 Pos DIP switch 3/$1.00 | DIP Relay D.P.S.T. Diode Protect . 5/$1 |
| D.P.D.T. Rocker Sw 4 A. 120 VAC 3/$1.00 | Horz P.C. Trimpots 250Ω, 500Ω, 5kΩ, 10kΩ . . . . . . . . 4/$1 |
| 2N2142 2N3905 2SC828 2SC644 5/$1.00 SPS7390/ECG123P | MC3420P . . . $1.00 |
| | SN75150 . . . . $1.00 |
| | LM3909 . . . . . $1.00 |
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# BEC BULLET ELECTRONICS

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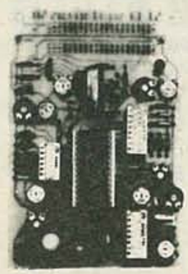
## Sound Effects Kit $18.50



The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip**, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains**, or almost an infinite number of **other sounds**. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included). **76477 is included.** Available separately for $3.15 each.

## The Super Music Maker

REVISION 2 **$24.95** (Basic Kit)

SEE SPECIAL OFFER BELOW

- Comes with 25 pre-programmed tunes.
- On board 7 watt amplifier drives 8 ohm speaker directly.
- Works on 12VAC or 12 VDC.
- Uses either 2708 or 2716 EPROM for expanded tune playing capability. Listing available pre-programmed ROM's.

A true electronic music maker based on a microprocessor chip. The Super Music Maker is the only kit that allows easy addition of pre-programmed tunes by plugging in one memory chip (ROM). Over 20 different ROM's with over 500 tunes are available. Use the kit for a **Car Horn, Doorbell, Door Announcer**, etc. If you have an EPROM programmer our manual tells you how to program your own tunes. Kit includes quality plated and drilled PC Board and all components.

**OPTIONAL ACCESSORIES**

| | |
|---|---|
| **DIP SWITCHES** One 8 pos., one 5 pos., for tune address | 2.00/set |
| **WALLPLUG TRANSFORMER** For operation on 117VAC house current | 3.00 |
| **INJECTION MOLDED PLASTIC CASE** w/custom front & rear panels, hardware and 2 five pos. rotary switches (replaces DIP switches) | 8.00 |
| HORN SPEAKER 8 watt, 8 Ohm with mounting bracket | 6.25 |

**SPECIAL OFFER**

Buy a Super Music Maker kit for $24.95 and get **FREE**, a 2708 ROM pre-programmed with 35 popular tunes. This offer gives you over 60 songs to choose from!

## 7 Watt Audio Amp Kit $6.95

SMALL, SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED). RUNS ON 12VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT.

## Doomsday Alarm Kit $9.95

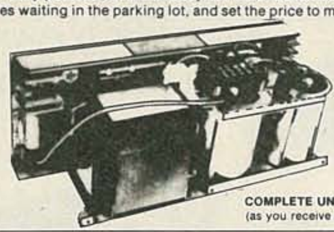
If you have trouble sleeping and you would like the rest of the neighborhood to share your misery then this little kit will be for you! There is no way to accurately describe the unearthly howls, screams and tones that come out of this kit. Four separate tone oscillators are mixed, cancelled and stepped at a varying rate. 10 Watts of crazy sounds. A great fun kit or a practical burglar alarm. Complete with PC board and all necessary components less speaker. For 6-12 VDC. ORDER DA-02.

## *THE PRESIDENT SAYS:* "HOGWASH!!"

After taking one look at the TRIPUT POWER SUPPLY our engineer declared that the units were worth several hundred dollars each. He pointed out the engineering, high quality construction and state-of-the-art intergrated design in support of his position. The President of **BEC** more pragmatically pointed out the already full warehouse and the two trailer truck loads of power supplies waiting in the parking lot, and set the price to move them **QUICKLY!**

- UNIT IS COMPLETELY ASSEMBLED!
- Fused primary and DC sections
- HUGE SHIELDED TRANSFORMER
- 2% Load & Line Regulation
- Low Ripple < 100mv.
- Short Circuit Protection
- Overvoltage Protection on all three outputs
- 25A Bridge Rectifier
- Over 60,000 mfd of filters
- High Efficiency **Switching Regulator** reduces heatsink area
- Schematics and service guide included
- Thermal Shutdown
- Status LED's (3)

**3 OUTPUTS**
12V @ 8A (12A Int.)
5V @ 10A
-12V @ 5A
INPUT 105 - 125VAC



COMPLETE UNIT (as you receive it)

**62.50**
**Plus $5.00 Freight**
21 lbs. 6 x 5¼ x 12

ONE TIME OFFER! LIMIT TWO (2) SUPPLIES PER CUSTOMER.

- COD MINIMUM $20.00 • ADD $2.50 FOR COD'S
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## TUSA

Use of this unit may be subject to rules by your local cable TV Co.

**A WHOLE NEW WORLD OF TV VIEWING WITH TUSA'S NEW MODEL CVU-40, 40 CHANNEL CABLE TV CONVERTER**

Receive all the EXTRA CABLE TV "MIDBAND" & SUPERBAND CHANNELS on your UHF DIAL.

Eliminates the need for renting or leasing. This stable and reliable system converts extra cable TV channels so they can be received on the UHF tuner of your TV set.

***A MUST FOR VIDEO-TAPING FROM CABLE TV!***

The system allows you to program both pay (pay TV decoder required) and standard cable channels for taping on any VCR — while you are watching a different channel on your TV. Now $28.95 ea. PLUS POSTAGE

Simple to install and operate on any make of TV with UHF.

*NOW AVAILABLE*
NEW TUNEABLE DELUX MODEL CVU-1000 $34.95 ea.

## UHF TUNERS

Continuous Tune Model — *While They Last*

$3.50 ea.
5 or more $2.25 ea.

## POPULAR IC's

TOP QUALITY NO SECONDS

| TYPE | DESCRIPTION | 1-9 | 10-UP |
|---|---|---|---|
| LM-380N | 2 watt Audio Power Amp | $1.49 | $1.29 |
| LM-386N-3 | Low Voltage Audio Amp .500W/9V | 1.59 | 1.29 |
| NE-564N | Digital Phase Locked Loop | 3.50 | 3.15 |
| LM-565N | Phase Locked Loop | 1.49 | 1.29 |
| LM-733N | Video Amp | 1.69 | 1.44 |
| MC-1330 | Video Detector | 2.49 | 1.89 |
| MC-1349 | Video If Amp | 2.06 | 1.85 |
| MC-1350 | Video If Amp | 1.75 | 1.55 |
| MC-1352 | Video If Amp AGC | 2.69 | 2.09 |
| MC-1358 | Audio If Amp | 1.95 | 1.79 |
| MC-1374P | R.F. Modulator | 3.19 | 2.87 |
| MC-1458 | Dual Comp. Op Amp | .88 | .79 |
| MC-1496N | Balanced Mod/Demodulator | 1.79 | 1.59 |
| MC-5121 | Hybrid Amplifier | 13.72 | Call |
| LM-1800 | PLL Stereo Decoder | 4.49 | 3.95 |
| LM-1889 | Video Modulator | 2.95 | 2.49 |
| | LINEAR VOLTAGE REGULATORS | | |
| LM-7805 | 5 Volt Positive Volt. Reg. | 1.39 | 1.25 |
| LM-7808 | 8 Volt Positive Volt. Reg. | 1.39 | 1.25 |
| LM-7812 | 12 Volt Positive Volt. Reg | 1.39 | 1.25 |
| LM-7815 | 15 Volt Positive Volt. Reg | 1.39 | 1.25 |
| LM-7818 | 18 Volt Positive Volt. Reg | 1.39 | 1.25 |
| LM-7824 | 24 Volt Positive Volt. Reg | 1.39 | 1.25 |

## WINEGARD 75 OHM UHF YAGI ANTENNAS

12 db GAIN
CHANNELS 44 - 52
$8.95 EA.
6 OR MORE $6.95 EA.

OPTIONAL Winegard UHF Antenna Preamp 18db Gain $39.95 ea.

## BRAND NEW UHF VARACTOR TUNERS

Sanyo 45 MHz Output — *YOUR CHOICE* $24.95 ea. — Mitsumi 45 MHz Output

*Call for Quantity Prices*

## SURPLUS SYLVANIA VHF VARACTOR TUNERS

45 MHz output. Channels 2 through 13 as well as the mid-band channels. Schematic included.

*WHILE THEY LAST!* $13.95 ea.

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Popular speaker cabinets for those famous home brew TV circuits. Speakers included.

**Cabinet Dimensions:** 7¾" wide x 9½" high x 5½" deep. Removable 1/8" thick back cover.

$10.95 ea.
2 or more $8.95 ea.

## MV-2109

33pf Tuning Diode
1-9 . . . . . . . . $1.20 ea.
10-Up . . . . . .89 ea.

## 5% MICA CAPS 5%

| | | | |
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| 10pf | .42¢ ea. | 560pf | .66¢ ea. |
| 43pf | .36¢ ea. | 1200pf | .89¢ ea. |
| 110pf | .36¢ ea. | 3000pf | 1.39 ea. |

*Call for Quantity Discount*

## Radial Lead Caps

| | | |
|---|---|---|
| 10 mfd@35V | 1-11 | $.25 ea. |
| | 12 or more | .16 ea. |
| 1 mfd@35V | 1-11 | .25 ea. |
| | 12 or more | .16 ea. |
| 470 mfd@35V | 1-11 | .59 ea. |
| | 12 or more | .49 ea. |
| 1000 mfd@35V | 1-11 | .89 ea. |
| | 12 or more | .69 ea. |
| 2200 mfd@35V | 1-11 | 1.29 ea. |
| | 12 or more | 1.09 ea. |
| 2200 mfd@50V | 1-11 | 1.69 ea. |
| | 12 or more | 1.39 ea. |

## Axial Lead Caps

| | | |
|---|---|---|
| 1000 mfd@50V | 1-11 | $.98 ea. |
| | 12 or more | .79 ea. |
| 2200 mfd@35V | 1-11 | 1.39 ea. |
| | 12 or more | 1.19 ea. |
| 3300 mfd@35V | 1-11 | 1.98 ea. |
| | 12 or more | 1.79 ea. |

**100V ± 10% Polyester Film (Mylar)**

| | 1-9 | 10-99 | 100-999 |
|---|---|---|---|
| .001mf | .20 | .15 | .10 |
| .0022mf | .20 | .15 | .10 |
| .01mf | .20 | .15 | .10 |
| .047mf | .20 | .15 | .10 |
| .1mf | .20 | .15 | .10 |
| .22mf | .30 | .27 | .22 |

## POWER TRANSFORMER

24V CT, 400 mA.
Made in U.S.A.

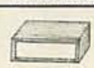
$3.69 ea.
10 or more $2.75 ea.

## POPULAR MICROWAVE PARTS

| | |
|---|---|
| MRF-901 | $2.75 |
| 9-Up | 2.19 |
| MRF-911 | 3.46 |
| 9-Up | 3.12 |
| MBD-101 | .98 |
| CHIP CAPS - .001 mfd | .50 |
| 26-Up | .30 |
| 2N6603 (formerly MRF-902) | 11.96 |

## PROJECT BOXES

Woodgrain



This box is 11¾"W - 4½"H - 6½"D with a removable aluminum U-shaped chassis 11"W - 3½"H - 6"D inside.

$12.50 ea.
4 or more $10.95 ea.

## UHF - VHF - FM SPLITTER

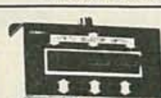
40-900 MHz

TUSA MAX-3

Low Loss 3.5-4 db, Low VSWR
Waterproof Housing $2.49 ea.

## 3-POSITION COAXIAL PUSH-BUTTON SWITCH

For TV & video cassette recorders. Heavily shielded. Provides maximum isolation. 4 "F" connectors accept 75-ohm coaxial cable with F59 fittings. Push button switches are top mounted. Cutouts for flush wall mounting. 3 75-ohm resistors properly terminate any unused position. Size: 3-9/16" x 2¾" x 2".



*Now* $6.95 ea.

## SURPLUS AUDIO & VIDEO RF MODULATORS

Hook up sheet included

*Now* $5.49 ea.

## WINEGARD DELUXE A-B SWITCH

For CATV - MATV - VCR
75 ohm - 90 db Isolation
*While They Last* $6.95 ea.

## POPULAR MISCELLANEOUS PARTS

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|---|---|
| 10K Volume Control with DPDT switch | $ 1.49 |
| 10-Up | 1.19 |
| Low Loss UHF/VHF/FM 75-300 ohm Matching Transformer | 1.29 |
| 10-Up | .98 |
| Toroids - T30-12 | .46 |
| 20-Up | .25 |
| Toroids - T37-2 | .38 |
| 20-Up | .25 |

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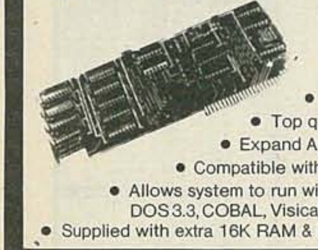
SEND $2.00 for 104 PAGE CATALOG

## 16K Apple™ Ramcard



LIST 195
ACP
$69.95

- Full 1 year warranty
- Top quality — gold fingers
- Expand Apple II 48K to 64K
- Compatible with Z-80 Softcard™
- Allows system to run with CP/M™, PASCAL, DOS 3.3, COBAL, Visicalc, etc.
- Supplied with extra 16K RAM & has (2) LED's

## 32K STATIC RAM

2 or 4 MHz Expandable Uses 2114L's

| | |
|---|---|
| 16K 4 MHz Kit | $159.95 |
| 16K 4 MHz A&T | 217.95 |
| 32K 4 MHz Kit | $199.95 ~~289.95~~ |
| • 32K 4 MHz A&T | • 339.00 |
| BARE BOARD | 39.95 |
| Bare Bd w/all parts less mem. | 99.95 |

## BARE BOARDS

| | |
|---|---|
| S-100 Sound Board | $34.95 |
| 8080A CPU | 34.95 |
| 32K Static RAM (2114) | 34.95 |
| 8K EPROM (2708) | 24.95 |
| 2708/2716 EPROM | 34.95 |
| ACP Proto Board | 22.95 |
| Vector 8800 Proto | 22.20 |
| Vector 8803 11 slot MB | 29.95 |
| ACP Extender with connector | 18.95 |
| 13 Slot Mother Board (WMC) | 32.95 |
| 9 Slot Mother Board (WMC) | 29.95 |
| 8 Slot Mother Bd (Expandable) | 34.95 |
| Floppy PCB (8" SHUGART) | 39.95 |
| S100 (AY5-8910) Sound Board | 34.95 |
| Apple Sound Board | 24.95 |

## 64K CMOS RAM

S100 (200nS)

Uses 2716's or 6116's $349.00

Assembled & Tested $399.00

## MOSTEK 4K RAMS

29¢ ea.

200,000 pieces in stock — priced to move. Same as MK4027 except 1mS refresh. MK4015 4Kx1 RAM

## STEPPER MOTOR

Operates by applying 12VDC in one direction and then reversing polarity (or square wave). Uses 12VDC, Clock Wise Rotation, Rated 3 RPM at 4 P.P.S. with a 5 degree stepping angle.

ACP PRICE $4.95 ea. 10 for $39.95

## UV "EPROM" ERASER

Model UVs-11E
$79.95
Holds 4 EPROM's at a time.

Model S-52T $325.00

## 4K STATIC RAM SELL-OFF

10/$9.90

Same as TMS4044 but designed specifically for Z-80 based systems. This is a full-spec 4Kx1 RAM, 450nS. Order P/N Zilog 6104-4 while supply lasts.

## 16K Memory Expansion Kits for Apple/TRS-80

8 pcs 4116 16K 200/250nS
Specify computer $12.95
CALL FOR VOLUME PRICING

## Zilog Z8 CPU with TINY BASIC

Debug prog. $49.95
Plus 6132 companion quasi-static RAM 29.95

## "D" SUB CONNECTORS

Unreal price. DB37 male, DB25 female. Gold PC mount with mounting holes. Mfg. AMP. Specify 25 or 37 pins.

DB37 $2.50 DB25 $1.95

## Stepper Motor

NEW

USED IN DATA PRODUCTS PRINTER
$19.95 ea.

## Astec RF Modulator

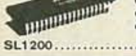
for COLOR & B/W

P/N 1082 Channel 3 or 4 $6.95

## CONNECTORS

| | |
|---|---|
| DB25P (RS232) | $3.25 |
| DB25S Female | 3.75 |
| Hood | 1.25 |
| Set with Hood, Sale | 7.50 |
| 22/44 S/T, KIM | 2.95 |
| 43/86 S/T, MOT | 6.50 |
| 50/100 S-100 Connector W/W | 4.95 |
| 50/100 S-100 Connector S/T | 3.95 |

## 1200 BAUD MODEM IC



Features:
- 1200 Baud
- 40 Pin
- 5Volts Only

SL1200 ............... $129.00

## PARALLEL ALPHA NUMERIC PRINTER

19 Column Printer prints 16 numerical columns plus 3 columns which have math, alpha and other notations. Each wheel has 12 positions with position 12 blank. Position 11 on numerical columns have decimal point or •. Utilizes 2.75" wide adding machine tape and a dual color ink ribbon. Input data parallel with four bit BCD comparator circuit (schematic provided). Print rate, 3 lines per second. Operating voltage 22-28VDC with typical cycle time of 340mS. Size 6½"W x 3⅛"H x 5⅝"Dp. New. $17.50 ea. 3/$45

## MICROPROCESSORS

| | | | | | |
|---|---|---|---|---|---|
| Z8001 | $99.00 | 8008-1 | $14.95 | 6802P | 14.95 |
| Z8002 | 69.00 | 2901 | 9.90 | 8035 | 14.95 |
| Z80 | 9.95 | 2901A | 14.95 | 8039 | 12.95 |
| Z80A | 11.95 | 9900JL | 49.95 | 8073N | 34.95 |
| F-8 (3850) | 16.95 | 6502 | 9.95 | 8755 | 49.95 |
| 2650 | 16.95 | 6502A | 16.95 | 8748 | 49.95 |
| 1802 | 9.75 | IM6100 | 29.95 | 6809 | 30.00 |
| 8080A | 4.75 | 6800 | 11.75 | 8086 | 49.95 |
| 8085 | 14.95 | 6800B | 19.95 | 68000 | 129.95 |

## RAMS

CALL FOR QTY PRICING

| | | | | | |
|---|---|---|---|---|---|
| 6116/2016 | $7.95 | 2147 | $5.99 | 5290 | $1.99 |
| 8264-64K | 8.50 | 411 | 5.99 | 5298 | 1.49 |
| 4116-2 | 1.99 | 414 | 4.69 | 6508 | 4.50 |
| 4116-2 | 8/12.95 | 1101 | .99 | 6518 | 6.79 |
| 2101 | 3.99 | 1103 | .99 | 6561 | 3.79 |
| 2102 | .79 | 4027 | 4.69 | 6604 | 3.99 |
| 21L02-2 | 1.49 | 4044 | 3.99 | 6605 | 7.99 |
| 21L02-4 | 1.29 | 4050 | 4.69 | 9130 | 8.99 |
| 2111 | 3.49 | 4060 | 4.69 | 9140 | 8.99 |
| 2112 | 3.49 | 4096 | 3.99 | 93415 | 6.99 |
| 2114 | 1.99 | 4115 | 1.49 | 93425 | 6.99 |
| 2114L-2 | 3.25 | 4200 | 7.95 | | |
| 2114L-4 | 2.29 | 4402 | 1.99 | | |
| 2125 | 6.99 | 5280 | 4.60 | | |

64K only $8.50

## SUPPORT

| | | | | | |
|---|---|---|---|---|---|
| 8155 | $9.95 | 8259 | $8.95 | 68047 | $22.95 |
| 8156 | 9.95 | 8275 | 19.95 | 68488 | 19.95 |
| 8202 | 29.95 | 8279 | 9.50 | 46505 | 22.95 |
| 8205 | 2.69 | 6810 | 4.75 | 6520 | 6.95 |
| 8212 | 2.75 | 6820 | 6.50 | 6522 | 9.95 |
| 8214 | 4.95 | 6821 | 6.50 | 6530-X | 24.95 |
| 8216 | 2.75 | 6828 | 10.50 | 6532 | 17.95 |
| 8224 | 2.95 | 6834 | 16.95 | 6551 | 19.95 |
| 8226 | 2.95 | 6845 | 22.95 | Z80-PIO | 6.50 |
| 8228 | 3.95 | 6847 | 27.95 | Z80A-PIO | 9.50 |
| 8243 | 9.50 | 6850 | 5.25 | Z80-CTC | 6.50 |
| 8250 | 14.95 | 6852 | 5.25 | Z80A-CTC | 9.50 |
| 8251 | 6.50 | 6860 | 10.95 | Z80-DMA | 19.95 |
| 8253 | 11.95 | 6862 | 10.95 | Z80A-DMA | 27.95 |
| 8255 | 4.50 | 6875 | 5.95 | Z80-SIO | 24.95 |
| 8257 | 9.50 | 6880 | 2.49 | Z80A-SIO | 29.95 |

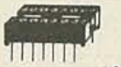
## MOS PROMS

| | | | |
|---|---|---|---|
| 2764 (8Kx8) TS | $69.95 | 2708 (450nS) | $5.75 |
| 2732 (4Kx8) TS | 12.95 | 2708 (650nS) | 5.25 |
| 2716/2516; 5V (2Kx8) TS | 7.95 | 1702A | 5.75 |
| TMS2716, 5V, 12V | 17.95 | MM5203AQ | 14.50 |
| 2758, 5V, (450nS) | 3.50 | MM5204Q | 9.95 |

## HI-TECH

| | | | |
|---|---|---|---|
| 2513-001 (5V) Upper | $9.50 | DAC08 | $9.95 |
| 2513-005 (5V) Lower | 10.95 | DAC100 | 9.95 |
| 2513-ADM3 (5V) Lower | 14.95 | 8038 Function Generator | 4.50 |
| MCM66710 ASCII Shifted | 12.95 | MC4024 VCO | 2.95 |
| MCM66740 Math Symbol | 13.95 | LM566 VCO | 1.95 |
| MCM66750 Alpha Control | 13.45 | XR2206 Function Generator | 5.25 |
| 1771-01 8" & Minifloppy | 24.95 | TR1602B (5V, 12V) | 3.95 |
| 1781 Dual Floppy | 29.95 | AY51013 (5V, 12V) | 4.95 |
| 1791-01 Dual Floppy | 36.95 | AY51014A/1612 (5-14V) | 6.95 |
| 1791-02 Dual Floppy | 44.95 | AY51015A/1863 (5V) | 6.95 |
| 1793 DD, DS Floppy | 44.95 | IM6402 | 7.95 |
| 1797 DD, DS Floppy | 54.95 | IM6403 | 8.95 |
| 1691 Data Separator | 18.95 | 2350 USRT | 9.95 |
| 2143 Clock Generator | 18.95 | 1671B Astros | 24.95 |
| 8700 8 bit Binary | 13.50 | MC14411 | 11.95 |
| 8701 10 bit Binary | 22.00 | 4702 | 14.95 |
| 8703 8 bit TS | 13.50 | WD1941 | 9.95 |
| 9400 Volt to Freq Conv. | 7.25 | COM5016 | 16.95 |
| 8750 3½ Digit BCD | 13.95 | INS8250 | 15.95 |
| 1408L6 6 bit | 3.95 | AY5-2376 | 13.75 |
| 1408L8 8 bit | 5.95 | AY5-3600 | 13.75 |
| DAC01 D to A | 5.95 | MM5740AAC | 8.95 |

## SOCKETS



### LOW PROFILE SOCKETS (TIN)

| | 1-24 | 25-49 | 50-100 |
|---|---|---|---|
| 8 pin LP | .16 | .15 | .14 |
| 14 pin LP | .20 | .19 | .18 |
| 16 pin LP | .22 | .21 | .20 |
| 18 pin LP | .29 | .28 | .27 |
| 20 pin LP | .34 | .32 | .30 |
| 22 pin LP | .29 | .27 | .24 |
| 24 pin LP | .38 | .37 | .36 |
| 28 pin LP | .45 | .44 | .43 |
| 40 pin LP | .60 | .59 | .58 |

### 3L WIREWRAP SOCKETS (GOLD)

| | 1-24 | 25-49 | 50-100 |
|---|---|---|---|
| 8 pin WW | .55 | .54 | .49 |
| 10 pin WW (Tin) | .65 | .63 | .58 |
| 14 pin WW | .75 | .73 | .67 |
| 16 pin WW | .80 | .77 | .70 |
| 18 pin WW | .95 | .90 | .81 |
| 20 pin WW | 1.15 | 1.08 | .99 |
| 22 pin WW | 1.45 | 1.35 | 1.23 |
| 24 pin WW | 1.35 | 1.26 | 1.14 |
| 28 pin WW | 1.60 | 1.53 | 1.38 |
| 40 pin WW | 2.20 | 2.09 | 1.89 |

## LINEAR

| | | | |
|---|---|---|---|
| 78H05K | $5.95 | LM1414N | $1.90 |
| 78M06 | 1.49 | LM1458CN/N | .49 |
| 78M.G. | 1.49 | MC1488N | .99 |
| LM108AH | 2.95 | MC1489N | .99 |
| LM300H | .99 | LM1496N | .89 |
| LM301CN | .35 | LM1556N | 1.50 |
| LM304H | 1.98 | LM1820N | .95 |
| LM305H | 1.89 | LM1850N | .95 |
| LM306H | 3.25 | LM1889N | 3.10 |
| LM307CN | .29 | LM2111N | 1.75 |
| LM308CN | .98 | LM2900N | .99 |
| LM309K | 1.49 | LM2901N | 2.50 |
| LM310CN | 1.25 | LM2917N | 2.95 |
| LM311D/CN | .89 | CA3013T | 2.19 |
| LM312H | 1.75 | CA3018T | 1.99 |
| LM317T | 1.70 | CA3021T | 3.49 |
| LM318CN | 1.49 | CA3023T | 2.99 |
| LM319N/H | 1.25 | CA3035T | 2.75 |
| LM320K-XX* | 1.35 | CA3039T | 1.29 |
| LM320T-XX* | 1.39 | CA3046N | 1.29 |
| LM320H-XX* | 1.25 | CA3053N | 1.49 |
| LM323K | 4.95 | CA3059N | 3.19 |
| LM324N | .95 | CA3060N | 3.19 |
| LM337K | 5.95 | CA3062N | 4.95 |
| LM338K | 6.95 | CA3065N | 1.49 |
| LM339N | .95 | CA3080T | 1.29 |
| LM340K-XX* | 1.75 | CA3081N | 1.69 |
| LM340T-XX* | 1.25 | CA3082N | 1.69 |
| LM340H-XX* | 1.25 | CA3083N | 1.55 |
| LM344H | 1.95 | CA3086N | .80 |
| LM348N | 1.20 | CA3089N | 2.99 |
| LM350K | 5.60 | CA3096N | 3.49 |
| LM358CN | .98 | CA3097N | 1.99 |
| LM360N | 1.49 | CA3130T | 1.30 |
| LM372N | 1.95 | CA3140T | 1.19 |
| LM376N | 3.75 | CA3146N | 2.49 |
| LM377N | 2.75 | CA3160T | 1.19 |
| LM380CN/N | 1.25 | CA3190N | 1.95 |
| LM381N | 1.79 | CA3410N | .59 |
| LM383T | 1.95 | MC3423N | 1.49 |
| LM386N | 1.25 | CA3460N | 3.95 |
| LM387N | 1.40 | SG3524N | 3.95 |
| LM390N | 1.95 | CA3600N | 3.39 |
| NE531V/T | 3.75 | LM3900N | .59 |
| NE555V | .39 | LM3905N | 1.19 |
| NE556N | .98 | LM3909N | .98 |
| NE561T | 19.95 | LM3914N | 3.75 |
| NE565N/H | 1.25 | LM3915N | 3.95 |
| NE566H/V | 1.75 | LM3916N | 3.75 |
| NE567V/H | 1.50 | RC4131N | 2.95 |
| NE592N | 2.75 | RC4136N | 1.10 |
| LM702H | 1.99 | RC4151N | 3.70 |
| LM709N/H | .29 | RC4194TK | 4.95 |
| LM710N/H | .75 | RC4195TK | 5.40 |
| LM711N/H | .39 | ULN2001 | 1.25 |
| LM715N | 1.95 | ULN2003 | 1.50 |
| LM723N/H | .65 | SN75450N | .59 |
| LM733N/H | .98 | SN75451N | .35 |
| LM739N | 1.15 | SN75452N | .49 |
| LM741CN/H | .33 | SN75453N | .49 |
| LM741CN-14 | .19 | SN75454N | .49 |
| LM747N/H | .75 | SN75491N | .89 |
| LM748N/H | .39 | SN75492N | .89 |
| LM760CN | 2.95 | SN75493N | .89 |
| LM1310N | 1.90 | SN75494N | .89 |
| MC1330 | 1.95 | TL494CN | 4.20 |
| MC1350 | 1.95 | TL496CP | 1.65 |
| MC1358 | 1.75 | | |

## 74S00

| | | | | | |
|---|---|---|---|---|---|
| 74S00 | $.39 | 74S124 | 3.69 | 74S244 | $2.99 |
| 74S02 | .43 | 74S133 | .54 | 74S251 | 1.35 |
| 74S03 | .45 | 74S134 | .66 | 74S253 | 1.35 |
| 74S04 | .52 | 74S135 | 1.15 | 74S257 | 1.29 |
| 74S05 | .52 | 74S136 | 1.69 | 74S258 | 1.29 |
| 74S08 | .49 | 74S138 | 1.29 | 74S260 | .75 |
| 74S09 | .49 | 74S139 | 1.29 | 74S280 | 2.79 |
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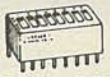

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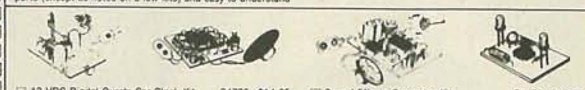

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| SN7448N | 16 | .69 |
| SN7450N | 14 | .19 |
| SN7451N | 14 | .19 |
| SN7453N | 14 | .19 |
| SN7454N | 14 | .19 |
| SN7459A | 14 | .25 |
| SN7460N | 14 | .19 |
| SN7470N | 14 | .29 |
| SN7472N | 14 | .29 |
| SN7473N | 14 | .35 |
| SN7474N | 14 | .35 |
| SN7475N | 16 | .45 |
| SN7476N | 16 | .35 |
| SN7479N | 14 | 4.95 |
| SN7480N | 14 | .69 |
| SN7482N | 14 | 1.19 |
| SN7483N | 16 | .59 |
| SN7485N | 16 | .59 |
| SN7486N | 14 | .35 |
| SN7489N | 16 | 2.25 |
| SN7490N | 14 | .39 |
| SN7491N | 14 | .59 |
| SN7492N | 14 | .39 |
| SN7493N | 14 | .39 |
| SN7494N | 14 | .69 |
| SN7495N | 14 | .49 |
| SN7496N | 16 | .49 |
| SN7497N | 16 | 2.75 |
| SN74100N | 24 | 1.49 |
| SN74104N | 14 | .89 |
| SN74105N | 14 | .89 |
| **SN74107N** | **14** | **.29** |
| **SN74109N** | **16** | **.39** |
| SN74116N | 24 | 1.49 |
| SN74121N | 14 | .39 |
| SN74122N | 14 | .55 |
| SN74123N | 16 | .49 |
| SN74125N | 14 | .45 |
| SN74126N | 14 | .45 |
| SN74132N | 14 | .49 |
| SN74135N | 16 | .69 |
| SN74141N | 16 | .69 |
| SN74142N | 16 | 2.95 |
| SN74143N | 24 | 2.95 |
| SN74144N | 24 | 2.95 |
| SN74145N | 16 | .59 |
| SN74147N | 16 | 1.49 |
| SN74148N | 16 | 1.19 |
| SN74150N | 24 | 1.19 |
| SN74151N | 16 | .59 |
| SN74152N | 14 | .59 |
| SN74153N | 16 | .59 |
| SN74154N | 24 | 1.25 |
| SN74155N | 16 | .59 |
| SN74156N | 16 | .59 |
| **SN74157N** | **16** | **.59** |
| SN74160N | 16 | .69 |
| SN74161N | 16 | .69 |
| SN74162N | 16 | .69 |
| SN74163N | 16 | .69 |
| SN74164N | 14 | .69 |
| SN74165N | 16 | .69 |
| SN74166N | 16 | .89 |
| SN74167N | 16 | 2.79 |
| SN74170N | 16 | 1.29 |
| SN74172N | 24 | 4.95 |
| SN74173N | 16 | .69 |
| SN74174N | 16 | .69 |
| SN74175N | 16 | .69 |
| SN74176N | 14 | .69 |
| SN74177N | 14 | .69 |
| SN74179N | 16 | 1.49 |
| SN74180N | 14 | .69 |
| SN74181N | 24 | 1.95 |
| SN74182N | 16 | .89 |
| SN74184N | 16 | 1.95 |
| SN74185N | 16 | 1.95 |
| SN74190N | 16 | .89 |
| SN74191N | 16 | .89 |
| SN74192N | 16 | .69 |
| SN74193N | 16 | .69 |
| SN74194N | 16 | .69 |
| SN74195N | 16 | .69 |
| SN74196N | 14 | .69 |
| SN74197N | 14 | .69 |
| SN74198N | 24 | 1.19 |
| SN74199N | 24 | 1.19 |
| SN74221N | 16 | 1.19 |
| SN74251N | 16 | .79 |
| SN74276N | 20 | 1.95 |
| SN74279N | 16 | .79 |
| SN74283N | 16 | 1.49 |
| SN74284N | 16 | 2.95 |
| SN74285N | 16 | 2.95 |
| SN74365N | 16 | .55 |
| SN74366N | 16 | .55 |
| SN74367N | 16 | .55 |
| SN74368N | 16 | .55 |
| SN74390N | 16 | 1.49 |
| SN74393N | 14 | 1.49 |

# 74LS

| Part No. | **Pins | Price |
|---|---|---|
| 74LS00 | 14 | .25 |
| 74LS01 | 14 | .25 |
| 74LS02 | 14 | .25 |
| 74LS03 | 14 | .25 |
| 74LS04 | 14 | .29 |
| 74LS05 | 14 | .29 |
| 74LS08 | 14 | .29 |
| 74LS09 | 14 | .29 |
| 74LS10 | 14 | .29 |
| 74LS11 | 14 | .35 |
| 74LS12 | 14 | .35 |
| 74LS13 | 14 | .39 |
| 74LS14 | 14 | .59 |
| 74LS15 | 14 | .35 |
| 74LS20 | 14 | .29 |
| 74LS21 | 14 | .29 |
| **74LS22** | **14** | **.29** |
| 74LS26 | 14 | .29 |
| 74LS27 | 14 | .29 |
| 74LS28 | 14 | .35 |
| 74LS30 | 14 | .29 |
| 74LS32 | 14 | .35 |
| 74LS33 | 14 | .55 |
| 74LS37 | 14 | .35 |
| 74LS38 | 14 | .35 |
| 74LS40 | 14 | .29 |
| 74LS42 | 16 | .55 |
| 74LS47 | 16 | .75 |
| 74LS48 | 16 | .75 |
| 74LS49 | 14 | .75 |
| 74LS51 | 14 | .25 |
| 74LS54 | 14 | .25 |
| 74LS55 | 14 | .29 |
| 74LS73 | 14 | .39 |
| 74LS74 | 14 | .39 |
| 74LS75 | 16 | .39 |
| 74LS76 | 16 | .39 |
| 74LS78 | 14 | .39 |
| 74LS83 | 16 | .65 |
| 74LS85 | 16 | .69 |
| 74LS86 | 14 | .39 |
| 74LS90 | 14 | .55 |
| 74LS92 | 14 | .55 |
| 74LS93 | 14 | .55 |
| 74LS95 | 14 | .79 |
| 74LS96 | 16 | .89 |
| 74LS107 | 14 | .39 |
| 74LS109 | 16 | .39 |
| 74LS112 | 16 | .39 |
| 74LS113 | 14 | .39 |
| 74LS114 | 14 | .39 |
| 74LS122 | 14 | .49 |
| 74LS123 | 16 | .79 |
| 74LS125 | 14 | .49 |
| 74LS126 | 14 | .49 |
| 74LS132 | 14 | .59 |
| 74LS133 | 16 | .59 |
| 74LS136 | 14 | .39 |
| 74LS138 | 16 | .59 |
| 74LS139 | 16 | .59 |
| 74LS151 | 16 | .59 |
| 74LS153 | 16 | .59 |
| 74LS154 | 24 | .99 |
| 74LS155 | 16 | .69 |
| 74LS156 | 16 | .69 |
| 74LS157 | 16 | .69 |
| 74LS158 | 16 | .59 |
| 74LS160 | 16 | .69 |
| 74LS161 | 16 | .69 |
| 74LS162 | 16 | .69 |
| 74LS163 | 16 | .69 |
| 74LS164 | 14 | .69 |
| 74LS165 | 16 | 1.19 |
| 74LS168 | 16 | 1.19 |
| 74LS169 | 16 | 1.19 |
| 74LS170 | 16 | 1.49 |
| 74LS173 | 16 | .69 |
| 74LS174 | 16 | .59 |
| 74LS175 | 16 | .59 |
| 74LS181 | 24 | 2.49 |
| 74LS190 | 16 | .89 |
| 74LS191 | 16 | .89 |
| 74LS192 | 16 | .79 |
| 74LS193 | 16 | .79 |
| 74LS194 | 16 | .69 |
| 74LS195 | 16 | .69 |
| 74LS197 | 14 | .79 |
| 74LS221 | 16 | .89 |
| 74LS240 | 20 | 1.09 |
| 74LS241 | 20 | 1.09 |
| 74LS242 | 14 | 1.09 |
| 74LS243 | 14 | 1.09 |
| 74LS244 | 20 | 1.09 |
| 74LS245 | 20 | 1.49 |
| 74LS247 | 16 | 1.09 |
| 74LS248 | 16 | 1.09 |
| 74LS249 | 16 | 1.09 |
| 74LS251 | 16 | .59 |
| 74LS253 | 16 | .59 |
| 74LS257 | 16 | .59 |
| 74LS258 | 16 | .59 |
| 74LS260 | 14 | .59 |
| 74LS266 | 14 | .69 |
| 74LS273 | 20 | 1.49 |
| 74LS279 | 16 | .49 |
| 74LS283 | 16 | .69 |
| 74LS290 | 14 | .89 |
| 74LS293 | 14 | .79 |
| 74LS298 | 16 | .89 |
| 74LS352 | 16 | 1.29 |
| 74LS353 | 16 | 1.29 |
| 74LS365 | 16 | .49 |
| 74LS366 | 16 | .49 |
| 74LS367 | 16 | .49 |
| 74LS368 | 16 | .49 |
| 74LS373 | 20 | 1.29 |
| 74LS374 | 20 | 1.29 |
| 74LS375 | 16 | .69 |
| 74LS386 | 14 | .45 |
| 74LS393 | 14 | 1.19 |
| 74LS399 | 16 | 1.49 |
| 74LS670 | 16 | 1.49 |
| 81LS95 | 20 | 1.49 |
| 81LS97 | 20 | 1.49 |

# 74S/PROMS*

| Part No. | **Pins | Price |
|---|---|---|
| 74S00 | 14 | .35 |
| 74S02 | 14 | .35 |
| 74S03 | 14 | .35 |
| 74S04 | 14 | .45 |
| 74S05 | 14 | .45 |
| 74S08 | 14 | .39 |
| 74S09 | 14 | .39 |
| 74S10 | 14 | .35 |
| 74S11 | 14 | .35 |
| 74S15 | 14 | .35 |
| 74S20 | 14 | .35 |
| 74S22 | 14 | .35 |
| 74S30 | 14 | .35 |
| 74S32 | 14 | .45 |
| 74S38 | 14 | .89 |
| 74S40 | 14 | .39 |
| 74S51 | 14 | .35 |
| 74S64 | 14 | .39 |
| 74S65 | 14 | .39 |
| 74S74 | 14 | .55 |
| 74S86 | 14 | .55 |
| 74S112 | 16 | .55 |
| 74S113 | 14 | .55 |
| 74S114 | 14 | .55 |
| 74S124 | 16 | 2.95 |
| 74S133 | 16 | .45 |
| 74S134 | 16 | .50 |
| 74S135 | 16 | .69 |
| 74S136 | 14 | 1.39 |
| 74S138 | 16 | .89 |
| 74S139 | 16 | .89 |
| 74S140 | 14 | .55 |
| 74S151 | 16 | .99 |
| 74S153 | 16 | .99 |
| 74S157 | 16 | .99 |
| 74S158 | 16 | .99 |
| 74S160 | 16 | 2.49 |
| 74S174 | 16 | .99 |
| 74S175 | 16 | .99 |
| 74S188* | 16 | 1.49 |
| 74S194 | 16 | 1.49 |
| 74S195 | 16 | 1.49 |
| 74S196 | 14 | 1.49 |
| 74S240 | 20 | 2.25 |
| 74S241 | 20 | 2.25 |
| 74S242 | 14 | 2.49 |
| 74S243 | 14 | 2.49 |
| 74S244 | 20 | 2.49 |
| 74S251 | 16 | 1.19 |
| 74S253 | 16 | 1.19 |
| 74S257 | 16 | 1.19 |
| 74S258 | 16 | 1.19 |
| 74S260 | 14 | .79 |
| 74S280 | 14 | 1.95 |
| 74S287* | 16 | 1.95 |
| 74S288* | 16 | 1.95 |
| 74S373 | 20 | 2.49 |
| 74S374 | 20 | 2.49 |
| 74S387* | 16 | 1.95 |
| 74S471* | 20 | 5.95 |
| 74S472* | 20 | 4.95 |
| 74S473* | 20 | 4.95 |
| 74S474* | 24 | 4.95 |
| 74S475* | 24 | 4.95 |
| 74S570* | 16 | 2.95 |
| 74S571* | 16 | 2.95 |
| 74S572* | 18 | 4.95 |
| 74S573* | 18 | 4.95 |
| 74S940 | 20 | 2.49 |
| 74S941 | 20 | 2.49 |

# CA—LINEAR

| Part No. | **Pins | Price |
|---|---|---|
| CA3010H | | .99 |
| CA3013H | | 2.15 |
| CA3023H | | 3.25 |
| CA3035H | | 5.95 |
| CA3039H | | 1.35 |
| CA3046N | 14 | .89 |
| CA3059N | 14 | 3.25 |
| CA3060N | 16 | 3.25 |
| CA3080E | 8 | .89 |
| CA3081N | 16 | 1.49 |
| CA3082N | 16 | 1.49 |
| CA3083N | 16 | 1.49 |
| CA3086N | 14 | .69 |
| CA3089N | 16 | 1.69 |
| CA3096N | 16 | 1.19 |
| CA3130E | 8 | 1.49 |
| CA3140E | 8 | .99 |
| CA3160H | | 1.95 |
| CA3401N | 14 | .59 |
| CA3600N | 14 | 3.95 |

# CD—CMOS

| Part No. | **Pins | Price |
|---|---|---|
| CD4000 | 14 | .29 |
| **CD4001** | **14** | **.29** |
| CD4002 | 14 | .29 |
| CD4006 | 14 | .89 |
| CD4007 | 14 | .29 |
| **CD4009** | **16** | **.39** |
| CD4010 | 16 | .39 |
| CD4011 | 14 | .29 |
| **CD4012** | **14** | **.15** |
| CD4013 | 14 | .39 |
| CD4014 | 16 | .79 |
| **CD4015** | **16** | **.39** |
| CD4016 | 14 | .39 |
| CD4017 | 16 | .75 |
| CD4018 | 16 | .79 |
| CD4019 | 16 | .39 |
| CD4020 | 16 | .75 |
| CD4021 | 16 | .79 |
| CD4022 | 16 | .79 |
| CD4023 | 14 | .29 |
| CD4024 | 14 | .69 |
| CD4025 | 14 | .23 |
| CD4026 | 16 | 2.49 |
| CD4027 | 16 | .45 |
| CD4028 | 16 | .69 |
| CD4029 | 16 | .79 |
| CD4030 | 14 | .39 |
| CD4034 | 24 | 1.95 |
| CD4035 | 16 | .89 |
| CD4040 | 16 | .79 |
| CD4041 | 14 | .79 |
| CD4042 | 16 | .69 |
| CD4043 | 16 | .79 |
| CD4044 | 16 | .79 |
| CD4046 | 16 | .89 |
| CD4047 | 14 | .89 |
| CD4048 | 16 | .39 |
| **CD4049** | **16** | **.39** |
| CD4050 | 16 | .39 |
| CD4051 | 16 | .79 |
| CD4052 | 16 | .79 |
| CD4053 | 16 | .79 |
| CD4056 | 16 | 2.95 |
| CD4059 | 24 | 7.95 |
| CD4060 | 16 | .89 |
| CD4066 | 14 | .39 |
| CD4068 | 14 | .39 |
| CD4069 | 14 | .29 |
| CD4070 | 14 | .39 |
| CD4071 | 14 | .29 |
| CD4072 | 14 | .29 |
| CD4073 | 14 | .29 |
| CD4075 | 14 | .29 |
| CD4076 | 16 | .79 |
| CD4078 | 14 | .49 |
| **CD4081** | **14** | **.29** |
| CD4082 | 14 | .29 |
| CD4093 | 14 | .49 |
| CD4098 | 16 | 1.95 |
| CD4506 | 16 | 1.19 |
| CD4507 | 14 | .39 |
| CD4508 | 24 | 3.95 |
| CD4510 | 16 | .89 |
| CD4511 | 16 | .89 |
| CD4512 | 16 | .89 |
| CD4514 | 24 | 1.79 |
| CD4515 | 24 | 1.79 |
| CD4516 | 16 | .99 |
| CD4518 | 16 | .99 |
| CD4519 | 16 | .39 |
| CD4520 | 16 | .79 |
| CD4526 | 16 | 1.19 |
| CD4528 | 16 | 1.19 |
| CD4529 | 16 | 1.19 |
| CD4543 | 16 | 1.19 |
| CD4562 | 14 | 6.95 |
| CD4566 | 16 | 1.39 |
| CD4583 | 16 | 2.49 |
| CD4584 | 14 | .59 |
| CD4723 | 16 | 1.19 |
| CD4724 | 16 | 1.19 |
| MC14409 | 16 | 13.95 |
| MC14410 | 16 | 13.95 |
| MC14411 | 24 | 11.95 |
| MC14412 | 16 | 13.95 |
| MC14419 | 16 | 7.95 |
| MC14433 | 24 | 13.95 |
| MC14538 | 16 | 1.19 |
| MC14541 | 14 | 1.19 |

(More in Catalog)

# MICROPROCESSOR COMPONENTS

## MICROPROCESSOR CHIPS

| Part No. | **Pins | Function | Price |
|---|---|---|---|
| CDP1802 | 40 | CPU | $9.95 |
| 2650 | 40 | MPU | 14.95 |
| IDM2901ADC | 40 | CPU—4-bit slice (Com. Temp. Gr.) | 19.95 |
| MCS6502 | 40 | MPU w/Clock (65K bytes mem.) | 9.95 |
| MC6802CP | 40 | MPU w/Clock and RAM | 7.95 |
| INS8035N-6 | 40 | MPU—8-bit (6MHz) | 5.95 |
| INS8039N-6 | 40 | CPU-Sgl. chip 8-bit (128 bts. Ram) | 5.95 |
| INS8040N-6 | 40 | CPU (256 bytes RAM) | 5.95 |
| INS8070N | 40 | CPU (64 bytes RAM) | 11.95 |
| INS8073N | 40 | CPU w/Basic Micro Interpreter | 14.95 |
| P8085A | 40 | CPU | 5.95 |

## Z80, Z80A, Z80B, Z8000 SERIES

| Part No. | **Pins | Function | Price |
|---|---|---|---|
| Z80 | 40 | CPU (MK3880N)(780C) 2MHz | $4.95 |
| Z80-CTC | 28 | Counter Timer Circuit | 5.95 |
| Z80-DART | 40 | Dual Asynchronous Rec./Trans. | 11.95 |
| Z80-DMA | 40 | Direct Memory Access Circuit | 15.95 |
| Z80-P10 | 40 | Parallel I/O Interface Controller | 5.95 |
| Z80-S10/0 | 40 | Serial I/O (TxCB and RxCB Bonded) | 15.95 |
| Z80-S10/1 | 40 | Serial I/O (Lacks DTRB) | 15.95 |
| Z80-S10/2 | 40 | Serial I/O (Lacks SYNCB) | 15.95 |
| Z80-S10/9 | 40 | Serial I/O | 15.95 |
| Z80A | 40 | CPU (MK3880N-4)(780C-1) 4MHz | 5.95 |
| Z80A-CTC | 28 | Counter Timer Circuit | 5.95 |
| Z80A-DART | 40 | Dual Asynchronous Rec./Trans. | 11.95 |
| Z80A-DMA | 40 | Direct Memory Access Circuit | 17.95 |
| Z80A-P10 | 40 | Parallel I/O Interface Controller | 5.95 |
| Z80A-S10/0 | 40 | Serial I/O (TxCB and RxCB bonded) | 16.95 |
| Z80A-S10/1 | 40 | Serial I/O (Lacks DTRB) | 16.95 |
| Z80A-S10/2 | 40 | Serial I/O (Lacks SYNCB) | 16.95 |
| Z80A-S10/9 | 40 | Serial I/O | 16.95 |
| Z80B | 40 | CPU (MK3880N-6) 6MHz | 11.95 |
| Z80B-CTC | 28 | Counter Timer Circuit | 13.95 |
| Z80B-P10 | 40 | Parallel I/O Interface Controller | 13.95 |
| Z8001 | 48 | CPU Segmented | 51.95 |
| Z8002 | 40 | CPU Non-Segmented | 55.95 |
| Z8030 | 40 | Serial Comm. Controller | 44.95 |
| Z8036 | 40 | Counter/Timer & Parallel I/O Unit | 29.95 |

## 6800/68000 SERIES

| Part No. | **Pins | Function | Price |
|---|---|---|---|
| MC6800 | 40 | MPU | 4.95 |
| MC6802CP | 40 | MPU with clock and RAM | 7.95 |
| MC6810API | 24 | 128x8 Static RAM | 3.95 |
| MC6821 | 40 | Peripheral Inter. Adapt (MC6820) | 4.95 |
| MC6828 | 24 | Priority Interrupt Controller | 15.95 |
| MC6830L8 | 24 | 1024x8-bit ROM (MC68A30-8) | 10.95 |
| MC6850 | 24 | Asynchronous Comm. Adapter | 4.95 |
| MC6852 | 24 | Synchronous Serial Data Adapter | 5.75 |
| MC6860 | 24 | 0-600bps Digital MODEM | 9.95 |
| MC6862 | 24 | 2400bps Modulator | 12.95 |
| MC6880A | 16 | Quad 3-state bus. trans. (MC8T26) | 2.25 |
| MC68000L8 | 64 | MPU 16-Bit (8MHz) | 69.95 |
| MC68488P | 40 | General Purpose Int. Adapter | 8.95 |
| MC68652P2 | 40 | Multi. Protocol Comm. Controller | 24.95 |
| MC68661PB | 28 | Enhanced Prog. Comm. Int. | 8.95 |

## 8080A SERIES

| Part No. | **Pins | Function | Price |
|---|---|---|---|
| INS8080A | 40 | CPU | 3.95 |
| TMS5501 | 40 | Synchronous Data Interface (SIRC) | 14.95 |
| INS8154 | 40 | 128 Byte RAM 16-Bit I/O | 13.95 |
| 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 | 2.25 |
| DP8224 | 16 | Clock Generator/Driver | 2.25 |
| DP8226 | 16 | Bus Driver | 2.25 |
| DP8228 | 28 | System Cont./Bus Driver (74S428) | 3.49 |
| DP8238 | 28 | System Controller (74S438) | 4.49 |
| INS8243 | 24 | I/O Expander for 48 Series | 5.95 |
| 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 (INS8250) | 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 | 7.95 |
| DP8259 | 28 | Prog. Interrupt Control | 6.95 |
| DP8275 | 40 | Prog. CRT Controller | 29.95 |
| DP8279 | 40 | Prog. Keyboard/Display Interface | 6.95 |
| DP8303 | 20 | 8-Bit Tri-State Bi-Directional Trans. | 3.95 |
| DP8304 | 20 | 8-bit Bi-Directional Receiver | 2.49 |
| DP8307 | 20 | 8-bit Bi-Directional Receiver | 2.49 |
| DP8308 | 20 | 8-bit Bi-Directional Receiver | 2.49 |
| DP8310 | 20 | Octal Latched Peripheral Driver | 4.95 |
| DP8311 | 20 | Octal Latched Peripheral Driver | 4.95 |

## MICROPROCESSOR MANUALS & DATA BOOKS

| Part No. | Description | Price |
|---|---|---|
| M-Z80 | User Manual | 7.50 |
| M-CDP1802 | User Manual | 7.50 |
| M-2650 | User Manual | 5.00 |
| 10400 | 1982 Intel Data Book (1405 pg.) | 14.95 |
| 30001 | 1981 Nat. CMOS Book (628 pg.) | 6.95 |
| 30002 | 1980 Nat. Interface Book (640 pg.) | 6.95 |
| 30003 | 1982 Nat. Linear Book (1952 pg.) | 11.95 |
| 30005 | 1981 Nat. TTL Book (624 pg.) | 9.95 |
| 30008 | 1980 Nat. Memory Data Book (464 pg.) | 6.95 |
| 30011 | 1980 Nat. Linear Applications (736 pg.) | 15.95 |
| 30013 | 1983 Zilog Data Book (641 pg.) | 7.95 |
| 205610 | 1981 Intel Peripheral Design (828 pg.) | 9.95 |

## DYNAMIC RAMS

| Part No. | **Pins | Description | 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) | 7.95 - 8/59.95 |
| 4164N-200 | 16 | 65,536x1 (200ns) | 7.49 - 8/54.95 |
| MM5261 | 18 | 1024x1 (300ns) | .49 - 8/1.95 |
| **MM5262** | **22** | **2048x1 (365ns)** | **.49 — 8/1.95** |
| 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 | Description | 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 | 2.95 |
| 2114 | 18 | 1024x4 (450ns) | 1.95 - 8/13.95 |
| 2114L | 18 | 1024x4 (450ns) L.P. | 2.25 - 8/15.95 |
| 2114-2 | 18 | 1024x4 (200ns) | 2.25 - 8/15.95 |
| 2114L-2 | 18 | 1024x4 (200ns) L.P. | 2.49 - 8/17.95 |
| 2141-3 | 18 | 4096x1 (150ns) | 3.95 |
| 2147 | 18 | 4096x1 (70ns) | 4.95 |
| 2148 | 18 | 1024x4 (70ns) | 8.95 |
| TMS4044 | 18 | 4096x1 (450ns) | 3.95 |
| TMS4045 | 18 | 1024x4 (450ns) | 3.95 |
| 5101 | 22 | 256x4 (450ns) CMOS | 4.95 |
| MM5257 | 18 | 4096x1 (450ns) 4044 | 4.95 |
| HM6116P-3 | 24 | 2048x8 (150ns) CMOS | 7.95 |
| HM6116-4 | 24 | 2048x8 (200ns) CMOS | 6.95 |
| HM6116LP-4 | 24 | 2048x8 (200ns) L.P. CMOS | 7.95 |
| 7489 | 16 | 16x4 (50ns) 3101 | 2.25 |
| 74C920 | 22 | 256x4 (250ns) CMOS (6551) | 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 |

## EPROMS

| Part No. | **Pins | Description | 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 | 6.95 |
| TMS2532 | 24 | 4096x8 (450ns) NMC2532 | 9.95 |
| TMS2564 | 28 | 8192x8 (450ns) | 19.95 |
| TMS2716 | 24 | 2048x8 (450ns) 3 voltage | 7.95 |
| 2716 | 24 | 2048x8 (450ns) | 4.95 |
| 2716-1 | 24 | 2048x8 (350ns) | 8.95 |
| 2732 | 24 | 4096x8 (450ns) | 9.95 |
| 2758Q | 24 | 1024x8 (450ns) single +5V | 2.95 |
| MM2764 | 28 | 8192x8 (450ns) | 16.95 |
| MM2764-3 | 28 | 8192x8 (300ns) | 19.95 |

## PROMS

| Part No. | **Pins | Description | Price |
|---|---|---|---|
| 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 |
| 74S478 | 24 | 1024x8 PROM T.S. (TBP28S86) | 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) | 3.95 |
| 82S129 | 16 | 256x4 PROM T.S. (27S21) | 3.95 |
| 82S130 | 16 | 512x4 PROM O.C. (27S12) | 5.95 |
| 82S185 | 18 | 2048x4 PROM T.S. (TBP24S81) | 9.95 |
| 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 | 2048x8 PROM O.C. (82S190) | 19.95 |
| DM87S191N | 24 | 2048x8 PROM T.S. (82S191) | 19.95 |

## DATA ACQUISITION

| Part No. | **Pins | Description | 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) | 2.49 |
| MC1408L8 | 18 | 8-bit D/A Converter (DAC0808LCN) | 2.95 |
| ADC0804 | 20 | 8-bit A/D Converter (1 LSB) | 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 |
| **AY-5-1013A** | **40** | **30K Baud Uart (TR1602)** | **4.95** |

# 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 |
| 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 |
| 7117CPL | 40 | 3½ Digit A/D LED Dis. HLD. | 15.95 |
| 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 |
| 7208IPI | 28 | Seven Decade Counter | 15.95 |
| 7209IPA | 8 | Clock Generator | 3.95 |
| 7215IPG | 24 | 4 Func. CMOS Stopwatch CKT | 13.95 |
| 7215EV/Kit* | 24 | 4 Func. Stopwatch Chip, XTL | 14.95 |
| 7216AIJI | 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 |
| 7240IJE | 16 | CMOS Bin Prog. Timer/Counter | 4.95 |
| 7242IJA | 8 | CMOS Divide-by-256 RC Timer | 2.25 |
| 7250IJE | 16 | CMOS BCD Prog. Timer/Counter | 6.00 |
| 7260IJE | 16 | CMOS BCD Prog. Timer/Counter | 5.25 |
| 7555IPA | 8 | CMOS 555 Timer | 1.45 |
| 7556IPD | 14 | CMOS 556 Timer | 2.20 |
| 7611BCPA | 8 | CMOS Op Amp Comparator 5MV | 2.25 |
| 7612BCPA | 8 | CMOS Op Amp Ext. Cmvr. 5MV | 2.95 |
| 7621BCPA | 8 | CMOS Dual Op Amp Comp. 5MV | 3.95 |
| 7631CCPE | 16 | CMOS Tri Op Amp Comp. 10MV | 5.35 |
| 7641CCPD | 14 | CMOS Quad Op Amp Comp. 10MV | 7.50 |
| 7642CCPD | 14 | CMOS Quad Op Amp Comp. 10MV | 7.50 |
| 7660CPA | 8 | Voltage Converter | 2.95 |
| 8038CCPD | 14 | Waveform Generator | 3.95 |
| 8048CCPE | 16 | Monolithic Logarithmic Amp | 16.95 |
| 8069CCQ | | 50ppm Band—GAP Volt Ref. Diode | 2.50 |
| 8211CPA | 8 | Volt Ref/Indicator | 2.95 |
| 8212CPA | 24 | Volt Ref/Indicator | 2.95 |

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# 74C—C/MOS

| Part No. | **Pins | Price |
|---|---|---|
| 74C00 | 14 | .35 |
| 74C02 | 14 | .35 |
| 74C04 | 14 | .29 |
| 74C08 | 14 | .35 |
| 74C10 | 14 | .35 |
| 74C14 | 14 | .59 |
| 74C20 | 14 | .35 |
| 74C30 | 14 | .35 |
| 74C32 | 14 | .39 |
| 74C42 | 16 | 1.39 |
| 74C48 | 16 | 1.95 |
| 74C73 | 14 | .79 |
| 74C74 | 14 | .69 |
| 74C85 | 16 | 1.95 |
| 74C86 | 14 | .39 |
| 74C89 | 16 | 5.95 |
| 74C90 | 14 | 1.19 |
| 74C93 | 14 | 1.19 |
| 74C95 | 14 | 1.39 |
| 74C107 | 14 | .89 |
| 74C151 | 16 | 2.49 |
| 74C154 | 24 | 3.49 |
| 74C157 | 16 | 2.25 |
| 74C160 | 16 | 1.19 |
| 74C161 | 16 | 1.19 |
| 74C162 | 16 | 1.19 |
| 74C163 | 16 | 1.19 |
| 74C164 | 14 | 1.49 |
| 74C173 | 16 | .79 |
| 74C174 | 16 | 1.19 |
| 74C175 | 16 | 1.19 |
| 74C192 | 16 | 1.49 |
| 74C193 | 16 | 1.69 |
| 74C195 | 16 | 1.39 |
| 74C221 | 16 | 1.95 |
| 74C240 | 20 | 1.95 |
| 74C244 | 20 | 1.95 |
| 74C373 | 20 | 2.49 |
| 74C374 | 20 | 2.49 |
| 74C901 | 14 | .59 |
| 74C903 | 14 | .59 |
| 74C908 | 14 | .59 |
| 74C911 | 28 | 8.95 |
| 74C912 | 28 | 8.95 |
| 74C915 | 18 | 1.19 |
| 74C917 | 28 | 8.95 |
| 74C922 | 18 | 4.49 |
| 74C923 | 20 | 4.95 |
| 74C925 | 16 | 5.95 |
| 74C926 | 18 | 5.95 |
| 80C95 | 16 | .39 |
| 80C97 | 16 | .39 |

# NEW PRODUCT! 74HC High Speed CMOS

| Part No. | **Pins | Price |
|---|---|---|
| 74HC00 | 14 | .75 |
| 74HC02 | 14 | .75 |
| *74HCU04 | 14 | .75 |
| 74HC08 | 14 | .75 |
| 74HC10 | 14 | .75 |
| 74HC20 | 14 | .75 |
| 74HC27 | 14 | .75 |
| 74HC74 | 14 | .99 |
| 74HC75 | 16 | .99 |
| 74HC86 | 14 | .99 |
| 74HC109 | 16 | 1.39 |
| 74HC138 | 16 | 1.49 |
| 74HC139 | 16 | 1.49 |
| 74HC147 | 16 | 1.19 |
| 74HC151 | 16 | 1.19 |
| 74HC157 | 16 | 1.19 |
| 74HC160 | 16 | 1.79 |
| 74HC161 | 16 | 1.79 |
| 74HC164 | 14 | 1.79 |
| 74HC174 | 16 | 1.39 |
| 74HC175 | 16 | 1.39 |
| 74HC242 | 14 | 2.79 |
| 74HC243 | 14 | 2.79 |
| 74HC251 | 16 | 1.19 |
| 74HC266 | 14 | .99 |
| 74HC280 | 14 | 4.95 |
| 74HC373 | 20 | 3.95 |
| 74HC374 | 20 | 3.95 |
| 74HC533 | 20 | 3.95 |
| 74HC534 | 20 | 3.95 |
| 74HC4075 | 14 | .75 |
| 74HC4538 | 16 | 2.95 |
| 74HC4543 | 16 | 4.95 |

*74HCU04 is unbuffered. All others are buffered. Send $.30 for Data Sheet.

# NEW Programmable Array Logic (PALS)

| Part No. | **Pins | Function | Price |
|---|---|---|---|
| PAL10H8 | 20 | Octal 10-Input AND-OR Gate Array (High Output) | $5.95 |
| PAL12H6 | 20 | Hex 12-Input AND-OR Gate Array (High Output) | 5.95 |
| PAL14H4 | 20 | Quad 14-Input AND-OR Gate Array (High Output) | 5.95 |
| PAL10L8 | 20 | Octal 10-Input AND-OR-Invert Gate Array (Low Output) | 5.95 |
| PAL12L6 | 20 | Hex 12-Input AND-OR-Invert Gate Array (Low Output) | 5.95 |
| PAL14L4 | 20 | Quad 14-Input AND-OR-Invert Gate Array (Low Output) | 5.95 |
| PAL16L8 | 20 | Octal 16-Input AND-OR-Invert Gate Array (Low Output) | 9.95 |
| PAL16R8 | 20 | Octal 16-Input Register AND-OR Gate Array | 9.95 |
| PAL16R6 | 20 | Hex 16-Input Register AND-OR Gate Array | 9.95 |
| PAL16R4 | 20 | Quad 16-Input Register AND-OR Gate Array | 9.95 |

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# LINEAR

| Part No. | **Pins | Price |
|---|---|---|
| TL071CP | 8 | .79 |
| TL072CP | 8 | 1.39 |
| TL074CN | 14 | 1.95 |
| TL081CP | 8 | .59 |
| TL082CP | 8 | 1.19 |
| TL084CN | 14 | 1.95 |
| LM301CN | 8 | .35 |
| LM302H | | 1.95 |
| LM304H | | 1.95 |
| LM305H | | .99 |
| LM307CN | 8 | .45 |
| LM308CN | 8 | .69 |
| LM309K | | 1.25 |
| LM310CN | 8 | 1.75 |
| LM311CN | 8 | .69 |
| LM312H | | 2.49 |
| LM317T | | 1.19 |
| LM317K | | 3.95 |
| LM318CN | 8 | 1.95 |
| LM319N | 14 | 1.95 |
| LM320K-5 | | 1.35 |
| LM320K-12 | | 1.35 |
| LM320K-15 | | 1.35 |
| LM320T-5 | | .89 |
| LM320T-12 | | .89 |
| LM320T-15 | | .89 |
| LM323K | | 5.95 |
| LM324N | 14 | .59 |
| LM337T | | 1.95 |
| LM338K | | 6.95 |
| LM339N | 14 | .69 |
| LM340K-5 | | 1.35 |
| LM340K-12 | | 1.35 |
| LM340K-15 | | 1.35 |
| LM340T-5 | | .79 |
| LM340T-12 | | .79 |
| LM340T-15 | | .79 |
| LM348N | 14 | .99 |
| LM350K | | 4.95 |
| LF355N | 8 | 1.10 |
| LF356N | 8 | 1.10 |
| *LM370N | 14 | 4.49 |
| LM373N | 14 | 3.95 |
| LM377N | 14 | 1.95 |
| LM380N | 14 | .89 |
| LM381N | 14 | 1.79 |
| LM382N | 14 | 1.39 |
| LM384N | 14 | 1.79 |
| LM386N-3 | 8 | .89 |
| TL494CN | 16 | 2.95 |
| TL496CP | 8 | 1.19 |
| NE510A | 14 | 4.95 |
| NE529A | 14 | 2.95 |
| NE531V | 8 | 2.95 |
| NE536H | | 8.95 |
| NE540H | | 4.95 |
| NE544N | 14 | 2.95 |
| NE550A | 14 | 1.95 |
| NE555V | 8 | .35 |
| LM556N | 14 | .69 |
| NE564N | 16 | 2.95 |
| LM565N | 14 | 1.19 |
| LM566CN | 8 | 1.49 |
| LM567V | 8 | .89 |
| NE570N | 16 | 3.95 |
| LM703CN | 8 | 1.19 |
| LM709N | 14 | .49 |
| LM710N | 14 | .69 |
| LM711N | 14 | .79 |
| LM723N | 14 | .55 |
| LM733N | 14 | 1.00 |
| LM739N | 14 | 1.95 |
| LM741CN | 8 | .35 |
| LM747N | 14 | .69 |
| LM748N | 8 | .59 |
| LM1310N | 14 | 1.49 |
| LM1458CN | 8 | .59 |
| LM1488N | 14 | .69 |
| LM1489N | 14 | .69 |
| LM1496N | 14 | 1.95 |
| LM1800N | 16 | 1.49 |
| LM1889N | 18 | 1.95 |
| LM1896N | 14 | 2.95 |
| LM2002T | | 1.49 |
| LM3189N | 16 | 1.59 |
| LM3900N | 14 | .59 |
| LM3905CN | 8 | 1.19 |
| LM3909N | 8 | .99 |
| LM3914N | 18 | 3.49 |
| LM3915N | 18 | 3.49 |
| LM3916N | 18 | 3.49 |
| **RC4136N** | **14** | **1.25** |
| RC4151NB | 8 | 1.95 |
| ICL8038B | 14 | 3.95 |
| LM13080N | 8 | 1.19 |
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| 47 pf | .08 | .06 | .05 | .01µF | .08 | .06 | .05 |
| 100 pf | .08 | .06 | .05 | .022µF | .09 | .07 | .06 |
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| 3.3/50V | .17 | .15 | .11 | 1.0/16V | .15 | .13 | .12 |
| 4.7/25V | .18 | .15 | .11 | 1.0/25V | .16 | .14 | .13 |
| 10/25V | .18 | .15 | .11 | 1.0/50V | .17 | .15 | .14 |
| 10/50V | .19 | .16 | .12 | 4.7/16V | .15 | .13 | .12 |
| 22/25V | .19 | .16 | .12 | 4.7/25V | .16 | .14 | .13 |
| 22/50V | .24 | .20 | .18 | 4.7/50V | .17 | .15 | .14 |
| 47/25V | .25 | .21 | .19 | 10/16V | .15 | .13 | .12 |
| 47/50V | .29 | .25 | .23 | 10/25V | .16 | .14 | .13 |
| 100/25V | .28 | .24 | .22 | 10/50V | .17 | .15 | .14 |
| 100/50V | .41 | .37 | .34 | 47/50V | .25 | .21 | .19 |
| 220/25V | .39 | .34 | .33 | 100/16V | .21 | .17 | .14 |
| 220/50V | .49 | .45 | .41 | 100/25V | .25 | .23 | .21 |
| 470/25V | .54 | .49 | .45 | 100/50V | .37 | .34 | .31 |
| 1000/16V | .79 | .69 | .61 | 220/16V | .25 | .21 | .19 |
| 2200/16V | .89 | .79 | .69 | 470/25V | .35 | .31 | .27 |

# CONNECTORS

## DB25 — D Subminiature (meets RS232)

| Part No. | Description | Price |
|---|---|---|
| DE9P | 9 Pin Plug | $1.79 |
| DE9S | 9 Pin Socket | 1.95 |
| DA15P | 15 Pin Plug | 1.95 |
| DA15S | 15 Pin Socket | 2.95 |
| **DB25P** | **25 Pin Plug (Meets RS232)** | **2.49** |
| **DB25S** | **25 Pin Socket (Meets RS232)** | **3.25** |
| DB25P-831 | 25 Pin Right Angle Plug | 4.95 |
| DB25S-831 | 25 Pin Right Angle Socket | 5.25 |
| DC37P | 37 Pin Plug | 4.95 |
| DC37S | 37 Pin Socket | 5.95 |
| DD50P | 50 Pin Plug | 5.95 |
| DD50S | 50 Pin Socket | 6.95 |

### Accessories

| Part No. | Description | Price |
|---|---|---|
| DE-9H | Hood for DE-9 Series Connectors | $1.19 |
| DA-15H | Hood for DA-15 Series Connectors | 1.29 |
| DB25H | Hood for DB25 Series Connectors | 1.25 |
| DC37H | Hood for DC37 Series Connectors | 1.39 |
| DD50H | Hood for DD50 Series Connectors | 1.49 |
| D20418-2 | 2 screws for mtg. connectors to a panel | .79 |

## Solder Eyelet/Wire Wrap Edge Card

| Part No. | Cnts. | Sp. | Description | Price |
|---|---|---|---|---|
| 15/30SE | 15/30 | .156 | Solder Eyelet | $1.79 |
| 18/36SE | 18/36 | .156 | Solder Eyelet | 1.95 |
| 22/44SE | 22/44 | .156 | Solder Eyelet | 2.49 |
| 22/44PC | 22/44 | .156 | PC type (no mtg. ears) | .99 |
| 50/100SE | 50/100 | .125 | Solder Eyelet | 9.95 |
| 22/44WW | 22/44 | .156 | Wire Wrap - Level 3 | 4.95 |
| 67031-5 | 22/44 | .156 | WW (Pins .0625x.03x.75) | 3.95 |
| R-681-1 | 50/100 | .125 | Wire Wrap - Level 3 | 7.95 |
| R-681-2 | 50/100 | .125 | Wire Wrap - Level 1 | 6.95 |

### RF Coaxial Connectors

| Part No. | Description | Price |
|---|---|---|
| PL259 | UHF Plug | $ .89 |
| SO239 | UHF Panel Receptacle | .69 |
| PL258 | UHF Straight Adapter | .89 |
| UG175/U | UHF Reducing Adapter | .49 |
| UG88/U | BNC Plug | 1.49 |
| UG89/U | BNC Jack | 1.69 |
| UG306/U | BNC Angle Adapter | 2.49 |
| UG260/U | BNC Plug | 1.49 |
| UG1094/U | BNC Bulkhead Receptacle | .89 |

# IC SOCKETS

For Socket Required, See Column After The IC Part No.

## LOW PROFILE (TIN) SOCKETS

| | 1-9 | 10-99 | 100-999 |
|---|---|---|---|
| 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 |

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| | 1-9 | 10-99 | 100-999 |
|---|---|---|---|
| 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 |
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| 40 pin WW | 1.99 | 1.89 | 1.79 |

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| 93L422 | 5.95 |
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| 4011 | .22 | 4043 | .65 | 4514 | 1.25 | 74C90 | .90 |
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| 74S10 | .30 | 74S135 | 1.10 | 74S240 | 1.00 |
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| 7405 | .24 | 7480 | .45 | 74170 | 1.60 |
| 7406 | .28 | 7483 | .50 | 74173 | .75 |
| 7407 | .28 | 7485 | .55 | 74174 | .65 |
| 7408 | .24 | 7486 | .35 | 74175 | .60 |
| 7409 | .18 | 7489 | 1.60 | 74176 | .75 |
| 7410 | .17 | 7490 | .35 | 74180 | 1.50 |
| 7411 | .22 | 7491 | .45 | 74182 | .45 |
| 7412 | .30 | 7492 | .45 | 74190 | .70 |
| 7413 | .35 | 7493 | .35 | 74191 | .75 |
| 7414 | .45 | 7494 | .60 | 74193 | .79 |
| 7416 | .25 | 7495 | .55 | 74194 | .85 |
| 7417 | .25 | 7496 | .60 | 74195 | .45 |
| 7420 | .17 | 74107 | .30 | 74196 | .75 |
| 7425 | .25 | 74116 | 1.50 | 74221 | 1.00 |
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| 7427 | .25 | 74122 | .39 | 74279 | .60 |
| 7430 | .17 | 74123 | .42 | 74298 | .65 |
| 7432 | .27 | 74126 | .45 | 74365 | .65 |
| 7437 | .27 | 74145 | .60 | 74367 | .65 |
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| 74LS08 | .23 | 74LS124 | 1.25 | 74LS244 | .80 |
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| 74LS51 | .22 | 74LS169 | 1.75 | 74LS368 | .58 |
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[A] **Deluxe.** Classy 2-tone styling, easy-to-work plastic end panels. 2¼ × 5 × 5¼". Reg. 7.95. **270-218 . . . Sale 5.95**

[B] **"Silver-Look".** Vented steel tops, easy-to-work aluminum chassis, rubber feet.

| Size | Cat. No. | Reg. | SALE |
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| 3¼ × 7½ × 5⅞" | 270-229 | 9.95 | 7.99 |
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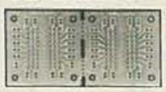
## PC Board Holder

Reg. 6.95 **4.88 Cut 30%**

Frees hands for easier soldering and repair. Mounts on bench or in a vice. Holds board securely at any angle. **276-1568 . . . . . . . . . . Sale 4.88**

## Dual IC Board



**1.49**

Accepts two 6 to 20-pin DIP ICs. Four contact points for each IC pin. **276-159 . . . . . . 1.49**

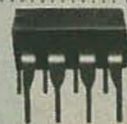
## Computer Communicators

14-Pin DIPs With Data

**1.79 Each**

**1488. RS232 Quad Line Driver.** Interfaces terminal equipment with communications devices or connects different logic families. Current limited output. Split supply, 15VDC max. **276-2520 . . . . . . . . . . . . . . . . . . . . . . . . . . 1.79**

**1489. RS232 Quad Line Receiver.** Use with above. Will perform logic level translation. Sections can be paralleled to obtain multiple outputs from one input. Input threshold hysteresis. Single supply, 10VDC maximum. **276-2521 . . . . . . . . . . . . . . . . . . . . . . . . . . 1.79**



**SN75446 Dual Peripheral Driver.** Drives relays and other devices up to 350 mA, 50VDC from logic level input. Diode-clamped inputs. Single 5.5VDC supply. **276-2530 . . . . . . . 2.79**

8-Pin DIP With Data

40-Pin DIP With Data **2.79**

**AY-3-1015. Single-Supply UART.** Full-duplex universal transceiver accepts asynchronous serial binary characters and converts to a parallel format, and vice versa. Selectable baud rate, number of data bits, stop bits, parity mode. Fully buffered outputs. Low power design. 4.75 to 5.25VDC. **276-1794 . . . . . . . . . . . . . . . . 5.95**

## EMI/RFI Filter

**11.95**

Keeps radio frequency interference from being conducted into sensitive equipment from power line or into line from equipment. 5A at 120VAC, 4A at 250VAC. **273-100 . . . . . 11.95**

## MOV Spike Protector

With Data

**V130LA10A Metal Oxide Transient Voltage Absorber.** Guards 120VAC equipment against malfunctions caused by voltage spikes. Fast response. Ideal for use with EMI/RFI filter. **276-570 . . 1.59**

**1.59** Easy to Install

## Miniature SPDT Relays

9/16 × 25/32 × ⅝"

For limited-space projects that require switching up to 3 amps at 125VAC. Excellent for computer control and other digital circuits. 72-ohm, 5VDC coil. **275-246 . . . . . . . . . . . 3.49**

**12VDC Coil.** 400 ohms, 30 milliamps. For mobile communications and automotive switching. **275-247 . . . . . . . . . . . 3.49**

**3.49 Each**

## Low-Voltage Sensor

**3.59**

TO-72 Case

**ICM7201.** Lights LED (not incl.) when voltage falls below preset 2.9V level. Add voltage divider for low-battery warning—ideal for nickel-cadmium packs! **276-2333 . . . . 3.59**

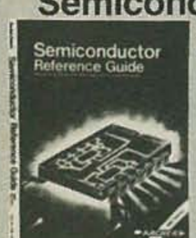
## Shielded Power Xformers

*Has Center Tap

■ *120VAC Primaries* ■ *Miniature Size* ■ *U.L. Listed*

| Secondary VAC | Cat. No. | Each |
|---|---|---|
| 6.3 at 450 mA | 273-1364 | 2.99 |
| 12.0* at 450 mA | 273-1365 | 3.59 |
| 24.0* at 450 mA | 273-1366 | 3.99 |

## Semiconductor Guide

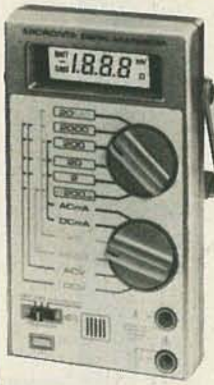


**3.49**

*Over 280 Fact-Filled Pages!*

Exclusive substitution section lists over 80,000 types and their low-cost Radio Shack equivalents! Also has pin-outs and detailed data on Radio Shack ICs, SCRs, LEDs, diodes and opto devices, replacement tips. **276-4006 . . . . . . . . 3.49**

## LCD Multimeter



**79.95**

- *Easy-to-Read Display*
- *Beep Indicates Range Change & Continuity*

Time-saving audible continuity function sounds at less than 300 ohms resistance. Tests forward conduction of diodes and transistors. Measures up to 1000 volts DC in four ranges; up to 500VAC in four ranges (accurate from 45 Hz to 10 kHz); AC and DC current up to 200 mA in six ranges; resistance to 20 megohms in six ranges. All ranges overload protected. Requires two "AA" batteries. With spare fuse and test leads. **22-191 . . . . . . . . . . . 79.95**

## Great Low Prices on Snap-In Panel Lamps

Pkg. of 2 **1.99** [A]  Pkg. of 2 **1.89** [B]

[A] **Neons.** One red, one green. Built-in resistors for 120VAC use. Mount instantly in 7/16" holes. **272-709 . . . . . . . . . . Pkg. of 2/1.99**

[B] **12V Snap-Ins.** One amber, one blue for for ½" holes. Long 4" leads. **272-335 . . . . . Pkg. of 2/1.89**

## Check These Video/RF Bargains!

[A] **UES-A56F.** Sensitive and stable—great for custom video projects and replacement. No moving parts—tuned by 0 to 28VDC control voltage. 75-ohm in/out. 12VDC. With data. **277-220 . . . . . . . . . . . . . . 24.95**

**24.95 Varactor UHF-TV Tuner**

[B] **Trimmer Capacitors.** 5-60 pF, PC mount. Ideal for IF and low-level RF peaking. 50VDC max. **272-1340 . . . . . . Pkg. of 2/1.59**

[C] **MC1330 Video Detector.** 3rd IF, detector, video and AFT buffers. 10-24VDC. **276-1757 . . . . . . . . . . . . . . 2.49**

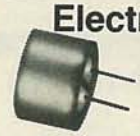
8-Pin DIP With Data

[C] **MC1350 Universal IF Amp With AGC.** For radio and TV use, DC to 60 MHz+. 12VDC. **276-1758 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2.19**

[D] **MC1358/CA3065 FM Detector.** IF amp, limiter, FM detector, electronic volume attenuator and audio driver. Perfect for homebrew receivers with 100 kHz to 5.5 MHz IFs. 10-24VDC. **276-1759 . . . . . . . . . 1.79**

14-Pin DIP With Data

## Electret Mike



**Omnidirectional.** PC mount. 20 Hz to 15 kHz response. Requires 2-10VDC, just 1 mA max. current drain. 9.4 mm dia. 6.6 mm high. **270-090 . . . . . . 1.19**

**1.19**

## Micro 5V Relay

Actual Size! **2.49**

Just 11/32 × ⅜ × ¼"! SPDT contacts: 1 amp at 125VAC. 55-ohm, 90 mA coil. .100" centers. **275-240 . . . 2.49**

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## STATIC RAMS

| | | |
|---|---|---|
| 2101 | 256 x 4 (450ns) | 1.95 |
| 5101 | 256 x 4 (450ns) (cmos) | 3.95 |
| 2102-1 | 1024 x 1 (450ns) | .89 |
| 2102L-4 | 1024 x 1 (450ns) (LP) | 1.29 |
| 2102L-2 | 1024 x 1 (250ns) (LP) | 1.69 |
| 2111 | 256 x 4 (450ns) | 2.99 |
| 2112 | 256 x 4 (450ns) | 2.99 |
| 2114 | 1024 x 4 (450ns) | 8/14.95 |
| 2114L-4 | 1024 x 4 (450ns) (LP) | 8/15.25 |
| 2114L-3 | 1024 x 4 (300ns) (LP) | 8/15.45 |
| 2114L-2 | 1024 x 4 (200ns) (LP) | 8/15.95 |
| 2147 | 4096 x 1 (55ns) | 4.95 |
| TMS4044-4 | 4096 x 1 (450ns) | 3.49 |
| TMS4044-3 | 4096 x 1 (300ns) | 3.99 |
| TMS4044-2 | 4096 x 1 (200ns) | 4.49 |
| MK4118 | 1024 x 8 (250ns) | 9.95 |
| TMM2016-200 | 2048 x 8 (200ns) | 4.15 |
| TMM2016-150 | 2048 x 8 (150ns) | 4.95 |
| TMM2016-100 | 2048 x 8 (100ns) | 6.15 |
| HM6116-4 | 2048 x 8 (200ns) (cmos) | 4.95 |
| HM6116-3 | 2048 x 8 (150ns) (cmos) | 5.95 |
| HM6116-2 | 2048 x 8 (120ns) (cmos) | 8.95 |
| HM6116LP-4 | 2048 x 8 (200ns) (cmos)(LP) | 6.95 |
| HM6116LP-3 | 2048 x 8 (150ns) (cmos)(LP) | 8.95 |
| HM6116LP-2 | 2048 x 8 (120ns) (cmos)(LP) | 10.95 |
| Z-6132 | 4096 x 8 (300ns) (Qstat) | 34.95 |

LP = Low Power  Qstat = Quasi-Static

## DYNAMIC RAMS

| | | |
|---|---|---|
| TMS4027 | 4096 x 1 (250ns) | 1.99 |
| MK4108 | 8192 x 1 (200ns) | 1.95 |
| MM5298 | 8192 x 1 (250ns) | 1.85 |
| 4116-300 | 16384 x 1 (300ns) | 8/11.75 |
| 4116-250 | 16384 x 1 (250ns) | 8/11.95 |
| 4116-200 | 16384 x 1 (200ns) | 8/13.95 |
| 4116-150 | 16384 x 1 (150ns) | 8/15.95 |
| 4116-120 | 16384 x 1 (120ns) | 8/29.95 |
| 2118 | 16384 x 1 (150ns) (5v) | 4.95 |
| MK4816 | 2048 x 8 (300ns) (5v) | 24.95 |
| 4164-200 | 65536 x 1 (200ns) (5v) | 6.25 |
| 4164-150 | 65536 x 1 (150ns) (5v) | 7.25 |

5V = single 5 volt supply

## EPROMS

| | | |
|---|---|---|
| 1702 | 256 x 8 (1us) | 4.50 |
| 2708 | 1024 x 8 (450ns) | 3.95 |
| 2758 | 1024 x 8 (450ns) (5v) | 5.95 |
| 2716 | 2048 x 8 (450ns) (5v) | 3.95 |
| 2716-1 | 2048 x 8 (350ns) (5v) | 6.25 |
| TMS2716 | 2048 x 8 (450ns) | 7.95 |
| TMS2532 | 4096 x 8 (450ns) (5v) | 7.95 |
| 2732 | 4096 x 8 (450ns) (5v) | 4.95 |
| 2732-250 | 4096 x 8 (250ns) (5v) | 12.95 |
| 2732-200 | 4096 x 8 (200ns) (5v) | 16.95 |
| 2764 | 8192 x 8 (450ns) (5v) | 16.95 |
| 2764-250 | 8192 x 8 (250ns) (5v) | 18.95 |
| 2764-200 | 8192 x 8 (200ns) (5v) | 19.95 |
| TMS2564 | 8192 x 8 (450ns) (5v) | 24.95 |
| MC68764 | 8192 x 8 (450ns) (5v)(24 pin) | call |

5v = Single 5 Volt Supply

## EPROM ERASERS

| | Timer | Capacity Chip | Intensity (uW/Cm²) | |
|---|---|---|---|---|
| PE-14 | | 6 | 5,200 | 83.00 |
| PE-14T | X | 6 | 5,200 | 119.00 |
| PE-24T | X | 9 | 6,700 | 175.00 |
| PL-265T | X | 20 | 6,700 | 255.00 |
| PR-125T | X | 16 | 15,000 | 349.00 |
| PR-320 | X | 32 | 15,000 | 595.00 |

## DISC CONTROLLERS

| | |
|---|---|
| 1771 | 16.95 |
| 1791 | 29.95 |
| 1793 | 38.95 |
| 1795 | 54.95 |
| 1797 | 54.95 |
| 6843 | 34.95 |
| 8272 | 39.95 |
| UPD765 | 39.95 |
| 1691 | 18.95 |
| 2143 | 18.95 |

## INTERFACE

| | |
|---|---|
| 8T26 | 1.69 |
| 8T28 | 2.49 |
| 8T95 | .99 |
| 8T96 | .99 |
| 8T97 | .99 |
| 8T98 | .99 |
| DM8131 | 2.95 |
| DP8304 | 2.29 |
| DS8835 | 1.99 |
| DS8836 | .99 |

## MISC.

| | |
|---|---|
| 3242 | 7.95 |
| 3341 | 4.95 |
| MC3470 | 4.95 |
| MC3480 | 9.00 |
| 11C90 | 13.95 |
| 95H90 | 7.95 |
| 2513-001 UP | 9.95 |
| 2513-002 LOW | 9.95 |

## SOUND CHIPS

| | |
|---|---|
| 76477 | 3.95 |
| 76489 | 8.95 |
| AY3-8910 | 12.95 |
| MC3340 | 1.49 |

## CRT CONTROLLERS

| | |
|---|---|
| 6845 | 14.95 |
| 68B45 | 35.95 |
| HD46505SP | 15.95 |
| 6847 | 12.25 |
| 68047 | 24.95 |
| 8275 | 29.95 |
| 7220 | 99.95 |
| CRT5027 | 39.95 |
| CRT5037 | 49.95 |
| TMS9918A | 39.95 |

## BIT-RATE GENERATORS

| | |
|---|---|
| MC14411 | 11.95 |
| BR1941 | 11.95 |
| 4702 | 12.95 |
| COM5016 | 16.95 |
| COM8116 | 10.95 |
| MM5307 | 10.95 |

## UARTS

| | |
|---|---|
| AY3-1014 | 6.95 |
| AY5-1013 | 3.95 |
| PT1472 | 9.95 |
| TR1602 | 3.95 |
| 2350 | 9.95 |
| 2651 | 8.95 |
| TMS6011 | 5.95 |
| IM6402 | 7.95 |
| IM6403 | 8.95 |
| INS8250 | 14.95 |

## KEYBOARD CHIPS

| | |
|---|---|
| AY5-2376 | 11.95 |
| AY5-3600 | 11.95 |
| 74C922 | See 74C00 |
| 74C923 | Series Prices |

## CLOCK CIRCUITS

| | |
|---|---|
| MM5314 | 4.95 |
| MM5369 | 3.95 |
| MM5375 | 4.95 |
| MM58167 | 8.95 |
| MM58174 | 11.95 |
| MSM5832 | 6.95 |

## Z-80

### 2.5 Mhz

| | |
|---|---|
| Z80-CPU | 3.95 |
| Z80-CTC | 5.95 |
| Z80-DART | 15.25 |
| Z80-DMA | 17.50 |
| Z80-PIO | 5.75 |
| Z80-SIO/0 | 18.50 |
| Z80-SIO/1 | 18.50 |
| Z80-SIO/2 | 18.50 |
| Z80-SIO/9 | 16.95 |

### 4.0 Mhz

| | |
|---|---|
| Z80A-CPU | 6.00 |
| Z80A-CTC | 8.65 |
| Z80A-DART | 18.75 |
| Z80A-DMA | 27.50 |
| Z80A-PIO | 6.00 |
| Z80A-SIO/0 | 22.50 |
| Z80A-SIO/1 | 22.50 |
| Z80A-SIO/2 | 22.50 |
| Z80A-SIO/9 | 19.95 |

### 6.0 Mhz

| | |
|---|---|
| Z80B-CPU | 17.95 |
| Z80B-CTC | 15.50 |
| Z80B-PIO | 15.50 |

### ZILOG

| | |
|---|---|
| Z6132 | 34.95 |
| Z8671 | 39.95 |

## CRYSTALS

| | |
|---|---|
| 32.768 khz | 1.95 |
| 1.0 mhz | 4.95 |
| 1.8432 | 4.95 |
| 2.0 | 3.95 |
| 2.097152 | 3.95 |
| 2.4576 | 3.95 |
| 3.2768 | 3.95 |
| 3.579535 | 3.95 |
| 4.0 | 3.95 |
| 5.0 | 3.95 |
| 5.0688 | 3.95 |
| 5.185 | 3.95 |
| 5.7143 | 3.95 |
| 6.0 | 3.95 |
| 6.144 | 3.95 |
| 6.5536 | 3.95 |
| 8.0 | 3.95 |
| 10.7836 | 3.95 |
| 14.31818 | 3.95 |
| 15.0 | 3.95 |
| 16.0 | 3.95 |
| 18.0 | 3.95 |
| 18.432 | 3.95 |
| 20.0 | 3.95 |
| 22.1184 | 3.95 |
| 32.0 | 3.95 |

## DATA ACQUISITION

| | |
|---|---|
| ADC0800 | 15.55 |
| ADC0804 | 3.49 |
| ADC0809 | 4.49 |
| ADC0817 | 9.95 |
| DAC0800 | 4.95 |
| DAC0806 | 1.95 |
| DAC0808 | 2.95 |
| DAC1020 | 8.25 |
| DAC1022 | 5.95 |
| MC1408L6 | 1.95 |
| MC1408L8 | 2.95 |

## 8000

| | |
|---|---|
| 8035 | 5.95 |
| 8039 | 6.95 |
| INS-8060 | 17.95 |
| INS-8073 | 24.95 |
| 8080 | 3.95 |
| 8085 | 5.95 |
| 8085A-2 | 11.95 |
| 8086 | 29.95 |
| 8087 | CALL |
| 8088 | 39.95 |
| 8089 | 89.95 |
| 8155 | 7.95 |
| 8156 | 8.95 |
| 8185 | 29.95 |
| 8185-2 | 39.95 |
| 8741 | 39.95 |
| 8748 | 29.95 |
| 8755 | 32.00 |

## 8200

| | |
|---|---|
| 8202 | 29.95 |
| 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 |
| 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 | 39.95 |
| 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 |

## FUNCTION GENERATORS

| | |
|---|---|
| MC4024 | 3.95 |
| LM566 | 1.49 |
| XR2206 | 3.75 |
| 8038 | 3.95 |

## INTERSIL

| | |
|---|---|
| ICL7103 | 9.50 |
| ICL7106 | 9.95 |
| ICL7107 | 12.95 |
| ICL8038 | 3.95 |
| ICM7207A | 5.59 |
| ICM7208 | 15.95 |

## 6800

| | |
|---|---|
| 68000 | 99.95 |
| 6800 | 4.95 |
| 6802 | 7.95 |
| 6808 | 13.90 |
| 6809E | 19.95 |
| 6809 | 12.95 |
| 6810 | 2.95 |
| 6820 | 4.95 |
| 6821 | 3.25 |
| 6828 | 14.95 |
| 6840 | 12.95 |
| 6843 | 34.95 |
| 6844 | 25.95 |
| 6845 | 14.95 |
| 6847 | 12.25 |
| 6850 | 3.45 |
| 6852 | 5.75 |
| 6860 | 9.95 |
| 6862 | 11.95 |
| 6875 | 6.95 |
| 6880 | 2.25 |
| 6883 | 24.95 |
| 68047 | 24.95 |
| 68488 | 19.95 |

6800 = 1MHZ

| | |
|---|---|
| 68B00 | 10.95 |
| 68B02 | 22.25 |
| 68B09E | 29.95 |
| 68B09 | 29.95 |
| 68B10 | 7.95 |
| 68B21 | 12.95 |
| 68B45 | 35.95 |
| 68B50 | 12.95 |

68B00 = 2 MHZ

## 6500

1 MHZ

| | |
|---|---|
| 6502 | 5.95 |
| 6504 | 6.95 |
| 6505 | 8.95 |
| 6507 | 9.95 |
| 6520 | 4.35 |
| 6522 | 8.75 |
| 6532 | 11.25 |
| 6545 | 22.50 |
| 6551 | 11.85 |

2 MHZ

| | |
|---|---|
| 6502A | 9.95 |
| 6522A | 11.70 |
| 6532A | 12.40 |
| 6545A | 28.50 |
| 6551A | 12.95 |

3 MHZ

| | |
|---|---|
| 6502B | 14.95 |

## EXAR

| | |
|---|---|
| XR 2206 | 3.75 |
| XR 2207 | 3.85 |
| XR 2208 | 3.90 |
| XR 2211 | 5.25 |
| XR 2240 | 3.25 |

## 9000 SERIES

| | |
|---|---|
| 9316 | 1.00 |
| 9334 | 2.50 |
| 9368 | 3.95 |
| 9401 | 9.95 |
| 9601 | .75 |
| 9602 | 1.50 |
| 96S02 | 1.95 |


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## 74LS00

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 74LS00 | .24 | 74LS86 | .39 | 74LS169 | 1.75 | 74LS323 | 2.75 |
| 74LS01 | .25 | 74LS90 | .55 | 74LS170 | 1.49 | 74LS324 | 1.75 |
| 74LS02 | .25 | 74LS91 | .89 | 74LS173 | .69 | 74LS352 | 1.29 |
| 74LS03 | .25 | 74LS92 | .55 | 74LS174 | .55 | 74LS353 | 1.29 |
| 74LS04 | .24 | 74LS93 | .55 | 74LS175 | .55 | 74LS363 | 1.35 |
| 74LS05 | .25 | 74LS95 | .75 | 74LS181 | 2.15 | 74LS364 | 1.95 |
| 74LS08 | .28 | 74LS96 | .89 | 74LS189 | 8.95 | 74LS365 | .49 |
| 74LS09 | .29 | 74LS107 | .39 | 74LS190 | .89 | 74LS366 | .49 |
| 74LS10 | .25 | 74LS109 | .39 | 74LS191 | .89 | 74LS367 | .45 |
| 74LS11 | .35 | 74LS112 | .39 | 74LS192 | .79 | 74LS368 | .45 |
| 74LS12 | .35 | 74LS113 | .39 | 74LS193 | .79 | 74LS373 | .99 |
| 74LS13 | .45 | 74LS114 | .39 | 74LS194 | .69 | 74LS374 | .99 |
| 74LS14 | .59 | 74LS122 | .45 | 74LS195 | .69 | 74LS377 | 1.39 |
| 74LS15 | .35 | 74LS123 | .79 | 74LS196 | .79 | 74LS378 | 1.18 |
| 74LS20 | .25 | 74LS124 | 2.90 | 74LS197 | .79 | 74LS379 | 1.35 |
| 74LS21 | .29 | 74LS125 | .49 | 74LS221 | .89 | 74LS385 | 1.90 |
| 74LS22 | .25 | 74LS126 | .49 | 74LS240 | .95 | 74LS386 | .45 |
| 74LS26 | .29 | 74LS132 | .59 | 74LS241 | .99 | 74LS390 | 1.19 |
| 74LS27 | .29 | 74LS133 | .59 | 74LS242 | .99 | 74LS393 | 1.19 |
| 74LS28 | .35 | 74LS136 | .39 | 74LS243 | .99 | 74LS395 | 1.19 |
| 74LS30 | .25 | 74LS137 | .99 | 74LS244 | .99 | 74LS399 | 1.49 |
| 74LS32 | .29 | 74LS138 | .55 | 74LS245 | 1.49 | 74LS424 | 2.95 |
| 74LS33 | .55 | 74LS139 | .55 | 74LS247 | .75 | 74LS447 | .37 |
| 74LS37 | .35 | 74LS145 | 1.20 | 74LS248 | .99 | 74LS490 | 1.95 |
| 74LS38 | .35 | 74LS147 | 2.49 | 74LS249 | .99 | 74LS624 | 3.99 |
| 74LS40 | .25 | 74LS148 | 1.35 | 74LS251 | .59 | 74LS668 | 1.69 |
| 74LS42 | .49 | 74LS151 | .55 | 74LS253 | .59 | 74LS669 | 1.89 |
| 74LS47 | .75 | 74LS153 | .55 | 74LS257 | .59 | 74LS670 | 1.49 |
| 74LS48 | .75 | 74LS154 | 1.90 | 74LS258 | .59 | 74LS674 | 9.65 |
| 74LS49 | .75 | 74LS155 | .69 | 74LS259 | 2.75 | 74LS682 | 3.20 |
| 74LS51 | .25 | 74LS156 | .69 | 74LS260 | .59 | 74LS683 | 3.20 |
| 74LS54 | .29 | 74LS157 | .65 | 74LS266 | .55 | 74LS684 | 3.20 |
| 74LS55 | .29 | 74LS158 | .59 | 74LS273 | 1.49 | 74LS685 | 3.20 |
| 74LS63 | 1.25 | 74LS160 | .69 | 74LS275 | 3.35 | 74LS688 | 2.40 |
| 74LS73 | .39 | 74LS161 | .65 | 74LS279 | .49 | 74LS689 | 3.20 |
| 74LS74 | .35 | 74LS162 | .69 | 74LS280 | 1.98 | 74LS783 | 24.95 |
| 74LS75 | .39 | 74LS163 | .65 | 74LS283 | .69 | 81LS95 | 1.49 |
| 74LS76 | .39 | 74LS164 | .69 | 74LS290 | .89 | 81LS96 | 1.49 |
| 74LS78 | .49 | 74LS165 | .95 | 74LS293 | .89 | 81LS97 | 1.49 |
| 74LS83 | .60 | 74LS166 | 1.95 | 74LS295 | .99 | 81LS98 | 1.49 |
| 74LS85 | .69 | 74LS168 | 1.75 | 74LS298 | .89 | 25LS2521 | 2.80 |
| | | | | | | 25LS2569 | 4.25 |

## IC SOCKETS

| | 1-99 | 100 |
|---|---|---|
| 8 pin ST | .13 | .11 |
| 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 |
| 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 | | |
| 16 pin ZIF | 6.75 | call |
| 24 pin ZIF | 9.95 | call |
| ZIF = TEXTOOL (Zero Insertion Force) | | |

## CONNECTORS

| | |
|---|---|
| RS232 MALE | 2.95 |
| RS232 FEMALE | 3.50 |
| RS232 FEMALE RIGHT ANGLE | 5.25 |
| RS232 HOOD | 1.25 |
| S-100 ST | 3.95 |
| S-100 WW | 4.95 |

## DIP SWITCHES

| | |
|---|---|
| 4 POSITION | .85 |
| 5 POSITION | .90 |
| 6 POSITION | .90 |
| 7 POSITION | .95 |
| 8 POSITION | .95 |

## 7400

| | | | |
|---|---|---|---|
| 7400 | .19 | 74132 | .45 |
| 7401 | .19 | 74136 | .50 |
| 7402 | .19 | 74141 | .65 |
| 7403 | .19 | 74142 | 2.95 |
| 7404 | .19 | 74143 | 2.95 |
| 7405 | .25 | 74145 | .60 |
| 7406 | .29 | 74147 | 1.75 |
| 7407 | .29 | 74148 | 1.20 |
| 7408 | .24 | 74150 | 1.35 |
| 7409 | .19 | 74151 | .55 |
| 7410 | .19 | 74152 | .65 |
| 7411 | .25 | 74153 | .55 |
| 7412 | .30 | 74154 | 1.25 |
| 7413 | .35 | 74155 | .75 |
| 7414 | .49 | 74156 | .65 |
| 7416 | .25 | 74157 | .55 |
| 7417 | .25 | 74159 | 1.65 |
| 7420 | .19 | 74160 | .85 |
| 7421 | .35 | 74161 | .69 |
| 7422 | .35 | 74162 | .85 |
| 7423 | .29 | 74163 | .69 |
| 7425 | .29 | 74164 | .85 |
| 7426 | .29 | 74165 | .85 |
| 7427 | .29 | 74166 | 1.00 |
| 7428 | .45 | 74167 | 2.95 |
| 7430 | .19 | 74170 | 1.65 |
| 7432 | .29 | 74172 | 5.95 |
| 7433 | .45 | 74173 | .75 |
| 7437 | .29 | 74174 | .89 |
| 7438 | .29 | 74175 | .89 |
| 7440 | .19 | 74176 | .89 |
| 7442 | .49 | 74177 | .75 |
| 7443 | .65 | 74178 | 1.15 |
| 7444 | .69 | 74179 | 1.75 |
| 7445 | .69 | 74180 | .75 |
| 7446 | .69 | 74181 | 2.25 |
| 7447 | .69 | 74182 | .75 |
| 7448 | .69 | 74184 | 2.00 |
| 7450 | .19 | 74185 | 2.00 |
| 7451 | .23 | 74186 | 18.50 |
| 7453 | .23 | 74190 | 1.15 |
| 7454 | .23 | 74191 | 1.15 |
| 7460 | .23 | 74192 | .79 |
| 7470 | .35 | 74193 | .79 |
| 7472 | .29 | 74194 | .85 |
| 7473 | .34 | 74195 | .85 |
| 7474 | .33 | 74196 | .79 |
| 7475 | .45 | 74197 | .75 |
| 7476 | .35 | 74198 | 1.35 |
| 7480 | .59 | 74199 | 1.35 |
| 7481 | 1.10 | 74221 | 1.35 |
| 7482 | .95 | 74246 | 1.35 |
| 7483 | .50 | 74247 | 1.25 |
| 7485 | .59 | 74248 | 1.85 |
| 7486 | .35 | 74249 | 1.95 |
| 7489 | 2.15 | 74251 | .75 |
| 7490 | .35 | 74259 | 2.25 |
| 7491 | .40 | 74265 | 1.35 |
| 7492 | .50 | 74273 | 1.95 |
| 7493 | .35 | 74276 | 1.25 |
| 7494 | .65 | 74279 | .75 |
| 7495 | .55 | 74283 | 2.00 |
| 7496 | .70 | 74284 | 3.75 |
| 7497 | 2.75 | 74285 | 3.75 |
| 74100 | 1.75 | 74290 | .95 |
| 74107 | .30 | 74293 | .75 |
| 74109 | .45 | 74298 | .85 |
| 74110 | .45 | 74351 | 2.25 |
| 74111 | .55 | 74365 | .65 |
| 74116 | 1.55 | 74366 | .65 |
| 74120 | 1.20 | 74367 | .65 |
| 74121 | .29 | 74368 | .65 |
| 74122 | .45 | 74376 | 2.20 |
| 74123 | .49 | 74390 | 1.75 |
| 74125 | .45 | 74393 | 1.35 |
| 74126 | .45 | 74425 | 3.15 |
| 74128 | .55 | 74426 | .85 |
| | | 74490 | 2.55 |

## CMOS

| | | | |
|---|---|---|---|
| 4000 | .29 | 4528 | 1.19 |
| 4001 | .25 | 4531 | .95 |
| 4002 | .25 | 4532 | 1.95 |
| 4006 | .89 | 4538 | 1.95 |
| 4007 | .29 | 4539 | 1.95 |
| 4008 | .95 | 4543 | 1.19 |
| 4009 | .39 | 4555 | .95 |
| 4010 | .45 | 4556 | .95 |
| 4011 | .25 | 4581 | 1.95 |
| 4012 | .25 | 4582 | 1.95 |
| 4013 | .38 | 4584 | .75 |
| 4014 | .79 | 4585 | .75 |
| 4015 | .39 | 4702 | 12.95 |
| 4016 | .39 | 74C00 | .35 |
| 4017 | .69 | 74C02 | .35 |
| 4018 | .79 | 74C04 | .35 |
| 4019 | .39 | 74C08 | .35 |
| 4020 | .75 | 74C10 | .35 |
| 4021 | .79 | 74C14 | .59 |
| 4022 | .79 | 74C20 | .35 |
| 4023 | .29 | 74C30 | .35 |
| 4024 | .65 | 74C32 | .39 |
| 4025 | .29 | 74C42 | 1.29 |
| 4026 | 1.65 | 74C48 | 1.99 |
| 4027 | .45 | 74C73 | .65 |
| 4028 | .69 | 74C74 | .65 |
| 4029 | .79 | 74C76 | .80 |
| 4030 | .39 | 74C83 | 1.95 |
| 4034 | 1.95 | 74C85 | 1.95 |
| 4035 | .85 | 74C86 | .39 |
| 4040 | .75 | 74C89 | 4.50 |
| 4041 | .75 | 74C90 | 1.19 |
| 4042 | .69 | 74C93 | 1.75 |
| 4043 | .85 | 74C95 | .99 |
| 4044 | .79 | 74C107 | .89 |
| 4046 | .85 | 74C150 | 5.75 |
| 4047 | .95 | 74C151 | 2.25 |
| 4049 | .35 | 74C154 | 3.25 |
| 4050 | .35 | 74C157 | 1.75 |
| 4051 | .79 | 74C160 | 1.19 |
| 4053 | .79 | 74C161 | 1.19 |
| 4060 | .89 | 74C162 | 1.19 |
| 4066 | .39 | 74C163 | 1.19 |
| 4068 | .39 | 74C164 | 1.39 |
| 4069 | .29 | 74C165 | 2.00 |
| 4070 | .35 | 74C173 | .79 |
| 4071 | .29 | 74C174 | 1.19 |
| 4072 | .29 | 74C175 | 1.19 |
| 4073 | .29 | 74C192 | 1.49 |
| 4075 | .29 | 74C193 | 1.49 |
| 4076 | .79 | 74C195 | 1.39 |
| 4078 | .29 | 74C200 | 5.75 |
| 4081 | .29 | 74C221 | 1.75 |
| 4082 | .29 | 74C373 | 2.45 |
| 4085 | .95 | 74C374 | 2.45 |
| 4086 | .95 | 74C901 | .39 |
| 4093 | .49 | 74C902 | .85 |
| 4098 | 2.49 | 74C903 | .85 |
| 4099 | 1.95 | 74C905 | 10.95 |
| 14409 | 12.95 | 74C906 | .95 |
| 14410 | 12.95 | 74C907 | 1.00 |
| 14411 | 11.95 | 74C908 | 2.00 |
| 14412 | 12.95 | 74C909 | 2.75 |
| 14419 | 7.95 | 74C910 | 9.95 |
| 4502 | .95 | 74C911 | 8.95 |
| 4503 | .65 | 74C912 | 8.95 |
| 4508 | 1.95 | 74C914 | 1.95 |
| 4510 | .85 | 74C915 | 1.19 |
| 4511 | .85 | 74C918 | 2.75 |
| 4512 | .85 | 74C920 | 17.95 |
| 4514 | 1.25 | 74C921 | 15.95 |
| 4515 | 1.79 | 74C922 | 4.49 |
| 4516 | 1.55 | 74C923 | 4.95 |
| 4518 | .89 | 74C925 | 5.95 |
| 4519 | .39 | 74C926 | 7.95 |
| 4520 | .79 | 74C927 | 7.95 |
| 4522 | 1.25 | 74C928 | 7.95 |
| 4526 | 1.25 | 74C929 | 19.95 |
| 4527 | 1.95 | 74C930 | 19.95 |

## *Prices Slashed!* 74S00

| | | | |
|---|---|---|---|
| 74S00 | .32 | 74S163 | 1.95 |
| 74S02 | .35 | 74S168 | 3.95 |
| 74S03 | .35 | 74S169 | 3.95 |
| 74S04 | .35 | 74S174 | .95 |
| 74S05 | .35 | 74S175 | .95 |
| 74S08 | .35 | 74S181 | 3.95 |
| 74S09 | .40 | 74S182 | 2.95 |
| 74S10 | .35 | 74S188 | 1.95 |
| 74S11 | .35 | 74S189 | 6.95 |
| 74S15 | .35 | 74S194 | 1.49 |
| 74S20 | .35 | 74S195 | 1.49 |
| 74S22 | .35 | 74S196 | 1.49 |
| 74S30 | .35 | 74S197 | 1.49 |
| 74S32 | .40 | 74S201 | 6.95 |
| 74S37 | .88 | 74S225 | 7.95 |
| 74S38 | .85 | 74S240 | 2.20 |
| 74S40 | .35 | 74S241 | 2.20 |
| 74S51 | .35 | 74S244 | 2.20 |
| 74S64 | .40 | 74S251 | .95 |
| 74S65 | .40 | 74S253 | .95 |
| 74S74 | .50 | 74S257 | .95 |
| 74S85 | 1.99 | 74S258 | .95 |
| 74S86 | .50 | 74S260 | .79 |
| 74S112 | .50 | 74S274 | 19.95 |
| 74S113 | .50 | 74S275 | 19.95 |
| 74S114 | .55 | 74S280 | 1.95 |
| 74S124 | 2.75 | 74S287 | 1.90 |
| 74S132 | 1.24 | 74S288 | 1.90 |
| 74S133 | .45 | 74S289 | 6.89 |
| 74S134 | .50 | 74S301 | 6.95 |
| 74S135 | .89 | 74S373 | 2.45 |
| 74S138 | .85 | 74S374 | 2.45 |
| 74S139 | .85 | 74S381 | 7.95 |
| 74S140 | .55 | 74S387 | 1.95 |
| 74S151 | .95 | 74S412 | 2.98 |
| 74S153 | .95 | 74S471 | 4.95 |
| 74S157 | .95 | 74S472 | 4.95 |
| 74S158 | .95 | 74S474 | 4.95 |
| 74S161 | 1.95 | 74S482 | 15.25 |
| 74S162 | 1.95 | 74S570 | 2.95 |
| | | 74S571 | 2.95 |

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| 2N3055 | NPN POWER | TO-3 | .79 | 10/6.99 |
| 3055T | NPN POWER | TO-220 | .69 | 10/5.99 |
| 2N3904 | NPN SWITCH | TO-92 | 10/1.00 | 100/8.99 |
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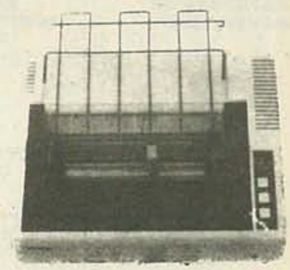

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 74LS00N | .21 | 74LS42N | .44 | 74LS138N | .50 | 74LS191N | .80 | 74LS283N | .65 |
| 74LS01N | .22 | 74LS47N | .72 | 74LS139N | .50 | 74LS192N | .70 | 74LS298N | .85 |
| 74LS02N | .24 | 74LS73N | .35 | 74LS148N | 1.33 | 74LS193N | .70 | 74LS348N | 1.65 |
| 74LS03N | .24 | 74LS74N | .32 | 74LS151N | .43 | 74LS194N | .70 | 74LS362N | 9.95 |
| 74LS04N | .24 | 74LS75N | .39 | 74LS153N | .42 | 74LS221N | .84 | 74LS365N | .48 |
| 74LS05N | .25 | 74LS76N | .39 | 74LS155N | .64 | 74LS240N | .99 | 74LS366N | .48 |
| 74LS08N | .25 | 74LS85N | .69 | 74LS157N | .44 | 74LS241N | .99 | 74LS367N | .48 |
| 74LS09N | .25 | 74LS86N | .35 | 74LS158N | .48 | 74LS242N | .99 | 74LS368N | .48 |
| 74LS10N | .24 | 74LS90N | .42 | 74LS160N | .67 | 74LS243N | .99 | 74LS373N | 1.09 |
| 74LS11N | .28 | 74LS92N | .50 | 74LS161N | .67 | 74LS244N | .99 | 74LS374N | 1.15 |
| 74LS12N | .25 | 74LS93N | .50 | 74LS163N | .69 | 74LS245N | 1.25 | 74LS375N | .60 |
| 74LS13N | .35 | 74LS96N | .69 | 74LS164N | .58 | 74LS251N | .55 | 74LS377N | 1.25 |
| 74LS14N | .38 | 74LS107N | .39 | 74LS165N | .85 | 74LS253N | .55 | 74LS378N | .99 |
| 74LS20N | .29 | 74LS112N | .35 | 74LS166N | 1.49 | 74LS257N | .55 | 74LS390N | 1.44 |
| 74LS21N | .27 | 74LS122N | .45 | 74LS170N | 1.49 | 74LS259N | 1.24 | 74LS393N | .99 |
| 74LS26N | .25 | 74LS123N | .67 | 74LS173N | .69 | 74LS266N | .42 | 74LS447N | .55 |
| 74LS30N | .25 | 74LS125N | .49 | 74LS174N | .44 | 74LS273N | .99 | 74LS624N | 1.68 |
| 74LS32N | .27 | 74LS132N | .55 | 74LS175N | .45 | 74LS279N | .44 | 74LS670N | 1.28 |
| 74LS38N | .28 | 74LS133N | .49 | 74LS189N | 3.48 | 74LS280N | 1.96 | | |

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### FAIRCHILD ADVANCED SCHOTTKY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 74F00PC | .96 | 74F64PC | .96 | 74F182PC | 3.30 | 74F353PC | 2.34 |
| 74F02PC | .96 | 74F74PC | 1.16 | 74F241PC | 4.50 | 74F373PC | 5.85 |
| 74F04PC | 1.11 | 74F138PC | 2.16 | 74F243PC | 5.25 | 74F379PC | 3.36 |
| 74F08PC | .96 | 74F139PC | 2.16 | 74F251PC | 2.34 | 74F381PC | 7.65 |
| 74F10PC | .96 | 74F153PC | 1.83 | 74F257PC | 2.34 | 74F398PC | 4.40 |
| 74F11PC | .96 | 74F157PC | 2.16 | 74F258PC | 2.34 | 74F399PC | 2.64 |
| 74F20PC | .96 | 74F158PC | 2.16 | 74F283PC | 3.40 | 74F521PC | 4.25 |
| 74F32PC | .96 | 74F175PC | 1.98 | 74F352PC | 2.34 | 74F534N | 5.85 |

## 9300 SERIES TTL

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9300PC | .79 | 9309PC | 1.56 | 9324PC | .84 | 9370PC | 2.45 |
| 9301PC | 1.35 | 9312PC | .79 | 9324PC | 2.45 | 9374PC | 2.45 |
| 9308PC | 1.75 | 9316PC | 1.65 | 9368PC | 2.39 | 93L16PC | 2.50 |
| | | | | | | 93S16PC | 2.98 |

## CMOS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4001 | .26 | 4020 | .89 | 4043 | .79 | 4073 | .26 | 4512 | .82 |
| 4002 | .26 | 4021 | .75 | 4047 | .92 | 4075 | .28 | 4514 | 1.79 |
| 4006 | .89 | 4022 | .89 | 4049 | .50 | 4076 | .85 | 4515 | 1.79 |
| 4009 | .46 | 4023 | .26 | 4051 | .90 | 4077 | .26 | 4518 | .79 |
| 4010 | .42 | 4024 | .69 | 4052 | .95 | 4078 | .26 | 4520 | .80 |
| 4011 | .26 | 4025 | .25 | 4053 | .95 | 4081 | .26 | 4528 | .99 |
| 4012 | .25 | 4027 | .55 | 4060 | .89 | 4082 | .28 | 4532 | 1.05 |
| 4013 | .49 | 4028 | .70 | 4066 | .65 | 4093 | .65 | 4555 | .65 |
| 4015 | .78 | 4029 | .85 | 4068 | .30 | 4104 | 2.99 | 4556 | .70 |
| 4016 | .45 | 4030 | .58 | 4069 | .26 | 4502 | .89 | 4582 | .75 |
| 4017 | .75 | 4035 | .89 | 4070 | .26 | 4510 | .94 | 4584 | .63 |
| 4018 | .75 | 4040 | .88 | 4071 | .26 | 4511 | .85 | 4702 | 8.96 |
| 4019 | .62 | 4042 | .75 | 4072 | .26 | | | | |

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## LINEAR IC'S

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 301ATC | .32 | 358TC | .44 | 741PC | .48 | 3302PC | .69 |
| 308TC | .59 | 380PC | .84 | 741TC | .29 | 3403PC | .96 |
| 309KC | 1.25 | 393TC | .45 | 747PC | .50 | 3900PC | .59 |
| 311TC | .48 | 555TC | .25 | 1458TC | .32 | 4136PC | .88 |
| 317KC | 2.25 | 556PC | .64 | 1488PC | .78 | 4151TC | .96 |
| 317UC | 1.25 | 567TC | .80 | 1489APC | .68 | 4558TC | .44 |
| 318TC | 1.25 | 709HC | .48 | 2207PC | 3.19 | N8T26N | 1.36 |
| 323KC | 3.96 | 723PC | .42 | 2211PC | 2.89 | AM26LS31CN | 2.25 |
| 324PC | .48 | 725TC | 1.25 | 2240PC | 1.39 | AM26LS32CN | 2.25 |
| 337UC | 1.65 | 733PC | .79 | 3081PC | 1.09 | ULN2002AN | .96 |
| 339PC | .45 | 741HC | .64 | 3086PC | .59 | | |

KC = TO3, UC = TO220, HC = TO5, TC = 8 PIN MINI DIP, N or PC = DUAL IN LINE IC

## SCR'S AND TRIACS

| | | | | |
|---|---|---|---|---|
| TIC 45 | SCR | .6 AMP | 200V | .51 |
| TIC 47 | SCR | .6 AMP | 400V | .59 |
| 2N5064 | SCR | .8 AMP | 200V | .39 |
| TIC 106D | SCR | 5 AMP | 400V | .59 |
| TIC 116D | SCR | 8 AMP | 400V | 1.19 |
| TIC 116E | SCR | 8 AMP | 500V | 1.89 |
| TIC 116M | SCR | 8 AMP | 600V | 2.38 |
| TIC 126D | SCR | 12 AMP | 400V | 1.48 |
| TIC 206D | TRIAC | 3 AMP | 400V | .99 |
| TIC 216B | TRIAC | 6 AMP | 200V | 1.12 |
| TIC 216D | TRIAC | 6 AMP | 400V | 1.96 |
| TIC 226D | TRIAC | 8 AMP | 400V | 1.10 |
| TIC 226E | TRIAC | 8 AMP | 500V | 1.29 |
| TIC 236D | TRIAC | 12 AMP | 400V | 1.30 |
| TIC 246D | TRIAC | 16 AMP | 400V | 1.60 |
| TIC 263D | TRIAC | 25 AMP | 400V | 2.59 |

## SILICONIX VMOS

| | | | |
|---|---|---|---|
| VN46AF | 40V 15W | | .98 |
| VN66AF | 60V 15W | | 1.28 |
| VN88AF | 80V 15W | 4 OHMS | 1.38 |
| VN89AF | 80V 15W | 4.5 OHMS | 1.28 |
| VN10KM | 60V 1W | | .69 |
| 2N6657 | 60V 25W | | 4.98 |
| 2N6658 | 90V 25W | | 6.88 |
| 2N6659 | 35V 6.25W | | 4.60 |
| 2N6660 | 60V 6.25W | | 2.69 |
| 2N6661 | 90V 6.25W | | 4.44 |

## PLASTIC POWER TRANSISTORS

| | | | |
|---|---|---|---|
| TIP 29C | .49 | TIP 107 | .99 |
| TIP 30C | .50 | TIP 112 | .72 |
| TIP 31C | .50 | TIP 115 | .69 |
| TIP 32C | .55 | TIP 117 | .74 |
| TIP 33C | .92 | TIP 122 | .76 |
| TIP 34C | .99 | TIP 125 | .75 |
| TIP 35C | 1.89 | TIP 127 | .82 |
| TIP 36C | 1.97 | TIP 142 | 1.91 |
| TIP 41C | .68 | TIP 146 | 1.79 |
| TIP 42C | .78 | TIP 147 | 2.15 |
| TIP 47 | .62 | TIP 152 | 1.27 |
| TIP 50 | .79 | TIP 161 | 2.49 |
| TIP 51 | 1.48 | TIP 620 | 1.54 |
| TIP 54 | 1.88 | TIP 2955 | .82 |
| TIP 102 | .98 | TIP 3055 | .72 |

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| | | | |
|---|---|---|---|
| SD41 | 30 AMPS | 45 VOLTS | 3.95 |
| SD51 | 60 AMPS | 45 VOLTS | 6.95 |

## SCHOTTKY BARRIER DIODES

| | | | |
|---|---|---|---|
| 1SS97 | UHF | MIXER | .36 |
| 1SS98 | UHF | DETECTOR | .35 |

## VOLTAGE REGULATORS

**1 AMP POSITIVE**

| | | | | |
|---|---|---|---|---|
| 78XXUC | T0220 CASE | | Reduced | .68 |
| 78XXKC | T03 CASE | | | 1.36 |

**1 AMP NEGATIVE**

| | | | | |
|---|---|---|---|---|
| 79XXUC | T0220 CASE | | Reduced | .69 |
| 79XXKC | T03 CASE | | | 1.44 |

**5 AMPS POSITIVE**

| | | | | |
|---|---|---|---|---|
| 78H05SC | 5 VOLTS | T03 CASE | Reduced | 5.95 |
| 78H12ASC | 12 VOLTS | T03 CASE | Reduced | 7.25 |
| 78HGASC | ADJUSTABLE | T03 CASE | Reduced | 6.45 |

**10 AMPS POSITIVE**

| | | | | |
|---|---|---|---|---|
| 78P05SC | 5 VOLTS | T03 CASE | Reduced | 9.45 |

## BIFETS OP-AMPS

| | |
|---|---|
| TL071 CP | .68 |
| TL072 CP | .96 |
| TL074 CN | 1.75 |
| TL081 CP | .64 |
| TL082 CP | .96 |
| TL084 ACN | 2.85 |
| TL084 CN | 1.65 |
| TL431 CLP | .72 |
| TL495 CN | 4.65 |
| TL497 ACN | 2.45 |
| TL604 CP | 1.25 |

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|---|---|---|---|---|---|
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| P2101-25 | 1K | (256 x 4) | 250NS 22 PIN | | 2.65 |
| P2102-25L | 1K | (1K x 1) | 250NS 16 PIN LOW POWER | | 1.59 |
| P2112-25 | 1K | (256 x 4) | 250NS 16 PIN | | 2.75 |
| P2114-20L | 4K | (1K x 4) | 200NS 18 PIN LOW POWER | | 1.89 |
| P2114-30L | 4K | (1K x 4) | 300NS 18 PIN LOW POWER | | 1.69 |
| P2147-055 | 4K | (4K x 1) | 55NS 18 PIN | | 3.95 |
| P4315-45L | 4K | (4K x 1) | 450NS 18 PIN (CMOS) LOW POWER | | 4.95 |
| C2167-070 | 16K | (16K x 1) | 70NS 20 PIN | | 18.50 |
| P5516-25L | 16K | (2K x 8) | 250NS 24 PIN (CMOS) | Reduced | 14.95 |
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| P6116-20 | 16K | (2K x 8) | 200NS 24 PIN (CMOS) | Reduced | 7.95 |
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|---|---|---|---|---|---|
| P4050-30 | 4K | (4K x 1) | 300 NS 18 PIN | | 3.65 |
| P4060-30 | 4K | (4K x 1) | 300 NS 22 PIN | | 3.65 |
| P4116-15 | 16K | (16K x 1) | 150 NS 16 PIN | | 2.45 |
| P4116-20 | 16K | (16K x 1) | 200 NS 16 PIN | | 1.40 |
| P4116-25 | 16K | (16K x 1) | 250 NS 16 PIN | | 1.35 |
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| P4416-20 | 64K | (16K x 4) | 200 NS 16 PIN | | 25.95 |

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| C2708-45 | 8K (1K x 8) | 450NS | 24 PIN | | 6.95 |
| C2716 / TMS2516 | 16K (2K x 8) | 450NS | 24 PIN | | 6.25 |
| | SINGLE 5 VOLT SUPPLY, INTEL PIN OUT | | | | |
| C2516-35 | 16K (2K x 8) | 350NS | 24 PIN | | 7.75 |
| | SINGLE 5V SUPPLY, INTEL PIN OUT | | | | |
| TMS2716 | 16K (2K x 8) | 450NS | 24 PIN | | 10.95 |
| | 3 POWER SUPPLY, T I PIN OUT | | | | |
| C2532 | 32K (2K x 8) | 450NS | 24 PIN | Reduced | 9.45 |
| | T I PIN OUT | | | | |
| C2732 | 32K (4K x 8) | 450NS | 24 PIN | Reduced | 8.95 |
| | INTEL PIN OUT | | | | |
| C2764-30 | 64K (8K x 8) | 300NS | 28 PIN | Reduced | 28.95 |
| | INTEL PIN OUT | | | | |
| C2764-45 | 64K (8K x 8) | 450NS | 28 PIN | | 26.95 |
| | INTEL PIN OUT | | | | |

## BIPOLAR PROM'S

| | | | | | |
|---|---|---|---|---|---|
| 6330/82S23 | 32 x 8 | OC | 16 PIN | Reduced | 1.95 |
| 6331/82S123 | 32 x 8 | TS | 16 PIN | Reduced | 2.35 |
| 93417/82S126 | 256 x 4 | OC | 16 PIN | Reduced | 2.35 |
| 93427/82S129 | 256 x 4 | TS | 16 PIN | Reduced | 2.35 |
| 93448/6341 | 512 x 8 | TS | 24 PIN | Reduced | 6.50 |
| 93453/82S137 | 1024 x 4 | TS | 18 PIN | | 6.50 |
| 93451/82S181 | 1024 x 8 | TS | 24 PIN | | 10.95 |
| 7128/27S185 | 2048 x 4 | TS | 18 PIN | Reduced | 12.95 |
| 7138/28S166 | 2K x 8 | TS | 24 PIN | | 21.80 |
| 7142/82S321 | 4K x 8 | TS | 24 PIN | | 49.95 |

TS = TRISTATE, OC = OPEN COLLECTOR

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|---|---|---|
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| 6802 | CPU | 7.95 |
| 6808 | CPU | 8.45 |
| 6809 | CPU | 13.95 |
| 6810 | RAM | 2.65 |
| 6821 | PIA | 2.65 |
| 6840 | PTM | 7.95 |
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| 6852 | SSDA | 4.85 |

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| Z80A-DMA | 15.95 |
| Z80A-SIO/2 | 17.25 |

## 8080 FAMILY

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|---|---|---|---|---|---|
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| 8039 | Reduced | 8.95 | 8226 | | 2.25 |
| 8080A | | 4.45 | 8228 | Reduced | 4.40 |
| 8085A | | 6.95 | 8251A | | 5.95 |
| 8086 | | 34.95 | 8253 | Reduced | 8.45 |
| 8748 | | 28.95 | 8255 | Reduced | 5.05 |
| 8155 | | 9.00 | 8257 | | 8.05 |
| 8212 | | 2.25 | 8259A | | 7.50 |

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| 33PF | 500V | .12 | 820PF | 1000V | .12 | .0100MF | 100V | .12 |
| 47PF | 500V | .12 | .0010MF | 500V | .12 | .0150MF | 500V | .14 |
| 68PF | 500V | .12 | .0012MF | 500V | .12 | .0200MF | 500V | .16 |
| 100PF | 500V | .12 | .0015MF | 500V | .12 | .0220MF | 50V | .16 |
| 120PF | 500V | .12 | .0022MF | 500V | .12 | .0330MF | 50V | .12 |
| 150PF | 500V | .12 | .0027MF | 100V | .12 | .0470MF | 50V | .12 |
| 180PF | 500V | .12 | .0033MF | 100V | .12 | .0500MF | 12V | .13 |
| 220PF | 500V | .12 | .0047MF | 50V | .12 | .0680MF | 50V | .13 |
| 220PF | 1000V | .12 | .0047MF | 500V | .12 | .1000MF | 50V | .16 |
| 330PF | 500V | .12 | .0050MF | 500V | .12 | .1000MF | 100V | .19 |
| 470PF | 500V | .12 | .0068MF | 500V | .12 | | | |

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| 334X9035 | .33MFD | 35V | .35 | 685X9035 | 6.8MFD | 35V | .90 |
| 474X9035 | .47MFD | 35V | .35 | 106X9035 | 10 MFD | 35V | 1.20 |
| 684X9035 | .68MFD | 35V | .35 | 186X9050 | 18 MFD | 50V | 6.50 |
| 105X9035 | 1 MFD | 35V | .35 | 226X9003 | 22 MFD | 3V | .50 |
| 155X9025 | 1.5 MFD | 25V | .35 | 226X9015 | 22 MFD | 15V | 1.00 |
| 225X9016 | 2.2 MFD | 16V | .35 | 476X9010 | 47 MFD | 10V | 1.50 |
| 225X9035 | 2.2 MFD | 35V | .89 | 476X9035 | 47 MFD | 35V | 8.99 |
| 225X9050 | 2.2 MFD | 50V | .89 | 107X9016 | 100 MFD | 16V | 5.50 |
| | | | | 227X9010 | 220 MFD | 10V | 6.95 |

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| 49-1115S | 15 | 4.80 |
| 49-1125P | 25 | 5.50 |
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| 49-1137P | 37 | 7.90 |
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S = SOCKET, P = PLUG

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|---|---|---|---|---|---|
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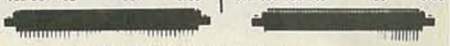
| 307-010-501-102 | 10 | 2.11 | 307-030-500-202 | 30 | 3.18 |
| 307-012-500-202 | 12 | 1.85 | 307-036-501-178 | 36 | 6.48 |
| 307-015-501-102 | 15 | 2.58 | 307-044-500-202 | 44 | 4.11 |
| 307-018-521-102 | 18 | 2.95 | 307-056-500-202 | 56 | 5.46 |
| 307-020-500-202 | 20 | 2.48 | 307-072-520-202 | 72 | 5.99 |
| 307-022-501-102 | 22 | 3.36 | 307-086-500-202 | 86 | 8.25 |



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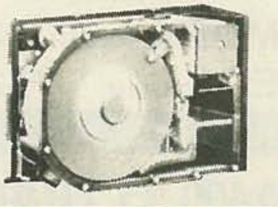

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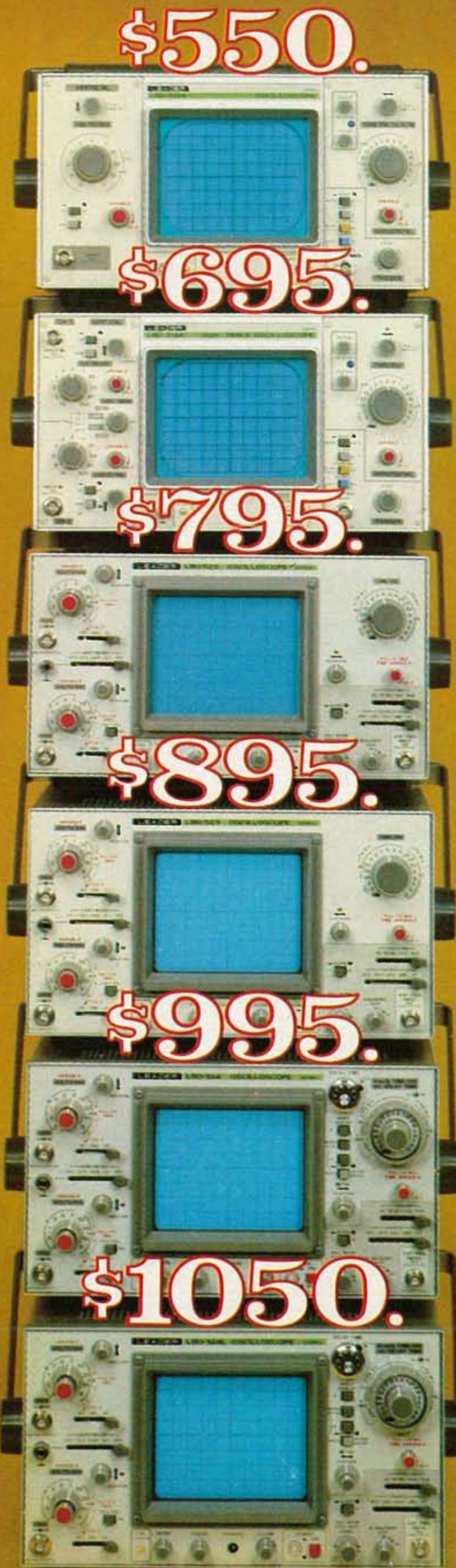


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