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Radio-Electronics

$1.75 MAY 1984

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Vote for the 3D TV system you like best. See how they work and back the one you like best.

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3:00 AM and it's a wrong number! Build our gadget and stop them cold.

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Cut through the hype– Select a computer modem that doesn't do more than you need.

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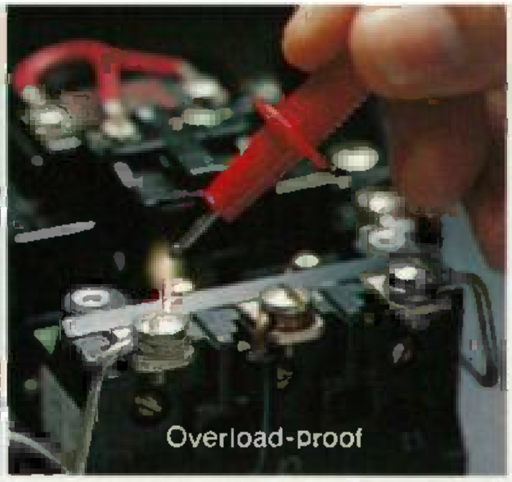

Overload-proof

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.

More Meter for Your Money

For starters you can get 2000 hours of continuous use from a common 9V transistor battery. You can run in-circuit diode tests and check continuity. You even get a one year warranty.

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, 630 Puente Street, Brea, CA 92621; (714) 773-8453.

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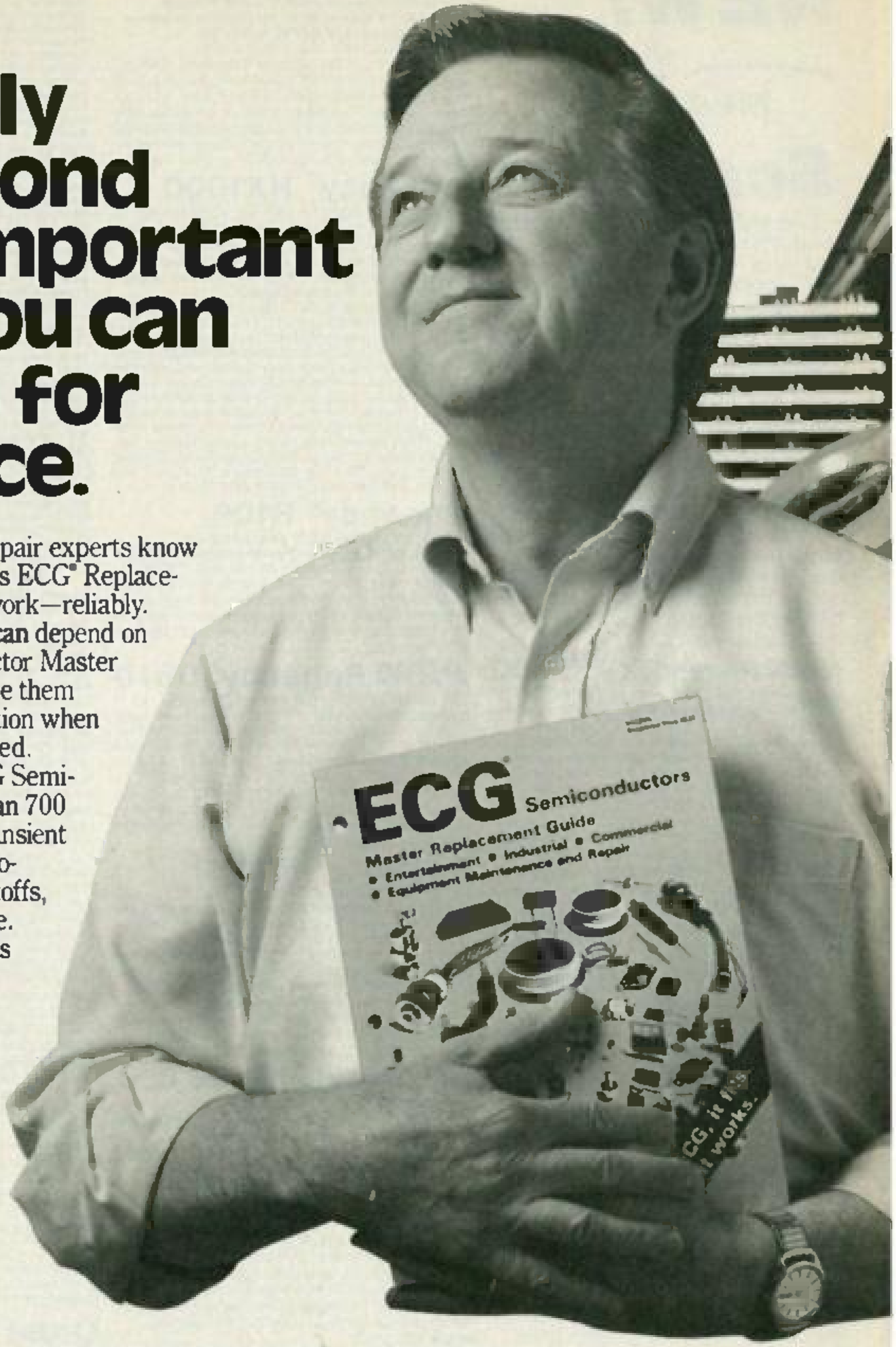
Probably the second most important book you can turn to for guidance.



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If it's ECG, it fits. And it works.

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CIRCLE 47 ON FREE INFORMATION CARD

NEW! Regency® Scanners

Communications Electronics™, the world's largest distributor of radio scanners, introduces new models with special savings on all radio scanners. Chances are the police, fire and weather emergencies you'll read about in tomorrow's paper are coming through on a scanner today.

We give you excellent service because CE distributes more scanners worldwide than *anyone* else. Our warehouse facilities are equipped to process thousands of scanner orders every week. We also export scanners to over 300 countries and military installations. Almost all items are **in stock for quick shipment**, so if you're a person who prefers fact to fantasy and who needs to know what's *really* happening around you, order your radio today from CE.

NEW! Regency® MX5000

List price $599.95/CE price $379.00
Multi-Band, 20 Channel • No-crystal scanner
Search • Lockout • Priority • AC/DC
Selectable AM-FM modes • LCD display
World's first continuous coverage scanner
Frequency range: 25-550 MHz continuous coverage.
Never before have so many features come in such a small package. The *Regency* MX5000 mobile or home scanner has continuous coverage from 25 to 550 MHz. That means you can hear CB, Television audio, FM broadcast stations, all aircraft bands including military and the normal scanner bands, all on your choice of 20 programmable channels.

NEW! Regency® MX3000

List price $299.95/CE price $181.00
6-Band, 30 Channel • No-crystal scanner
Search • Lockout • Priority • AC/DC
Bands: 30-50, 144-174, 440-512 MHz.
The *Regency* Touch MX3000 provides the ease of computer controlled, touch-entry programming in a compact-sized scanner for use at home or on the road. Enter your favorite public service frequencies by simply touching the numbered pressure pads. You'll even hear a "beep" tone that lets you know you've made contact.

In addition to scanning the programmed channels, the MX3000 has the ability to search through as much as an entire band for an active frequency. The MX3000 includes channel 1 priority, dual scan speeds, scan or search delay and a brightness switch for day or night operation.

NEW! Regency® Z30

List price $269.95/CE price $179.00
6-Band, 30 Channel • No-crystal scanner
Bands: 30-50, 144-174, 440-512 MHz.
Cover your choice of over 15,000 frequencies on 30 channels at the touch of your finger.

NEW! JIL SX-200

CE price $264.00/***NEW LOW PRICE***
8-Band, 16 Channel • No-crystal scanner
Quartz Clock • AM/FM • AC/DC
Bands: 26-88, 108-180, 380-514 MHz.
Tune Military, F.B.I., Space Satellites, Police & Fire, D.E.A. Defense Department, Aeronautical AM band, Aero Navigation Band, Fish & Game, Immigration, Paramedics, Amateur Radio, Justice Department, State Department, plus thousands of other *restricted* radio frequencies no other scanner is programmed to pick up.

Regency® HX1000

Allow 60-120 days for delivery after receipt of order due to the high demand for this product.
List price $329.95/CE price $209.00
6-Band, 20 Channel • No Crystal scanner
Search • Lockout • Priority • Scan delay
Sidelit liquid crystal display
Frequency range: 30-50, 144-174, 440-512 MHz.
The new handheld *Regency* HX1000 scanner is fully keyboard programmable for the ultimate in versatility. You can scan up to 20 channels at the same time. When you activate the priority control, you automatically override all other calls to listen to your favorite frequency. The LCD display is even sidelit for night use. A die-cast aluminum chasis makes this the most rugged and durable hand-held scanner available. There is even a backup lithium battery to maintain memory for two years. Includes wall charger, carrying case, belt clip, flexible antenna and nicad battery. Reserve your *Regency* HX1000 now.

Regency® R106

List price $149.95/CE price $92.00
5-Band, 10 Channel • Crystal scanner • AC/DC
Frequency range: 30-50, 146-174, 450-512 MHz.
A versatile scanner, The *Regency* R-106 is built to provide maximum reception at home or on the road. Rugged cabinet protects the advanced design circuitry allowing you years of dependable listening.

NEW! Regency® D810

List price $399.95/CE price $244.00
8-Band, 50 Channel • Crystalless • AC only
Bands: 30-50, 88-108, 118-136, 144-174, 440-512 MHz.
This scanner offers Public service bands, plus Aircraft and FM broadcast stations. You can listen to Bach or a Boeing 747, the Rolling Stones or the riot squad, or any of 50 channels. Plus special direct access keys let you listen to police, fire, emergency, or any of your favorite channels just by pushing a button.

Regency® R1040

List price $199.95/CE price $124.00
6-Band, 10 Channel • Crystalless • AC only
Frequency range: 30-50, 144-174, 440-512 MHz.
Now you can enjoy computerized scanner versatility at a price that's less than some crystal units. The *Regency* R1040 lets you in on all the action of police, fire, weather, and emergency calls. You'll even hear mobile telephones.

Programming the R1040 is easy. Merely touch the keyboard and enter any of over 15,000 frequencies on your choice of 10 channels.

NEW! Regency® HX650

List price $119.95/CE price $79.00
5-Band, 6 Channel • Handheld crystal scanner
Bands: 30-50, 146-174, 450-512 MHz.
Now you can tune in any emergency around town, from wherever you are, the second it happens. Advanced circuitry gives you the world's smallest scanner. Our low CE price includes battery charger/A.C. adapter.

QUANTITY DISCOUNTS AVAILABLE

Order two scanners at the same time and deduct 1%, for three scanners deduct 2%, four scanners deduct 3%, five scanners deduct 4% and six or more scanners purchased at the same time earns you a 5% discount off our super low single unit price.

OTHER RADIOS & ACCESSORIES

Regency® C403 Scanner	$59.00
Regency® Z10 Scanner	$149.00
Panasonic RF-9 Shortwave receiver	$84.00
Panasonic RF-B50 Shortwave receiver	$129.00
Panasonic RF-799 Shortwave receiver	$219.00
Panasonic RF-2600 Shortwave receiver	$199.00
Panasonic RF-2900 Shortwave receiver	$249.00
Panasonic RF-3100 Shortwave receiver	$279.00
Panasonic RF-6300 Shortwave receiver	$195.00
Panasonic RF-B600 Shortwave receiver	$429.00
Panasonic RF-6300 Shortwave receiver	$539.00
Bearcat® † 350 Scanner	$399.00
Bearcat® 300 Scanner	$349.00
Bearcat® 260 Scanner	$259.00
Bearcat® 250 Scanner	$279.00
Bearcat® 200 Scanner	$189.00
Bearcat® 210XL Scanner	$229.00
Bearcat® 20/20 Scanner	$289.00
Bearcat® 151 Scanner	$169.00
Bearcat® 100 Scanner	$289.00
Bearcat® Five-Six Scanner	$129.00
Bearcat® DX1000 Shortwave Receiver	$489.00
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Freedom Phone® 4000 Cordless telephone	$239.00
Fanon FCT-200 Cordless telephone	$139.00
SP55 Carrying case for Bearcat Five-Six	$15.00
MA-506 Carrying case for Regency HX650	$15.00
FB-E Frequency Directory for Eastern U.S.A.	$12.00
FB-W Frequency Directory for Western U.S.A.	$12.00
TSG "Top Secret" Registry of U.S. Government Freq.	$15.00
RRF Railroad Frequency Directory	$10.00
ESD Energy Services Directory	$10.00
ASD Frequency Directory for Aircraft Band	$10.00
SRF Survival Radio Frequency Directory	$10.00
TIC Techniques for Intercepting Comm. Manual	$12.00
CIE Covert Intelligence, Elect. Eavesdropping Man.	$12.00
B-4 1.2 V AAA Ni-Cad batteries (set of four)	$9.00
B-6 1.2 V AA Ni-Cad batteries (set of four)	$12.00
A-135c Crystal certificate	$3.00
A60 Magnet mount mobile antenna	$35.00
A70 Base station antenna	$35.00

Add $3.00 shipping for all accessories ordered at the same time.
Add $12.00 per shortwave receiver for U.P.S. shipping.
Add $3.00 shipping per scanner antenna.

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CIRCLE 35 ON FREE INFORMATION CARD

Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

MAY 1984 Vol. 55 No. 5

ON THE COVER

Does your state require that your car pass an annual emissions tests? In those states that do, many "do-it-yourselfers" are beginning to feel left out. After all, who else but the state-licensed inspection shop can make the emission test? If you build this month's featured project, you'll be able to keep tabs on your own emissions—even while you're driving! The story begins on page 47.

WILL THERE EVER BE A 3-D TV system that will give us more than eye strain? Carl Laron, our Associate Editor takes a look at three systems that look promising. Each has its own advantages—and drawbacks. But one thing is sure: You'll be hearing a lot more about those systems in the future. But read about them here first, starting on page 57.

COMING NEXT MONTH
On Sale May 22

- **Satellite TV.** A special section that deals with antennas, downconverters, receivers, and more, including a look at DBS.
- **Repairing PC Boards.** It's easy—we'll show you
- **Tuning Microwave Downconverters.** It's easier than you think and you don't have to perch yourself on your roof!
- **And lots more!**

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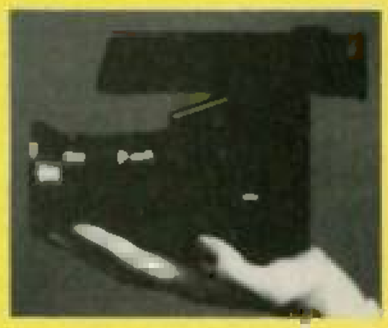
VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR



8mm CAMCORDER

Eastman Kodak's debut in video has upset the plans of the Japanese VCR establishment. Kodak jumped the gun on what seemed to be a tacit agreement to hold up introduction of the new 8mm-Video format until 1985, at the earliest, by demonstrating two one-piece camera-recorder combinations slated for sale in the U.S. in July. (See left-hand photo.) Kodak's machines weigh about 5½ pounds with battery and the little cassette, which is about the size of an audio cassette. The camera section contains a newly designed ⅔-inch Newvicon pickup tube, a ½-inch electronic viewfinder, and a 6:1 power zoom; the recorder section has two video heads, fast-forward, reverse, and visual scan. The deluxe model adds autofocus, fade-in and fade-out, three heads, still-frame, and the ability to superimpose the date on the recorded picture.

For playback, the entire camcorder is placed in a "cradle," which contains RF circuitry and a battery charger. An accessory to the cradle is a slip-in tuner-timer for recording off the air or from cable. The cassettes initially will be available in 30-, 60- and 90-minute lengths, in either metal powder or metal evaporated tape. Suggested list prices of the camcorders are $1,599 and $1,899; the obligatory cradle is $199, and the tuner-timer $300. However, the products actually are expected to sell for considerably less. The camcorders are made by Matsushita, the tape by TDK, both in Japan.

TINY CAMERAS

Just about the time that 8mm is being introduced, along comes a barrage of miniaturized, lightweight cameras designed to be used with portable VCR's. Sony has introduced a camera using a CCD pickup; it weighs two pounds five ounces and sells for $1,350. (See right-hand photo.) RCA countered with a palm-sized MOS camera, weighing two ounces less, for $995. But the lightest one introduced to date has a pickup tube instead of a solid-state sensor. It's made by Konika and weighs less than one pound ten ounces, has a new ½-inch "Cosvicon" tube, and sells for $750. Its light weight is due partially to the fact that it lacks such features as electronic viewfinder and motorized zoom lens—it has a 3:1 manual zoom and a through-the-lens viewfinder. Upcoming are solid-state cameras from Sanyo and Fisher patterned after 35mm still-film cameras.

THE SWITCH TO VHS

As I forecasted in this space last month, Zenith has dropped its line of Beta VCR's and joined the VHS camp with a line of recorders made to its specifications by JVC. Included in the five-unit line is the miniaturized *Video Movie* camcorder, the hit of Berlin's Audio-Video Fair (**Radio-Electronics**, December 1983). *Video Movie* uses the 20-minute VHS-C cassette, which can be played back on any VHS deck by placing it in an adaptor. Zenith's home decks all feature remote control units that will operate any Zenith infrared remote-control TV set that was made since 1977. In addition to Zenith, NEC—long a Beta stalwart—has added VHS to its new line in the United States, but NEC is also retaining its line of Beta machines. Thus NEC, with nine different VCR models, including the *Betamovie* camcorder, has more VCR's than any other brand. **R-E**

TEK 2213A/2215A
60 MHZ OSCILLOSCOPES

THE PERFORMANCE/
PRICE STANDARD

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

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

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

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

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

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

Specification enhancement	2213/2215 "A" Series	2213/2215
CRT brightness	1.4 kv accel. potential	10 kv accel. potential
Vertical accuracy	3%. 0° to 50°C	3%. +20° to 30°C
Chop rate	500 kHz	250 kHz
Input capacitance	20 pF	30 pF
CMRR	10 to 1 at 25 MHz	10 to 1 at 10 MHz
Channel isolation	100:1 at 25 MHz	Not specified
A Trigger sensitivity (int)	0.3 div at 5 MHz	0.4 div at 2 MHz
TV triggering	1.0 div compos. sync	2.0 div compos. sync
Sweep accuracy (in 10X)	4%, 15° to 35°C	5%, 20° to 30°C
Delay jitter	20,000 to 1 (2215A) 10,000 to 1 (2213A)	10,000 to 1 (2215) 5,000 to 1 (2213)
Holdoff Range	10:1	4:1

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

Talk to our technical experts.

Call toll-free: 1-800-426-2200 Ext. 156.

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*Price F.O.B. Beaverton, OR
All scopes are UL Listed and CSA approved. 3-year warranty includes CRT and applies to 2000 family oscilloscopes purchased after 1/1/83

WHAT'S NEWS

Philips and Sony agree on a CD read-only memory format

Philips and Sony have announced agreement on a basic format for a Compact-Disc Read-Only Memory system. Details will be formalized shortly.

The new format is based on the Compact-Disc Digital-Audio System sound-reproduction format. Since June, 1980, Philips and Sony have been studying the possibilities of using the CD as a read-only memory, to take advantage of its large capacity, compactness, and ease of operation.

The CD read-only memory has a storage capacity of 550 megabytes, which is 500 to 1,000 times that of conventional floppy disks. The 12-cm disc can contain the contents of up to 12,000 standard typewritten sheets.

The new CD read-only memory standard format comes as an addition to the existing CD standard for audio applications, which remains unchanged.

MCI plans new services to Belgium and Greece

MCI, an international voice- and data-communications services company, is preparing to test direct-dial voice services to Greece and Belgium in preparation for implementing service between the United States and those countries.

MCI officials have stated that, with the encouragement of the Federal Communications Commission—which has urged U.S. carriers to seek arrangements to provide international services—negotiations with Belgium and Greece have reached the stage where MCI has asked the FCC for permission to conduct the tests.

Games and education software to boom?

"If 1982 was 'the year the computer came home'," says Frost & Sullivan, international market researchers, "the year 1983 is programmed to be the beginning of a home-computer software boom." But games and education, rather than home-finance and word-processing programs, will dominate.

Software for machines costing less than $1,000 should increase 70 percent per year between 1984 and 1986. Games will represent well over 50 percent of the software sold for home use. Educational software will advance from almost 3 million units in 1983 to more than 18 million in 1986, according to the report. That will increase its share of the market to 20 percent.

Home-management software has not been as popular, partly because low-end home computers lack the memory needed by many of the programs. With the coming of more powerful small computers, however, the segment is expected to increase its present 5 percent share over the next few years.

Navigation satellites outlive expectations

The U.S. Navy *Transit* satellites placed in orbit in the early '70's have greatly surpassed their expected lifetimes. RCA Astro Electronics made fifteen satellites for the Navy's Strategic Systems Project Office, three of which were immediately launched, while the others were held as spares. Two of the original three are still operating. Their long life and high reliability have kept the remaining twelve in ground storage.

Those drum-shaped satellites, traveling in polar orbits, beam signals to ground every two minutes. Using those signals, ships or aircraft with the required on-board equipment can ascertain their positions on or over Earth's surface within a few hundred feet.

RCA Astro-Electronics is now modifying eight of the remaining *Transit* satellites for dual launches, beginning in 1985. That operation is known as Stacked Oscars in Service. The satellites will be kept in orbital storage where they will be more readily available when needed.

Videocassette sales pass $3-million mark

Sales of videocassette recorders (VCR's) in 1983 had topped the $3-million mark in October, the Electronic Industries Association's Consumer Electronics Group reports. Sales to that date amounted to nearly 400,000 units, up 91.8 percent over the same period in 1982.

Color TV's also registered impressive gains. Sales up to October exceeded 11 million units, an improvement of more than 20 percent over the first 10 months of 1982. Black-and-white-TV sales were slightly lower than in the same period the previous year.

RCA builds three advanced satellites

Three Advanced TIROS-N satellites are being built for NOAA (National Oceanic and Atmospheric Agency) under the supervision of NASA's Goddard Space Flight Center in Greenbelt, MD. Advanced TIROS-N's are the fourth generation of satellites built since the launch of the first weather satellite, TIROS-1, in 1960. They will bring the TIROS-N series to 11 spacecraft.

Each satellite is equipped with systems to collect meteorological data from several-hundred data-collection locations. Those supply information for weather forecasting, hurricane tracking and warnings, agriculture, fishing, and other activities. Since 1966 no storm anywhere in the world has gone undetected by those satellites.

All 29 of the nation's polar-orbiting weather satellites have been provided by RCA Astro-Electronics.

EIA sets new standards for silicon digital IC's

The Engineering Department of the Electronic Industries Association has established JEDEC Standard No. 7, setting industry specifications for three series of new high-speed silicon-gate digital IC's.

The 54/74HC series includes buffered CMOS logic devices with the primary characteristic of V_{IL} (logical low-input voltage) and V_{IH} (logical high input voltage) ratings for good noise immunity in CMOS system designs. The 54/74HCU series includes a limited number of unbuffered (1 active logic circuit) inverters or gates where V_{IL} and V_{IH} ratings are less than those of the HC series. The third series is designated 54/74HCT, having V_{IL} and V_{IH} ratings of 0.8- and 2-volts respectively for direct interfacing with TTL logic IC's.

New G.E. picture tube adds more color to TV

Introducing *Neo-Vision*, a new picture tube whose faceplate contains neodymimum oxide. General Electric claims two advantages: First, the new blue neodymimum glass absorbs the usually yellowish room light; thus produces richer, more natural colors and is less affected by the ambient illumination.

The second advantage is the appearance of the blue-tube set when turned off, a distinct improvement over the "dull, drab, greenish-grayish blank screen of present-day sets," says G.E.

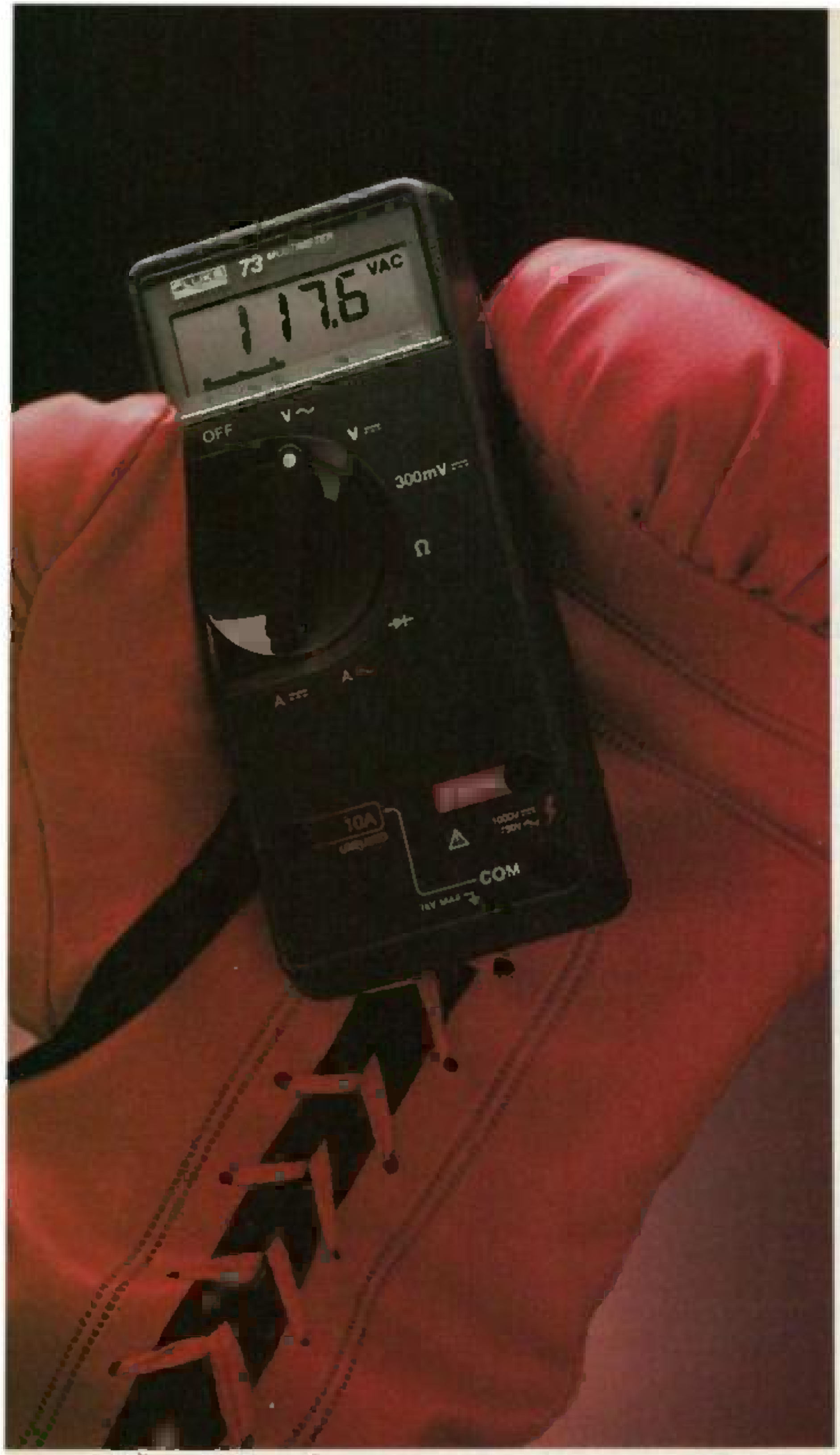
The *Neo-Vision* tubes will appear in nine models, including the "Command Performance" series.

Police radar inaccurate another test shows

In a recent release, Regency Electronics of Indianapolis, IN urges both police and drivers to be suspicious of the accuracy of police speed radars, citing a report of tests of six speed-measuring radar units; the tests were prepared by the National Bureau of Standards.

CB transmissions in particular were cited as one cause of inaccuracy. While police transmissions from the vehicle in which the radar was operated had a limited effect: "CB transmission in the same vehicle affected nearly all radars." When radar and CB radio were connected to the same battery, readings on the radar target readout depended on the frequency of the CB audio. "CB radio mounted in a pickup caused readings of 60 to 70 mph at distances up to 75 feet from patrol car. . .100-watt police-radio transmission did not interfere with the radar units at distances beyond 30 feet from the vehicle in which the radar was operated."

Other sources of error were shadowing, or the tendency of a moving-mode radar to use a slow-moving large vehicle rather than the ground to measure the speed of the patrol car; and batching, or target speed bumping, a change in the target-vehicle speed display when the patrol car changes speed. Shadowing was observed to some extent in all but one of the six radars tested and target-speed bumping was seen in three. R-E



The Digital vs. Analog battle is over.

$85* buys you the new champion.
The new Fluke 70 Series.

They combine digital and analog displays for an unbeatable two-punch combination.

Now, digital users get the extra resolution of a 3200-count LCD display.

While analog users get an analog bar graph for quick visual checks of continuity, peaking, nulling and trends.

Plus unparalleled operating ease, instant autoranging, 2,000+ hour battery life and a 3-year warranty.

All in one meter.

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PUBLISHER'S LETTER

As I promised last month, this issue of **Radio-Electronics** includes something new. Directly following pages 106, you'll find the premier issue of **ComputerDigest**. Yes; Volume 1, Number 1 has arrived. Please note that it is a separate tear-out section. We have tried to put together a package you will enjoy, find valuable, and one that meets your needs as an electronics professional.

We do expect the section to grow, but it will not take any space away from the regular **Radio-Electronics** editorial lineup of features that you are accustomed to receiving each month.

What's inside? Four feature articles. The lead story presents a quick comparison of LISA - PC - MACINTOSH - PEANUT. Then we go on with a feature that tells how you can upgrade budget printers....present a look at the new Macintosh....and show you why CP/M is an operating system you should learn more about.

If you like **ComputerDigest**, take a moment to tell me that you do and why you do. If you don't like it, I'd like to know why.

Remember, this is only the beginning. As **ComputerDigest** grows, we'll be able to bring you even more computer coverage designed for the interests of the electronics professional....you and other readers just like you.

Now go ahead and enjoy this action-packed issue of **Radio-Electronics** and the bonus 16-page issue of **ComputerDigest**.

Larry Steckler

LARRY STECKLER
Publisher

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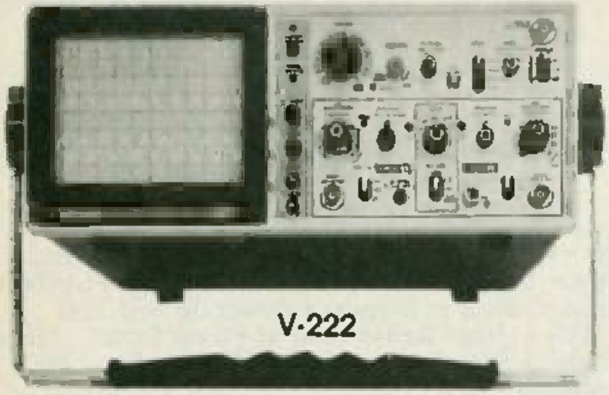

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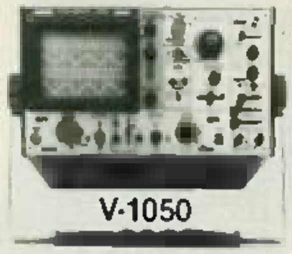

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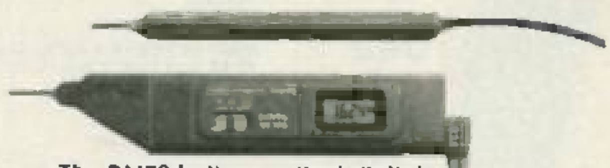

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SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

TELETEXT TEST ENDS

Several teletext/videotex projects closed down at the end of 1983, forcing reevaluations of the immediate prospects for developing such systems in the U.S. Time Teletext ended its $25 million, two-year teletext experiment, which had involved satellite-cable TV transmission of a 5,000-page teletext database. Matsushita, which had been working with Time to build a low-cost teletext decoder, will continue its efforts to design teletext equipment using the NABTS format. Meanwhile, ConTelVision, a videotex project in Manassas, Virginia, run by one of the nation's largest independent phone companies, shut down until videotex technology becomes more clearly defined. Another videotex experiment in Connecticut, run by the Southern New England Telephone Co., was temporarily closed after a legal settlement with the state's newspaper publisher's association, which opposes phone-company involvement in videotex operations. And the pioneering British Columbia Telidon trial in Canada has taken a hiatus until commercial operations can be defined.

AUDIO ADD-ON

XCom, a French videotex company, has introduced an audio enhancement that brings digital sound to online systems. The device, called *Demosthene*, permits audio to be linked to individual videotex frames, with digital audio encoded at 2.4 kilobits-per-second. Seventy videotex frames can carry up to eight minutes of sound. The technology costs about $2,500 per unit, far higher than the price planned for a prototype Japanese audio add-on for videotex—but the XCom system is envisioned primarily for public-access videotex terminals, replacing other audio-visual technologies now used.

DIGITAL TELETEXT IC'S

In a move that could accelerate teletext introduction throughout the U.S., Zenith may begin installing teletext receivers in some 1985 model television sets late this year, using new digital IC's developed by ITT in Europe. Zenith's exclusive deal gives the company a lead of one or two years over other U.S. manufacturers in incorporating a low-cost teletext device into TV sets. The ITT Digivision IC's are built to specifications for British-format teletext service, being sold in the U.S. as "World System Teletext." ITT's teletext processor IC set (MAA 2700) is one of three new integrated circuits developed at ITT's German technology center. Target price is $10 per set when production begins this spring.

DOWNLOADING TEXT TO COMPUTERS

Financial News Network, a satellite-programming service used by cable TV and some broadcast television stations, is laying the groundwork for a financial-data teletext service to be sent to personal computers via the vertical blanking interval of the business-news channel (Westar IV, transponder 10). The service, due for late-1984 start-up, would download data to home computers, eliminating the need for expensive teletext decoders. Material would be formatted into pages consistent with a teletext standard. Computer software sold as part of the FNN package would format and analyze information as it is fed into the unit.

DBS DEVELOPMENTS

Skyband Inc., the DBS company owned by media mogul Rupert Murdoch, has delayed its DBS service until late 1985 at the earliest. Skyband, which will use an existing 14/12-GHz satellite operated by Satellite Business Systems, had intended to go up in mid-1984. Now it wants to wait until a new generation of higher-powered birds is ready—which is more than a year away.

Home Box Office is working with Turner Broadcasting Co. (which owns Superstation WTBS and Cable News Network) to develop a quasi-DBS service. The service, which could begin by late 1984, would use the newly launched Galaxy I satellite, a 4/6-GHz bird which is becoming a major cable TV programming source. Galaxy I's transponders are turning out to be 60% more powerful than expected, encouraging the belief that dishes as small as 4 to 6 feet in diameter could pick up a high-quality video signal. HBO and Turner are negotiating with other Galaxy programmers (including Group W, Disney, Spanish International, and C-SPAN) about using signals from that bird for direct-to-home service, aimed primarily at areas where there are no cable-TV systems. R-E

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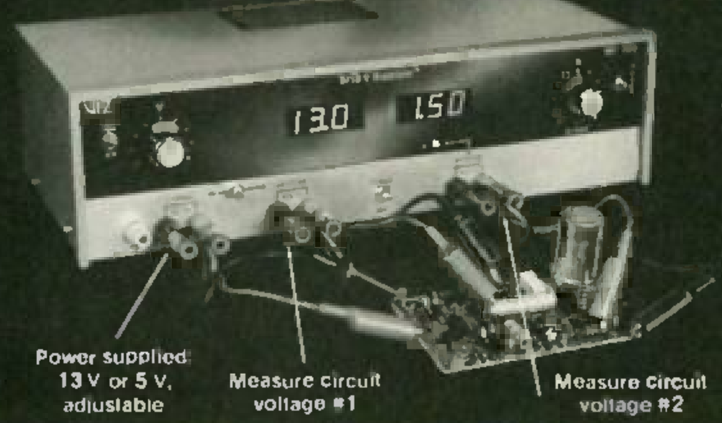

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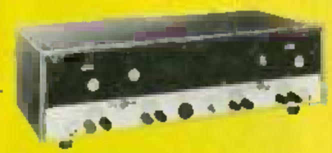

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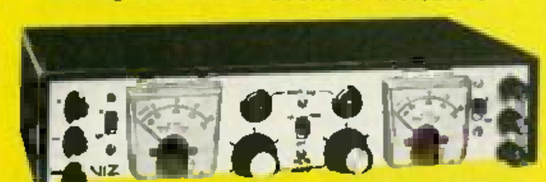

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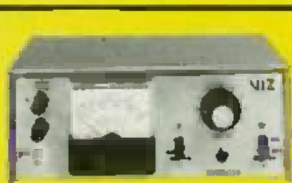

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LETTERS

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COMPUTER SECURITY

I would like to comment on Les Spindle's article on page 111 of the February 1984 issue, entitled "Computer Security." He fails to discuss call-back units, an important and relatively new protection device that prevents unauthorized remote-computer access. The unit is placed between the phone line and your modem. When a call is placed to that phone line, the call-back unit receives the call but does not produce a carrier tone; in fact, there is no sound produced at all. Using a tone-phone, you enter a security-access code that indicates who and where you are. Then you hang up, and if the code you have entered is valid, you will be called back automatically at a pre-designated phone number. That prevents the sequential auto-dialer search depicted in *War Games* (see photo). There are many companies which sell these units: Digital Pathways, 1060 East Meadow

Circle, Palo Alto, CA 94303, (415) 493-5544; International Mobil Machines Corp., 100 N. 20th Street, Philadelphia, PA 19103, (215) 569-1300; LeeMAH, 729 Filbert Street, San Francisco, CA 94133, (415) 434-3780, and Western Datacom Co., 5083 Market Street, Youngston, OH 44512, (216) 788-6583.

One other point needs correction. The article states: "When the security problem is not one of remote on-line access (for example, an on-premises computer used by several people), another protection scheme is possible. Passwords can be assigned...". However passwords are useful, and necessary, regardless of whether the access is from on-premises or off-premises. In fact, passwords are probably the least expensive and most beneficial security mechanism.

I enjoy reading your magazine. Despite this long letter about computer security, I read your magazine for the electronics articles. Keep up the good work. In fact, I discontinued my subscription to *Popular Electronics* when the name was changed to *Computers and Electronics*. I do not believe that one magazine can successfully cover both subjects.

TONY S. PATTI
Arlington, VA

continued on page 20

Learn robotics and you build this robot

New NRI home training prepares you for a rewarding career in America's newest high-technology field.

The wave of the future is here. Already, advanced robotic systems are producing everything from precision electronic circuits to automobiles and giant locomotives. By 1990, over 100,000 "smart" robots will be in use.

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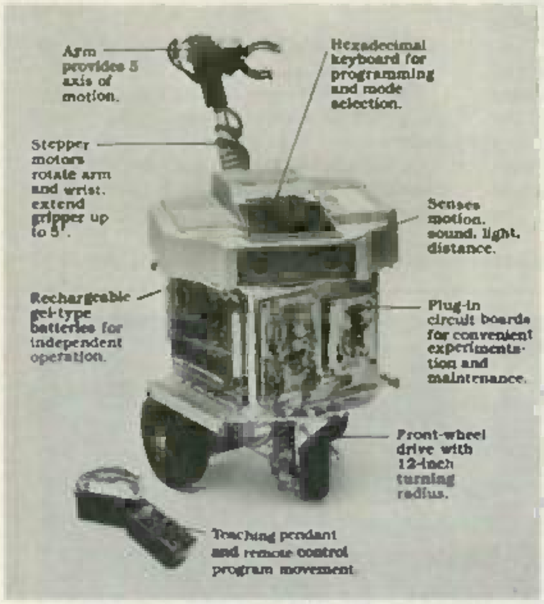

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LETTERS

continued from page 14

AM STEREO

Marty Bergan's recent construction article dealing with AM stereo (**Radio-Electronics**, January 1984) was a real delight, but there is one statement that should be more fully explained so that readers will not assume that there are consumer-type AM radios available that are capable of hi-fi performance. The author states that the Realistic *12-656A* has a 3-dB bandwidth of 12 kHz. He is clearly referring to the IF bandwidth, but that would imply that the 3-dB audio bandwidth is 6 kHz. The test data (see Fig. 1) shows that the 3-dB audio bandwidth is under 3 kHz for that particular radio, which is still better than the typical AM radio.

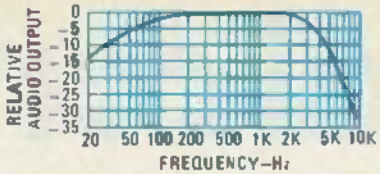


FIG. 1

The *12-656A* uses the standard arrangement of 2 IF amplifiers with 3 singly tuned transformers. The adjacent channel selectivity is set by those coils, and, assuming that the loaded Q's of the coils are equal, an audio response of 3 kHz means that the attenuation at plus and minus 10 kHz is only 18 dB. The attenuation at plus and minus 20 kHz is 33 dB. Since the coils have a loaded Q of 38, each coil has a bandwidth of 12 kHz, and that bandwidth might be what the author had in mind when he made his statement.

F. DAVID HARRIS
West Hartford, Connecticut

COMREX

The article on the abilities of the Comrex to improve the frequency response of remote broadcasting using a telephone company dial line (**Radio-Electronics**, January 1984—"Communications Corner"), was great as far as it went. However, your readers might be interested in another product line that does a much better job. The C.N. Rood BAX *114* portable transmitter and *110D* receiver, when hooked together through two telephone dial-up lines, will deliver the sports announcer's voice to the control room with his/her "studio" sound.

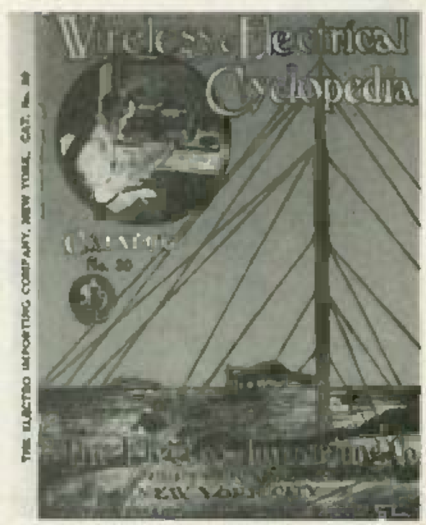
The Rood transmit/receive pair has the frequency response and signal-to-noise ratio of a 5 kHz equalized telephone company line from anywhere in the world. Briefly, the transmitter circuits include a band splitter (50 Hz to 2.5 kHz and 2.5 kHz to 4.95 kHz), an audio compressor for each band, a 350 Hz slide up for the low band and a 2.1 kHz slide down for the high band. The receiver circuits include an audio expander for each band, a 350 Hz slide down for the low band, and a 2.1 kHz slide up for the high band. The two bands are then sent through a combining network.

The result can be considered "nothing short of a miracle" as one grizzled old radio engineer puts it. That "miracle", however, does not come cheap. (Name me a miracle that does!) Expect to pay close to $9,500 for the required transmit/receive pair.

C. JOHN WEED
ABC Radio Network
Larchmont, N.Y.

REPRINT APPRECIATED

Thank you for the great idea of this reprint (The *Electro Importing Catalog*). I am and always will be in love with Hugo Gernsback and all of his publications. If you ever decide



to reprint any other items, please keep me in mind; price is no object. Use the best grade of paper and the latest techniques, you will find that the collecting fraternity is not a penny-pinching crowd. Thanks again.

PHIL WEINGARTEN
Forest Hill, N.Y.

NO MORE COMPUTER MAGAZINES

Why don't you tell Edward W. Loxterkamp of New York, that if he wants to read more about computers, there are plenty of magazines he can buy. I definitely agree with Stephen F. Wiley. You don't need any more emphasis on computers than you have now.

Radio-Electronics is the last good general-interest electronics magazine on the stands. I have subscribed to both **Radio-Electronics** and *Popular Electronics* since 1976. As long as you stay the all-around electronics magazine that you are, I plan to be a subscriber for life.

The February 1984 issue of *Computers & Electronics* I just received doesn't have a single article dealing with anything but computers. The next renewal slip I get from them goes in the round file.

RICHARD D. TAYLOR
Shorewood, IL

POWERLINE TRANSIENT SUPPRESSOR

In reference to the powerline transient suppressor, **Radio-Electonics**, September 1983, pages 57–58:. As that circuit is presented, when an excessive transient causes fuse F1 to blow, whatever is plugged into the suppressor is not protected from any *further* transients that may occur.

When I built this powerline transient sup-

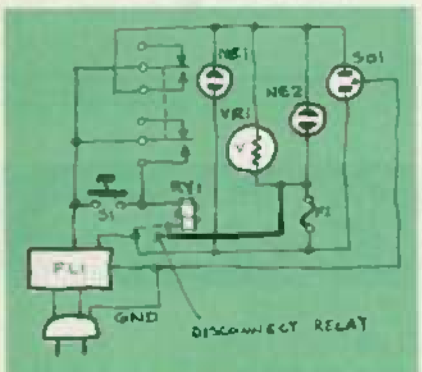


FIG. 2

pressor, I altered the circuit as shown in Fig. 2. If the fuse blows, the relay drops out and stays out to protect the equipment. Disconnect the relay from FL1 and reconnect it to fuse top--see Fig. 2.

I would appreciate it if you would publish this letter, so readers could make this modification to their transient suppressors.

ERIC DEUTSCHMANN
Spence Bay, Canada

TV SOUND CONVERTER

The article on the "TV Sound Converter", that appeared in the November, 1983 of **Radio-Electronics** seems to have generated quite a bit of interest and has brought an excellent response from the readers!

Many people have asked questions regarding the circuitry. Here are a few answers to the most frequent ones.

If you wish to use the project with your stereo amplifier, simply tap off the audio at switch S1. In addition, it will probably be necessary to connect a 1µF capacitor in series with the hot lead to remove the DC-offset voltage. If you chose to do that, it may not be necessary to build the rest of the audio circuitry, as it isn't used.

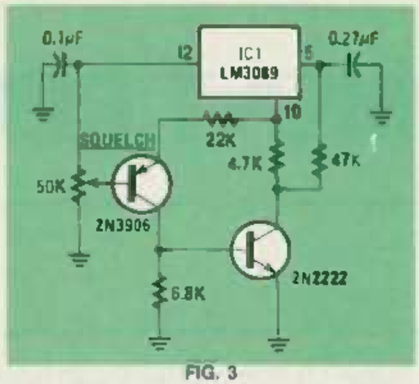


FIG. 3

With some LM3089 IC's, squelch operation may be poor or nonexistent. You can easily snap up the squelch performance by building the circuit shown in Fig. 3 onto the back of the board. No foil cuts are necessary, but you must remove all parts connected to pins 5 and 12 before starting the wiring. Pin 10 wiring stays as is.

And finally, for those readers who made their own circuit boards, there is troubleshooting assistance available, if needed. Please send a SASE to the supplier address given in the article.

GARY McCLELLAN
La Habra, CA

R-E

EQUIPMENT REPORTS

Kaypro 10 Hard Disk Computer

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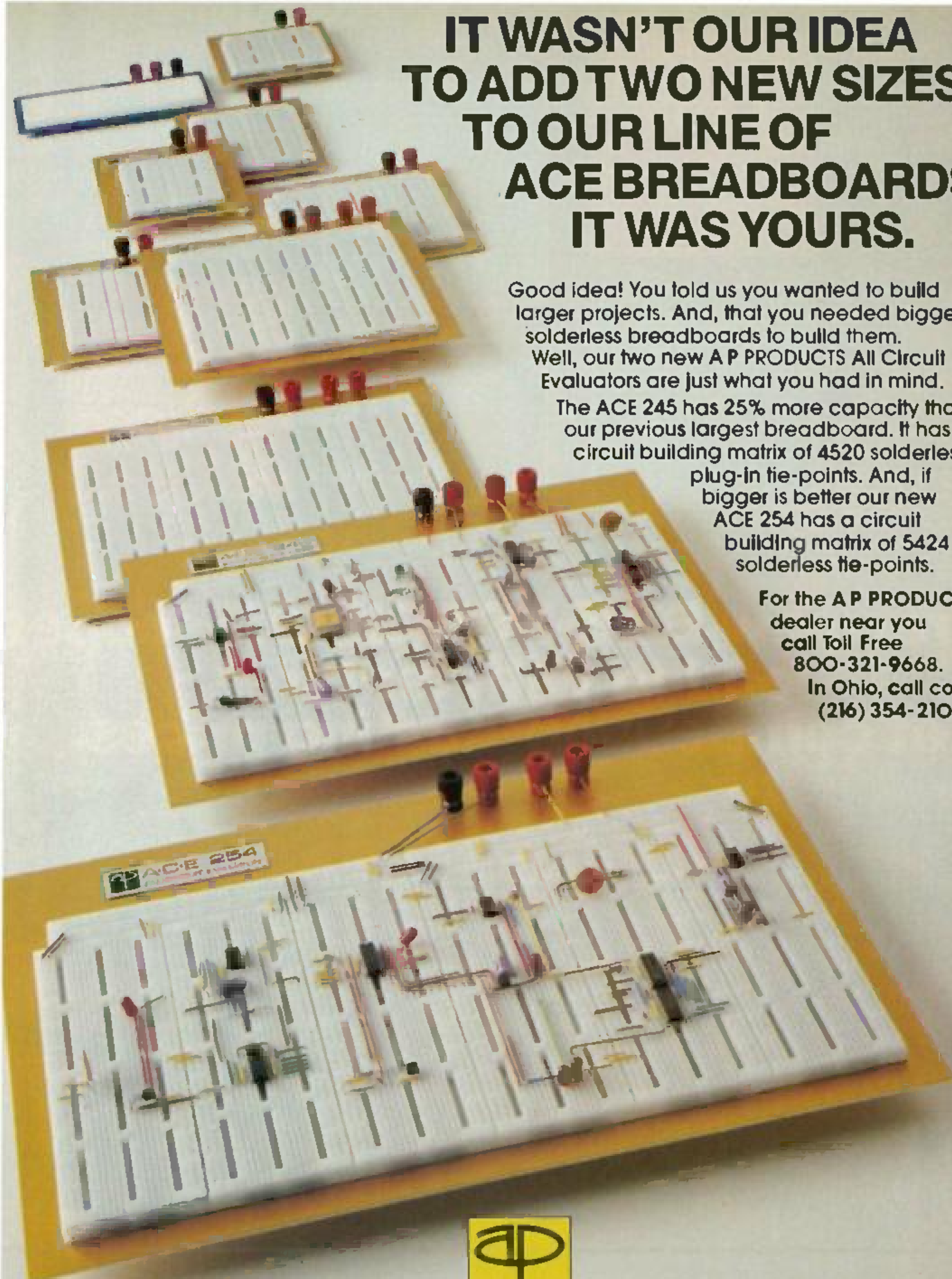
Outwardly, the *Kaypro 10* closely resembles the well-known *Kaypro II* in overall size and appearance, though it's slightly heavier at 31 lbs. The computer is housed in a metal cabinet with a carrying handle on the top. When placed flat on a table, two catches release the keyboard unit revealing the front panel of the computer. The typewriter-style keyboard contains four-way directional keys and a separate 14-key calculator-style numeric keypad. The front panel of the computer

continued on page 25

IT WASN'T OUR IDEA TO ADD TWO NEW SIZES TO OUR LINE OF ACE BREADBOARDS. IT WAS YOURS.



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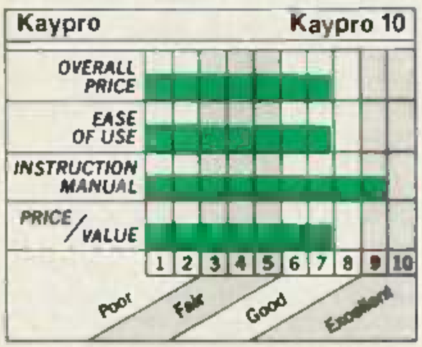
EQUIPMENT REPORTS

continued from page 22

contains an 80-column × 24-row 9-inch green monochrome anti-glare CRT display. To the right of the display there's a power-indicator lamp, a hard-disk-ready lamp, and a vertically mounted half-height floppy-disk drive.

A swing-out tilt bracket elevates the front of the computer so that its bottom is level with the top of the keyboard. The tilt bracket allows easy access to the floppy-disk drive. It also positions the display screen so that it's tilted directly toward the user's eyes, making it one of the few computer displays that won't give you a stiff neck after extended use. Unfortunately, most computer displays are too high, and you'll really appreciate having the tilt bracket after several hours at the computer punching in data.

In addition, the display is recessed so that it's shielded from overhead lights and its face is etched to sharply reduce the affects of room glare. The screen position and antiglare precautions make that display one of the best we've seen for long-term viewing.



Turning to the rear of the computer we find a power-cord receptacle along with storage clips for the cord, the power switch, a reset switch, a brightness control, and a parallel-printer output with a Centronics-type connector. The rear panel also contains two standard RS-232 I/O ports—one that can be used for a serial printer and the other for a modem—and a modular telephone connector for an optional light pen. In addition, there is another modular connector for the connecting cable that is used to connect the keyboard to the computer.

The main features of the *Kaypro 10* are the internal 10-megabyte hard-disk, a CP/M operating system, and an extensive bundle of software. (Bundle means software supplied with the computer at no additional cost.) The hard disk has a basic capacity of 10-megabytes and is automatically partitioned to function as drives A and B. Almost all the softwear is duplicated on drives A and B and is so extensive that it uses more than 2.5-megabytes of storage, thus the hard disk comes with almost 6 megabytes already in use.

If the user inadvertently "blows" (erases) a program on, say, drive A; it can recopied on drive A from drive B using the PIP (copy) command. The floppy-disk drive is used as drive C and provides 390K of storage. That drive can be used to make back-up copies. Almost all the software can be transferred to floppy disk, thereby freeing the hard disk for data storage. (As you can see from the preceeding, the system is extremely flexible and easy to handle.)

Software

The list of software provided by Kaypro at the time this report was prepared included: *MBASIC*, an easy-to-use BASIC language for the beginner and experienced programer; *SBASIC*, an advanced BASIC language that you can use to write your own programs. There's also *Perfect Writer* (a word-processor program) and *Perfect Speller* (a spelling checker), *The Word Plus* (a highly rated spelling checker), and *Perfect Filer* (a database program). In addition there's *Perfect Calc* (a "What If...?" program), *Profit Plan* ("What If...?" business planning), and a game package. Also included are the usual CP/M utilities such as PIP and SUBMIT, as well as some unusual but extremely convenient routines. For example, one utility allows the user to instantaneously select the baud rate for the modem RS-232 port, while another utility allows the simultaneous selection of a different baud rate for the second RS-232 port. (Since two serial ports have been provided, you, of course, can have both a modem and a serial printer connected at the same time; the modem does not disable the printer.)

There's also Kaypro's version of the public-domain utility XDIR that provides an alphabetized directory showing the size of each program and the free space on the disks. Kaypro also provides a dumb-terminal program and a utility called SAFETY.

SAFETY is the software that permits the hard disk to be truly portable. As you might have wondered, how does one prevent knocks and jolts from causing the hard disk's heads from crashing into the disk and damaging the magnetic surface? The very last thing the user does before shutting down is to run the short and fast *SAFETY* program that parks the heads on a safe area of the disk. With the heads parked, knocking the computer around causes no damage to the surface of the hard disk.

Keep in mind that in the past Kaypro has continuously upgraded and changed the software bundled with their computers, so that by the time you read this report the bundled software that is being provided with the computer might be completely different. There might even be several different packages. In that case, you might even be allowed to choose between different software packages at no extra cost.

Instructions

We had the fourth draft of Kaypro's own preliminary operating manual for the computer. It was excellent: notably clear, well organized, with an excellent table of contents (among the best operating manuals we have seen). Unfortunately, the same cannot be said for the other software, whose documentation is the original from the software houses. Except for *The Word Plus* documentation, the remainder of the software documentation was the usual wordy, dull, tutorial style that has come to characterize personal-computer manuals. The CP/M documentation that was provided was the version by Digital Research, which is virtually incomprehensible to anyone except a computer specialist or engineer. (We wish that most of the documentation were rewritten by Kaypro!)

There is not much negative to say about the computer itself because it worked flawlessly, even after being subjected to some rather rough handling for two months. However, we must point out that we were extremely careful at all times about always parking the hard disk's heads with the *SAFETY* program.

The screen display is quite bright and razor sharp, with an outstanding, easily readable font (type style). The display looks as good as what you'd expect from a high performance typewriter or printer. As mentioned, the overall handling of the unit was exceptional, though we're not fond of the locking lever on the half-height floppy-disk drive (most half-height drives have a similar lever).

The only real complaint with the computer is the female Centronics-type socket connector used for the parallel printer output; it's the wrong gender. A socket is generally used on a printer. The computer should have a plug connector so a standard extension or connecting cable can be used. (And anyone who's ever looked knows, it's not easy to locate a male-to-male cable in local computer stores.)

Other than the printer connector there are no complaints, not even nit-picking. The *Kaypro 10* does exactly what it's supposed to do—and it does it remarkably well. R-E

Heath EE-3201 Digital Techniques Course

Learn all about digital electronics with this home-study course.

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IF THERE IS ONE WORD WHICH TYPIFIES the world of electronics today, the word is digital. There is no escaping it. Everywhere we turn in this electronics world—whether we're involved with it for hobby or business purposes—we encounter the need to be familiar with digital techniques.

It doesn't matter whether we're involved with computers, radio, television, or consumer-electronics repair because they are all using digital circuitry in one way or another. And, since that is the case, it makes sense to learn about digital theory and applications.

But, where do you begin the learning process? If you are in school, then you have no problem because it's what you are studying. Otherwise, you have the alternatives of going to the library and trying to teach yourself from the books on the shelf; buying every modern book on the subject and studying them thoroughly; signing up for an evening course at a local school or college, or taking a home-study course.

A home-study course

Some of the best home-study material on the market is provided by the Heath Co. (Benton Harbor, MI 49022) via their series of continuing education courses. Those courses provide the type of training needed for the person who wants some knowledge, but doesn't need the full course provided by a traditional correspondence school. To be sure, you can use the Heath series in such a manner. But, if you are simply looking for specific training on a specific topic, then Heath's courses provide an ideal program.

The course we will be looking at this month is their *EE-3201* Digital Techniques course. Using well-written, highly illustrated textual material, that course takes you through every step you need to become fully familiar and comfortable with digital theory and electronics. The course relies not only on the traditional question-and-answer technique of learning, but also provides positive reinforcement to that learning with short tests at the end of each learning unit and with a final examination at the end of the course. The unit exams allow you to test your knowledge and give you the opportunity of reviewing any material on which you may be a little weak, while the final examination tests your overall learning of the material. It is returned to Heath for grading and, if you pass the course, you can earn continuing education credits.

As with other Heath courses, programmed experiments are used to help you appreciate and gain a better understanding of what you have learned. Like all Heath products, the company supplies you with all the discrete components you will need to complete the experiments.

However, completing those experiments does require that you to invest in

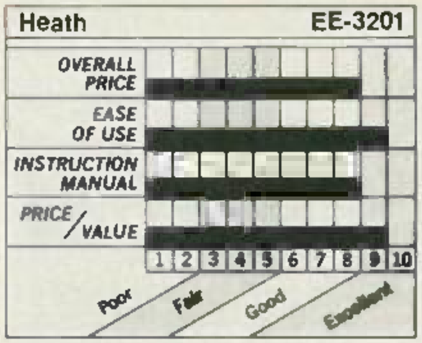
82-90

the *ET-3200B* Trainer, which provides not only three built-in, regulated power-supplies, but also four logic switches, a three-frequency clock, and a solderless breadboard. You can assemble this kit yourself or have it preassembled from the factory. The kit costs $99.95, while the assembled version costs $179.95. Either way, it does increase the $89.95 cost of the course, although you can buy both the course and trainer kit for $174.90.

That added investment is well justified if you intend to continue with other Heath courses, or if you do breadboard circuits and need a way to test them as part of your hobby or professional work.

Further, the course does require you to have a multimeter and single-trace oscilloscope, which, if you are just purchasing them for the first time, can also raise the cost of this course appreciably. However, once you have that important test equipment, it is always there on your bench for you to use.

As with all Heath courses, Digital Techniques comes with high-quality vinyl binders that hold the course material, and all of the components needed for the experiments. At one time, Heath offered audio learning aides as part of the course, but that policy has now changed and the company makes them available as a $19.95 option.



What's covered

The purpose of all of that is to make you completely comfortable when working with digital circuitry. By the time you finish the course, you will be able to discuss the advantages and benefits of using digital techniques in electronic equipment. You will also be able to name the major applications of digital techniques in electronics, convert between the binary and decimal number systems, and recognize the most commonly used binary codes.

Further, you will also be able to name the major components used in implementing digital circuits, such as gates and flip-flops, and explain how they operate. You will also be able to identify the more commonly used integrated circuit families used in digital equipment, as well as be able to discuss their operation, characteristics, and features.

Other topics covered in the course include Boolean algebra and how to use it to express logic operations and minimize logic circuits in design. Among the digital circuits examined are binary and BCD counters, shift registers and a variety of other sequential and combinational logic circuits.

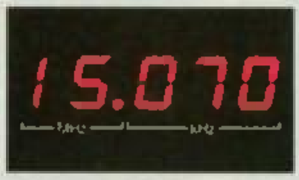
Also covered is how to design combinational and sequential logic circuits for a given application, the operation and application of digital counters in time and frequency measurements, and how a digital computer is organized and how it operates. Finally, the course concludes with a thorough discussion of microprocessors, including a look at their operation and applications.

Through all of the lessons in the course you are constantly performing experiments to help increase your knowledge and reinforce what you've already learned. It is a very good teaching method. Overall, we found the Heath *EE-3201* Digital Techniques course to be worth the time and effort involved. It was well-written and easy to use. We would have liked to see the audio aids still included as part of the unit as they do help. As such we recommend their purchase. **R-E**

The Bearcat® DX1000 makes tuning in London as easy as dialing a phone.

Direct access keyboard tuning brings a new level of simplicity to shortwave radio. With the *Bearcat® DX 1000,* dialing in the BBC in London is as easy as dialing a telephone. And you can switch from the BBC to Peruvian Huayno music from Radio Andina instantly. Without bandswitching.

Featuring the innovative microprocessor digital technology made famous by *Bearcat* scanner radios, the *DX 1000* covers 10 kHz to 30 MHz continuously, with PLL synthesized accuracy. But as easy as it is to tune, it has all the features even the most sophisticated "DXer" could want. 10 memory channels let you store favorite stations for instant recall—or for faster "band-scanning" during key openings.



The digital display measures frequencies to 1 kHz, or at the touch of a button, doubles as a two time zone, 24-hour digital quartz clock. A built-in timer wakes you to your favorite shortwave station. Or, it can be programmed to activate peripheral equipment like a tape recorder to record up to five different broadcasts—any frequency, any mode—while you are asleep or at work.

The *DX 1000* also includes independent selectivity selection to help you separate high-powered stations on adjacent frequencies. Plus a noise blanking system that stops Russian pulse radar interference.

There's never been an easier way to hear what the world has to say. With the *Bearcat DX 1000* shortwave radio, you have direct access to the world.

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Frequency Range: 10 kHz to 30 MHz continuously. **Tuning:** Direct keyboard entry, selectable 3 or 24 kHz per revolution knob tuning, or manual step tuning in selectable 1-99 kHz steps. **Sensitivity:** 1.0 µV AM, 0.5 µV CW/SSB/FM, 1.6-30 MHz. **Image and IF Rejection:** 70 dB or more. **Memory:** 10 frequency capacity. **Frequency Stability:** Better than 100 Hz after warm-up. **Modes:** AM/LSB/USB/CW/FM. **AGC:** Selectable Fast/Slow release times. **Filter Bandwidths:** 2.7 kHz, 6 kHz and 12 kHz. **Filter Selection Independent of Mode.**

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ITT Pomona Electronics

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NEW PRODUCTS

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

MOBILE SCANNER, model *MX-3000* is a compact-size unit with computer touch-entry programming and six-band coverage, with 30 channels, designed for use at home or on the road. Programming is simple and a "beep" tone verifies entry.

The model *MX-3000* can also search for active channels through as much as an entire band; when one is found, its frequency will appear on the digital display. Search can then resume, or the new frequency can be stored in one of the 30 scan channels. A selected priority frequency can be programmed into Channel 1; if active, it automatically overrides any other signal. A scan-delay feature holds a channel open for approximately two seconds at the end of a transmission to wait for any reply: if scan delay is not selected; scanning resumes in about six-tenths of a second. Scanning can be at either 5 or 15 channels per second. A channel-lockout feature excludes selected channels from the scan; that keeps generally busy channels programmed into the scanner, while preventing them from "locking in" on each scan.

CIRCLE 101 ON FREE INFORMATION CARD

The multifunction digital display shows channel numbers when scanning, the channel and frequency when receiving, delay-function and channel-lockout status, and search-mode operation. A brightness switch can be set for day or night operation.

The model *MX-3000* is priced at $299.95.—**Regency Electronics, Inc.**, 7707 Record Street, Indianapolis, IN 46226.

COMPUTER-SECURITY DEVICE, "*Gateway*," is a stand-alone device for use with asynchronous modems on dial-up or leased lines, connecting to micro's, mini's, or mainframes. It requires entry of both a correct ID code and password before entry is allowed. If the correct codes are not entered within three attempts, *Gateway* forces the modem to disconnect, defeating everything from the often-used "Monte Carlo" to the highly-sophisticated "Trojan Horse" style of gaining illegal entry. There is also a user-definable time limit for the logon attempt. Again, if successful logon is not achieved before time runs out, *Gateway* breaks the connection.

Gateway allows the use of up to 20 passwords and user ID codes, which can be easily defined and changed by the authorized person. ID codes can be up to 20 characters. Passwords can be any length, with an optional minimum length, and can use not only letters and numbers, but characters such as

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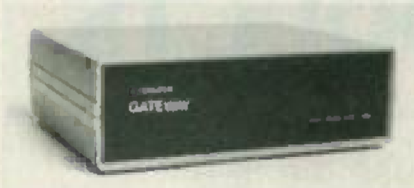
spaces, commas, and control characters for added password security. Since the unit is menu-driven, no programming knowledge is



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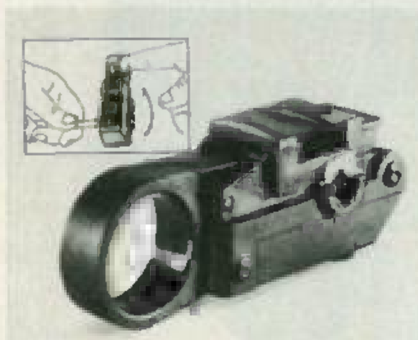
needed to change passwords, ID codes, time limits, or other *Gateway* features. A record is kept of all logon attempts, both successful and unsuccessful. The authorized person can access that record and spot attempted illegal entries. The record is protected from power failure (as are all other *Gateway* functions) by a non-volatile memory.

Gateway is priced at $395.00.—**Adalogic**, 1522 Wistaria Lane, Los Altos, CA 94022.

COAX STRIPPER, No. *70374*, has a holding-ring design that allows the user to strip coax cable with minimum effort. With one's finger in the holding ring, one simply inserts the wire and rotates the tool. It is designed to strip cleanly all of the five most popular sizes of



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coax cable: RG-6, RG-8, RG-9, RG-174, and RG-182. The stripping blades can be adjusted easily for different cutting depths to meet the user's specifications, and the tool can be set to perform both two- and three-level strips. A 2-bladed replacement blade cassette for the stripper is available. The No. *70374* is priced at $45.90 — **Vaco Products Company**, 1510 Skokie Blvd., Northbrook, IL 60062.

EQUALIZER ANALYZER, the model *dbx 10/20*, enables automatic equalization to be achieved individually for left and right channels, or in combination, with the accuracy that only a computer can provide. It can analyze

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as many as 10 locations within a room and then automatically adjust equalization for flat response. The proper equalization setting within a room can be accomplished in sec-

continued on page 43

CIRCLE 67 ON FREE INFORMATION CARD

performance by design

Folding Meters are Better

Not all multimeters fold. There's a reason. While other manufacturers were busy copying each others designs, BBC looked at where portable meters were used and how they could be improved.

The result is a unique approach. Folding meters with large displays (18 mm LCDs) and adjustable viewing angles. Now you can have high performance in a meter that excels in the field and on the bench.

Hands Free vs Handheld

In multimeters "hands free" is significantly better than "handheld." You need three hands to operate the typical "handheld" meter in the field. One for the meter and two for the probes. BBC's folding design lets you use a neck strap for the meter. This frees your hands for the probes.

On the bench, the large, adjustable displays pay off. It's a sensible design that lets you make measurements faster and more easily.

A Heritage of Precision

BBC's track record of expertise in precision engineering spans eight decades. All our meters are built to tough VDE and DIN safety standards. The 3½-digit DMM's feature 0.1% basic dc accuracy and externally accessible fuses for overload protection.

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Compact, Rugged and Affordable

To design the impact resistant case that protects these DMM's, BBC relied on the industrial design skills of the Porsche Design Studios.

When open, the display angle is easily adjustable. When closed, the display and the controls are protected, and the meters turn off automatically.
Competitive pricing is another feature of BBC meters. Prices start at $193.00.

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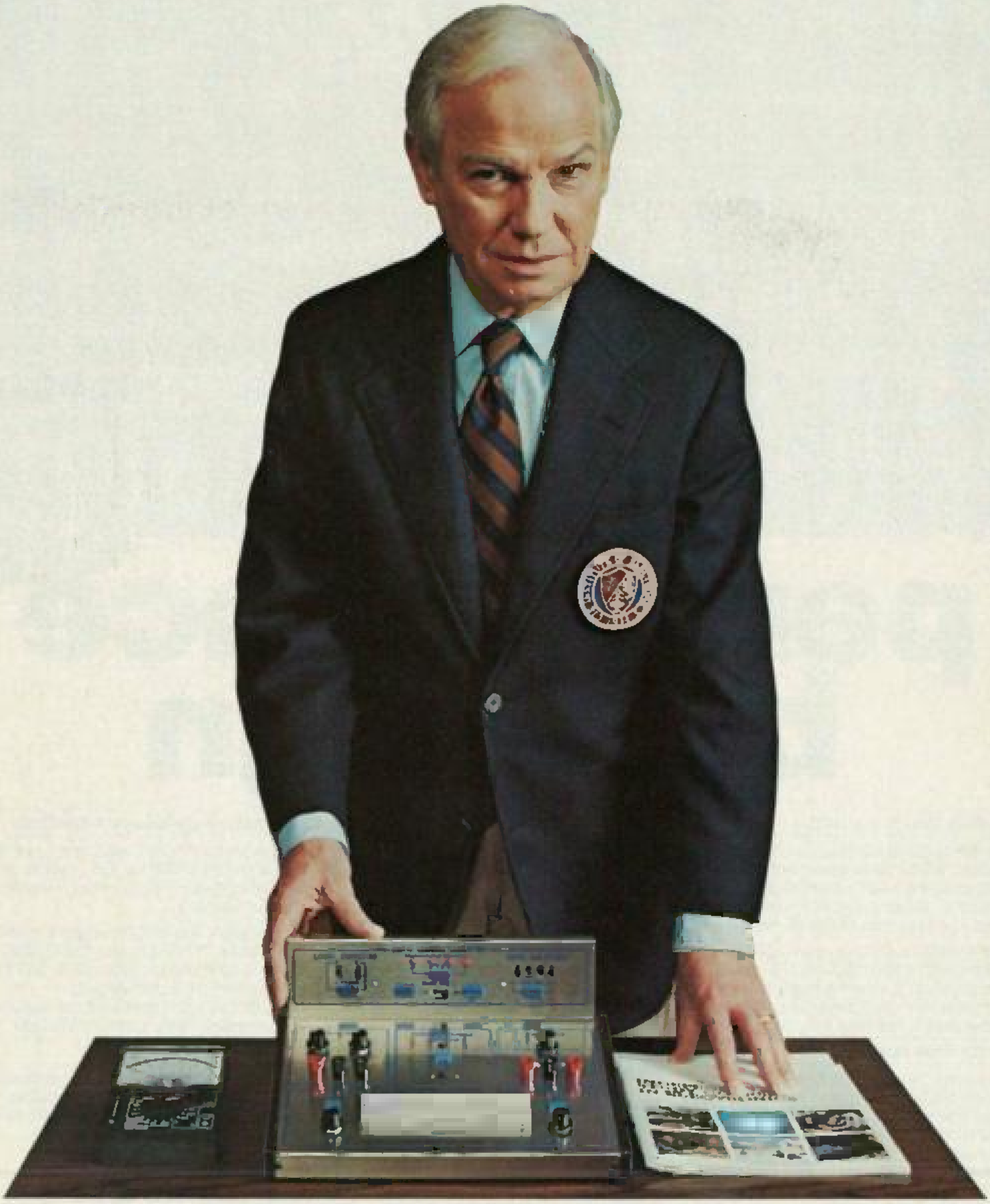
At CIE, you get electronics career training from specialists.



If you're interested in learning how to fix air conditioning, service cars or install heating systems— talk to some other school. But if you're serious about electronics... even earning an Associate Degree... come to CIE —The Electronics Specialists.

Why trust your education and career future to anything less than a specialist?

You shouldn't. And you certainly don't have to.

If you talked to some of our graduates, chances are you'd find a lot of them shopped around for their training. They pretty much knew what was available. And they picked CIE as number one.

Be sure to shop around. Because, frankly, CIE isn't for everyone.

There are other options for the hobbyist. If you're the ambitious type—with serious career goals in electronics—take a close look at what we've planned for you at CIE.

What you should look for first.

Part of what makes electronics so interesting is it's based on scientific discoveries—on ideas! So the first thing to look for is a program that starts with ideas and builds on them!

That's what happens with CIE's Auto-Programmed® Lessons. Each lesson takes one or two principles and helps you master them—before you start using them!

How practical is the training?

This is the next big important question. After all, your career will be built on what you can do—and on how well you do it.

Here are ways some of CIE's career courses help you get your "hands-on" training...

With CIE's Personal Training Laboratory... you learn and review the basics—perform dozens of experiments. Plus, you use a 3-in-1 precision Multimeter to learn testing, checking, analyzing!

When you get your own 5MHz, solid-state oscilloscope, you take some real professional steps. You use it as a doctor uses an X-ray machine—to "read" waveform patterns...lock them in...study, understand and interpret them!

When you get your Digital Learning Laboratory, you'll be into digital theory—essential training today for anyone who wants to keep pace with the state of the art of electronics. With CIE's Digital Lab, you'll be applying in dozens of fascinating ways the theory you've learned. For example, you'll compare analog and digital devices. You'll learn to make binary to decimal conversions and to work with semiconductor devices and circuits. You'll see how digital equipment is vital to today's exciting, growing fields such as security... where digital theory provides the brains for space-age alarm and protective devices.

You'll build your Microprocessor Training Laboratory, a working microcomputer—from "scratch." You'll also learn how to program and interface it with displays, memories, switches, and more.

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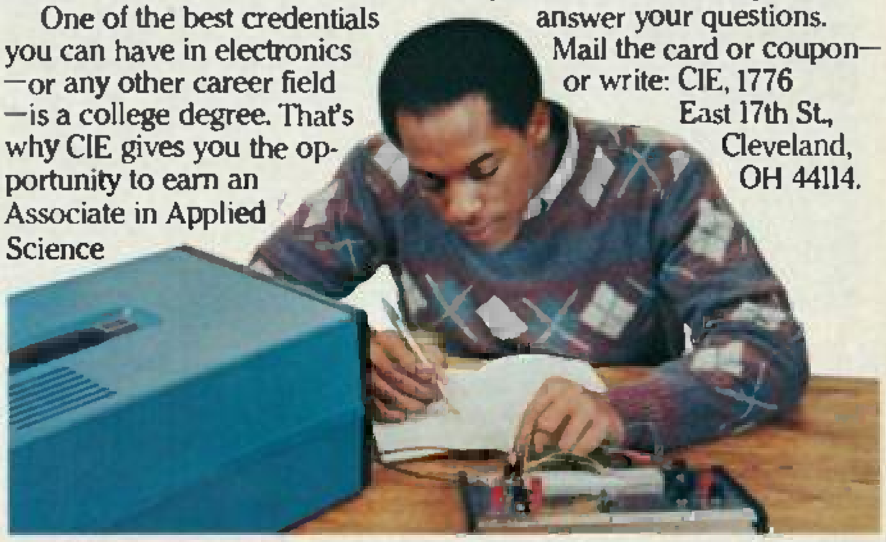

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NEW IDEAS

Proximity power switch

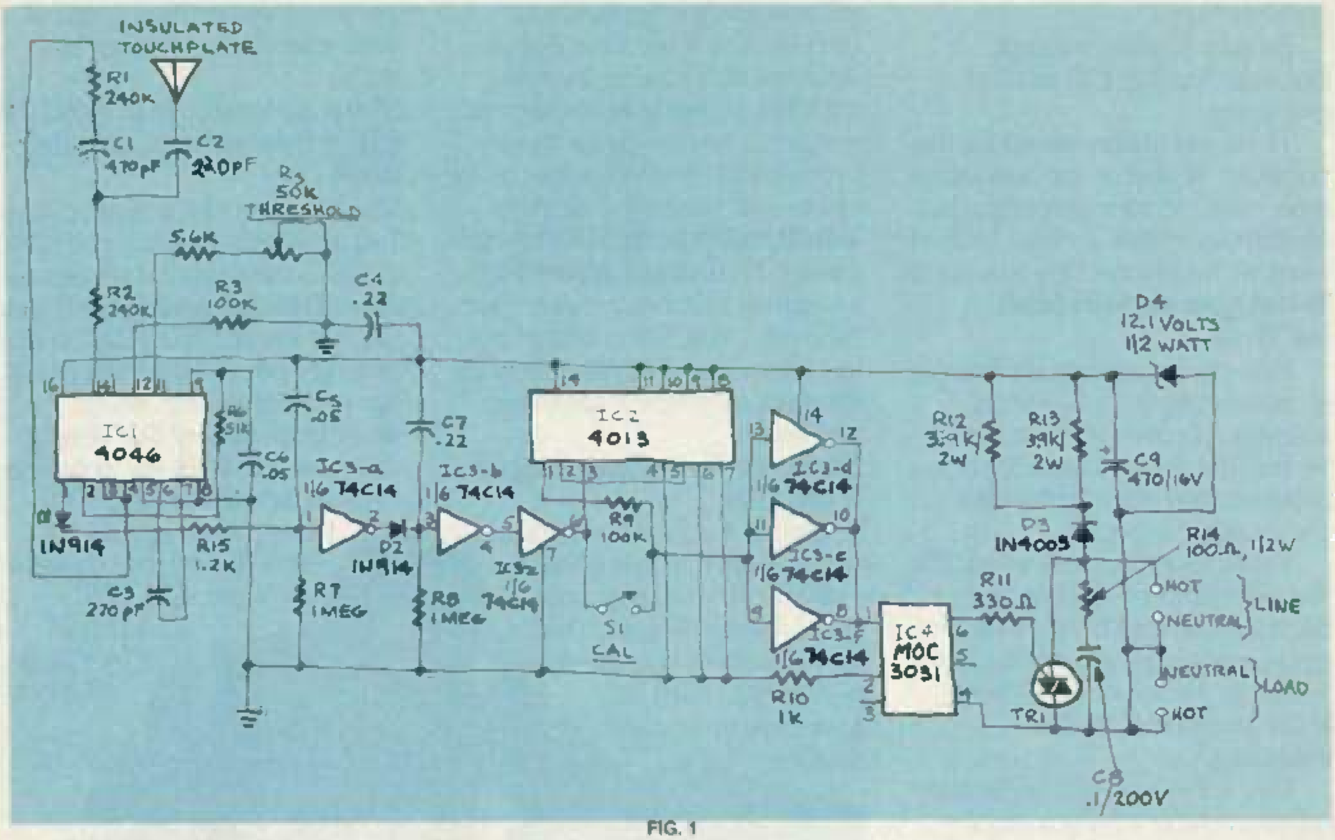

FIG. 1

HOW MANY TIMES HAVE YOU COME YOUR home with your arms loaded down with packages and, after great difficulty, managed to turn on the light? And how often have you wished for an easier way? This month we'll look at a little gadget that allows you to switch an AC device on and off by simply passing a hand (or some other part of the body) near an insulated touchplate.

How it works

The circuit is powered by a 12.1-volt regulated power supply made up of diodes D3 and D4, capacitor C9, and resistors R12 and R13. The AC voltage is picked directly off the AC line and rectified by D3 (half-wave rectifier). The resulting DC voltage is filtered by C9 and regulated by D4, a 12.1-volt Zener.

Turning to the rest of the circuit we have IC1, which is a 4046 PLL (*P*hase-*L*ocked-*L*oop). That IC contains a VCO (*V*oltage-*C*ontrolled-*O*scillator), a source follower, and two phase comparators (which we'll call comparators 1 and 2) with a common input-amplifier. When power is applied to the IC, the VCO outputs a signal at pin 4 that is fed to both comparators via pin 3 for use as a reference. That same signal is also fed to its input at pin 14 through an R-C network consisting of R1, C1, and R2. As long as there's no phase difference detected by the internal phase-comparator between the VCO output and the input signal, the output of IC1 is zero. But when a hand is passed close to the touchplate, body capacitance causes a phase difference. That phase difference is fed to the comparators through the common input amplifier. Comparator 1 now takes that input signal, compares it to the reference and outputs a squarewave signal at pin 2 that is proportional to the difference between the two input signals.

The output of comparator 1 is then filtered and fed to the VCO as an error signal. The error signal causes the VCO to generate an error-correction signal, which is then fed back to the comparators. Comparator 2 then outputs a train or series of pulses that is fed to a pulse-stretching circuit consisting of three of the op-amps contained in IC3, a 74C14 hex Schmitt trigger. (A pulse stretcher is a shaping circuit whose output pulse duration is greater than its input.) The stretcher circuit also provides for debouncing and noise rejection.

After conditioning, the signal is fed to pin 3 of IC2, a 4013 dual D-type flip-flop that's used as a toggle flip-flop for alternate-action switching. By that we mean that the device is turned on or off alternately by the input signal (push on/push off). To accomplish that action, the $\overline{Q1}$ output of the flip-flop (pin 2) is fed to its DATA input (pin 5). The logic level at the pin 5 is transferred to its Q output at pin 1 during each positive-going transition of the clock pulse.

At this point, the Q output of the flip-flop is fed to the remaining three inverters

continued on page 110

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Input: BNC	
Impedance:	1MΩ @ 25pF in all modes
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Modes:	
Frequency:	.1 Hz to 50 MHz (gate times 0.01, 0.1, 1.0, 10 s)
Period:	50 ns to 10 s (1, 10, 100, 1000 cycle averages)
Pulse Width:	25 ns to 10 s (1, 10, 100, 1000 cycle averages)
Full Signal Conditioning:	
Coupling:	AC or DC switch selectable
Attenuation:	x1, x10, x100 switch selectable
Polarity:	+/− edge Freq. & Period; >/< trigger level, Pulse Width
Trigger Level:	variable 0 ± 500 mV x attenuator setting
Time Base:	10 MHz crystal oscillator (± 4 ppm, 0-40°C.)
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THE DRAWING BOARD

Bipolar supplies from a single 9-volt battery

ROBERT GROSSBLATT

A FEW MONTHS AGO WE ASKED IF ANY OF you out there could come up with a way to generate positive and negative voltages using only one nine-volt battery. To tell you the truth, we expected to get a few answers and then that would be the end of it. Well, as someone once said, the longer you live the more you learn. In the first installment of "Designer's Notebook" (March, 1984) we presented a handy circuit that would produce a bipolar supply from a single battery. Needless to say, that column was written some time before we started this "contest" and in actual fact, the circuit shown and described there is one that we've been using in one variation or another for quite a few years. It fills all the criteria we've talked about for circuit design: simplicity, reliability, and best of all—it's cheap!

The circuits that were sent to us covered the entire spectrum of possible designs from the straightforward to the convoluted, and from the perfectly workable to the absolutely ridiculous. A few of them were absolutely wonderful and we found ourselves really admiring them and wishing that the laws of the universe were changeable so that they could be made to work! In a nutshell, all the designs that were sent in can be grouped into three categories: 1. Simple voltage dividers; 2. Oscillator and charge-pump variations; and 3. Wishful thinking. It's impossible for us to list and mention all the people who sent in answers, so we've had to pick a representative sampling from the three categories. The ones that we'll discuss here are those that we thought would be the most interesting for everyone—not the best or the worst, mind you, but simply the most interesting. (Everyone who sent in an answer and included a return address will get an answer from me. I'm sorry that I've gotten a little behind in answering my mail but I promise that I'll take care of that in the near future.)

We had planned to spend this month discussing our digital sinewave-generator but obviously many of you out there want to know about positive and negative power-supplies. In any event, we'll get back to the sinewave generator next month; remember, any time that you spend learning something is a far cry from being time wasted.

Generating a bipolar supply

The most logical approach to the problem of creating a bipolar supply is to build a simple voltage divider. Now, we know that there are many very obvious disadvantages to doing something like that, but there are also lots of advantages as well. And since the whole purpose of creating a bipolar supply is to save time and money, it stands to reason that you'd want to use the simplest design possible. In fact, the whole problem can be eliminated by the simple expedient of using either a center-tapped transformer or two batteries.

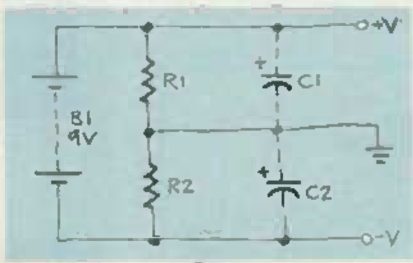

FIG. 1

A classic voltage divider is shown in Fig. 1. That basic circuit was sent in by Brian Corzilius, Ken Fink, and David Berger among others. For starters, you couldn't ask for anything simpler. Just dive into your junk box, grab a pair of resistors and presto—a bipolar supply. No fancy parts, no silicon, and best of all, no brain damage. So what, you may well ask, is wrong with that? The first problem with the voltage divider is that it should only be used with circuits that have a relatively high input-impedance. Any circuit that draws serious amounts of power is going to drain the battery in record time. Remember: current has to return to ground, therefore the same resistors that are creating the bipolar supply will also act as current limiters. If the supply is to power some device that draws 50 milliamps or more, then the resistor values have to be chosen by the application of Ohm's law, but be careful because it's not quite as straightforward as you might think.

Let's suppose that you need 30 mA from the positive side, 5 mA on the negative side and the voltages have to be the same (i.e. plus and minus 5 volts). In order to get equal voltages you have to have equal resistors. That means that both R1 and R2 must be able to pass 30 mA. Since those two resistors are in series with each other and in parallel with the battery, that translates into a 15 mA drain—roughly 50% of the needed current. That's quite a price to pay. And if you pick a value for R2 that limits the negative current to 5 mA you're not going to get an equal bipolar supply.

Tom Mosteller has also pointed out another often overlooked drawback to that kind of circuit. Battery impedance isn't constant: it rises with frequency; also resistive voltage dividers can cause problems when used in circuits that have high-frequency signals running through them. Fortunately, that can be overcome by using a pair of capacitors to decouple the power supply from the rest of the circuit. For the capacitors shown with dotted lines in Fig. 1, Tom recommends a value of about 10 µF and we agree with him.

The last awful thing that we have to say about this circuit is that the best voltage you can hope to get from either side of the supply is half the battery voltage (assuming you want an equal bipolar supply). Assuming that we're talking about a nine-volt battery (which is what we were originally talking about) we're only looking at plus and minus 4.5 volts for a new battery—most nine-volt batteries are lower than that right out of the blister pack. That 4.5 volts is a bit low for most applications and the battery is going to start dying at a seemingly incredible rate. In addition, when a nine-volt battery settles into middle age, it usually puts out around 7 volts. That translates into less than 4 volts on either side of the supply, and there's not a whole lot you can do with such small voltages. All in all, the voltage divider approach to a bipolar supply leaves a lot to be desired.

Unless your application can tolerate all the restrictions we've just discussed, a much better approach to the problem is to use an oscillator/charge-pump design. That's the kind of circuit that was shown in the first installment of the "Designer's Notebook." Although that circuit is more complex, the basic idea is rather simple and the design is a lot more versatile. Because there's no convenient AC source in a battery-powered circuit, the most direct approach is to manufacture one. That is, put together an oscillator and then rectify the resulting AC to produce a negative DC supply. The amount of current you get from the circuit depends on how much current the oscillator can output. The design of the circuit downstream of the AC is a direct clone of the transformer/rectifier that we're all familiar.

Dick Kaufman, Dale Nassar, David Van Stone, Tom Lewis, and others all used that approach, though their individual circuits differed. Figure 2 is a block diagram of the circuit we're talking about. It's really as simple as it looks and your design can be as simple or sophisticated as you need. The oscillator can be whatever you want and the rectifier can be either half-wave or full-wave—it doesn't really matter. It should be set to trap the negative half of the voltage swing from the oscillator but, other than that, there's nothing new. See the circuit in the March, 1984 "Designers Notebook" for the circuit details. The circuit's output voltage will be unregulated but that can be handled easily enough by hanging a regulator at the output. Since there's a voltage loss when you do that, it might be a good idea to use a voltage doubling rectifier.

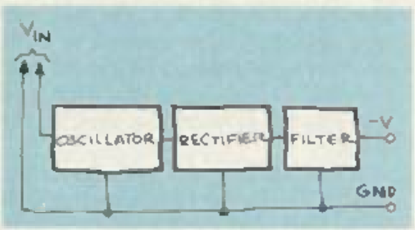

FIG. 2

The filter shown in Fig. 2 can be as simple as a capacitor or as complex a scheme as you want—again it depends on what you need. Remember that your oscillator is producing a high-frequency signal, and that the high frequency can drive some circuitry around the band. If you have any doubts, make sure that your filter can take care of it.

The last category we listed was wishful thinking: rather than describing some of the more ridiculous circuits, let's take a look at an idea that is at least theoretically possible—it was certainly the most direct solution that was sent in. Mr. D. L. Bray suggested, more or less as a joke, that we take a 9-volt battery apart and solder a ground connection to the center cell. To save all of you a lot of trouble, let us tell you that we tried it and it works! Now all we need is some advice on how to put the battery back together again.

Before we forget, our special thanks to James Richey for sending us a working model of a charge-pump type of circuit. It's always nice to see an idea on paper, but it's much more satisfying to see it actually turned into hardware. R-E

DESIGNER'S NOTEBOOK

Extending the counting range of the 4017

ROBERT GROSSBLATT

THE 4017 IS ONE OF THE MOST POPULAR OF the CMOS MSI (*Medium Scale Integration*) counters. Because it sequences its outputs one at a time, it's ideally suited to serve as a frequency divider, pulse delayer, and so on. That IC even has a carry output that allows you to cascade as many 4017's as desired.

There is an application, however, where the use of the 4017 isn't quite as simple and straightforward. We're talking about connecting several of them together so that they will all sequence their outputs one IC after another. The carry output isn't any good here because it goes high for one-half of the IC's full count and low for the other half. That's great if you want a squarewave whose repetition rate is one-tenth of the input clock frequency. But it doesn't help at all if you need a simple circuit that will take an input-clock signal and turn on more than ten outputs in sequence. Doing that requires a bit of external gating.

This month we will look at how you can arrange three 4017's to sequence in turn and provide up to twenty-five outputs with a minimum of external gating. We will be using a 4011 quad-NAND gate to achieve the desired gating arrangement. The same principle can be followed if you need more than twenty-five outputs; just add more 4017's and a few more gates. Since there are four NAND gates in the 4011, it will accommodate two more 4017's to give you a total of 41 outputs. We're losing five possible outputs for a variety of reasons that will become clear shortly.

How it works

In Fig. 1, the clock inputs of all the 4017's are tied together so that they can all be triggered by a common clock pulse, and the same goes for the reset pins. The key to making the circuit work is using the gates to control the enable pins (pin 13) so that the three IC's can be made to count in sequence. Since the enable pins are active high, they have to be brought low. We'll use the NAND gates to control the order in which the 4017's are enabled.

When power is first applied to the circuit, capacitor C1 generates a reset pulse that forces all the 4017's to output a "0" at pin 3. One of the unfortunate features of the 4017 is the lack of a convenient inhibit pin that we could use to turn off all the outputs. When the enable pin is brought high it only disables the clock input—it doesn't do anything to the outputs. That's why we need the external gating and that's also the reason that we can only get 25 outputs from the circuit instead of 30.

When the counting first starts, pin 11 of all the counters is brought low. Because pin 11 of IC1 is connected to its enable pin, the IC is enabled and starts to count. That same low signal is fed to one leg of NAND gate IC4-a at pin 5 to control the enable pin of IC2. The other leg of the NAND gate, pin 6, is connected to IC2 pin 11 through IC4-b, which is used as an inverter. Because IC2 was reset at the start of the counting process, its output at pin 11 is also low. That low output is inverted by IC4-b and the resulting high output is applied to IC3 to disable it. The high output from IC4-b is also applied to IC4-a, which in turn outputs a high to the enable pin of IC2 disabling it too. That means that only IC1 is enabled at the start of the count.

When pin 11 of IC1 goes high, it disables IC1 and at the same time that high is fed to pin 5 of IC4-a. Because both inputs to IC4-a are now high, it's output goes low and that in turn enables IC2. When the output at pin 11 of IC2 goes high, it's inverted by IC4-b and the resulting low enables IC3. The same low is applied to IC4-a causing it to change states (go high), thus disabling IC2. After nine more clock pulses the output of IC3 at pin 11 goes high applying that signal to all of the reset pins simultaneously, causing all the 4017's to reset to zero and start the whole sequence all over again.

Essentially, what we're doing is using pin 11 of each 4017 to control the enable pin of the next IC in line. When the output at pin 11 of the last IC in the sequence goes high, a high is applied to the reset pins of all the IC's causing them to be reset to the beginning. The same principle can be used to extend the sequence. Just remember that you can only use eight of the 4017's ten outputs—pin 3 is needed because there's no inhibit control and pin 11 controls the next 4017.

Let us know if you can figure out a way to use a simple gating arrangement to recover the use of some of the five lost outputs in the circuit. After all, there's always a better way to do something. R-E

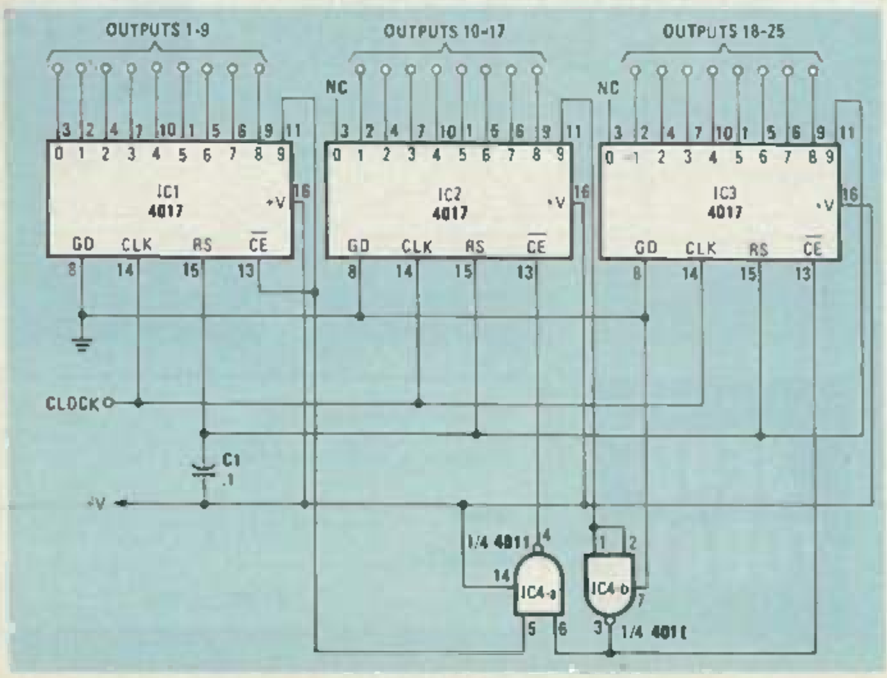

FIG. 1

NEW PRODUCTS

continued from page 32

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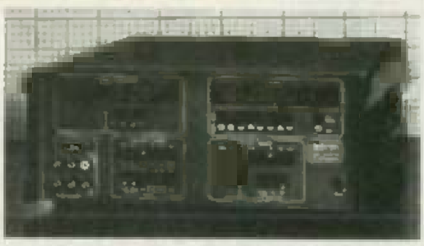

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output ranges from 1 nanovolt to 1000 volts all from a single self-contained and transportable package. An optional AC current calibrator is available. It is designed as a prime source for any standards or calibration laboratory.

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The model *4200* is priced at $17,995. — **Datron Instruments Incorporated,** 3401 S.W. 42nd Ave., Stuart, FL 33497.

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Freez-It is available in two sizes: 15 oz., priced at $2.95; 22 oz., priced at $4.50.— **Chemtronics, Inc.,** 681 Old Willets Path, Hauppauge, NY 11788.

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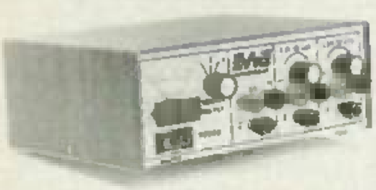

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power supplies can be either positive or negative; they can be stacked in series so that a 5-volt and two 15-volt supplies can total 35-volts DC, or any combination of the three, resulting in a fully adjustable 0- to 35-volt DC power supply.

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continued on page 46

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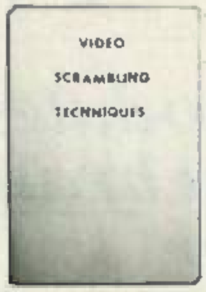

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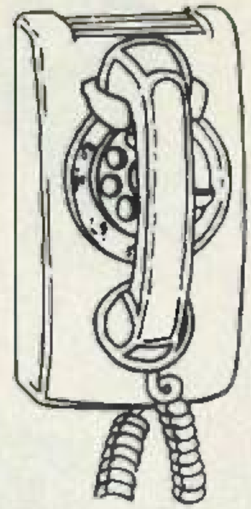

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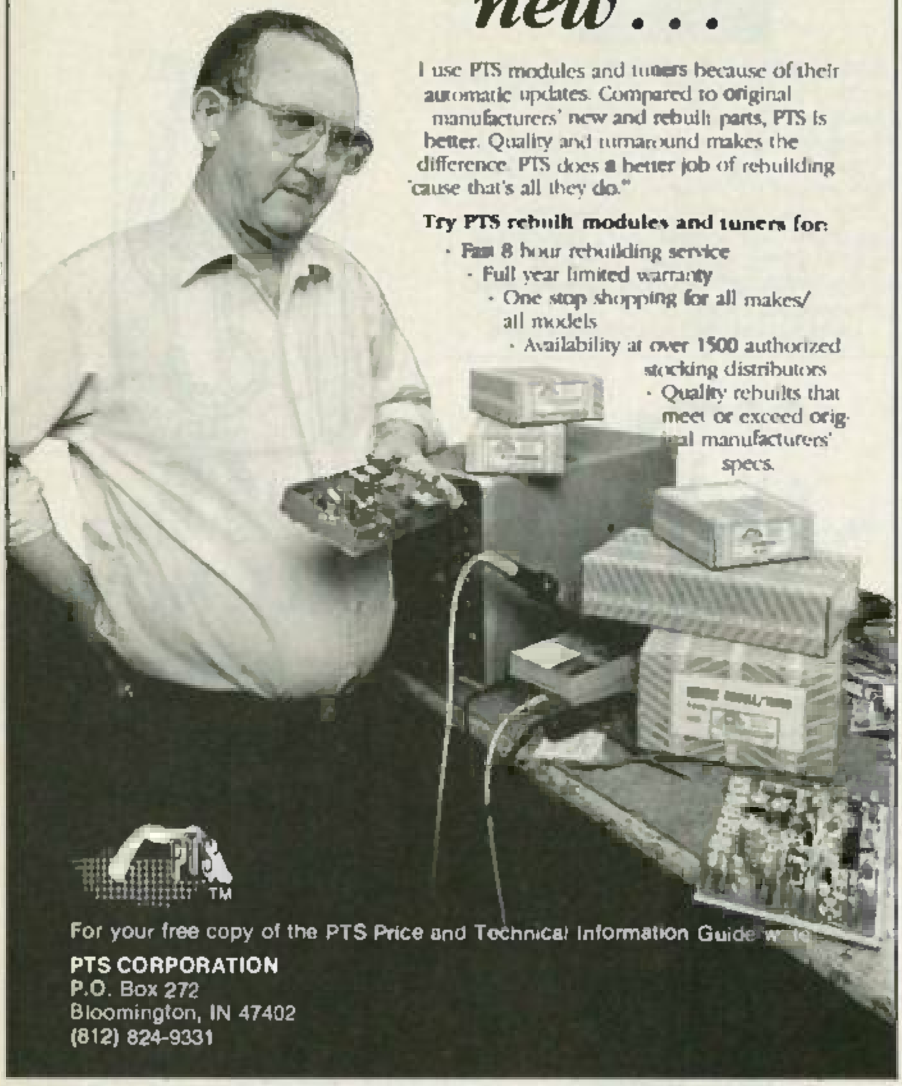

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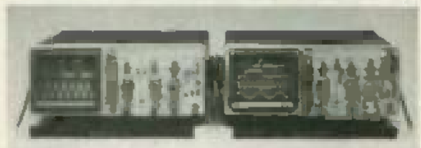

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The new "A" versions reflect a composite of suggestions from customers owning the earlier versions. They incorporate such features as a 10-MHz bandwidth-limit switch, a single-sweep mode and power-on light, and separate A/B dual intensity controls.

The model *2213A* weighs 12.8 pounds and is priced at $1200.00; the model *2215A* weighs 13.5 pounds and costs $1450.—**Tektronix, Inc.,** PO Box 500, Beaverton, OR 97077.

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The labels are self-adhesive and adhere to any dry surface. They measure 0.3 mm thick.

The temperature indicators are available in booklets, each with identical rated labels, and can cost less than 10 cents each in large quantities.—**Solder Absorbing Technology, a Spirig** Company, South End Bridge Circle, Agawam, MA 01001. R-E

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PHILIP M. VAN PRAAG

THE GROWING NUMBER OF STATE AND federal auto-emission requirements has added yet another burden on just about every motorist. Not only do you have to worry about monthly payments, insurance, and sufficient maintenance to keep your car running down the road, now you also have to worry about the next emissions test. Will your car pass, or will you have to go through the time and often considerable expense to have it "tuned up" and then retested?

Worse yet, even if you are a do-it-yourselfer with an "army" of tools, timing lights, and dwell meters, you are still at a disadvantage with regard to emissions tuning. Those items alone are not enough to do the job, and doing what we did in the "good old days"—that is, simply replacing the plugs and points, setting timing and dwell, and then "tweeking" the carburetor until the engine runs smoothly and performs well—just won't cut it anymore.

Indeed, often the best low-emission settings for your car will be quite different from those settings that provide the best performance. There is simply no way to optimize those adjustments for, nor adequately predict the results of, an emission test with common service equipment. That's why you need the digital exhaust-gas analyzer that will be described in this article.

That device is a small, easy-to-use diagnostic aid. In a general sense, it monitors combustion efficiency of the engine system. That is vitally important as combustion efficiency directly affects exhaust-gas content. More efficient combustion means more complete burning of the gasoline. That translates to smaller amounts of hydrocarbons and carbon monoxide (CO) in the exhaust. Hydrocarbons and CO are the "polluters" typically monitored by government test facilities. (More about the relationship between combustion and exhaust makeup later.) Specifically, the unit displays CO in concentrations of less than 1% to about 10%, and air/fuel (A/F) ratios from 14.5 down to about 11.0.

The project consists of three parts: an exhaust-gas probe, which is inserted into the auto tailpipe; a "conversion box", which transforms part of the exhaust into a proportional electrical signal; and a display unit, which amplifies and digitizes the signal for easy viewing. The unit can be used either while the car is stationary, allowing you to make adjustments, or while it is in motion, allowing you to verify those adjustments under dynamic operating conditions.

To simplify the circuitry, a commercially-available clock/timer module is used for the display. It contains an LCD readout, providing easy viewing under almost any lighting conditions. The module's crystal-controlled timing is also used by the project's A/D converter to ensure a stable timebase throughout the system. An interesting side-benefit to using the clock module is that the unit can be used as an ordinary clock or stopwatch when not being used to measure exhaust gas.

The unit also contains low-voltage sensing circuitry to prevent faulty readings due to inadequate battery voltage.

Theory of operation

Figure 1 is a block diagram of the primary circuit functions. Exhaust-gas conversion takes place in a thermal-conductivity cell (TCC). The TCC produces an electrical signal that varies with the difference in temperature between a "test" temperature sensor exposed to exhaust gas and a "control" sensor exposed only to ambient changes that affect both sensors. The sensors are self-heated identically, so that they will be at the same temperature when no exhaust gas is present.

When exhaust gas enters the test-sensor area, the ther-

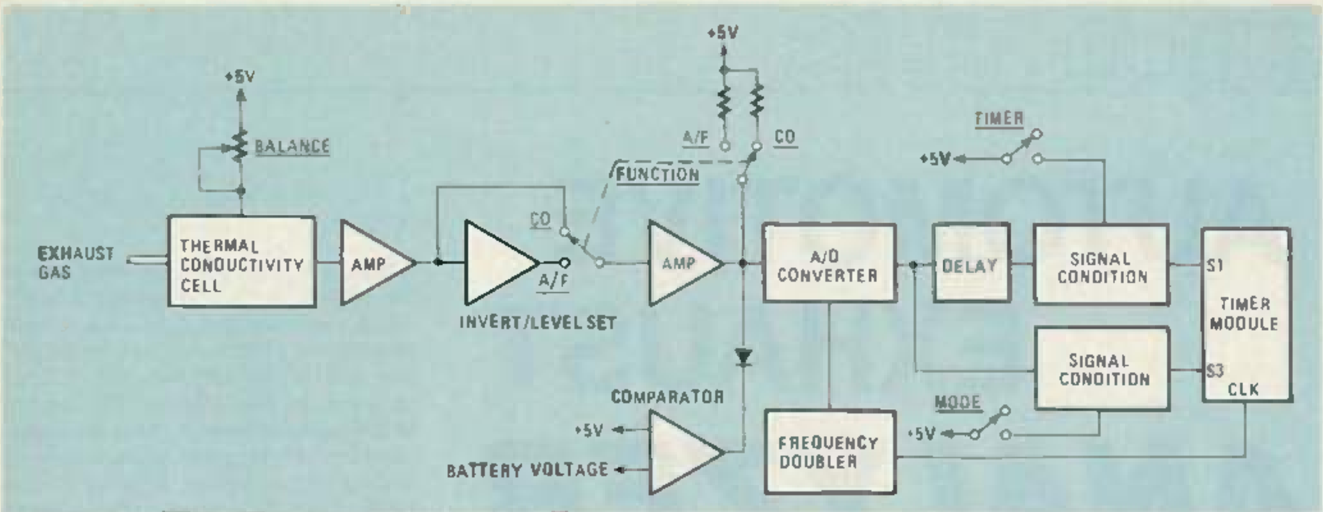


FIG. 1—ALL CRITICAL circuit functions are shown in this block diagram of the exhaust-gas analyzer.

mal conductivity of the air changes. That affects heat dissipation away from the sensor, thus altering the test-sensor temperature. Changes in sensor temperature cause its resistance to change. In this application, sensor temperature never changes more than a few degrees centigrade, but that is sufficient. It produces enough resistance change to unbalance the TCC. Because of the narrow operating-temperature range, sensor resistance changes linearly with changes in temperature.

At first glance, the difference between thermal conductivity and temperature measurement may not seem clear. They both involve electrical-output changes in response to sensor-temperature changes. In a common "thermometer," the change in temperature is due to an ambient-air temperature change. In the TCC, however, the temperature change is due to an ambient-air thermal-conductivity change. That is, the ability of heat to dissipate away from the sensor is a function of heat conductivity through the gas mixture. By the time the exhaust gas gets to the test sensor, it has essentially cooled down to ambient temperature. Thus, it is not the temperature of the gas that affects the sensor, but rather the thermal conductivity of the gas.

Thermal conductivity of exhaust gas differs from that of air. The exhaust consists of water vapor, carbon dioxide, hydrocarbons in various gaseous states, and CO. The exact proportions of the different hydrocarbon gases and CO, and their precise relationship to the thermal conductivity of the mixture, is very complex, beyond the scope of absolute measurement for this unit. Fortunately, there are predictable relationships over the temperature ranges of the exhaust gas commonly emitted from a 4-cycle internal-combustion, gasoline-drive engine; those can be used to help us in performing auto-emission adjustments. Over those ranges, reasonable accuracy and (more important) repeatability can be achieved.

The unit's CO and A/F functions bear an inverse display-relationship to each other. Thus, as the TCC output signal is amplified, an inverted version is also made available. The CO and A/F display ranges differ for those functions, so different amplifier output-voltage ranges and levels are also provided.

A digital display was chosen because it is easier to read than an analog meter. That is particularly important if the unit is used while driving. Conversion of the analog sensor-signal to digital form is performed by an A/D converter whose operation is shown in Fig. 2. Clock pulses from the timer module are counted, and the results of that count are used by an adder to generate a ramp. Comparator 1 is then used to compare that ramp with the analog sensor-signal. The output of the comparator is a pulse. The duration of the pulse is determined by the amplitude of the sensor signal; that is, the comparator's output is high as long as the ramp amplitude is greater than the sensor amplitude.

When the ramp amplitude dips below the sensor amplitude, the comparator's output goes low. The duration of the ramp

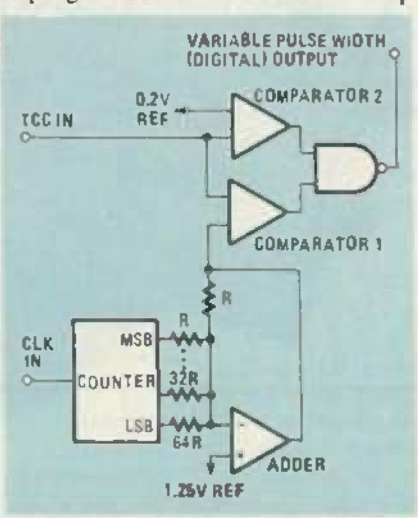


FIG. 2—HOW THE A/D CONVERTER works. Note that for simplicity, only 3 of the 7 resistors at the counter's outputs are shown.

(2 seconds), and hence the test-cycle length, is determined by the nature of the counter (divide by 128) and the clock frequency (64 Hz).

The output signal is used as a gate to allow a certain number of timer pulses to be counted by the timer module for each test cycle. That output is used to reset the timer from the previous count and define the start and stop of the current count.

The remaining task of counting and displaying the pulses is accomplished by the clock-timer module. Figure 3 shows the basic timer-module operation. The module is operated in its stopwatch mode, and has a resolution of 10 ms. That means that the display advances by one count every 10 ms. A series of internal counters divide a crystal-controlled 32-kHz oscillator signal down to the desired count rate. The stopwatch START/STOP and RESET switches are operated electrically when power is applied.

The unit uses the three least-significant digits of the display, with an implied decimal point between the two rightmost digits. Thus, a display of 00040 in the CO mode would be a reading of 4.0%, while a 00131 display in the A/F mode would be a reading of 13.1. Note that CO content is expressed as a percentage, while the A/F (air/fuel ratio) is expressed, naturally enough, as a ratio.

Circuit description

Figure 4 is a schematic diagram of the gas-analyzer circuit. The test and control sensors are precision-matched thermistor glass beads. Those beads are extremely tiny, about .014-inch in diameter. The small mass of the glass bead gives the unit a fast response time. The beads are premounted in fixtures, as they would be impossible to handle otherwise. (The bead leads are only .001-inch in diameter!) The fixtures and their housings comprise the TCC within the conversion box. A four-conductor cable routes the sensor signals and ground between the box and the display unit.

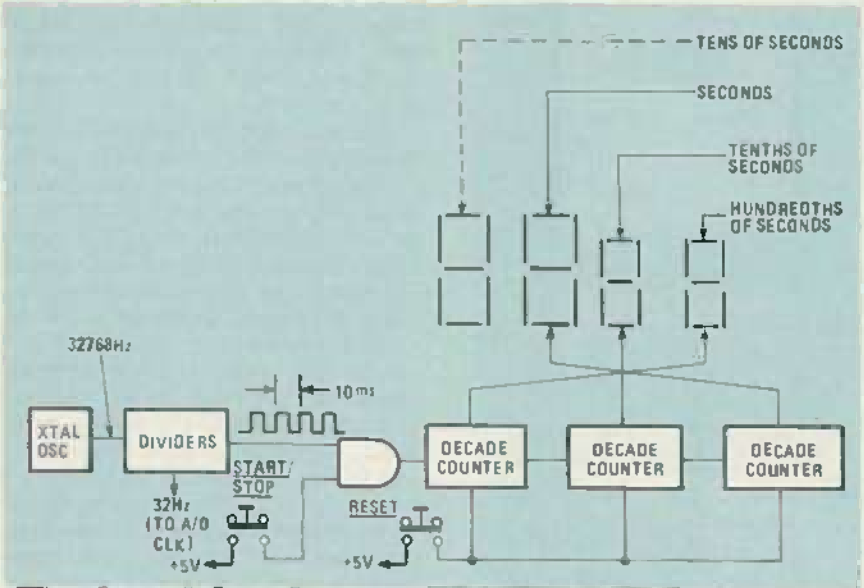


FIG. 3—THE TASK OF COUNTING and displaying the result is handled by a clock/timer module. The basic operation of that module is illustrated here.

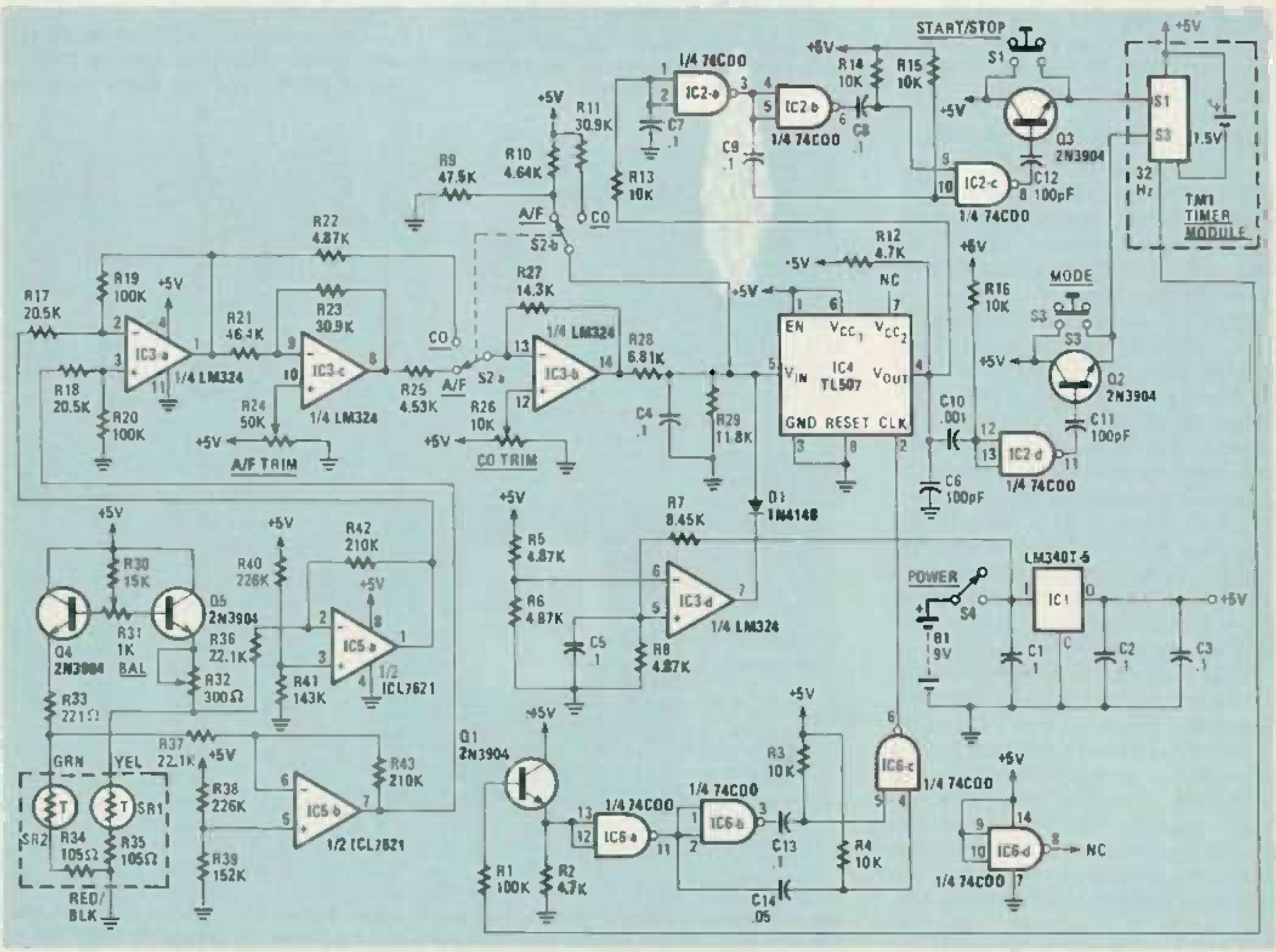


FIG. 4—AN AUTOMOTIVE EXHAUST-GAS ANALYZER. The circuitry enclosed by the dashed box in the lower left-hand corner is located on the TCC PC-board, which is mounted in the conversion box. All remaining circuitry is housed within the display-unit cabinet. Note that many of the resistors have tolerances of 1% (See Parts List).

All other circuitry is housed in the display unit. Transistors Q4 and Q5 translate BALANCE control (R31) changes into the very subtle bridge adjustments needed to "balance" the currents to the test sensors under ambient conditions. The two sections of IC5, a dual op-amp, are used to amplify the TCC outputs, and inject a fixed bias between them to provide a proper operating point for the next stage.

One section of an LM324 quad op-amp, IC3-a, is used to amplify the TCC outputs, and convert them to a single-ended signal. Another section, IC3-c inverts that signal and provides level translation for the A/F mode. Resistor R24 is a trimmer used to calibrate for the desired A/F ambient operating point. Final amplification is provided by IC3-b; that device also provides the CO operating-point calibration. The fourth section of IC3, IC3-d, functions as a voltage comparator, sensing the battery input-voltage to regulator IC1. If the voltage drops below 7.2, the pin 7 output goes to ground, which loads down the output of IC3-b, causing the device to stop update testing. Then it's time to replace the battery.

Transistor Q1, and IC6 and its associated circuitry, prepare clock pulses for the A/D converter (IC4) using a 32-Hz intermediate-countdown signal obtained from the timer module. Transistor Q1 shifts the timer voltage-levels, while IC6 functions as a frequency doubler to provide the 64-Hz signal needed by the A/D converter to define the two-second test interval.

Resistors R9 and R10 determine the final ambient voltage-level for the A/F mode, while R11 determines the final ambient voltage-level for the CO mode. Those voltage levels define particular A/D pulse durations, which, in turn, define particular display readouts.

The A/D output is conditioned so that it can be used to control the clock module by IC2 and the Q2–Q3 circuit. One section of the IC, IC2-d, along with C10 and R16 are used to differentiate and invert the A/D output's leading edge to form the S3 reset pulse. Another section of the device, IC2-a, delays the A/D output from reaching the stop/start circuitry until the reset pulse has been applied to the timer module. The IC2-b–IC2-c circuit is a "double differentiator that provides short trigger pulses on the delayed leading and trailing edges of the A/D output signal. Those pulses are used to start and stop the timer. By presenting a very high impedance to the timer when the unit is switched off, Q2–C11 and Q3–C12 allow the timer module to be used as an ordinary clock or stopwatch when the unit is not being being used for exhaust analysis.

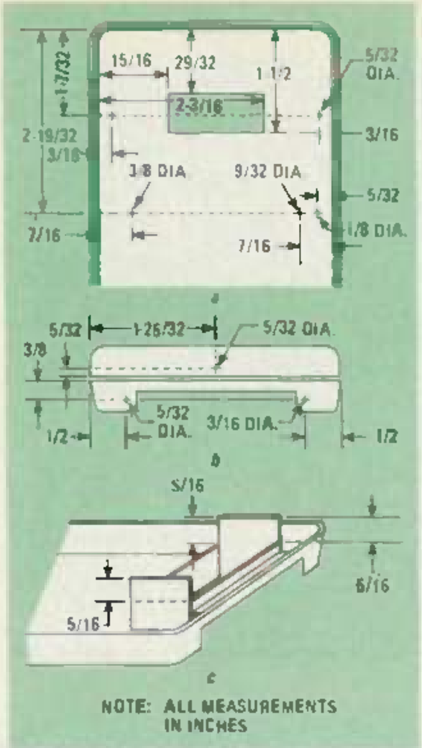


FIG. 5—IF THE CABINET available from the source given in the Parts List is used, it is drilled and modified as shown above.

Display cabinet and timer module

Caution: Before proceeding with any modification to the clock-timer module, be certain that it is functioning correctly in all modes of operation. Once it has been modified the manufacturer will not honor warranty claims.

Figure 5 shows display-cabinet preparation details for the cabinet available from the source mentioned in the parts list. (If you purchase the complete kit, the cabinet will already have been completely prepared.) The cutout for the LCD display can be done by first drilling a number of holes within the cutout border, then carefully filing to eventually produce a clean rectangular hole. The bottom of what was intended to be a battery compartment must be cut out to provide a mounting fixture for the clock/timer module. The detail for that is shown in Figure 5-c.

Figure 6 shows how the timer is modified and mounted in the clock/timer-module cabinet. Figure 6-a shows the ridges on the sides of the timer that must be filed off to allow it to slip-fit into the flanges that are formed when the battery compartment is modified. You will also need to file off a portion of the timer's case rear to allow a 9-volt battery to be inserted into the battery compartment: remove a $1\frac{1}{16}$-inch section to a depth of $\frac{3}{32}$-inch as shown. Doing that will disable the S1 and S3 switches on the timer module, but their functions are replaced by the analyzer's switches. Figure 6-b shows the final alignment of the timer in the display cabinet. A tiny amount of contact cement can be used to secure the timer to the cabinet, but it may not be needed if the side ridges are carefully filed just to the point of allowing a light press fit in the cabinet. In any event, provision must be made to allow the module to be removed, as must be done to insert or remove the PC board. Removal may also be needed to change the timer battery, although if the bottom battery retaining-clamp screw is left a little loose it is possible to change the battery through the battery-compartment access lid.

Four wires have to be added to the timer module to interface it with the rest of the circuitry. Figure 7-a shows where three of those wires are attached; shown there is the side of timer's PC board that's seen when the timer's back cover is removed. The fourth wire is attached to the other side of that board as shown in Fig. 7-b. To gain access to the timer-circuit board, pry off the back cover, then very carefully remove the four small chrome Phillips-head screws that hold the mechanism in place. Note the locations of the screws as well as the orientation of the battery retaining clamp. You should now be able to lift the molded black plastic lid away from the circuit board. Carefully solder three fine (30-gauge) wires in place, using very little solder and trying to keep the wires and solder close to the edge of the PC board.

Next, very carefully lift out the spring-steel switch strip using a pair of needle-nosed pliers; note the position of the strip—it is over two small red-plastic studs. Then, remove the circuit board by gently lifting from beneath at various points along the edge of the board. When the PC board is removed, the LCD display will probably stick to it. If it does, care-

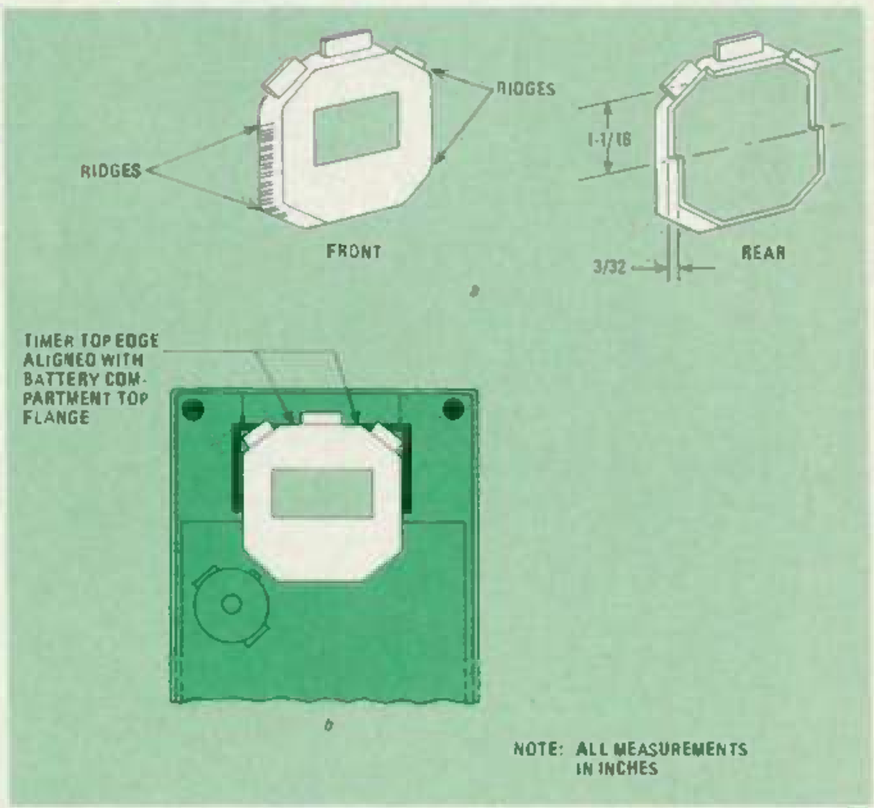
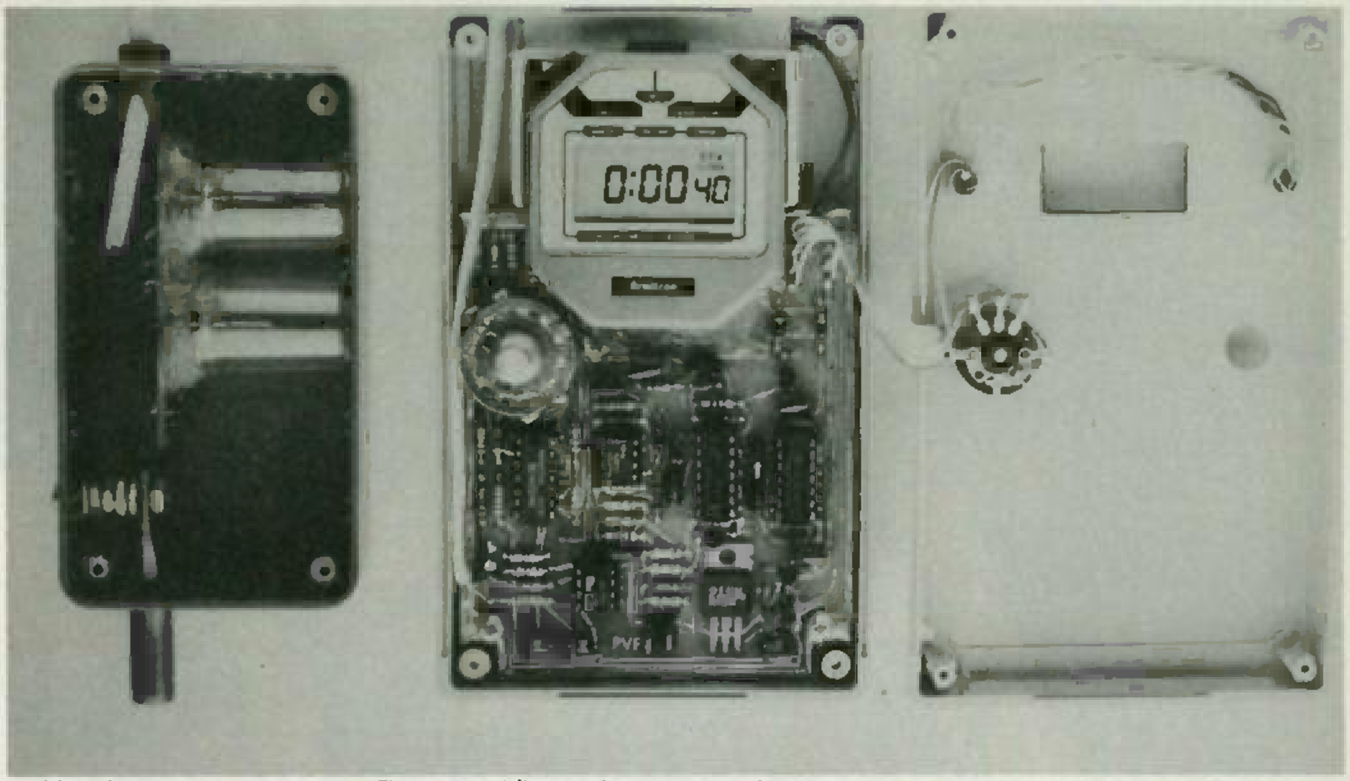


FIG. 6—A POPULAR WATCH/TIMER is used in this project. That timer's case must be modified as shown in a so that both it and a 9-volt battery will fit in the display unit cabinet. How the timer is mounted in the cabinet is shown in b.



A LOOK INSIDE the exhaust-gas analyzer. The completed display unit and conversion box are shown here with their cases open.

PARTS LIST

All resistors 1%, ¼-watt unless otherwise noted

R1—100,000 ohms, 5%
R2, R12—4700 ohms, 5%
R3, R4, R13–R16—10,000 ohms, 5%
R5, R6, R8, R22—4870 ohms
R7—8450 ohms
R9—47,500 ohms
R10—4640 ohms
R11, R23—30,900 ohms
R17, R18—20,500 ohms
R19, R20—100,000 ohms
R21—46,400 ohms
R24—50,000 ohms, miniature potentiometer, linear taper, vertical PC-board mount
R25—4530 ohms
R26—10,000 ohms, miniature potentiometer, linear taper, vertical PC-board mount
R27—14,300 ohms
R28—6810 ohms
R29—11,800 ohms
R31—1000 ohms, miniature potentiometer, linear taper, panel mount, with SPST switch (S4)
R32—300 ohms, miniature potentiometer, linear taper, vertical PC-board mount
R33—221 ohms
R34, R35—105 ohms
R36, R37—22,100 ohms
R38, R40—226,000 ohms
R39—152,000 ohms
R41—143,000 ohms
R42, R43—210,000 ohms

Capacitors

C1–C5, C7–C9, C13—0.1µF, ceramic disc
C6, C11, C12—100 pF, ceramic disc
C10—.001 µF, mylar
C14—.05 µF, ceramic disc

Semiconductors

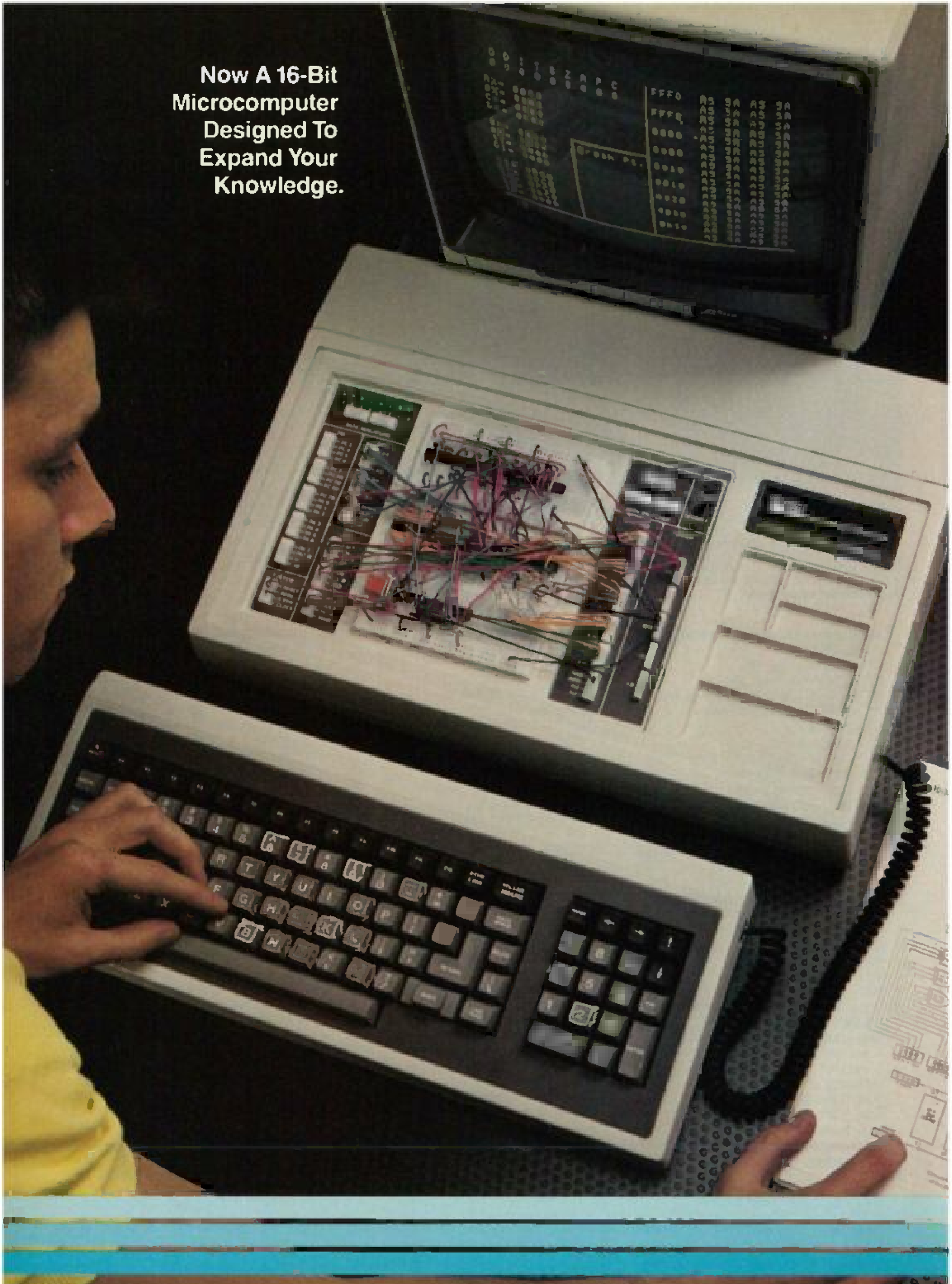
IC1—LM340T-5 or 78M05 +5 volt regulator
IC2, IC6—74C00 CMOS quad NAND gate
IC3—LM324 quad operational amplifier
IC4—TL507C A/D converter
IC5—ICL7621DCPA dual operational amplifier
Q1–Q5—2N3904 NPN silicon transistors
D1—1N914 or 1N4148 general purpose diode
SR1, SR2—G126 precision matched thermistor pair (Fenwal Electronics, 63 Fountain St., Framingham, MA 01701)
TM1—timer module, model U01 sport stopwatch (Armitron Corporation, 29-10 Thompson Ave, Long Island City, NY 11101)
S1, S3—SPST momentary normally open pushbutton (C & K 8631 or equivalent)
S2—4PDT rotary, panel mount
S4—SPST potentiometer switch, part of R31
B1—9-volt battery

Miscellaneous: PC boards, display and conversion-box cabinets, IC sockets, 9-volt battery terminal clip, modular telephone extension cord, 25 feet, with plug and receptacle (MCM TA625 or equivalent), vinyl thin-wall tubing (⅜-inch I.D., ½-inch O.D., 48-inch length), copper tubing (⅜-inch O.D., 1/32-inch wall thickness, 14-inch length), spray bottle caps (see text), alligator clip, cable strain-relief (5/16-inch mounting hole), silicone glue, Velcro strip (1½ inches wide by 3 inches long), double-sided carpet tape, 30 gauge wire, 8-conductor ribbon cable, knobs, hardware, etc.

The following are available from PVP Industries, P.O. Box 35667, Tucson, AZ 85740: Etched and drilled epoxy-glass PC boards for display cabinet and conversion box for $14.95; SR1, SR2 sensor pair for $22.95; PC board set, both cabinets (not drilled), timer module, front panel decal for display cabinet, and modular extension cord for $49.95; complete kit of all parts (except glue and battery), including pre-drilled cabinets for $98.95; completely assembled, calibrated, and tested unit for $129.95. The above prices are postpaid in the continental U.S. Arizona residents add 5% sales tax. Readers of Radio-Electronics are invited to send a SASE to the above address to receive free updates on this project, along with user tips as they become available.

fully separate it from the board, noting its orientation and setting it back into the case exactly as it was before the board was removed. (That is important because there is usually no pin identifications on those displays.) Using a jeweler's screwdriver, very carefully scrape the green lacquer coating off the PC pattern at the point

continued on page 56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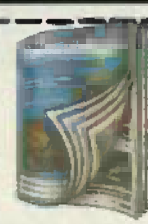

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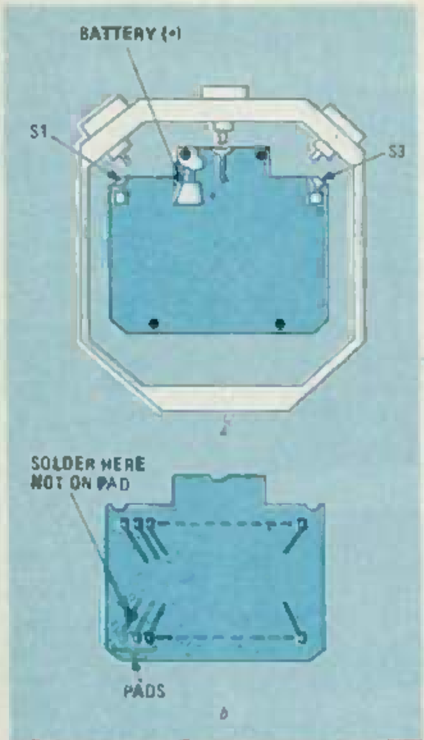


FIG. 7—FOUR WIRES must be added to the timer's PC board as shown above.

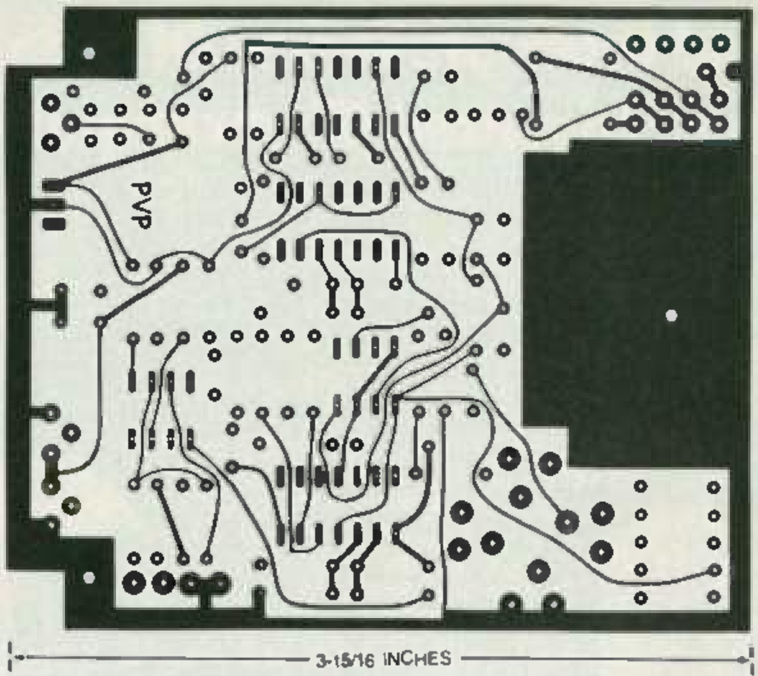


FIG. 9—THE COMPONENT SIDE of the double-sided display PC board. It, too, is shown full sized.

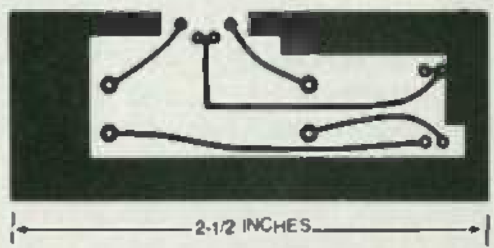


FIG. 10—FULL-SIZED FOIL PATTERN for the TCC board. That board mounts in the conversion box.

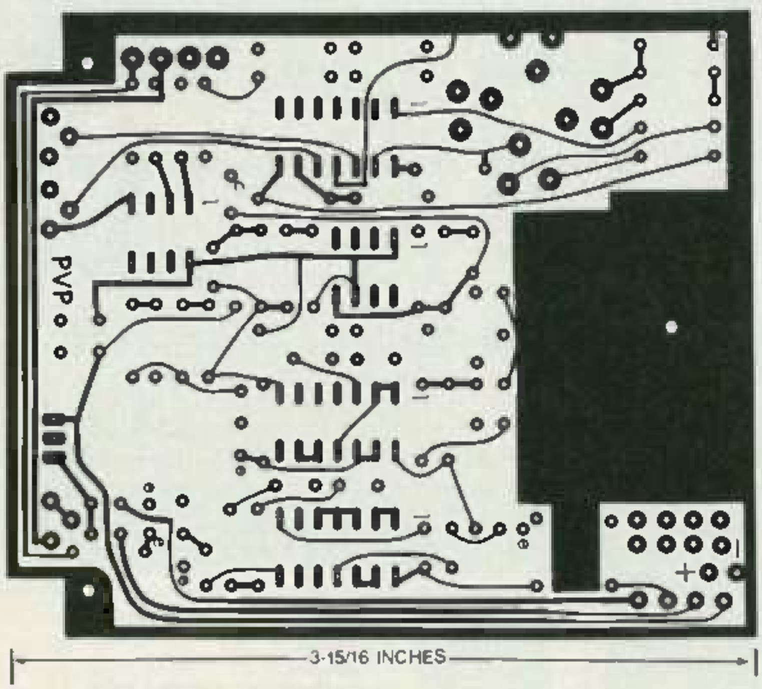


FIG. 8—THE FOIL SIDE of the double-sided display PC board is shown here full sized. It's parts-placement diagram will be shown next month.

shown in Fig. 7-b. Do not touch any of the pads that mate with the LCD display. Using a very fine-tipped soldering iron, and a small amount of solder, tin both the exposed copper foil and the wire to be attached. Do not allow any solder or flux to contact the pad located below the trace. Touch the wire and the iron to the point that was tinned to attach the wire.

Next, set the PC board into the case along with the switch-contact strip. Re-insert the molded black plastic lid and and the screws (do not over tighten), dress the wires up out of the way, and make a note of the wire colors for later identification when connecting them up to the gas analyzer's PC board. The timer's back cover will not be used in the cabinet.

Display-electronics construction

Full-size PC-board patterns are shown in Figs. 8, 9, and 10. We recommend using PC boards, as that will considerably reduce construction and debugging time. It will also help eliminate the possibility of any high-impedance-leakage paths or spurious-signal pickup. The use of IC sockets is recommended as those allow easy IC removal/replacement should servicing ever be required.

Full-size foil patterns for the double-sided display PC board are shown in Figs. 8 and 9. If you choose to etch your own board, and cannot provide plated-through holes, you will have to solder all component leads on both sides of the board. In addition, you will have to insert a wire into all pads that do not contain component leads, then solder those feed through wires on both sides of the board.

Unfortunately, that's all we have room for now. Next time, we will take a look at the parts-placement diagrams, and show you how to complete the electronics part of the project. R-E

ALL ABOUT

CARL LARON
ASSOCIATE EDITOR

The promise of 3-D TV has gone largely unfulfilled up to now. But that appears to be about to change, thanks to the work being done on systems like the ones we'll show you in this article

What's New in 3-D TV

IF YOU ARE LIKE MOST PEOPLE, WHEN YOU think of "3-D", you think of bad movies, eye strain, and often unsuccessful special effects. Yet 3-D TV remains one of the "holy grails" of the video industry. But that should come as no surprise considering the enormous popularity such a system would have for not only everyday viewing, but also for such things as videogames. In addition, 3-D TV has many important applications in science, medicine, and industry.

The key to the success or failure of a 3-D system is the quality of the effect. Also, only slightly less important is the degree of inconvenience and/or cost imposed on the viewer.

In this report we are going to look at three 3-D TV systems currently under development, and examine their strengths and weaknesses. Each, from different manufacturers, takes a completely different approach as to how the 3-D image is produced. Finally, these systems are not all dreams and promises. All have reached the stage where at least working prototypes have been produced, and all could be introduced commercially in the near future.

No glasses

The first system we'll be looking at is also the only one that is "autostereoscopic;" that means that it does not require some sort of viewer-worn glasses to create its 3-D effect. Developed by a small California toy manufacturer, The Bright and Morning Star Company (5319 West 146th St., Lawndale, CA 90260), and called the *Autostereoscopic Image Display System*, it uses plastic Fresnel lenses instead.

Let's see how it works. First of all, two images, one of which must be reversed, are required for the system. That means that two monitors, with one displaying a reversed image, are needed for TV viewing; as we'll soon see, other applications are possible.

The heart of the system is a sandwich made up of prismatic Fresnel lenses. In use, the monitors are placed at right angles to each other and the Fresnel "sandwich" is placed diagonally between them as shown in Fig. 1.

When the viewer sits as shown in the figure, his converging sight paths are separated. One of the sight paths strikes the Fresnel sandwich at such an angle as to be totally reflected. That eye "sees" left-hand monitor, which is displaying the reversed image. The reason that the image on that monitor must be reversed is that, due to the total reflection of the sight path, we are essentially viewing it in a mirror. If it were displayed normally, the images seen would be reversed. Thus, by reversing the image, a normal image is seen. (That can get a bit confusing, so reread the last few lines, if needed, to be sure you understand them. Also, as an experiment, you might want to try watching TV in a mirror to see the effect.)

The other sight path is not reflected, but some slight refraction does occur. That eye sees the right-hand monitor, which is showing the normal image. Thus, since each eye is seeing the same image, although from a slightly different perspective, the viewer's brain is able to derive the 3-D image. In fact, that is how the brain normally provides us with three dimensional information.

Of course, the chief advantage of the system is that it requires no glasses. The other important advantage is that, because of the nature of the viewing system, its use is not limited to video. Indeed, it will

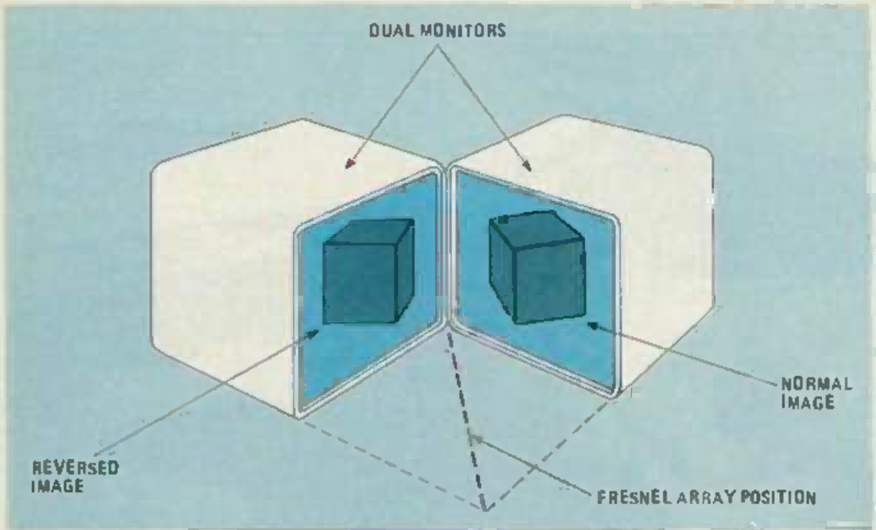


FIG. 1—THIS AUTOSTEREOSCOPIC 3-D TV system requires two monitors; those monitors are placed at right angles to each other.

work with photographic prints and transparancies (both still and moving), or with any other image source such as X-rays, radar, electron microscopes, and computer displays.

On the negative side, there are disadvantages, especially for home-video applications. For one thing, there's the cost associated with providing the two monitors required. Secondly, ideal viewing occurs only at one point, about 12 to 24 inches away from the unit; the exact point varies from individual to individual. That fact limits ideal viewing to just one person. A second person could also view the picture as shown in Fig. 2, but that second person would see a reversed image. The third disadvantage lies in the nature of the Fresnel lens. Those familiar with that type of lens know that the image rendered by them is unacceptable unless the lens is of the highest quality.

That is not to say, however, that that system does not have great potential, especially in areas outside of home video. For instance, the cost of a second monitor would not be too great a concern in a stand-alone arcade videogame. Another possible consumer application would be as a stereoscopic photographic viewer. The cost of the optics (only) for a snapshot viewer could be as low as one dollar; the optics for larger viewers would, of course, cost more.

Red and blue

The second system we'll be looking at uses a technique that should be familiar to anyone who has ever seen one of Hollywood's 3-D efforts. Those films were made using two cameras with different colored filters—one red, the other blue. The result was a film with two images slightly out of register. If the film were viewed directly, it would appear as if everything had a red outline.

But those films were not meant to be viewed directly. Instead, glasses with one red lens and one blue lens are used. Those lenses direct the appropriate image to each eye, and because the images are offset, the viewer sees the scene in three dimensions.

A German company, ABDY AG, is marketing a system that converts a standard TV so that it can create the same effect using standard TV signals. The system is also called ABDY, and its secret lies in its name, which is an anagram for *Anaglyphic By DelaY*.

The nice thing about this system is that it does not require special signals. Instead, it electronically alters a standard two-dimensional TV picture so that the illusion of 3-D is created. It does that by splitting off the red signal and delaying its viewing until a small fraction of a second after the blue signal has been displayed. That small time-delay creates an effect that is nearly identical to that of the 3-D movies so that when the image is viewed through special glasses, a three-dimensional image is seen.

The key to the success or failure of the system may very well lie in the glasses used. According to Garry D. Silivanch, President of 3DS Systems, Ltd. (Crescent Office Park 1, Hempstead Turnpike, Levittown, NY 11756), the U.S. distributor of the system, earlier efforts (such as the 3-D movies that were shown on TV in various parts of the country a few years back) failed mainly because of the poor quality of the glasses used. Those glasses were typically made of cardboard and used colored cellophane for the the lenses. On the other hand, the glasses that will be provided for the system, dubbed *Tri-Dimensional Television* for U.S sales, are comparable in quality to expensive sunglasses. Even viewers who wear prescription glasses have been considered: A clip-on version for wearing over regular glasses will be available.

Another strong point in favor of the system is that it can be added to any standard TV set at a relatively low cost. It is expected that the modification, complete with installation and two pairs of glasses, will sell for about $100. Once installed, 3-

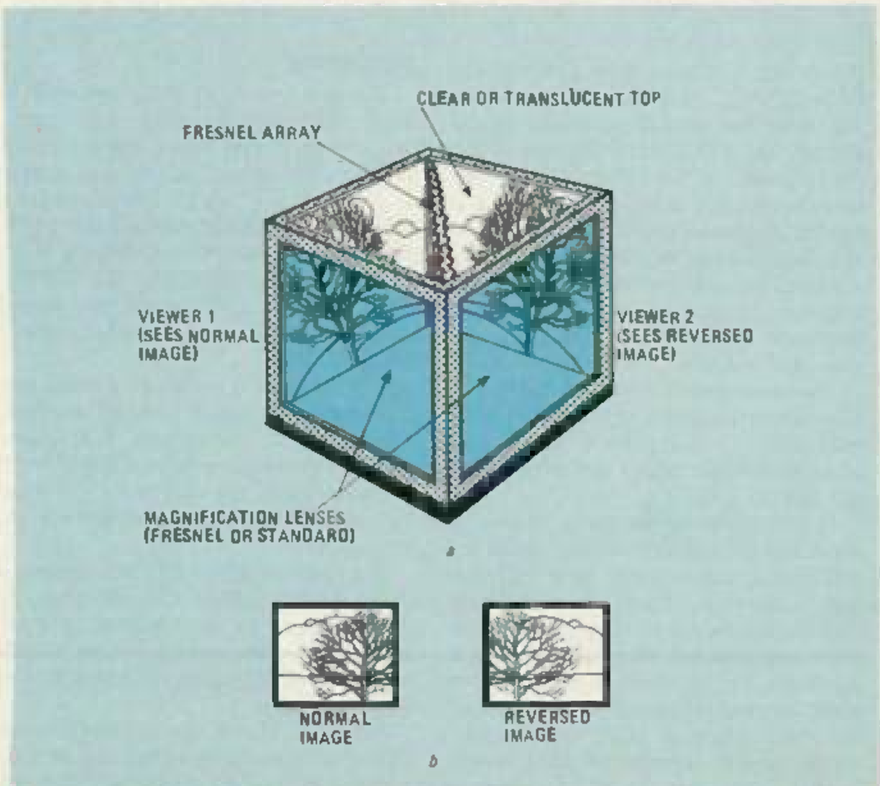


FIG. 2—A LOW-COST TWO-PERSON VIEWER is shown in a. Note that while one viewer will see a normal 3-D picture, the second will see a reversed image as shown in b.

D viewing is available at a flip of a switch; when the device is turned off, regular viewing is unaffected.

On the negative side, glasses, which are a viewer inconvenience, are required. Also, because colored lenses are being used to create the effect, at least some distortion of the colors displayed on the set will take place.

What about availability? The system has been sold in Germany for well over a year now. In the U.S., production in now underway, with testing scheduled to begin in July of this year in an area of suburban New York City.

Interlacing images

The third system we'll look at seems to be the one that is generating the most interest in the industry. Dubbed *StereoDimensional*, it was developed by Stereographics (Box 2309, San Rafael, CA 94912).

The *StereoDimensional* system consists of the electro-optical shuttering glasses, a video monitor, an imaging source such as stereoscopic cameras or a stereoscopic microscope (see Fig. 3), and a "black box" (see Fig. 4) that contains the propriatary electronics that keep the entire system synchronized.

Figure 5 shows how the system works. In it, a special pair of video cameras is used to photograph the scene. The images from the cameras are then presented sequentially on a monitor using the odd and even fields of the television interlace. The monitor is viewed using special glasses that first obscure one eye and then the other. The glasses are wired to the system and synchronized to the transmission so that the right eye sees only what the right camera photographed and the left eye sees only what the left camera photographed. (Research is also under way to develop some form of wireless glasses, perhaps using ultrasonic or infrared transmission techniques.) The brain, once again, sees the image from two different viewpoints and thus can reconstruct the three-dimensional scene.

If successful, such a system has distinct advantages over several other approaches currently being explored. For instance, in an anaglyphic system, the use of colored glasses prevents the image from being seen in its normal colors. Another problem often associated with those systems is eyestrain. Polarizing systems, on the other hand, allow the image to be seen in full color, but require that the viewer keep his head perfectly vertical to prevent ghosting or loss of depth. The *StereoDimensional* system overcomes those problems and allows the image to be seen in full, normal color, and allows the viewer complete freedom of head, neck, and body movement.

Using the odd and even fields of the television interlace to present sequential right and left images is not a new idea, but it only became practical because of recent developments in electro-optical technology. Also, previous systems using that technique suffered from bad flicker. That was caused by the fact that the normal field rate of a television raster is 60 Hz. Thus, when alternating fields are used, only 30 fields per second are devoted to the right eye and 30 fields per second to the left one.

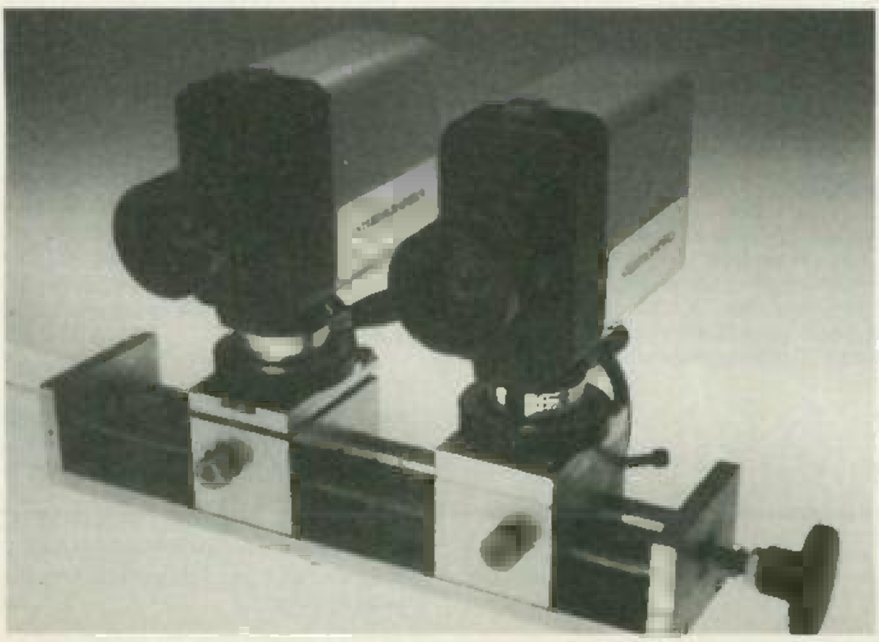
That is just too few; according to Stereographics, the minimum number of frames per second required to produce satisfactory results under most circumstances is 50. In the *StereoDimensional* system, several techniques are used to increase the number of fields displayed each second. In one of those, the vertical scanning rate is doubled, thus producing 120 fields per second as opposed to the usual 60. When such a signal is displayed on a standard monitor, however, it is vertically compressed and two images appear one over the other.

FIG. 3—ANOTHER 3-D IMAGE SOURCE. Here, twin video-cameras are mounted on a stereoscopic zoom-microscope to create a "3-D microscope."

To see the image in proper sequence, the field rate of the monitor must be increased to 120-Hz. In addition, suitable circuitry must be provided to double the sync frequency so that the fields will be decompressed and the images displayed in their proper proportions.

To keep costs down (it is hoped that eventually the cost of adding the system to a set during its manufacturing will increase the cost of the set by only 10%) the system was designed to be compatible with existing video systems. The first system manufactured (which, incidently, was delivered to Lockheed this past November) was designed around the NTSC system, but there is nothing inherent in the technique that would prevent its use in areas of the world that have adopted either the PAL or SECAM formats. Of course those formats use different field rates, and different numbers of total lines per field, but the *StereoDimensional* system can be adapted to them.

By the same token, that 3-D system can be adapted for use with a high-resolution video system, one with many more horizontal lines. The system can also be used



THREE-DIMENSIONAL TV CAMERAS. Signals from the cameras are routed to the control box, where they are processed and sent to a video monitor.

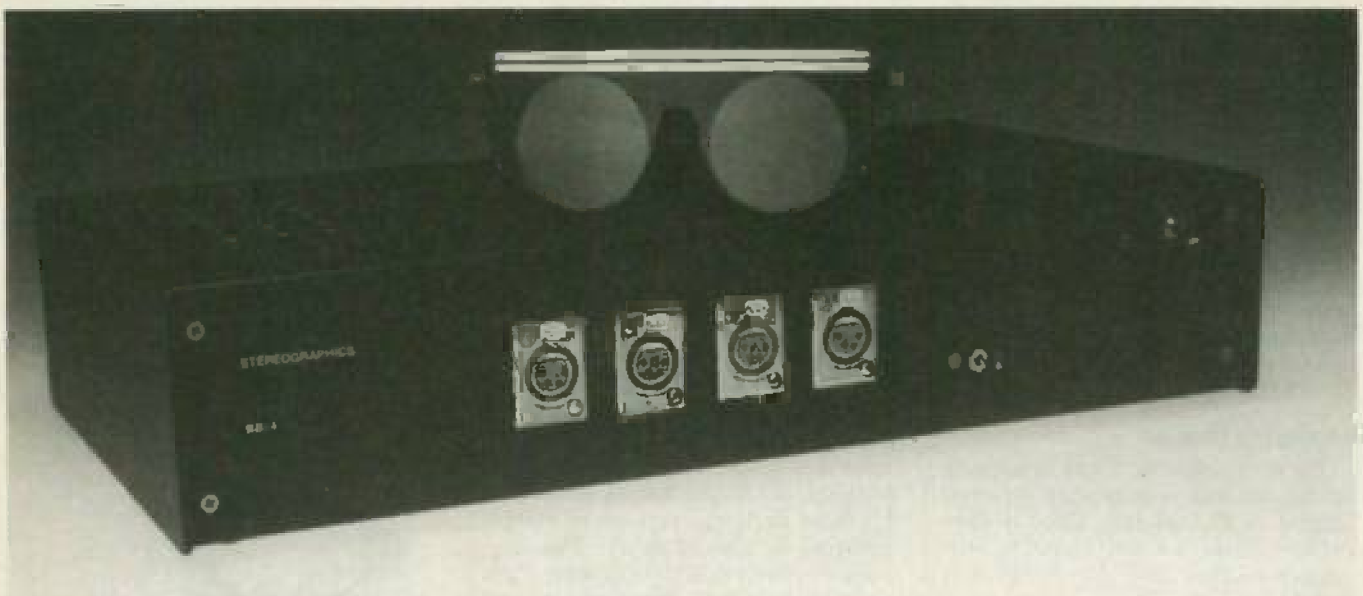


FIG. 4—THE EXTERNAL SYNC GENERATOR, the heart of the *StereoDimensional* system, is shown here with a pair of their electro-optical glasses.

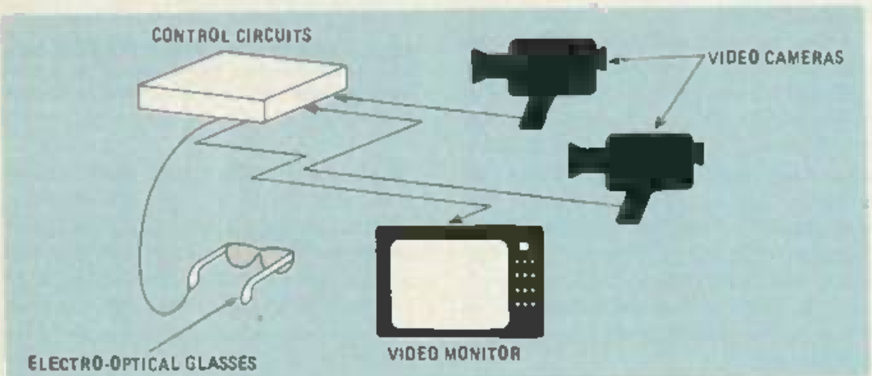


FIG. 5—PUTTING IT ALL TOGETHER. This diagram shows how the basic elements in the *StereoDimensional* system are connected together.

in just about any application that uses a CRT for display. Those applications include ultrasonics, radar, flouroscopy, and, of course, videogames.

Changing the number of fields per second does not effect such signal factors as bandwidth. Thus the altered signals could be broadcast over the air, used in a closed-circuit system, or distributed via cable without any problems. Existing videotape and videodisc formats could also be used to record the signals without any modifications.

That is not to say that there are not some serious drawbacks to the system. Glasses are, of course, still required. More importantly, the image must be photographed and transmitted using the *StereoDimensional* process, and the resulting signal can not be viewed satisfactorily on a "standard" TV set.

That, of course, means that it is unlikely that you will be seeing your favorite over-the-air TV show in 3-D using that system in the near future. Instead, the future of this system seems to lie in industrial applications such as computer-aided design and manufacture, cartography, flight simulation, IC inspection, microsurgery, mechanical training, and even air-flight control.

On the entertainment front, as previously mentioned, cable or videotape/videodisc distribution of programming using the process is certainly possible. Even more interesting are the possibilities offered by DBS. High-definition TV has received a great deal of attention in connection with DBS, and its use by one or more of that service's prospective programmers has been considered. Needless to say, a service that combines high-definition TV with 3-D TV could create quite a bit of excitement.

In this article, we've looked at three 3-D systems that have drawn a bit of interest. That is not to say, however, that those are the only systems under development. Indeed, because of the wide range of lucrative consumer and industrial applications, we expect that 3-D TV will be one of the hottest and most interesting areas of video research and development for many years to come. R-E

WHAT DO YOU THINK?

In this article we have presented an overview of three 3-D TV systems that have attracted a great deal of interest. We would like to know what our readers think of them. Which system do you think shows the greatest potential? If you had the opportunity, which one would you like to use to view 3-D programming? We invite you to vote below, and add any comments that you might have. We will let you, and the developers, know how the systems fared in a future issue of **Radio-Electronics**. Mail your ballots to: Radio-Electronics, 3-D TV, 45 East 17th St., New York, NY 10003.

- ☐ Autostereoscopic Image Display System
- ☐ Tri-dimensional TV
- ☐ StereoDimensional

Comments: ____________________

Telephone Add-On

NO MORE WRONG NUMBERS!

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

GARY McCLELLAN

Part 3 THIS MONTH, WE conclude our look at a device that keeps unwanted calls from reaching you. All that's left to do now is prepare the cabinet, install the boards, and make a few adjustments.

Putting it together

Start by referring to the Parts List for the materials you'll need and obtain them. Here are a few suggestions on the parts that might make shopping easier:

The switches may be any SPST types. We give the supplier and part numbers for switches that looked especially attractive, however you are welcome to use others. Just be sure to get a momentary type push-button switch for S1 and not an alternate action type. Using the wrong switch will cause problems!

The piezoelectric buzzer may be any similar device but don't substitute a mechanical type: the current draw is too high. Note that if you substitute for that device, be sure to get a surface-mounted buzzer. That is necessary because there isn't enough room inside of the cabinet for a different type.

A different cabinet may be substituted if the one specified is not readily available. Simply use any cabinet greater than 2×5×5 inches. But note that if you substitute the cabinet, you'll probably have to label your own front panel. That's because the front-panel board used in the project (see Fig. 9) is sized for the cabinet that was specified.

And finally, a few words about the hardware. All items are standard and should be available through most electronics supply houses. The spacers may seem unusual, though. We want four 1.125-inch threaded spacers, but that size must normally be custom made. Instead, four one-inch threaded spacers are used, plus four more 0.125-inch unthreaded spacers. That way, we get what we want by using standard parts.

Start assembly by drilling the front-panel board and mounting the switches. Start with a small drill bit, then use several larger bits and a round file to enlarge the holes to prevent damage. Then install the switches in the proper places and set the panel board aside for a moment.

Next, drill the rear panel, using the template shown in Fig 10 as a guide. Drill the small holes with a 0.125-inch bit and use a 0.25-inch bit on the large holes. When done, mount the buzzer using 4-40×0.5-inch screws and hardware.

Cut the telephone cord to about 6 feet and thread it and the 12-volt leads from the transformer through the large hole at the left edge. Pull about 7 inches of wire through, then install a cable clamp in the remaining small hole and thread the wires through it.

Turn to the main board and install the spacers. Note that each spacer mounts in the corners of the board—do not mount spacers in the holes located closer to the center of the board. Refer to Fig. 11 for details and install the spacers as shown. Place a lockwasher on a 4-40×0.5-inch screw, then pass it through the board. Place the 0.125-inch spacer and then the 1-inch spacer on the screw and tighten. Install the other spacers in the same way.

Now it is time to connect some wires to the main board—refer to Fig. 12 for details. Strip the telephone cable back about a half-inch. Then strip and tin the red and green wires; cut any others off.

PARTS LIST—MAIN BOARD

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

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

Semiconductors
IC1—TIL-119 optoisolator (Texas Instruments)
IC2—M290 ring-detector subsystem (Mendakota—see below)
IC3—CD4538 CMOS one-shot (RCA)
IC4—CD4093BE CMOS Schmitt trigger NAND gates
IC5—MOC-5010 optoisolator (Motorola)
IC6, IC7—78L05ACP 5-volt, 100-mA regulator (Motorola)
Q1, Q2—2N2222 NPN transistor
D1–D6, D8–D11—1N4002 diodes
D7—1N4148 diode
F1—0.25 amp, 3AG fuse
PL1—6 pin male PC-header (GC Electronics 41-046 or similar)
RY1—DPDT relay, 12-volt DC coil (Radio Shack 275-213 or equivalent)
PB1—Piezoelectric buzzer (Radio Shack 273-060 or equivalent)
S1—SPST momentary pushbutton switch (Radio Shack 275-618 or equivalent)
Miscellaneous: PC board, solder, wire, 2 PC-mount fuse clips (Littlefuse 122087), IC sockets, etc.

The following is available from Mendakota Products, Ltd., PO Box 20HC, 1920 W. Commonwealth Ave., Fullerton, CA 92633: A set of three PC boards and the M290 ring detector IC (order part No. NWR). The cost is $26.00 postpaid in the U.S. and Canada. The M290 is available for $12. California residents please add 6% sales tax. Sorry, no C.O.D's or credit-card orders.

FIG. 9—FOR SIMPLICITY, a PC board is used for the front panel. The foil pattern for that board is shown here.

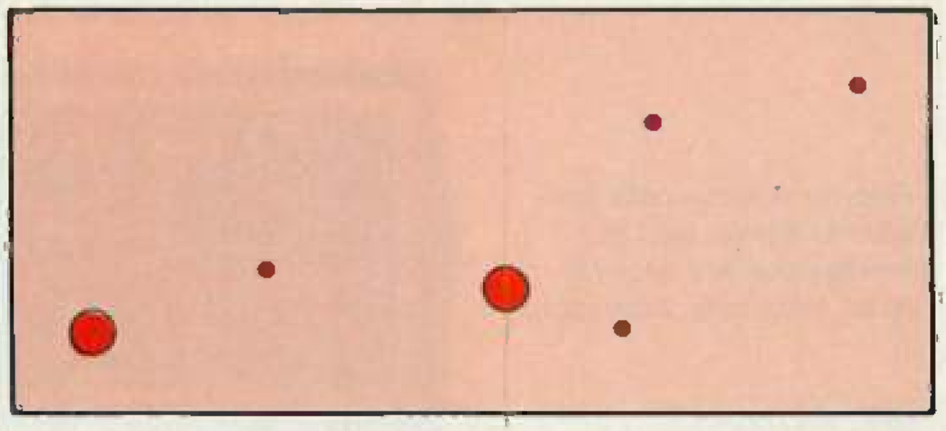


FIG. 10—IF YOU USE THE CABINET specified in the Parts List, using this template will simplify drilling the rear panel.

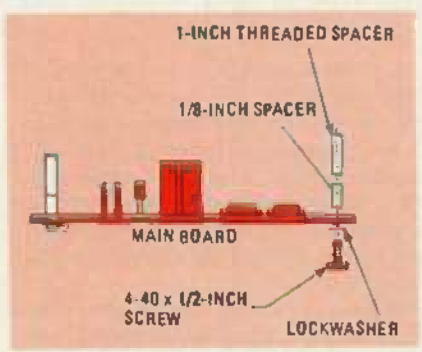


FIG. 11—HOW THE ONE-INCH and ⅛-inch spacers are mounted on the main board.

Here is a useful hint: Before connecting the wires, cut six ⅛-inch pieces of lead from some half-watt resistors. Insert the pieces into the main-board locations for the off-board connections so that they protrude from the component side and solder. Then, make the off-board connections to those leads. Doing that will allow you to repair any broken wires once the main board is installed in the cabinet. Otherwise such repairs would require removing the board.

Wire the main board and rear-panel as shown in Fig. 12. Place the rear panel into the slot cut in the cabinet and place the main board inside. Note that connector PL1 must point toward the front of the cabinet. Secure the main board with the screws supplied with the cabinet.

Next, slide the front-panel board in the slot and wire the switches as shown in Fig. 12.

The decoder board is installed next. Connect SO1 to PL1 on the main board. Then position the board over the standoffs and secure with 4-40 x 0.25-inch screws and lockwashers. Check to be sure that filter capacitor C15 does not short any traces on the decoder board.

That takes care of the assembly so let's move on to the adjustments!

Adjustments

Basically, there are three adjustments. One sets the volume of the buzzer and the others set the pushbutton tone-pairs that the decoder board will respond to.

There are two methods you can use to set the pushbutton tone-pairs that the project will respond to, and the method chosen depends upon your test equipment. The first method is the best and the easiest, but requires the use of a frequency counter. The second method requires no test equipment. Instead, you'll need the assistance of a friend with a pushbutton phone. That method works well enough, but is time-consuming.

Note that the volume adjustment is done by ear and will be saved for last.

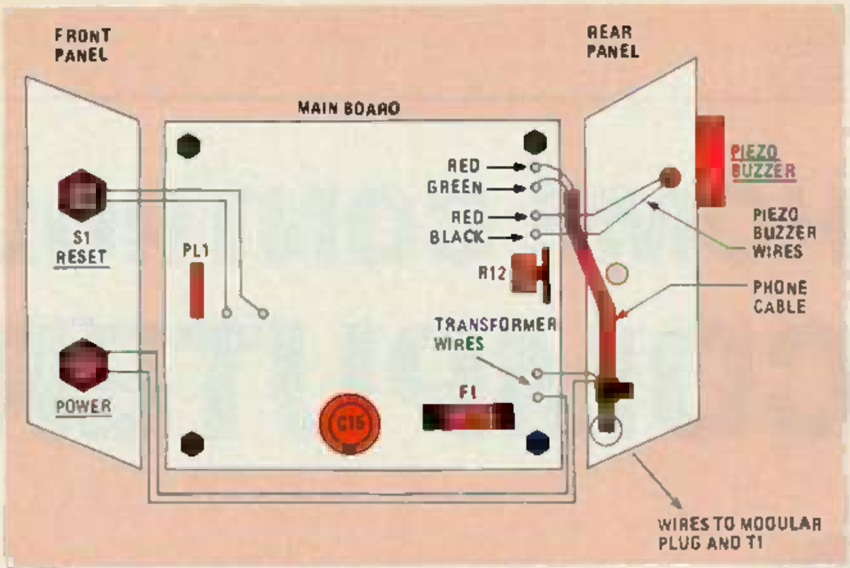


FIG. 12—THE WIRING BETWEEN the main board and the front and rear panels is done as shown here.

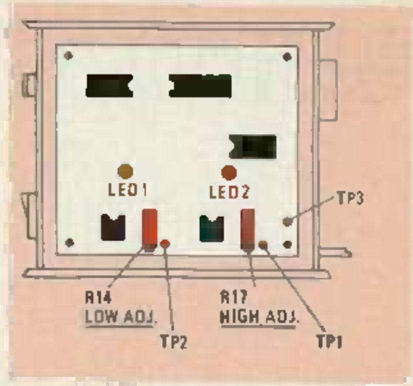


FIG. 13—THESE POTENTIOMETERS and test points, used in aligning the project, are found on the decoder board.

PARTS LIST—DECODER BOARD

All resistors 5%, 1/4 watt unless otherwise noted

R1, R13, R16—2200 ohms
R2—22 ohms
R3, R5, R11, R12—100,000 ohms
R4, 46, R8—4700 ohms
R7—100 ohms
R9—10 megohms
R10—47,000 ohms
R14, R17—20,000 ohms, 15-turn potentiometer, PC-mount (Radio Shack 271-340 or equivalent)
R15, R18—6200 ohms
R19, R20—180,000 ohms
R21—1 megohm

Capacitors

C1, C6, C13—1µF, 16V, electrolytic, radial leads
C2—0.001µF, 50V, polyester
C3, C7—47µF, 16V, electrolytic, radial leads
C4, C8, C9, C10, C11, C15—0.1µF, 50V, polyester
C5, C12—2.2µF, 16V, electrolytic, radial leads
C14, C16—0.1µF, 16V, ceramic disc
C17—1µF, 16V, tantalum

Semiconductors

IC1—LM339 linear quad comparators (National)
IC2—CD4017 CMOS counter (RCA)
IC3, IC4—LM567 linear tone decoders (National)
IC5—CD4001 CMOS quad NOR gates (RCA)
D1–D6—1N4148 silicon switching diodes
LED1, LED2—jumbo red LED's (Radio Shack 276-041 or equivalent)
SO1—6-pin female plug (Calectro 41-126 or equivalent)
S2—SPST rocker switch (Radio Shack 275-690)
T1—12 VAC, 250mA, plug-in transformer (Jameco AC-250 or equivalent)

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

Also note that the procedures outlined below assume that the code number selected will be 7.

Use this procedure if you have a frequency counter: Plug in the transformer and set the project's power switch to the ON position. Observe that the LED's on the decoder board blink when power is applied. That tells us that the decoders are working. Next, set up your counter and connect the ground lead of its probe to TP3, the ground test point on the decoder board (see Fig. 13).

Adjust the decoders by measuring the frequency at the testpoints and by adjusting the potentiometers for the right values. Connect the counter to TP1 and adjust R17 until the counter reads 1209 Hz. Next, connect the counter to TP2 and adjust R14 until the counter reads 852 Hz. Finish by dabbing nail polish on the potentiometers to lock the settings.

Use this procedure if you do not have a counter: Temporarily remove the decoder board and unplug it. Remove IC3, the MC14538, from its socket and place a wire jumper into the socket between pins 10 and 16. That causes the relay to close when power is applied. That way, incoming tones will be received by the decoder board. Reinstall the decoder board.

Preset the potentiometers on the decoder board—turn R17 fully clockwise and R14 fully counterclockwise. You'll know when the end is reached when the potentiometers start to turn hard.

Plug in the transformer and plug the phone connector into your phone jack. Do not turn on the power switch yet. Then call your friend.

When your friend answers, tell him to press and hold down number 7. Turn R17 until LED2 lights. Likewise, turn R14 until LED1 comes on. At the same time the beeper will sound; that is normal. Finish up by having your friend press number 7 several times. Both LED's must light. If not, touch up the adjustment for the one that doesn't.

Finish the adjustments by dabbing nail polish on the potentiometers to lock the settings then remove the jumper from the IC3 socket on the main board and replace the MC14538.

Adjust the volume control by setting it to midposition through the hole in the rear panel. Later on, if you find that the buzzer is too loud or too soft, adjust the volume as required.

Using the project

Using the project is simplicity in itself, and the hardest part will be to get other people to remember to dial your access code.

To use the project, connect the transformer to a nearby outlet. Also, using a T-connector, connect both the project and your phone to your modular phone jack. Then set the power switch to the ON position to prevent undesired phone calls.

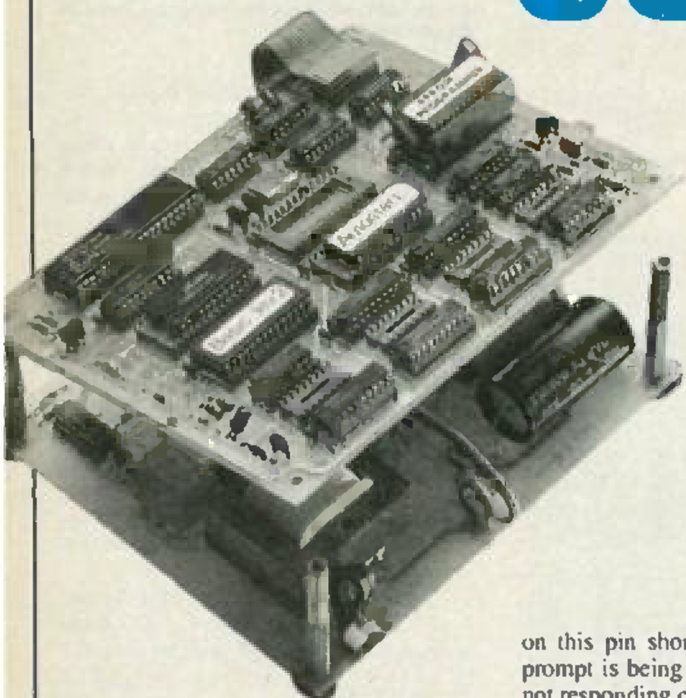
Tell those who you want to be able to reach you about the project and the procedure that must be followed to call you. That is, they dial your phone number as usual, hear one ring, and then have 10 seconds to dial "7". If they don't dial the code number, your phone won't ring and they can't reach you.

There may be times when you want to receive calls from people who shouldn't

continued on page 107

BUILD THIS

HOME CONTROL COMPUTER



One of the best things about this control computer is that it can operate BSR-type remote controllers. Let's see how, as we look at the power-supply, the wireless remote controller, and the computer's I/O system.

STEVEN E. SARNS

Part 2

WHEN WE LEFT OFF last time, we had just set up the computer. We said that if the BASIC prompt (>) appeared on your terminal, you could assume that things are working properly. If you do not get the prompt, turn off the power and disconnect the board. If you are using a wire-wrap or other prototype system, check *every* line with an ohmmeter. If you use a printed-circuit board, examine the board closely (with a magnifying glass) for solder bridges or splats, cold solder joints, solder-flux residue, or "whiskers" of PC material under the solder mask. Use an ohmmeter to check adjacent pins and lines for whisker shorts. Check every IC to insure that no pin has been folded under during insertion. Use an ohmmeter to check the orientation of every diode. It is unfortunately not uncommon to find the markings reversed. If those basic troubleshooting steps don't work, reapply +5 volts DC and check the state of the pins on the microprocessor according to Table 2.

Reset the board and observe the RS-232 output pin. If there is any activity on this pin shortly after reset, then the prompt is being sent, but the terminal is not responding correctly. Check the communications settings on the terminal. (Although we said last month that the terminal should be set to 4800 baud, that's not essential. Simply type a space within 8 seconds after reset, and the computer will adapt.) Examine the input of the RS-232 port; this line should be at a TTL low level. Typing any character on the terminal should produce a short series of positive-going pulses.

When you get the BASIC prompt, and your terminal and the control computer are communicating properly, you are ready to enter your first program:

```
OK
>NEW
OK
>1 PRINT "HELLO",
>2 GOTO 1
>RUN
```

We hope that everything worked as it should have, and your screen is now full of "HELLO's." We'll now leave our discussion of the computer board and begin our discussion about the computer's power supply and wireless remote control that we promised last month.

You may think we're getting ahead of ourselves because we haven't finished discussing the computer circuitry yet—specifically, the I/O system. But some people will not be able to test out the basic system until they build a power supply. So now we'll discuss the power-supply board. After we've done that, we'll return to the computer board with a look at its I/O capabilities.

TABLE 2—8088 PIN STATES

Pin	Function	State
1,20	GROUND	ground
21	RESET	low
23	$\overline{TEST}$	high
31	HOLD	low
19	CLOCK	4 MHz
17	NMI	low
40	V_{CC}	+5 VDC
22	READY	high
24	$\overline{INTA}$	high
33	MN/$\overline{MX}$	high
18	INTR	low

The second board

As we mentioned last time, we know that the computer board requires a supply of +5 volts DC at less than 1 amp. If you plan to use an RS-232 cable longer than 10 feet, then you'll also need a −5-volt supply to establish the RS-232 "mark" level. And if you'll want to program EPROM's, you'll need a higher-voltage

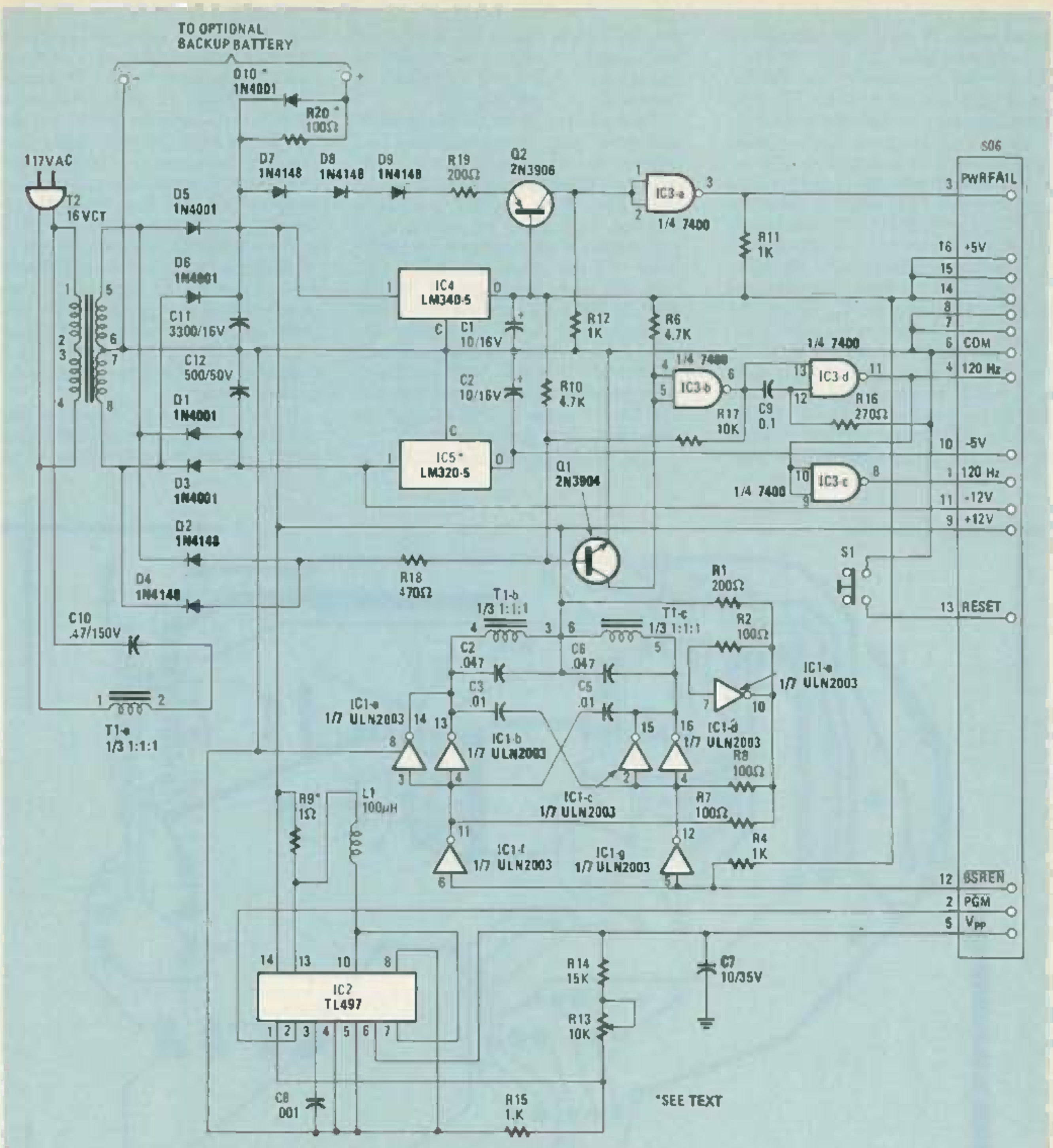


FIG. 5—POWER-SUPPLY/REMOTE CONTROLLER schematic. Components that are marked with an asterisk are optional. Note that some component values do not agree with the Parts List that appeared last month. Those have been corrected in the Parts List on page 69.

supply—the 2716 EPROM requires a 25-volt DC supply at 30 mA.

Other EPROM's require other supplies. For example, the 2732 requires a 21-volt switched supply at 20 mA, while the 2764 requires a 21-volt supply at 30 mA. We mention the requirements for other EPROM's because, as you may remember, the first installment of this article made note of some "unused pads" on the board, some of which are for jumpers to select various options (including the option to program EPROM's other than the 2716). Unfortunately we cannot go into detail on all the possible options—we'll discuss a basic configuration and leave the experimenting up to you. We strongly recommend that you have the board working correctly using 2K × 8 RAM's like the TMM 2016P and 2K × 8 EPROM's like the 2716 before you start making changes.

Presuming that everything is working correctly, then you can begin to change the board configuration. Let's say, for example, that you want to program a 2732 or 2764 EPROM. You will have to connect pin 23 *of the socket* (remember—we're using 28-pin sockets even though the 2716 and 2732 have 24 pins) to A11. And you'll have to cut the trace that now brings V_{pp} there. Pin 20 of the socket should be connected to IC16, pin 7 instead of IC20 pin 13. Study the data sheets and pin functions carefully so that you understand why those changes have to be made—before you make any changes.

A look at the power supply

The schematic of the power supply we'll use is shown in Fig. 5. It can supply all of the V_{pp} options. (The level of V_{pp} can be varied by trimmer potentiometer R13.) The power-supply board also provides some signals that are used—but not required—by the control computer itself. Those signals include: PWRFAIL (which tells the computer that the AC power has failed) and a 120-Hz TTL-level pulse that is used for time-of-day routines.

The ±5-volt DC power supply is made up of simple linear-IC regulators (IC4 and IC5). The V_{pp} supply must supply only 30 mA, but it must be switched on and off for the 2732 type EPROM. The switching is accomplished with IC2, a TL397 switching regulator. Besides giving us the ability to program 2732's, there is an additional benefit to switching the V_{pp} supply: We can control its turn-on characteristics. That's important because most EPROM's specify the programming voltage to within .5 volt. If the supply goes any higher, the device can be destroyed. Unfortunately, many power supplies generate an overshoot greater than .5 volt when they are switched on or off. Even a few nanoseconds of ringing on the line is enough to cause some EPROM's to crowbar the +5-volt supply.

The power-fail circuit is a simple common-base, level-detection circuit that monitors the voltage across the +5VDC regulator. When that voltage falls to less than 4 diode drops, the PWRFAIL signal is activated. That allows approximately 30 milliseconds of warning before the output of the +5-volt supply falls below 4.75 volts. The PWRFAIL signal is fed (through SO6 and SO5) to the non-maskable interrupt (pin 17) of the microprocessor. The microprocessor will enter a wait state until its TEST pin (23) goes low, which will happen when a 120-Hz signal is detected. The 120-Hz signal will be detected, of course, when AC power is restored.

That 120-Hz signal is a positive-going pulse at AC zero cross. That signal is important for several reasons. It allows the control computer to be used for time-of-day applications. (A time-of-day routine has been included in the BASIC interpreter. See the Parts List for ordering information.) The second use of the AC zero-cross signal is to synchronize the control computer to the AC line. Many types of machinery require switching on or off at AC zero-crossing to minimize the amount of interference generated. More important for us is that the the remote-control link requires that transmissions be synchronized to AC zero crossing. We'll discuss that shortly. Transistor Q1 is connected in a common-emitter configuration, driving IC3.

If you're worried about power failures and brownouts, you can make the power supply uninterruptable by adding an op-

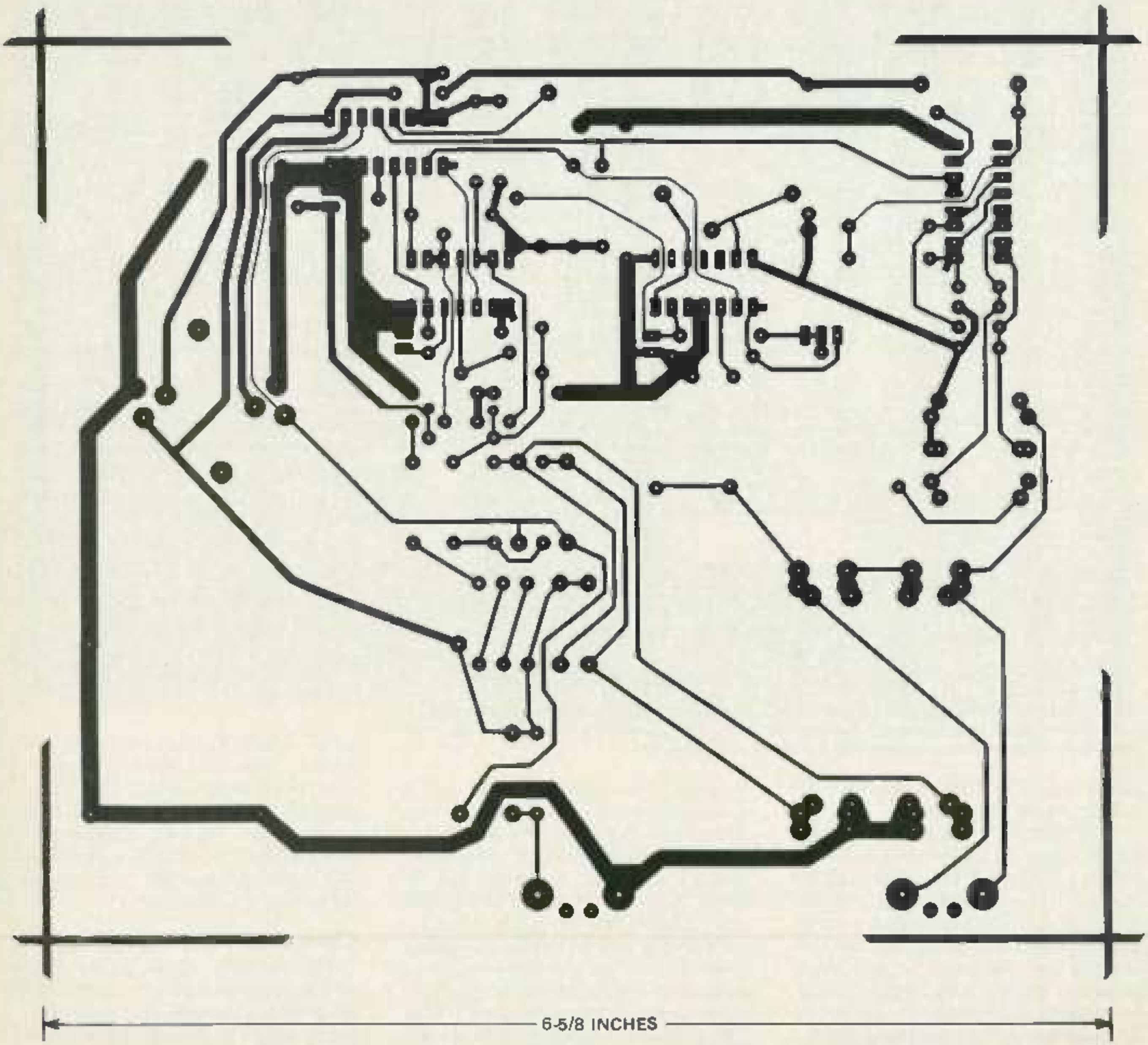


FIG. 6—FOIL PATTERN for the power supply/remote controller. The single-sided board is the same size as the computer board that we showed last month.

tional backup battery, D10, and R20. That approach is simple and effective for small systems such as this, where an 8-volt, 4 amp-hour *Gel-Cell* will give you about 6 hours of backup operation. Unfortunately, while a battery-backup system will protect the contents of RAM, it will not protect the time-keeping function, which relies on the 60-Hz line frequency.

The foil pattern for the single-sided power-supply/remote-control board is shown in Fig. 6. Note that it's the same size as the computer board that we showed you last month. The parts-placement diagram for the board is shown in Fig. 7.

Building the power supply is simply a matter of "stuffing the board." There are a few points that we should mention, though. Figure 8 shows the assembled board of the author's prototype. Note that only one regulator is installed. That's because the −5-volt supply is necessary only for RS-232 cables longer than 10 feet. Up at the top of the board is SO6—a standard 16-pin IC socket. A 16-conductor cable that leads to the computer board is simply plugged in there.

The flat PC-mounted transformer and the heatsink for the regulators bring the overall height of the power supply to less than 1.5 inches. That means that even with the computer board mounted directly on top of the power supply, the total height can be kept well below three inches.

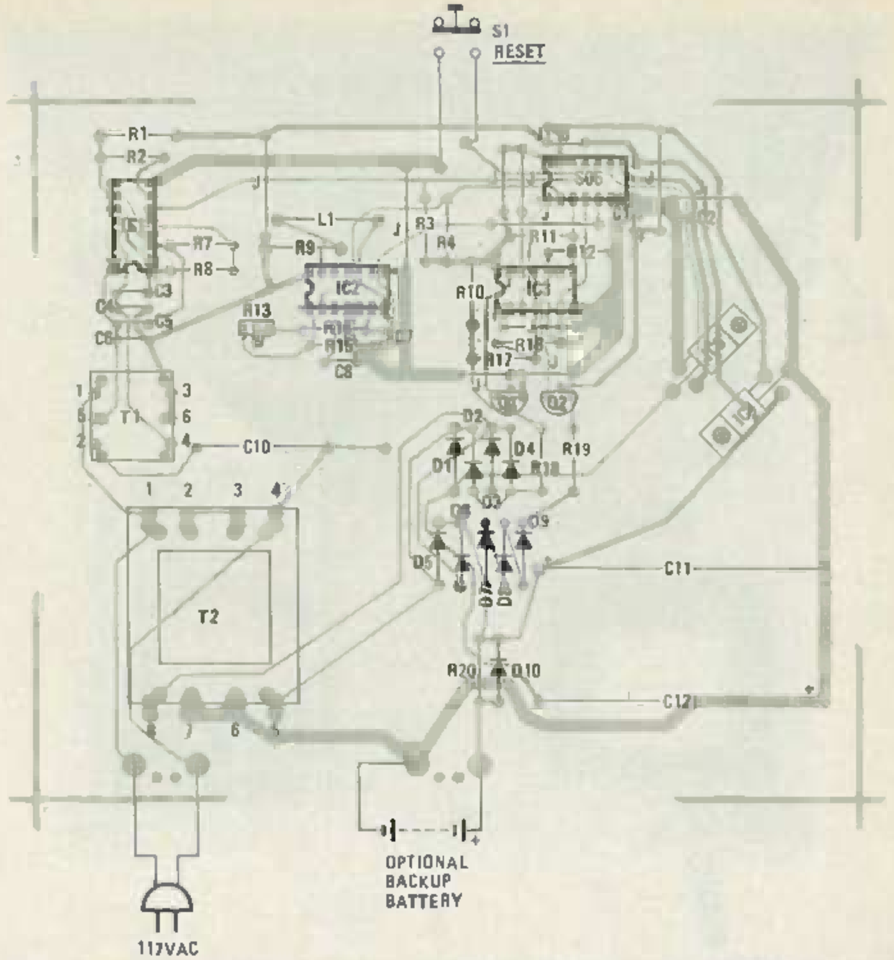


FIG. 7—PARTS-PLACEMENT diagram for power supply/remote controller.

The remote-control link

The greatest feature of the power-supply board is the wireless remote-control link that allows the computer to control instruments and appliances without the hassles of stringing wires to the control point. Signals are sent via the power lines and are decoded at the control site so that remote control is simply a matter of plugging the unit that you want to control into a remote module, and transmitting the appropriate codes to the module under control of a BASIC program. (We're getting a little ahead of ourselves here; we haven't yet discussed the computer's I/O system that enables us to do that. But we'll get to the details on that shortly.)

The best way to familiarize you with the remote-control system is to compare it to the BSR model *X-10*—a remote-control system based on the carrier-current method. A transmitter superimposes a high-frequency signal onto the AC power lines. That signal contains information that is decoded by the receiver module. There are many advantages to using carrier-current communications. First, the wires are already there—there is no need to drill, cover, or hide the wires around the home. Second, the system is highly portable—because there are no wires, it is not built into your existing location. Another advantage is that the system is popular—Radio Shack, Heath, Sears Roebuck, and Advance Electronics are among the largest suppliers. The receiver modules are inexpensive ($8–$17) and are available for a wide variety of functions. Plug-in modules (see Fig. 9), wall-mounted switches, and dual outlets are the most common.

There are two basic types of receivers. The lamp controller uses a Triac as the control element and can regulate the AC power into resistive loads up to 300 watts. The appliance modules contain a relay that can be used to switch loads that draw up to 15 amps.

It should be noted that this system does not include "handshaking." No response from the receiver is expected; it cannot indicate that the message was received or that the command was executed. The transmitter simply transmits and assumes that everything is all right. Because of that, you should be very careful if you plan to use this system in any application that requires high reliability. However, in the home environment where the system was designed to operate, it is as secure and reliable as possible for the low module cost.

There are several possible problems with transmitting information over the AC power lines. First, if you live in an apartment complex, you may find that your transmissions control your neighbor's units as well as your own. But because there are 256 unit codes available, a bit of coordination will easily solve that problem. The second problem occurs when attempting to transmit from one branch of the AC line to the other. When 230 volts AC is brought into the home at the service entrance, the home circuits are shared between the two phases. A transmitter on one leg may not be able to communicate with a receiver on the other. Many times, however, appliances that are connected between the 230-volt phases will serve as a high-frequency bypass path between the legs. If a problem is encountered, a 0.1µF capacitor connected across the legs should solve it. (The capacitor provides a high-frequency bypass path around the transformer to the other leg.)

We mentioned that the remote-control system requires that the code transmission be synchronized to AC zero crossing—the transmission must begin within 100 microseconds of zero cross. A data "one" bit is defined as 3 bursts of 120 kHz starting immediately after zero cross, lasting 1.0 milliseconds, and spaced 1.6 ms apart. A data "zero" bit is defined as no transmission of 120 kHz after zero cross. Fig. 10 shows one cycle of 117-volts AC, over which is superimposed first a one and then a zero. Notice that each bit of data is

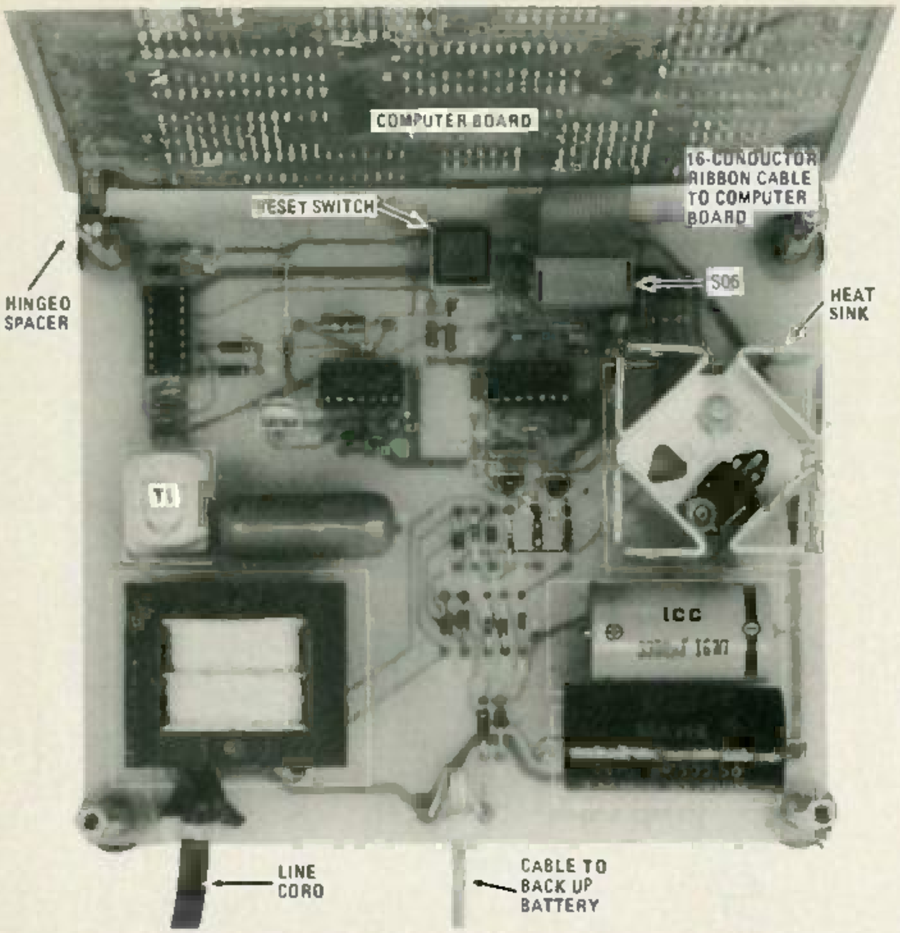


FIG. 8—THE ASSEMBLED board. Note that IC5 was not installed in the author's prototype.

FIG. 9—THE BSR LAMP-CONTROL MODULE. The house and unit codes are easily set using thumbwheel switches.

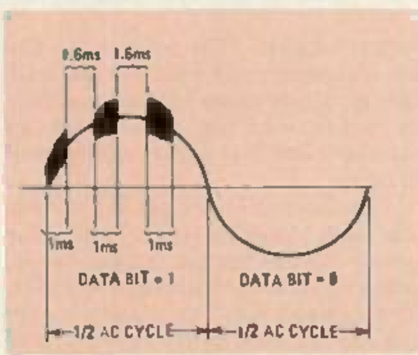


FIG. 10—ONE CYCLE of a 60-Hz waveform showing a superimposed control signal.

sent during one-half AC cycle. Therefore, the data-transmission rate is 120 Hz.

Each message sent to the control module is made up of 22 bits of data as shown in Fig. 11. That data is organized as follows: First a start sequence of 1,1,1,0 is transmitted. (That takes two full cycles.) Next the 9-bit address/command code is transmitted. Following each transmitted data bit, the compliment of that bit is transmitted on the next AC zero cross. The complete message, including the start sequence, takes 11 full AC cycles.

The 9-bit (18 bits if you include the complements) data packet consists of 4 bits that determine the "house code" (A-P) followed by 5 bits that contain either the command or unit code. A typical control-command sequence consists of two transmissions. First, for example, house code M, unit 3 is transmitted. That causes all modules that are set to code M—except for any modules set to unit 3—to ignore the next transmission. (Of course, any modules that are not set to house-code M will also ignore the next transmission.) That next transmission would be, for example, house-code M, ON. And module 3—which is the only module "paying attention" responds by turning on.

Table 3 lists the house codes and Table 4 lists the command codes that are available in the system. Notice that if you select house code M, the upper 4 bits are always zero. The data word transmitted then consists of only the following 5-bit word—the decimal value shown in Table 4. If you wish to use other house codes, simply form the 9-bit word by placing the house code bits in front of the command bits. We'll look at an example shortly.

The hardware required to transmit the commands is surprisingly simple. The AC zero-cross detector is already a part of our system. The 120-kHz transmitter is an inductive multivibrator that can be enabled with a TTL signal (BSREN from pin 11 of SO5). This multivibrator consists of 4 open-collector inverters (IC1) connected in an astable configuration. Each stage is formed by paralleling two gates for increased reliability. A fifth IC inverter is connected in a negative-feedback configuration, biased at the same level as the multivibrator stages to provide a stable bias source. The multivibrator is controlled through two additional (open-collector) gates connected to the inputs of the astable gates. Those will clamp the astable inputs to ground in order to disable the oscillator.

The software required to drive the BSR remote-control link is, unfortunately, not as simple as the hardware. Because of the submillisecond timing requirements, BASIC cannot be used. However, the transmitter driver routine has been incorporated into the BASIC interpreter. (See the Parts List for information on availability of the interpreter.) The command "XMIT" eliminates all of the inconvenience of developing and debugging a machine-code routine. For example, to turn on unit 6, house code M, the proper sequence of commands is:

XMIT(18)
XMIT(5)

The first command alerts any units that are set to house code M, unit 6. The second command turns those units on. Just to make sure you understand how to use the

TABLE 3

House Code	D8	D7	D6	D5
A	0	1	1	0
B	1	1	1	0
C	0	0	1	0
D	1	0	1	0
E	0	0	0	1
F	1	0	0	1
G	0	1	0	1
H	1	1	0	1
I	0	1	1	1
J	1	1	1	1
K	0	0	1	1
L	1	0	1	1
M	0	0	0	0
N	1	0	0	0
O	0	1	0	0
P	1	1	0	0

PARTS LIST—COMPUTER BOARD

All resistors ¼-watt, 5% unless otherwise noted
R1,R4,R14–R18—1000 ohms
R2,R5,R6—user-determined. To be discussed next month
R3,R11,R12—10,000 ohms
R7—680 ohms
R8—390 ohms
R9—12,000 ohms
R10—2,000 ohms
RN1—4.7K×9 resistor network
Capacitors
C1—user-determined. To be discussed next month
C2—150 pF. ceramic disc
C3–C8,C11–C13,C16–C20—0.1 µF, ceramic disc
C9—0.001 µF
C10—27 pF
C14,C15—10µF, 16 volts, electrolytic
Semiconductors
IC1—ADC0804 A/D converter (National)
IC2,IC3—74LS541 octal buffer and line driver
IC4—SN75478 seven high-current darlington drivers (TI, also Sprague ULN-2003, Motorola MC1413)
IC5—4051 8-input analog multiplexer
IC6,IC7—74LS377 octal latch
IC8—74LS251 8-input digital multiplexer
IC9—System ROM, 2716, 2732, or 2764, 450 ns maximum access time
IC10,IC12—TMM 2016P-2 (Toshiba or similar) 2K×8 static RAM, 450 ns
IC13—Programmed EPROM (2716)
IC14—EPROM to be programmed
IC11—74LS259 8-bit addressable latch
IC15—74LS373 octal latch
IC16—74LS139 dual 2-to-4 line decoder/multiplexer
IC17—74LS32 quad OR gate
IC18—8088 microprocessor
IC19—74LS04 hex inverter
IC20—74LS123 dual one-shot
Q1,Q2—2N3904
Q3—2N3906
D1,D2, D4–D8—1N4148
D3—1N4001
Miscellaneous: IC sockets, PC board, mounting hardware, etc.

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

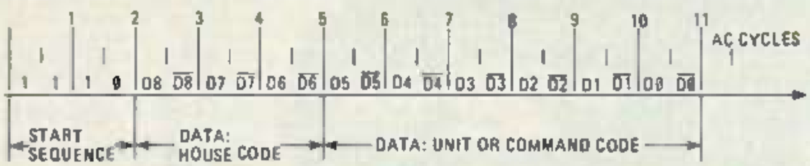


FIG 11—ONE TRANSMISSION consists of a start sequence, a house code, and a unit or command code. (Remember—the complete *command* transmission consists of two separate transmissions; the first ends with the unit code, and the second ends with the command code.)

TABLE 4

ADDRESS COMMAND	D4	D3	D2	D1	D0	DECIMAL VALUE
Unit 1	0	1	1	0	0	12
Unit 2	1	1	1	0	0	28
Unit 3	0	0	1	0	0	4
Unit 4	1	0	1	0	0	20
Unit 5	0	0	0	1	0	2
Unit 6	1	0	0	1	0	18
Unit 7	0	1	0	1	0	10
Unit 8	1	1	0	1	0	26
Unit 9	0	1	1	1	0	14
Unit 10	1	1	1	1	0	30
Unit 11	0	0	1	1	0	6
Unit 12	1	0	1	1	0	22
Unit 13	0	0	0	0	0	0
Unit 14	1	0	0	0	0	16
Unit 15	0	1	0	0	0	8
Unit 16	1	1	0	0	0	24
CLEAR	0	0	0	0	1	1
ALL UNITS ON	0	0	0	1	1	3
ON	0	0	1	0	1	5
OFF	0	0	1	1	1	7
DIM	0	1	0	0	1	9
BRIGHTEN	0	1	0	1	1	11

PARTS LIST—POWER-SUPPLY/BSR LINK BOARD

All resistors ¼ watt, 5% unless otherwise noted
R1,R19—200 ohms
R2,R7,R8,R20—100 ohms
R3,R4,R11,R12,R15—1000 ohms
R6,R10—4700 ohms
R9—1 ohm (a jumper works fine)
R13—10,000 ohms trimmer potentiometer
R14—15,000 ohms
R16—270 ohms
R17—10,000 ohms
R18—470 ohms
Capacitors
C1,C2—10 µF, 16 volts, electrolytic
C3,C5—0.01 µF, ceramic disc
C4,C6—0.047 µF, ceramic disc
C7—10 µF, 35 volts, tantalum
C8—.001 µF, ceramic disc
C9—0.1 µF, ceramic disc
C10—0.14 to 0.47 µF, 150 volts, electrolytic
C11—3300 µF, 16 volts, electrolytic
C12—500 µF, 50 volts, electrolytic
Semiconductors
IC1—ULN2003 darlington array (Sprague)
IC2—TL497 switching regulator
IC3—74LS00 quad NAND gate
IC4—LM340-5 +5-volt regulator
IC5—LM320-5 −5-volt regulator
Q1—2N3904
Q2—2N3906
D1,D3,D5,D6,D10—1N4001
D2,D4,D7–D9—1N4148
T1—11Z2100 1:1:1 pulse transformer (Sprague)
T2—16 volts, center tapped, 0.4 amps. (Signal ST-4-16 or similar)
S1—normally open momentary pushbutton switch
Miscellaneous: line cord, printed-circuit board, IC sockets, heat sink for regulator, mounting hardware, etc.

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

command/address codes, how would you turn off house-code N, unit 6? If you study Tables 3 and 4 and our discussion, you should see that the commands

XMIT(151)
XMIT(135)

would do it. The first command sends the house/address code 0100/10010 (151 decimal) and the second command sends the house/command code 0100/00111. (135 decimal).

One final point that we should make about the remote-control system is that it is a low-power communications device operating between 10 kHz and 490 kHz and is therefore subject to FCC regulation part 15, paragraph 15.111 (Operation below 1600 kHz) and 15.102 (Interference) which states: "Notwithstanding the other

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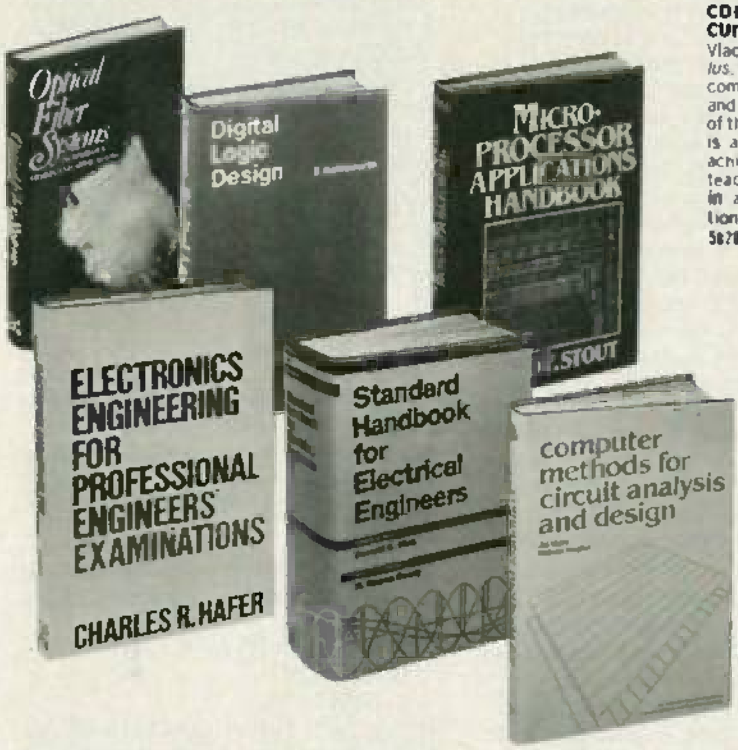

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The I/O systems

Now that we have taken a look at the power-supply board, we can return to the computer and discuss its input and output capabilities. (We briefly mentioned some of those I/O capabilities when we talked about the remote-control system and the RS-232 port.)

A computer's only link to the outside world is through its inputs and outputs. If we take, for example, a personal computer, the input is usually a keyboard and the output device is usually a CRT screen. A control computer's I/O is oriented more toward hardware. Individual lines can sense external conditions while other lines control external devices.

The number and type of those control lines are very important specifications of a control computer—they are what determine whether or not the computer can do the task that you have in mind.

A microprocessor interfaces with I/O devices in the same manner as it does with memory: An address is sent out on the address bus, data is transferred over the data bus, and the control bus controls the actual transfer. In many systems, I/O devices are treated exactly as memory, in which case they are said to be *memory mapped*. Memory mapping of I/O functions may be done to save hardware (additional decoders), or it may be done because the microprocessor has no provision for separate memory and I/O space.

The alternative to memory mapping is *I/O mapping*, which our system uses. In that case, the control bus has an additional line called IO/$\overline{\text{MEM}}$ that determines if the data will be transferred between the microprocessor and memory or between the microprocessor and I/O. The 8088 has an I/O space of 64K (which is equal to the memory space of many microprocessors).

The various types of inputs and outputs are implemented with various types of IC's that are enabled onto the data bus whenever their address is present on the address bus. We will decode the I/O space in much the same way that we did for memory. In fact we will use the other half of the same IC (IC16-b, a 74LS139 dual 2-to-4 line decoder/multiplexer) plus a few additional gates. (Refer back to Fig. 1 in the April issue of **Radio-Electronics**.) The signal IO/$\overline{\text{MEM}}$ will be used to enable that half of the decoder—that prevents an I/O device from responding to an address meant for memory. We will use address lines A4 and A5 to select which of the four outputs will be active (low).

Further decoding is required to separate the input devices from the output devices. Two OR gates (IC17-b IC17-c) provide that function for those IC's that do not have two ENABLE inputs. The memory map that results from that decoding is shown in Table. 3

Digital I/O—bit-addressable

The inputs of a control computer are used primarily to sense the status (high or low) of an external device. Outputs are generally used to turn something on or off. Bit-addressable I/O allows us to act on or read only one bit of information—that bit is isolated from all of the other inputs and outputs. Although bit-addressable I/O is neither the simplest to implement nor the most common type of I/O, it is, in most cases, the easiest to use.

All we have to do to get our outputs is to connect an addressable latch onto data-bus line D0. By using IC11, a 74LS259, we can latch and output 8 individually-addressable bits to the "real world".

Inputs are no more difficult than outputs. The hardware for bit-addressable inputs consist of a multiplexer (IC8—74LS251) that selects the desired line that will be connected to data-bus line D7. In the case of both the input multiplexer and the output latch, the address lines A0, A1, and A2 are connected to the address inputs of the IC.

Before we go any farther we should remind you that the last bit-addressable input and the last bit-addressable output are used by BASIC for the RS-232 port. *Do not change the state of the output or connect anything to the input if you are using a terminal for communications.*

A glance at the software required to exercise these I/O functions will give you an idea of how easy it will be to start using the computer. For example, to set the first output high we simply execute the OUT (port,value) statement: "OUT(Ø,1)." That BASIC statement outputs to I/O location Ø, the value 1. (See Table 5 for other port "addresses.") The latch will hold that value on the output line. Reading an input is just as easy. In this case we must assign the result to a variable as in the statement: "LET A = INP(Ø)." Then the status of the first input line, IØ determines the value of A.

Note that the BASIC INP and OUT statements are used instead of PEEK and POKE. That's because we are exchanging the data in the I/O space, not in memory.

The output line of the multiplexer is connected to data-line D7, the *Most Significant Bit* (MSB) of the **data** bus. Because of that, we can check the state of the input line with a single statement that tests whether the data on the bus is greater than 127 (or less than 128). If you wanted to use data-line DØ (which is connected to the inverted output of the multiplexer) you would have to mask off the unused bits.

At last we can start using our computer for control. As a demonstration, let's connect 7 LED's to the 7 outputs as shown in Fig. 12. Also connect a single, normally open, pushbutton switch between the first input, IØ, and 5 volts DC.

TABLE 5

Port "Address"	Description
0-7*	BIT-ADDRESSABLE, SO4
16	8-BIT I/O - PORT 1, SO2
32	8-BIT I/O - PORT 2, SO3
48	A/D CONVERTER SO1

*PORT 6 IS USED TO ENABLE REMOTE-CONTROL TRANSMITTER. PORT 7 IS USED FOR RS-232 PORT.

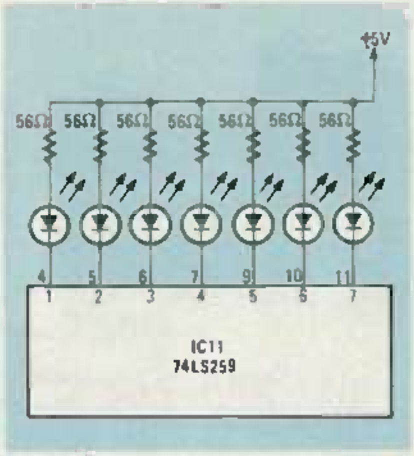


FIG. 12—TO TEST THE bit-addressable output port, you can use this simple circuit. If you install IC4, then you can test the output at socket SO4, pins 1–7.

First we should initialize all LED's to the off state (note that because the LED's are connected to +5, off is high).

```
10 FOR I = Ø TO 6
12 OUT(I,1)
14 NEXT I
```

Having turned all of the LED's off, we will wait until the switch is turned on before going further:

```
20 LET I = INP(Ø)
22 IF I <120 GOTO 2Ø
```

This will loop until the switch state is turned "on".

```
30 FOR I = Ø TO 6
32 OUT(I,Ø)
34 NEXT I
```

Those three lines will turn all LED's on.

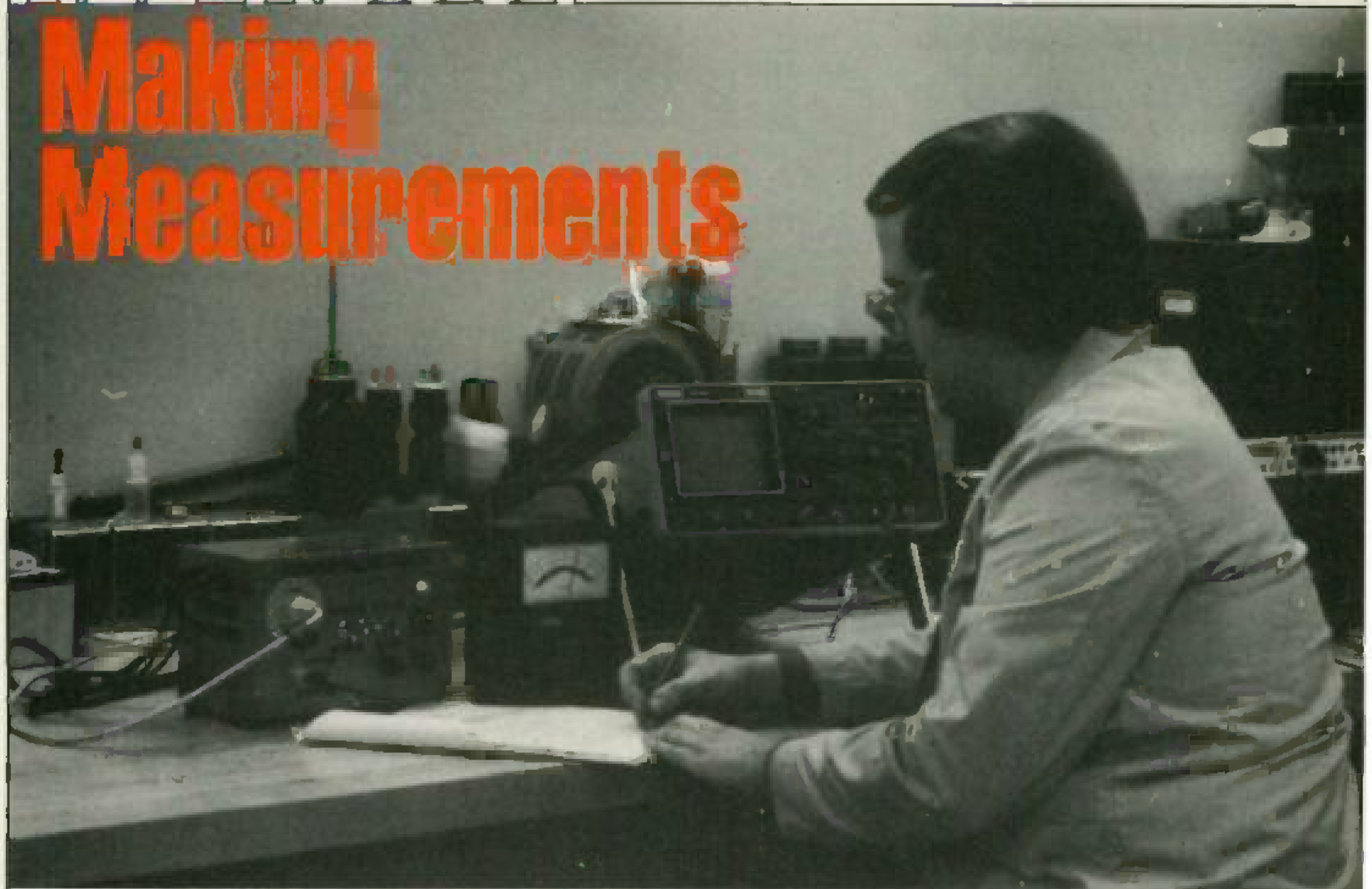
```
30 FOR J = Ø TO 5Ø
40 FOR I = Ø TO 6
42 OUT(I,Ø)
44 OUT(I,1)
46 NEXT I
50 NEXT J
60 GO TO 1Ø
```

Lines 30 to 60 will blink the LED's and then return to the switch-monitoring loop.

The 74LS251 can sink/source one LSTTL load. If we are not concerned too much about the logic high or logic low voltages, then we can sink or source many times that amount. The practical limits of the output drive capacity is limited to

continued on page 110

ALL ABOUT Making Measurements



ELECTRONICALLY

HARRY L. TRIETLEY

In this article, we'll take a look at thermocouples, thermistors, piezoelectric crystals, and other types of transducers. We'll also look at some techniques that will help you use transducers more effectively.

ELECTRONIC MEASUREMENTS HAVE BEcome a part of everyday life. It can even be seen in your car, where microprocessors—using electronic sensors—control fuel-injection and ignition systems. Even your auto-exposure camera uses electronic sensors. Electronic thermometers and weather stations are becoming commonplace, as are microcomputer-controlled appliances. And those are just a few examples of where transducers are used in consumer applications. In science and industry, the need for transducers for precision measurements, logging, and automatic control also abound.

In this article, we'll take a look at some of the most common transducers and their applications. We'll see how they can be used to measure temperature, pressure, flow, force, vibration, liquid level, conductivity, and other variables.

Position measurement

The best known and understood position transducer (see Fig. 1) is the potentiometer. Precision single-turn potentiometers can provide accuracy (linearity) to 0.5% and better, and repeatability to 0.1%. They are available with wirewound, metal-film or conductive-plastic elements. Multiturn potentiometers offer the same specifications; they are used for applications where rotation may exceed 360 degrees. Potentiometers are available with different, nonlinear responses—such as logarithmic and square-root.

Because of the potentiometer's high electrical sensitivity, amplification- and readout-circuitry may be simple, or even nonexistent. An ohmmeter might be used to read the potentiometer's resistance directly—but that's not recommended. While the potentiometer's linearity may

FIG. 1—THIS POSITION TRANSDUCER provides a signal proportional to the extension of a stainless steel cable.

be one percent or better, its end-to-end resistance is typically within only ±3 to ±10%. Its contact resistance may add further readout inaccuracy. A better approach is to connect a known voltage across the potentiometer and use a high impedance voltage readout to measure the wiper position. By properly selecting the voltage, the output may be read directly as inches, millimeters, degrees of rotation, etc. Or, the voltage may be fed to an A/D converter for computer input or data logging.

Potentiometers are not limited to measuring angular and linear position—they can be used to sense any variable which can be *converted* to position. For example, pressure often is sensed by using a bellows that is linked mechanically the wiper of a potentiometer. A bimetallic element will transform temperature to position, while liquid level may be measured using a float. Companies that produce such assemblies commercially often use custom-designed potentiometer elements rather than standard products.

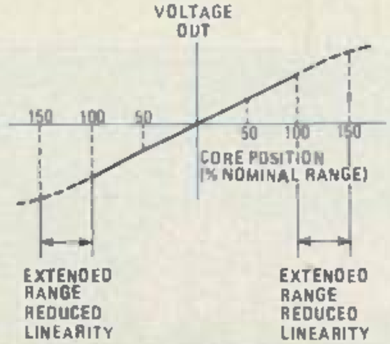


FIG. 2—AN LVDT produces a voltage output as a function of the core position.

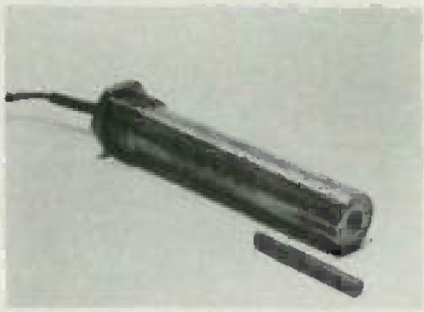


FIG. 3—AN LVDT. Note the separate, free-moving core.

Transformer transducers

Another widely used position transducer is the *L*inear *V*ariable *D*ifferential *T*ransformer, or LVDT. The LVDT is an electromechanical device that produces an output proportional to the displacement of a separate, movable core. It consists of three coils around a cylindrical form. The primary is wound at the center of the form, with a secondary wound at either side. A free-moving rod-shaped core inside the coil assembly links the primary's magnetic flux with the two secondaries.

If the secondaries are connected series-opposing, the net output of the LVDT will be the difference between their voltages. That voltage will be zero when the core is at the center, or null, position. When the core is moved, the induced voltage in the coil toward which the core moves increases, while the opposite coil's output drops. As shown in Fig. 2, that produces a differential voltage output that varies linearly with changes in the core position, the phase changing by 180° as the core moves from one side of null to the other.

Straight-line LVDT'S with linear travel from under 0.1 inch to one-half or three-quarters of an inch are most popular, (see Fig. 3) but devices with travel up to 24 inches are available. Linearities from 0.5 to 0.1% are normal. Units that operate from 115 volts at 60 Hz are available, but operating frequencies from 1 to 20 kHz at one to ten volts are more common. Average sensitivity for each 0.001 inch travel is a few millivolts (per volt of input), but long-travel units are less sensitive.

An LVDT may be read out by connecting its secondaries series-opposing and measuring the output AC voltage. That's less than ideal, however, for several reasons. First, the AC readout will read upscale regardless of which direction the core moves. Second, even when the core is at the center position, the output will not be zero—there will be a residual, phase-shifted null signal. Another problem is that the output sensitivity may change with temperature due to changes in the resistance of the windings.

The circuit shown in Fig. 4 solves those problems. The secondaries' outputs are rectified, filtered and fed to an amplifier that responds to their difference (a differential amplifier). The outputs are also fed to a summing amplifier that controls the amplitude of the primary voltage source. As the core moves toward secondary 1 or 2, that secondary's output increases while the other drops. The differential amplifier responds to both magnitude and direction; also, the amplifier's output at null is zero. Meanwhile the summing amplifier sees a constant signal, since the increase in one output exactly matches the decrease in the other in the linear region. If temperature or other influences affect the primary-to-secondary ratio, feedback alters the AC source to compensate.

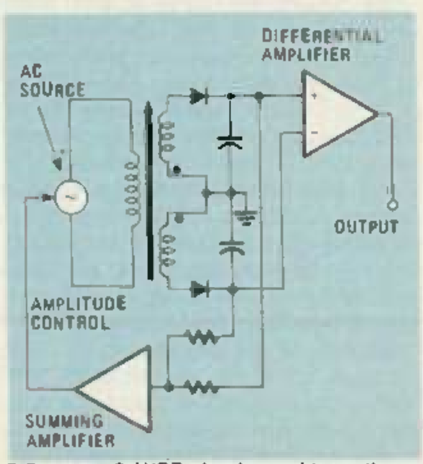


FIG. 4—THIS LVDT circuit provides a linear, bidirectional, regulated readout of core position.

Although LVDT's require a bit more circuitry than potentiometers, they're still relatively straightforward to use and offer good sensitivity. Being essentially frictionless they offer long life and excellent resolution and repeatability. LVDT's with built-in oscillator and amplifier circuitry are available to provide DC-in, DC-out operation.

Like potentiometers, LVDT's are used to sense position, pressure or any other variable which may be transformed into position. Also like potentiometers, LVDT's may be custom designed for specific applications.

Strain gages

The strain gage is a simple, no-moving-parts device that transforms strain, force, or pressure directly into electrical resistance. To understand its operation, consider stretching a length of wire. As it is stretched, its length will increase and its cross-sectional area will decrease. Therefore its resistance will increase. If the wire isn't stretched too far (past its elastic limit), it will recover. Thus we have a transducer that provides a resistance that goes up or down with applied strain.

Most strain-gage elements consist of etched metal foil or wire arranged in a zig-zag pattern for maximum sensitivity. Figure 5 shows two examples. The foil usually is bonded to a high grade plastic or other flexible film and etched, much like a flexible circuit board. Wire may be similarly bonded or it can be stretched unbonded between support points.

Many conductor alloys and backing materials are available (depending on the sensitivity and temperature range required). Silicon strain-gages, which exhibit much higher sensitivity (typically thirty times that of wire or foil) are also available. Unfortunately they also have higher temperature coefficients and more limited temperature ranges, requiring care in application.

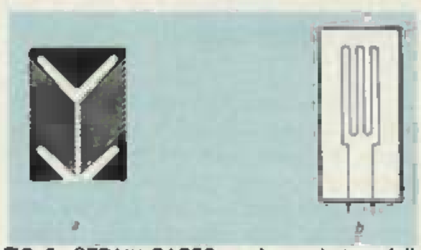


FIG. 5—STRAIN GAGES can be made from foil (as in *a*) or from wire (as in *b*)

Strain gages usually are connected in a Wheatstone-bridge configuration such that the bridge imbalance varies with strain. Since the sensor's resistance is low and changes generally less than a percent with strain, the bridge output is small. Amplifying electronics must have high gain and good DC stability: High-grade op-amps or instrumentation amplifiers are normally used. Alternately, the bridge may be excited from an AC source, using AC amplification followed by phase-sensitive demodulation for measurement. The bridge voltage should be kept low to minimize errors (resistance shift) due to resistive heating of the sensor.

Achieving precision results with strain gages requires a fair degree of mechanical sophistication. Electrical sophistication also is needed: for example, look at Fig. 6. That system uses temperature-sensitive resistors (R_T1 and R_T2) to compensate for changes in zero and sensitivity caused by temperature changes. Fixed resistors (R1 and R2) are used to trim sensitivity and zero. Temperature-related errors are caused not only by the strain gage elements, but also by mechanical expansion and contraction of the measuring assembly.

Strain-gage resistances usually are low enough (typically 350 ohms) that the resistance of the leads between the regulator and the bridge have to be considered. (The resistance of the leads can lower the bridge voltage, reducing its sensitivity.) When long leads are necessary, errors may be eliminated using a *four wire* regulator. Such a regulator uses an extra pair of wires to sense and control the regulator's output directly at the bridge's input. This is not necessary if long leads are not used.

Many companies offer a wide variety of strain-gage load-cell assemblies for force and weight measurement, and pressure-sensor assemblies to measure liquid and gas pressure. Examples are shown in Fig. 7. Typical specifications for such assemblies include 350-ohm bridge resistance, 10-volt maximum excitation, 0.1 to 0.5% nonlinearity, and a full-scale sensitivity of 2 or 3 millivolts per volt of excitation. Load capacities range from a few pounds to a hundred tons or more; similarly, pressures from a few to hundreds of thousands of pounds per-square-inch may be measured. Such devices are used to measure weight, fullness of a bin (using the weight of the bin), liquid level (using fluid pressure at the bottom of a tank), barometric pressure, and many other variables.

The flow rate of liquid or gas is also measured using strain gages (or, for that matter, any other pressure sensors). By placing a restriction in a pipe (as shown in Fig. 8) and measuring the pressure drop across it, the flow velocity may be determined. The most common restriction is the *orifice plate*, a thin metal plate that has an opening that's smaller than the diameter of the pipe. Pressure-measurement taps, at precisely located points above and below the plate, are connected to an as-

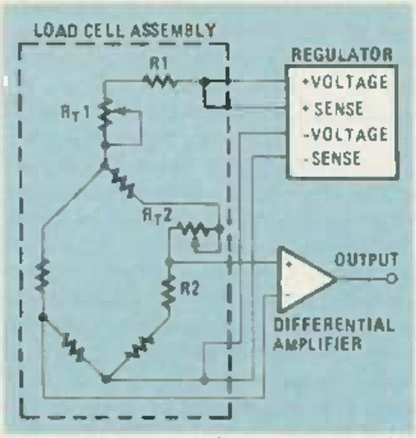


FIG. 6—A COMPLETE STRAIN GAGE bridge compensates for temperature shifts in zero and sensitivity. A four-wire regulator is used to compensate for lead-wire resistances.


FIG. 7—STRAIN GAGE load cells and pressure sensors are available in a wide variety of configurations, some of which are shown here.

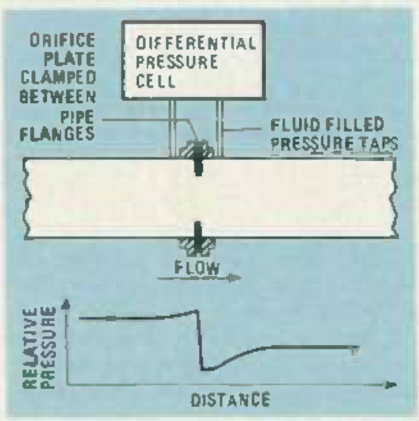


FIG. 8—PLACING A RESTRICTION in a pipe causes a pressure drop that can be used to measure flow.

sembly designed to measure differential pressure. With such an arrangement the flow rate is proportional to the square root of the pressure difference, requiring a square-root amplifier in the electronics.

There are other arrangements that are also used to measure flow rates. For example, the pressure difference between the inside and outside radii of an elbow-shaped band in the pipe can be used to calculate the rate of flow. For large, open streams, the liquid height behind a specially-shaped notched dam known as a weir is used. (The relationship between height and flow depends on the shape of the notch, but is not linear.)

Piezoelectrics

Quartz and other natural and manmade crystals generate a small voltage between their opposite sides when stressed. Therefore they're ideal for making force and pressure measurements. (Microphones and phonograph cartridges are examples of other ways that effect is used.) Although useless at DC, such devices are superior to strain gages for measuring high-frequency vibrations or impulses with fast risetimes.

Piezoelectric crystals are not conductive: they act as a high impedance AC source. More precisely, they act as an AC-voltage source in series with a small capacitor. A change in the voltage, ΔV, causes a small charge, ΔQ, to flow on or off the plates of the capacitor. Outputs of piezoelectric transducers are generally specified as picocoulombs per unit force (for example, picocoulombs per psi). Voltage amplifiers for piezoelectric transducers must have a very high input impedance (just as amplifiers for microphones or phono pickups must). The capacitive loading due to input cables can become a problem.

A circuit that minimizes those problems is the charge amplifier shown in Fig. 9. In that circuit, an op-amp (or other high-gain, high-impedance inverting amplifier) is provided with C_F, a negative-feedback capacitor. The high negative feedback holds the voltage at the input to near zero—nearly all the charge from the transducer flows onto C_F. Also, since the input voltage is zero, the cable capacitance stores no charge, and so causes no errors.

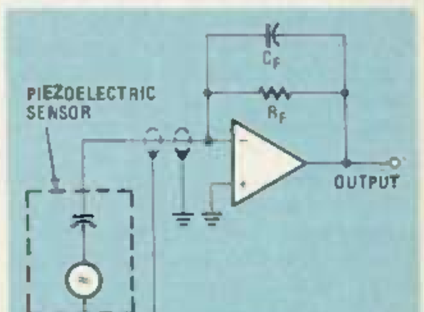


FIG. 9—A CHARGE AMPLIFIER completely transfers the piezoelectric sensor's AC charge output signal to the feedback capacitor, producing a proportional AC output voltage. The feedback resistor (which should be large) stabilizes the DC output level.

The voltage on the feedback capacitor is given by $\Delta V = \Delta Q/C$. Therefore the charge amplifier's output is 1/C volts per coulomb. This output is directly proportional to the AC force or strain on the piezoelectric crystal. The design of a suitable amplifier involves a tradeoff between using a large feedback capacitor (for high negative feedback) and using a small capacitor (for high gain.)

Accelerometers can be made by connecting a mass to a piezoelectric crystal. Any change in velocity causes the mass to push or pull on the crystal, producing an output proportional to the rate of acceleration. Accelerometers are used to study the vibration and shock response of mechanical designs and to measure shock, acceleration and vibration in engines and vehicles. They also are used to monitor seismic vibrations as well as the vibrations of structures such as bridges. A crystal may also be mounted directly between an object under test and the point of impact to measure peak forces during impact testing. The crystals themselves are fairly rugged and capable of withstanding high peak loads.

Piezoelectric sensors are especially valuable in measuring explosions, blasts and pressure surges. Depending on their design, response times to one microsecond are possible. Applications include gun and ammunition testing, engine-cylinder and even atomic-blast measurements. Industrial measurements range from plastic injection molding pressure to the impact force of punch presses.

Temperature measurements

Perhaps the most common uses for transducers is to measure temperature. Electronic temperature-sensors fall into three classes: resistive (thermistors and wirewound), thermocouples, and integrated circuits.

The resistance of both thermistors and wirewound sensors changes with temperature—but that's where their similarity ends. Thermistors are highly sensitive (typically 4%/°C), nonlinear devices with negative temperature coefficients and a narrow range. Wire wound sensors are less sensitive (typically 0.4%/°C), fairly linear, have positive temperature- coefficients, and are wider-range devices.

Thermistors

Thermistors are formed by mixing together various powdered metal-oxides, forming them into desired shapes, and firing them at temperatures around 1000°C (1832°F). They may be formed by pressing the powder into discs, washers, rods, squares, sheets, or other shapes before firing. Another method is to dip platinum-alloy wires into a slurry of the oxides and fire directly to form small beads. The oxides form a semiconductor material whose resistance decreases as temperature goes up. An almost limitless variety of sizes, shapes and tolerances are available, with resistances at room temperature running from 100 ohms to a megohm.

Small discs and beads are commonly used for precision temperature measurement. Discs, generally under 0.1 inch in diameter, may be ground to a precise resistance and are available with accuracies up to ±0.1°C or better. Since their construction usually involves soldered connections and epoxy coatings, their service temperatures often are limited to 150°C (302°F) or less. Glass-encapsulated discs are available for use at higher temperatures; they provide superior stability plus a hermetic seal. Bead thermistors may be much smaller and generally operate at higher temperatures. Because of their small size and method of construction, they cannot be ground to tolerance. (Selected or matched units may be ordered, however.)

Designing with thermistors is easy because their high sensitivity means that precise measurements may be achieved using ordinary components. At 4% per-degree, a one-percent error is equivalent to only 0.25°C. Figure 10 shows two basic circuits: a Wheatstone bridge and a parallel network. The bridge provides an output that increases with temperature, while the parallel network's resistance decreases with an increase in temperature. When designing thermistor circuits, the power dissipation should be kept low (0.1 mW or less) to avoid self-heating errors.

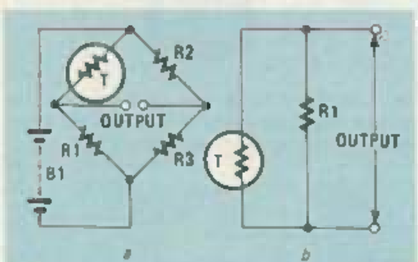


FIG. 10—THERMISTOR CIRCUITS. The Wheatstone bridge output increases with temperature, while the resistor network's resistance decreases.

The bridge may be made to read temperature differentials by replacing R2 with a second, identical precision thermistor. Such a circuit is useful for measuring heat-exchanger or solar-collector performance or for measuring the difference between a wet- and dry-bulb thermometer.

If the circuits in Fig. 10 are changed by adding a series resistor-thermistor combination in parallel with the thermistor, then the bridge and the parallel network may be made to provide linearity to 0.2°C and better over temperature ranges as wide as 100°C. Calculation of the best combinations of resistors and thermistors is not easy, but some thermistor manufacturers offer preselected component sets.

Thermistors often are mounted in probe assemblies or other housings for protection. Figure 11 shows a variety of assemblies such as sheathed probes, surface mounts, thermistors mounted in screw heads etc.

FIG. 11—THERMISTORS AND OTHER temperature sensors are available in a wide variety of sensor assemblies.

Thermistors offer a variety of uses besides temperature measurement. They often are used as temperature-compensating components in electronics. One example is compensating the temperature-induced changes in a copper meter-coil. Large, nonprecision thermistors are used as current-inrush limiters (their resistance drops as the current heats them up). Large, washer-shaped thermistors monitor temperature in such applications as motor overtemperature protection.

Resistance thermometers

Resistance thermometers generally are made of a length of fine-gauge wire wound on a ceramic (or other insulating) support. Surface-temperature sensors are made of wire or foil sandwiched between flexible plastic films.

Platinum is the most common metal used, but many sensors use nickel, copper and other metals. (Platinum need not be expensive: a typical element uses only 20 inches of 0.001 inch diameter wire.) International-standard (DIN, IEC, ASTM) platinum sensors have a resistance of 100 ohms at 0°C and 138.5 ohms at 100°C. Common temperature ranges go down to −200°C (−328°F) and up to between 500°C and 800°C (932°F and 1472°F), with a tolerance of ±0.25°C at zero. Other resistances, ranges and tolerances are available. Wirewound sensors generally are cylindrical, under 0.1 inch diameter, one half to one inch long.

Resistance thermometers have a lower sensitivity and lower resistance than thermistors. For example, 100-ohm platinum sensors change by 0.4 ohms per degree C—one ohm equals a change of 2.5°C (4.5°F). Therefore the lead wires or cables used with them can introduce appreciable errors. To avoid those errors it is common to use readout circuits which either ignore or compensate for lead resistance. Figure

12 shows one such circuit, which requires four interconnecting leads. In that circuit, a constant current is fed through one pair of leads, and the voltage drop across the sensor is read via a second pair. The energizing current does not flow through the measurement leads, so the readout sees only the I × R volt drop across the sensor itself.

Figure 12 also shows a method of compensating for the nonlinear temperature response of platinum. (Platinum's sensitivity drops slightly at higher temperatures.) A small amount of positive feedback causes the current source to increase at higher temperatures, offsetting the drop in sensitivity. With proper design, linearity as good as ±0.1% from 0 to 500°C is possible. This method does not necessarily work for sensors other than platinum.

Resistance thermometers are widely used for the measurement and control of chemical, refinery, food and other manufacturing processes and in precision testing of jet engines, large diesels, etc. Platinum offers the best precision of any electronic temperature sensor, with stability and repeatability better than ±0.1°C after use at 500°C (932°F) and beyond. They are available in most of the same assemblies shown in Fig. 12, but are generally enclosed in sheathed probes.

Thermocouples

A thermocouple is nothing more than two dissimilar wires joined together. It is based on the principle that if two different metals are joined together, they will produce an output voltage that is dependent on the temperature of their junction. Over the years, specific wire pairs have become standardized, with published voltage-vs.-temperature tables and agreed-upon letter designations. Types J, K, T, and E designate various combinations of chromel, constantan, iron, alumel and copper. Among them they cover the temperature range from −200°C (−328°F) to 1250°C (2282°F). Types R, S and B use combinations of platinum alloys to cover temperatures up to 1800°C (3272°F). All seven

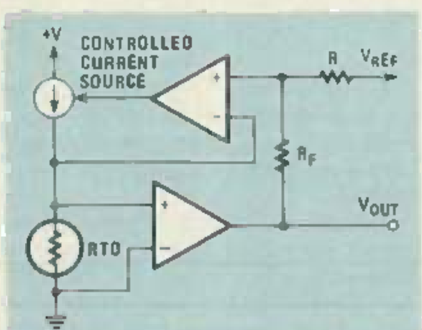


FIG. 12—FOUR-WIRE MEASUREMENT eliminates errors due to lead resistances when measuring with RTD's. A small amount of positive feedback compensates for sensor nonlinearity when using platinum RTD's.

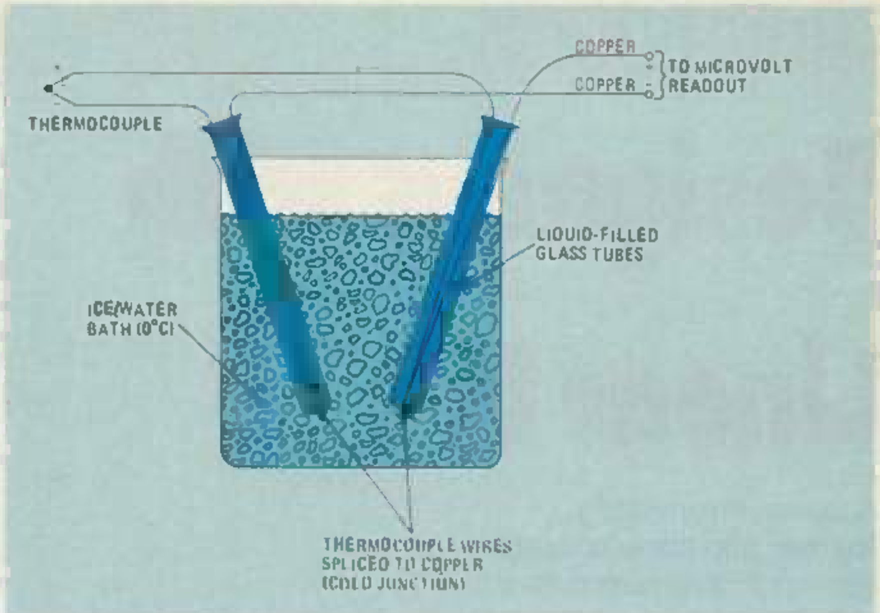


FIG. 13—THERMOCOUPLE COLD JUNCTIONS must be kept at a constant temperature for correct readings. Electronic temperature-compensation could also be used.

TRANSDUCER MANUFACTURERS

This list does not pretend to be complete. Each manufacturer listed makes a variety of transducers.

Analog Devices
PO Box 820
Norwood, MA 02062

BLH Electronics
42 Fourth Ave.
Waltham, MA 02254

Bournes Instruments
6135 Magnolia
Riverside, CA 92506

Celesco
7800 Deering Avenue
PO Box 1457
Canoga Park, CA 91304

Entran Devices
10 Washington Ave.
Fairfield, NJ 07006

Fenwall Electronics
63 Fountain Street
Framingham, MA 01701

Gould Inc., Measuring Systems
2230 Statham Blvd.
Oxnard, CA 93030

Micro Switch
11 W. Spring St.
Freeport, IL 61032

Schaevitz Engineering
130 Union Ave.
Pennsauken, NJ 08110

Sensym
1255 Reamwood Avenue
Sunnyvale, CA 94089

Weston Instruments
Div. of Sangamo Weston, Inc.
614 Frelinghuysen Ave. Newark, NJ 07114

Yellow Springs Instrument Co.
PO Box 279
Yellow Springs, OH 45387

conform to tables developed by the National Bureau of Standards, and are covered by specifications issued by the American National Standards Institute (ANSI). Other types of thermocouples are in use and may be covered by future standards.

Thermocouples lack the sensitivity, accuracy, and stability of resistance thermometers or precision thermistors. They are usable at much higher temperatures, however, and are much more versatile with generally lower cost. Types J, K, T and E have sensitivities around 40 to 60 microvolts per °C while the platinum couples (R, S, and B) trade lower sensitivity (8 to 12 μV/°C) for higher temperature use. Response is roughly linear. Standard accuracies are around ±2.2°C or ±0.75% of the temperature being measured, whichever is greater.

Thermocouples present a unique readout problem in that their connection to copper circuitry creates additional couples. Known as *cold junctions*, those connections produce additional voltages that vary with temperature. The actual readout will be the difference between the measured temperature and that of the cold junctions.

In the laboratory, the cold junctions may be held in an ice bath as shown in Fig. 13. Published thermocouple tables assume that the cold junction temperature is 0°C. In test or control systems that contain many thermocouples, it is not uncommon for all the cold junctions to be placed in a constant-temperature heated block. Most modern instruments, however, include "cold junction compensation" using a thermistor or semiconductor sensor to automatically offset the cold junctions' voltages.

continued on page 99

CIRCUITS

Designing with Linear IC's

A look at the inverting follower, and some common op-amp problems and their solutions.

JOSEPH J. CARR

Part 2 LAST TIME, WE INTRODUCED you to the basic operational amplifier, and two other types of linear amplifier IC's, the CDA and OTA. This month, we will discuss the basic inverting follower, and how to solve some of the basic problems found in operational amplifier circuits.

First, though, let's review the basic properties of the op-amp. There are six of those: 1. Infinite open-loop (i.e. no feedback) gain, 2. infinite input impedance, 3. zero output impedance, 4. zero noise contribution, 5. infinite bandwidth, and 6. both inputs stick together (we'll see what is meant by that in a moment). Of those, properties 1, 2, and 6 are the most important to our analysis. Let's review these and see how they relate to the real world.

"Infinite open-loop gain" refers to the gain with no feedback. In real devices the "infinite" isn't quite realized, but "very, very high" gain is common. Typical real open-loop gain values range from 20,000 for low-quality op-amps to over 1,000,000 for premium devices. It is the extremely high open-loop gain that makes it possible to set operating gain by manipulating feedback resistors.

"Infinite input resistance" again translates in reality to "very, very high." Although most common devices have input resistances (Z_{IN}) values of around 1 megohm, there are MOSFET-input devices (for example, RCA CA3140) that have input impedance values of 10^{12} ohms.

A result of the "infinite" Z_{IN} is that the op-amp input will neither sink nor source current. That fact is critical to our method of simplified circuit analysis.

Our last property states that op-amp inputs "stick together." That means that the two inputs must be treated as if they were both at the same potential. If we apply +1 volt to the noninverting input, then we must treat the inverting input as if it were also at a potential of +1 volt. That property is not just true in theory, but can be observed on the bench using real op-amps, real signal sources, and real voltmeters.

The inverting follower

The inverting follower (Fig. 1) produces an output signal that is 180 degrees out of phase with the input signal.

The signal is applied to the inverting input; the noninverting input is grounded. Grounding the noninverting input places it at zero potential. By ideal property 6, therefore, we must also treat the inverting input as if it is grounded. That situation results in a confusing concept known as the virtual ground. The inverting input is not physically grounded by a piece of wire, but will be at zero potential i.e. ground potential, because the noninverting input is grounded. Thus, we must make calculations based on the assumption that point A in Fig. 1 is grounded. That point is called the summing junction for reasons that will shortly be evident.

The currents at the summing junction are I1 and I2; I_0 might exist in real op-amps, but is zero in our ideal model. Since only two currents exist, we know by Kirchoff's current law (KCL) that

$$I1 + I2 = 0 \qquad (1)$$

so by rearranging equation 1

$$I1 = -I2 \qquad (2)$$

So, what do we know about I1 and I2? Since point A is virtually grounded, the following are true by Ohm's law:

$$I1 = V_I/R1 \qquad (3)$$

and,

$$I2 = V_O/R2 \qquad (4)$$

By substituting equations 3 and 4 into equation 2 we obtain the following:

$$V_I/R1 = -V_O/R2 \qquad (5)$$

The transfer equation of any circuit tells us the gain of the circuit, and that gain is equal to the quotient V_O/V_I; solving 5 for V_O/V_I yields

$$V_O/V_I = -R2/R1 \qquad (6)$$

You will sometimes see V_O/V_I denoted by A_V, which means "voltage gain." The alternate forms of equation 6 are, therefore:

$$A_V = -R2/R1 \qquad (7)$$

$$V_O = V_I(-R2/R1) \qquad (8)$$

and,

$$V_O = -V_IA_V \qquad (9)$$

Equations 6 thru 9 are all variations on the same theme, and should be memorized if you plan to do a lot of op-amp work in the future (it will save you a lot of trouble).

The above arithmetic implies that we can set the voltage gain of the inverting follower by setting the ratio of R2 to R1. Note that the absolute values of the resistors are not important, only their ratio. Let's look at a simple example. Suppose we require an amplifier with a 10-kilohm input impedance and a gain of −56. Let's find appropriate values for R2 and R1.

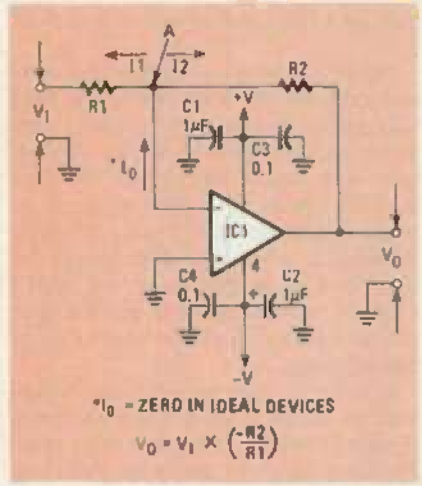


FIG. 1—THE INVERTING FOLLOWER produces an output that is 180° out-of-phase with the input.

Since point A in Fig. 1 is grounded, the input resistance is simply R1. By specifying R_{IN}, we set R1 at the same value, namely 10 kilohms. By equation 7, then:

$$-56 = -R2/(10K) \quad (10)$$
$$R2 = (56)(10K) \quad (11)$$
$$R2 = 560K \quad (12)$$

There are certain constraints on permissible values for R1 (especially) and R2 (in some cases). Recall from above that R1 determines the input impedance. A common design rule states that an amplifier's input impedance must be at least ten times the output impedance of the preceding stage. If the preceding stage has an output impedance of, say, 100 ohms, then R1 must be 1,000 ohms or more. That constraint is not usually important if the signal source is another amplifier or some other electronic source. It becomes critical, however, when the signal source is a transducer, medical electrode, or a chemical electrode. A certain thermistor transducer has a nominal source resistance of 5 kilohms, so for use with that device, R1 must be 50 kilohms or higher.

There is no theoretical constraint on the values of R2 in ideal op-amps. In real devices, however, current I_0 (see Fig. 1) is not zero, so it will create a voltage drop across R1 and R2. That voltage drop is reflected as an error term, and is directly proportional to R1 and R2. As a result, when using most common op-amps, use the minimum values for R1 and R2 permissible within the limits allowed R1 by the ten-times rule. An exception to that rule is seen on normally high-Z devices such as the 725, BiMOS devices such as the CA3140, or BIFET devices. Those op-amps have such low I_0 values that almost any obtainable resistance is practical for R2.

The bypass capacitors on the power-supply lines in Fig. 1 are used to improve the stability of the circuit. Those capacitors are not needed in all cases, especially where unconditionally stable devices (the 741 or 1458, for example) are used. In those devices, the inherent stability is achieved by artificially reducing the frequency response to less than 10 kHz. Those devices are called frequency-compensated operational amplifiers.

On non-compensated op-amps, we may require the capacitors. The polarized units (C1, C2) are for low-frequency decoupling, but are ineffective at higher frequencies (a problem with tantalum units). We therefore must use the 0.1 µF units (C3, C4). In many cases, only C3 and C4 are required, and in all cases must be placed as close as possible to the body of the op-amp.

Op-amp problems

The ideal op-amp of our model does not exist. All real op-amps have certain problems that must be solved.

One irksome problem is output offset-voltages; that is, an output potential that exists when V_O should be zero!

A common cause of output offset-voltages are input offset currents. Those currents exist in real op-amps (remember, I_0 is not zero), and are due to bias currents of the input transistors. Figure 2 shows a method for suppressing the effect of the currents. In that circuit, a compensation resistor (R3) is used between the non-inverting input and ground. The value of R3 should equal the parallel combination of R1 and R2. For example, assume R1 = 10 kilohms and R2 = 100 kilohms; R3 should be

$$R3 = (R1 \times R2)/(R1 + R2) \quad (13)$$
$$R3 = (10K \times 100K)/(10K + 100K) \quad (14)$$
$$R3 = 9.1K \quad (15)$$

The effect of R3 is to develop a voltage drop ($I_0 2 \times R3$) equal to the voltage drop created by $I_0 1$ passing through R1 and R2. The assumption is that $I_0 1$ and $I_0 2$ are approximately equal. Since the two equal voltage drops are applied to differential inputs, they will cancel each other thereby eliminating the output offset potential.

Not all offsets are so easily trimmed out of the circuit. The method of Fig. 2 will not affect some forms of op-amp offset, and can not deal with DC offset voltage riding on the input signal. For those cases, the methods of Figs. 3 and 4 are required.

The method shown in Fig. 3 is used when the op-amp has a pair of offset terminals (often pins 1 and 5, or 1 and 8). A trimmer potentiometer is connected across the offset terminals, and its wiper is connected (usually) to the negative power supply.

Not all op-amps have offset terminals, so we must sometimes use the "universal" circuit shown in Fig. 4. That circuit is usable regardless of whether the op-amp has offset terminals, or not.

The technique illustrated in Fig. 4 uses a potentiometer (R4) and resistor (R3) to inject a countercurrent into the summing junction (point A) of a magnitude and polarity sufficient to cancel any output offset. The voltage at point B is set to exactly counter the offset potential. The "gain" seen by this voltage is approximately equal to $-R2/R3$. Adjustment of R4 is made with $V_I = 0$; that is, with the input shorted to ground.

There are several tactics that can be used to make the control over the offset finer. We can, for example, make R4 a ten- to twenty-turn trimmer potentiometer, thereby reducing the change in offset per turn. We could also increase the value of R3 so that any given voltage at point B produces a smaller change in offset voltage. We could also use one of a number of techniques to reduce the voltages available to the potentiometer, and thereby create a smaller change of voltage per turn.

The frequency response of op-amp circuits must sometimes be trimmed to something less than its "wide open" value. There are at least three reasons for tailoring the bandwidth of a circuit: noise

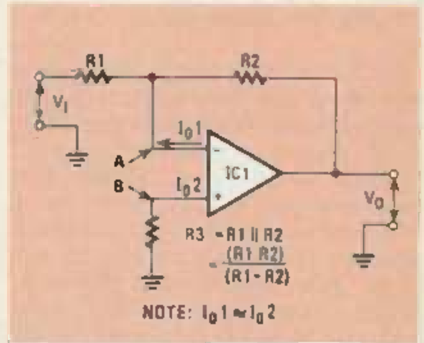


FIG. 2—OUTPUT OFFSET VOLTAGES can be eliminated by getting rid of any input offset currents.

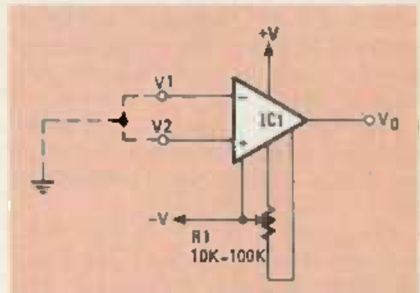


FIG. 3—IF THE OP-AMP has a pair of offset terminals, a potentiometer connected across them can be used to remove any output offset.

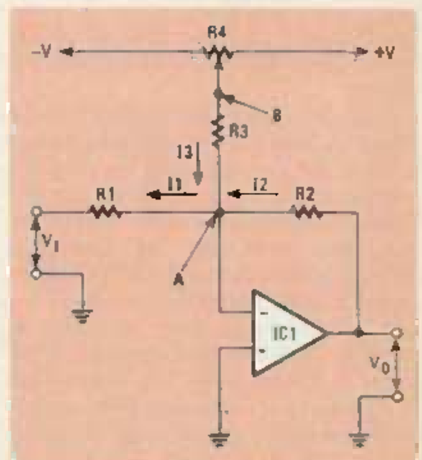


FIG. 4—IN CASES WHERE the op-amp has no offset terminals, this "universal" circuit can be used.

reduction (noise is proportional to bandwidth), customized requirements (for example, a communications bandwidth of 300–3000 Hz), and prevention of oscillation.

Oscillation in any circuit occurs when the feedback is in-phase and the loop-gain is unity or more. Recall that a phase shift of 360 degrees constitutes "in-phase" feedback. The inverting follower normally produces 180 degrees of phase shift. Additional phase shift occurs in the circuit due to resistance and stray capacitances. There may be some frequency, typically a high one, where that "stray" phase-shift adds up to 180 degrees, which when combined with the 180 degrees inherent in inverters, produces 360 degrees. If the frequency at which that occurs is at a point where the op-amp gain is unity (1) or more, then the "amplifier" will oscillate at that frequency. The circuit designer must take steps to ensure that the gain drops off to less than unity at some frequency below the frequency at which 360 degrees of phase shift occurs. Figures 5 and 6 show methods for accomplishing that.

The method shown in Fig. 5 is simplicity itself. A capacitor (C1) is shunted across feedback resistor R2. The −3dB breakpoint, *f*, is given by

$$f = \frac{1}{2\pi R2C1} \qquad (16)$$

The frequency response rolls off at approximately 6dB/octave at frequencies above *f*.

Some IC operational amplifiers have frequency-response compensation terminals that are intended to aid the designer in tailoring the bandwidth of the circuit. Figures 6-a through 6-c show methods for using those "lead" and "lag" terminals. In those devices that have lead terminals, a small valued capacitor (10 to 1000 pF) is used either between them, as shown in Fig. 6-a, or from a lead terminal to the output, as shown in Fig. 6-b. Consult the IC manufacturer's data sheet for exact values for the device you are using. For those devices with lag terminals (Fig. 6-c), either a capacitor or an RC network is connected between the terminal and ground. The values of those components are found from equation 16.

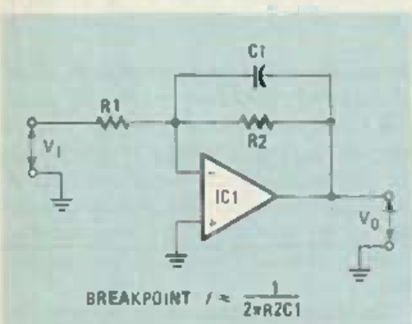


FIG. 5—TO PREVENT OSCILLATION, the op-amp's gain must fall to less than 1 below the frequency where 360° of phase shift occurs. The circuit shown above will tailor the bandwidth of the device to be sure that that happens.

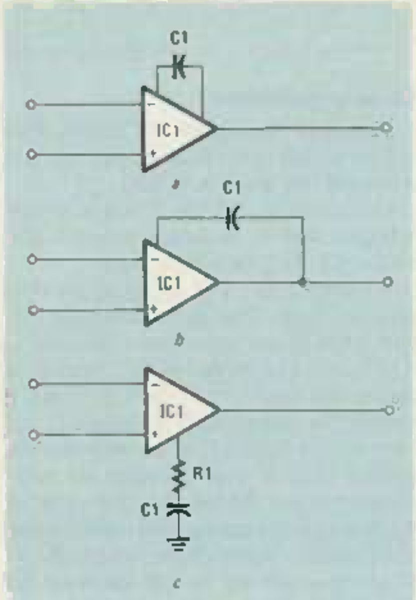


FIG. 6—THREE METHODS of using an op-amp's frequency compensation terminals.

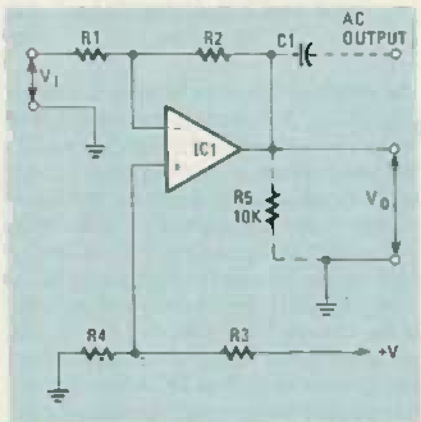


FIG. 7—USING AN OP-AMP in applications where only a single-ended supply is available.

Special applications

The basic inverting follower can be modified to produce certain special circuits. Figure 7, for example shows how an op-amp can be used with just a single-sided power supply. Such a situation might occur in automotive electronics, or where some existing equipment has only a single DC supply.

In Fig. 7, the only power supply is +V, and the −V terminal is grounded. We compensate for the loss of −V by applying bias from a voltage divider (R3/R4) to the noninverting input. The ratio of R3/R4 is usually set at 1:3, 1:1, 2:1, or 3:1 in order to give maximum output voltage swing. The disadvantage of that technique is that a DC bias (set by R3/R4) will appear as a permanent offset at the output. If only AC signals are anticipated, then we can rid ourselves of the offset by capacitor coupling the output (C1). In that case, however, load resistor R5 must be used to prevent the DC offset from latching up the circuit by charging C1.

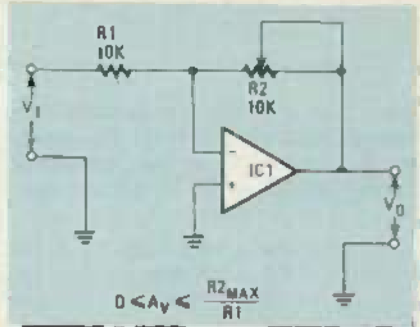


FIG. 8—A GAIN CONTROL can be formed by making the feedback resistor variable.

A gain control can be formed by making the feedback resistor variable (see Fig. 8). The gain will vary from zero to the maximum value of R2/R1. When R2 = R1, the gain ranges from zero to one. Anytime that R2 is less than R1, the gain will be less than one, according to the standard relationship (−R2/R1). Some designers use a stage like that shown in Fig. 8 as the output stage of a cascade chain, thereby affording gain control.

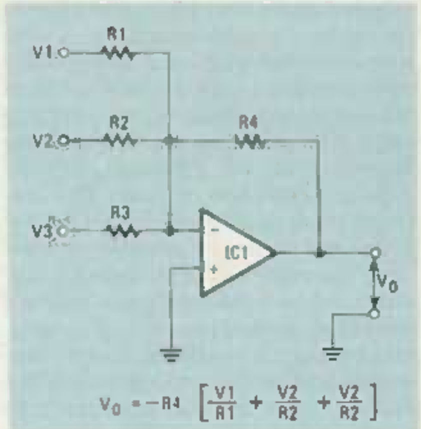


FIG. 9—MULTIPLE VOLTAGE SOURCES can be handled using the circuit shown above.

Figure 9 shows a method for accommodating multiple input sources (V1, V2, and V3). The output voltage V_O will be given by:

$$V_O = R4 \left(\frac{V1}{R1} + \frac{V2}{R2} + \ldots + \frac{Vn}{Rn} \right)$$

Typical applications for that circuit include use as an audio mixer and in circuits where voltage summation is required.

This month we have discussed the design of circuits using the op-amp inverting follower, certain op-amp problems (namely, frequency response and output offset voltages), and some special applications. In the next part of this series we will discuss the noninverting follower and AC (audio) amplifiers using operational amplifiers. R-E

HERB FRIEDMAN

Telecommunications

All about computer communications, and the hardware and software you need to become involved with it.

TO GEORGE ORWELL, 1984 WAS THE AGE OF BIG BROTHER. TO those who make their living by writing books about the future, 1984 is supposed to be the age of the "network," with every home connected to almost everything else through the personal computer. You will do your banking through your personal computer, work from your home through your computer, order goods and services through your personal computer, pay for the goods through the computer, get your education through the computer, get your news through the computer, even pay your taxes through the computer. To hear the pundits tell it, "networking" will provide you with everything except birth and death.

For those of you not yet familiar with the term, let's explain "networking." It is believed by many that within the next few years, probably by 1988 at the latest, virtually all U.S. households with discretionary income to spend will have a household personal computer. The computer will be equipped with a "communications package" consisting of a modem and the necessary software that will permit the computer to access central mainframe computer systems such as those used by your local bank, the information and news services such as the Source and Dow Jones Information Service (for you stocks and bond gamblers), electronic newspapers, electronic book digests, communication services such as E-mail (electronic mail) or a personal computer version of Telex, and "value added" services we haven't even imagined yet. (A "value added" service means an extra charge is added to the basic service fee, much like the extra charge for Home Box Office (HBO) that is added to the basic monthly fee for cable-TV service.)

Another concept of networking is work-at-home. Many jobs do not require a centralized work location. The work, whatever it is, can be done from home through a personal computer. A few examples easily illustrate the work-at-home networking concept: The stockbroker or Wall Street "wheeler-dealer" can easily work from home; he's presently getting his communications by computer anyway. An author need never show up at an office because he or she can download his book or article from his personal computer to his editor's computer through the telephone system. Insurance and real estate agents can also work from home because their records can also be stored within a home computer or accessed from a mainframe computer via a modem. If you stop to think about it, a lot of the future is happening right now.

The reason for the excitement about networking is because it's easy to do and relatively inexpensive for the average home-and-family user. All it takes to access a databank, electronic banking, news services, or even the computers of friends and associates is a modem and the specific software required for a particular function.

Modems

First things first: the modem. For home-and-family personal computers, a modem is a device that connects the personal computer to the dial-up telephone system. Generally, the modem simply plugs into an RS-232-C serial input/output port on the computer, or some other input/output connector specifically intended for a proprietary modem ("proprietary" meaning here a

AN ACCOUSTIC-COUPLED modem has rubberized cups into which the telephone handset seats.

modem that can only be used with a particular computer). The purpose of the modem is to translate a computer's digital electronic signals into audio tones that can be transmitted through the dial-up telephone system. The modem also translates audio tones arriving through the telephone system from a distant computer into digital information for the local computer.

Depending on the particular modem used, the modem-to-telephone system connection can be direct or acoustic. Direct means a "hard wire" connection from the modem to the telephone wiring, usually through a modular plug and jack. If your telephone wiring has only one modular jack—for the telephone itself—you can use a modular T-adapter, which provides two modular jack connections: one for the telephone and one for the modem.

The acoustic-coupled modem has rubberized cups into which the telephone handset is placed. A speaker within one cup feeds the audio tones representing the local computer's digital information into the telephone handset's transmitter. A microphone within the cup under the handset's receiver couples the audio tones from the telephone system into the modem for conversion to the digital information for the local computer. (How the conversions are actually made and the frequencies used are subjects for another article.)

Modems come in many different configurations, but regardless of whether they are manually or automatically switched to the telephone circuit, or the type of software used, the speed of information exchange depends on something called *baud rate*.

Baud rate simply means how fast the information can be exchanged through the modem. As far as personal computers are concerned, the "standard" baud rates are 300 and 1200. Without getting into the how's and why's, 300 baud means a transfer rate of nominally 30 characters per second; 1200 baud means a transfer rate of nominally 120 characters per second. Since 1200 is four times greater than 300, at 1200 baud your information can be transmitted in one fourth the time that it would take at 300 baud. In practical terms, that means that if you would normally be on a telephone/computer interconnect for 10 minutes at 300 baud, you will accomplish the same information exchange in 2.5 minutes at 1200 baud. Of course, no one gives the consumer anything free. Presently, there are often substantial surcharges for using a database or information service at 1200 baud. For example, if you pay $5 per hour of connect time at 300 baud, you might pay about $18-20 per hour if you use 1200 baud. Also, 1200 baud modems cost about four times the price of a 300 baud modem. (Yes, many modems will operate at both 300 and 1200 baud.)

As a general rule, the least expensive modems must be manually switched or connected to the telephone system. Either the user must move a switch or place the telephone handset in the modem's cups. General purpose modems of that type, which can be used with almost all computers, cost in the neighborhood of $80 to $125 depending on the model and whether you're buying at full list or discount. Those devices are invariably 300 baud; there were no budget-priced 1200 baud modems at the time this article was prepared.

For about $225 to $500 you can obtain a direct-connect modem that has auto-dial, or auto-dial and auto-answer. Auto-dial means that at a command from the computer the modem will automatically connect itself to the telephone system and dial the telephone number of the receiving computer. It will also sense when the receiving computer has answered and is on-line, and will indicate on your screen that it is ready for communications.

The auto-dial sequence is originated from the computer keyboard. To do so, the user enters a sequence of keystrokes (just what those keystrokes are depends on the device and the software used) that causes the modem to connect itself to the telephone system. Then the user types the desired telephone number on the keyboard, which causes the modem to either pulse (rotary) or *Touch-Tone* dial the computer access telephone number. Some telecommunications software allows the user to create a "telephone directory" of often-called numbers. To use the directory, only a designated number, letter, or phrase need be entered and the rest will be taken care of automatically.

When you want your computer to exchange information with an information service or database, you must use an originate modem. An originate modem generates and receives specific tone frequencies recognized by dial-up computers. The computer at the receiving end uses an answer modem. Originate and answer modems are identical, only their input and output frequencies are different.

Until recently, virtually all modems for personal computers were originate-only because no one ever suspected they would be used for anything other than accessing a mainframe computer. But networking doesn't only mean mainframes or a service you must pay for. Imagine for a moment that you are a student working on a group school-assignment. Or maybe you need some technical information a fellow worker or associate has stored in his or her home computer. Or maybe your business partner has the inventory in his home computer, but you are processing orders with your computer, and you need that data from his files. Any personal computer can communicate with any other personal computer except for one thing: if they both use originate modems no information is going to pass between the computers. One of the two computers must be using an answer modem—the same kind of modem device used by the mainframe databank and news services. It doesn't matter who has what as long as one computer has an answer modem and the other an originate modem.

Since it requires very few internal parts to make a modem function in either the originate or answer modes, most modern modems—even the low cost models—can work in either the answer or originate mode. If you plan on exchanging data or correspondence with other personal computers make certain you get an answer/originate modem. The few originate-only modems still available in the marketplace might prove more of a problem than the few dollars you will initially save are worth.

A DIRECT-CONNECT, auto-answer, auto-dial modem, the *Smartmodem* is from Hayes (5923 Peachtree Industrial Blvd., Norcross, GA 30092).

Originate/answer modems with auto-dial usually also feature auto-answer so you can access your own computer through a remote terminal, another computer, or one of the so-called "lap computers" with built-in modems such as the Radio Shack *Model 100*.

Auto-answer usually works this way. You preset the modem to "answer" your telephone on the fourth, fifth or sixth ring; that's so someone can have a chance to answer the telephone by voice if they wish before the modem automatically answers it. If the modem answers, it transmits an "answer carrier tone" into the telephone. The modem on the remote (originate) end hears the answer carrier and in turn transmits an "originate carrier tone" into the telephone. When the answer modem senses the originate carrier, contact is established and information transfer can begin.

Some software considerations

It is wrong to assume that if you have an originate modem and the other party has an answer modem that everything will work out. Some communications software packages cannot properly receive (or sometimes originate) a binary data exchange unless the computer is using an answer modem.

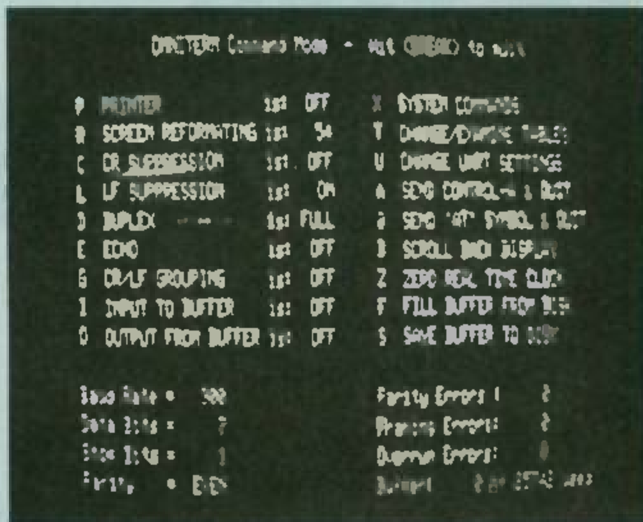
A binary exchange is an exchange of non-text data. With very few exceptions the information services exchange text transmitted in ASCII—the *A*merican *S*andard *C*ode for *I*nformation *I*nterchange. Thus what is being exchanged is plain text, with no error checking. If a character gets garbled during transmission you can usually figure out what's missing. For instance, if you receive "The quicc brown foxcjumped over the lazi dog", you can be reasonably certain that what was transmitted was "The quick brown fox jumped over the lazy dog." Things get tougher if you are working with a BASIC program, but chances are good that you would be able to spot any transmission errors.

All modern communications software, of any kind, for any personal computer, transmits and receives text in ASCII. But what happens if you require absolute precise reception, or you are exchanging a machine-language program, or binary-encoded data? You must receive an exact representation of the binary data because one single garbled bit out of thousands can crash the program, or change a check for a $100 refund into $10,000 or more. A binary data exchange requires what is known as a "protocol" exchange.

Basically, it works this way. The originating computer transmits a block of binary data and then mathematically derives a "checksum" value determined by the particular data transmitted. It transmits the checksum following the data and then stops transmitting. The receiving computer calculates a checksum from the data it receives and sends its checksum value back to the originating computer. If the checksums at the originate computer agree, that computer transmits the next block of data and the process repeats. If the checksums do not agree, the originating computer repeats the block transmission until it receives a correct checksum. If after a predetermined number of attempts the originating computer cannot get a correct checksum response, it stops sending and notifies the operator that it cannot complete the transmission.

The software that does protocol transmission is very fussy as to the way in which the checksums are derived and as to the unseen (phantom) signals that pass between the computers as part of the protocol transmission. Those must match precisely; hence, as a general rule exactly the same type of software must be used at both the originating and receiving computers. If the software is different, it must have some way to recognize the various protocols in use.

For example, because it is so easy to use, supports full auto-originate and auto-answer, does so many things without fuss, and is so reliable, one of the most popular communications software packages is ***Crosstalk*** (Microstuff, Inc., 1845 The Exchange, Atlanta, GA 30339). But it can do a protocol data exchange only with other computers running Crosstalk. On the other hand, the communications software package *M.I.T.E.* (Mycroft Labs, Inc., Box 6045, Tallahassee, FL 32314), which does more or less the same things but not as easily (that point is debatable), can do a binary exchange with computers running software using Crosstalk, CLINK, Hayes, and XMODEM (Christiansen CP/M) protocols, as well as, of course, with computers running *M.I.T.E.* Generally, if you plan to do protocol exchanges with anyone make certain your software accommodates their computer's protocols. The best communications software turns out to be worthless if you require a protocol exchange that can't be done.



A POPULAR COMMUNICATIONS PACKAGE. *Omniterm* is from Lindberg Systems (41 Fairhill Rd., Holden, MA 01520).

The Videotex software sold for CompuServe, Dow Jones, and other information services provide the proper protocol for each particular service so you never have difficulty getting a protocol download. If a special protocol is necessary you can generally purchase the correct software at nominal charge. For example, Radio Shack *Model I* and *Model III* users can purchase special "executive" software from CompuServe that allows an automatic protocol download of data from the service to the user.

Virtually all communications software sold today is what we call "smart," meaning it allows the user to store incoming data in memory for later viewing or for storage to tape or disk. It also permits the transmission of stored data from tape or disk to a remote computer. It might perform many other functions such as storing prewritten strings of characters for signing onto an information provider's computer and automatic answerback for Telex (which identifies the originating user when the computer receives a CONTROL-E from the Telex service). Another popular feature is character conversions or filtering. You've got to be a bit careful with the last one—as nice as it is it could cause some problems. For example, one of the most popular modem reserves CONTROL-H for its own internal use and thus a received or transmitted CONTROL-H is automatically changed to another character. But one of the major information providers uses CONTROL-B in its password system. If you use that communications software and attempt to sign on to the provider, and your password has a CONTROL-H, there is absolutely no way to sign on to the remote computer. Such a problem can be gotten around in most software as some means of redefining any reserved or filtered characters is usually provided.

In this article we've tried to show you what to look for, and what to look out for, when looking for telecommunications hardware and software. Whatever your needs, however, bear in mind that with almost no exceptions any personal computer can enter the age of computer networking. **R-E**

BUILD THIS

TRS-80 TELEPHONE DIALER

Turn your computer into an automatic telephone dialer.

HOWARD BERENBON

IF YOU OWN A TRS-80 COMPUTER AND want something unique to do with your computer system, then this project may be what you've been looking for. With just a couple of components, you can build a telephone interface that will let a TRS-80 dial a telephone number. That may be the missing link to your automated telephone directory or your computerized burglar alarm.

In addition to the interface circuit, there is a short BASIC program that is presented to drive the interface circuit. Since that circuit is connected to the cassette-tape I/O port, you should be able to connect it to just about any computer with a cassette port and modify the BASIC program to fit your system if you know the port address.

The actual BASIC program is listed in Table 1. It is a Level 2 program that drives the interface circuit through the remote-control relay inside the computer that is connected to the remote-control plug. All that is required is the simple phone interface circuit shown in Fig. 1. The circuit is connected to the remote-control plug of your cassette interface cable.

The interface consists of a relay, a silicon diode, one 9-volt rectangular battery, and a microphone jack. That's about $4.00 worth of parts. Simply connect the contacts of the relay in series with the green telephone wire. Since the relay is a normally-closed type, it will not interfere with the normal operation of your telephone. However, before you actually connect the telephone, you must contact your local telephone company to insure compliance with local telephone-company regulations.

The BASIC-language program uses the OUT command to access the I/O port (port FF) and thus dial the phone. It pulses the cassette remote-control relay that is connected to the telephone line via the interface circuit.

The dialer is set to dial one phone number, and print the number on the CRT screen as it is dialed. The program simulates the operation of a rotary dial, by

continued on page 106

TABLE 1—PHONE DIALER PROGRAM

```
10   PRINT "TRS-80 PHONE DIALER
       PROGRAM"
20   PRINT "COPYRIGHT © 1979 BY
       HOWARD BERENBON"
30   PRINT
40   PRINT "ENTER AN 'A' TO DIAL"
50   INPUT A$
60   IF A$<>"A" THEN 40
70   CLS:Q=14:R=14
80   REM DIAL THE NUMBER IN THE
       DATA STATEMENT
90   x=200
100  PRINT "DIALING"
110  READ C
120  IF C=55 THEN 700
130  PRINT @ x,C
140  IF C=O GOSUB 800
150  x=x+2
160  REM DIAL THE PHONE NUMBER
       ONE DIGIT AT A TIME
170  GOSUB 400
180  OUT 255,4
190  GOSUB 500
200  OUT 255,0
210  GOSUB 550
220  C=C-1
230  IF C=O THEN 110
240  GOTO 180
400  FOR A=1 TO 90
410  NEXT A
420  RETURN
500  FOR A=1 TO Q
510  NEXT A
520  RETURN
550  FOR A=1 TO R-5
560  NEXT A
570  RETURN
700  PRINT
710  PRINT "DIALING COMPLETE"
720  END
800  C=10
810  RETURN
990  REM DATA STORAGE FOR PHONE
       NUMBER
1000 DATA 1,8,0,0,5,5,5,1,2,1,2,55
```

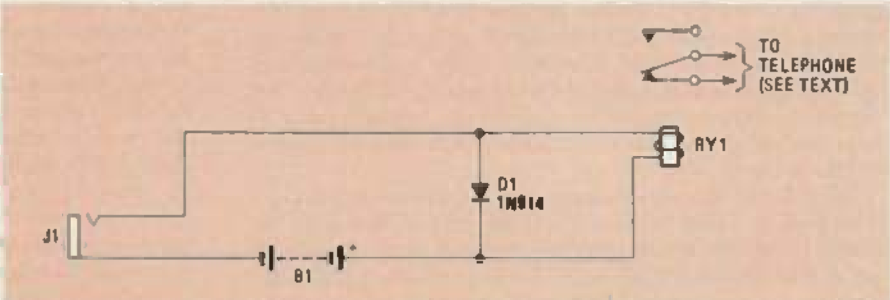


FIG. 1—TELEPHONE INTERFACE circuit can be built on perfboard. The relay contacts are connected in series with the green telephone wire.

PARTS LIST

D1—1N914 diode
RY1—SPDT relay, 5 or 6-volt 500-ohm DC coil.
B1—9-volt rectangular battery
J1—phone jack

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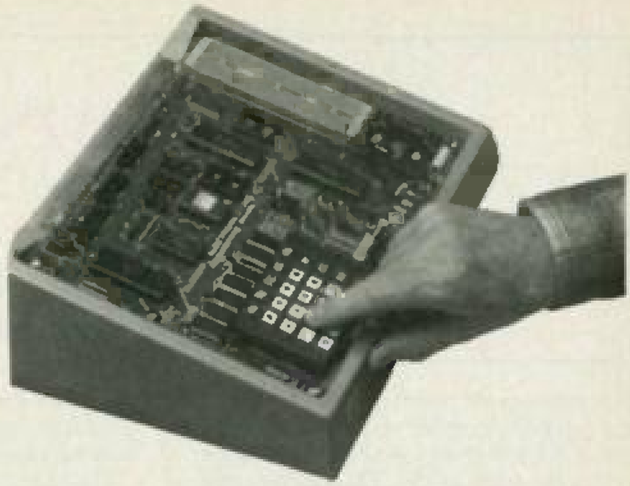

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HOBBY CORNER

Finding an unknown transmitter location

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

IN THE PAST SIX MONTHS WE'VE RECEIVED a surprising number of requests for a circuit that will allow you to find the location of a radio transmitter. The reasons given for needing such a circuit are quite varied. Several readers want to use the locator on ham (amateur radio) transmitter hunts. Others want to be able to find the source of CB transmissions. One wanted to use it to locate his dog when it runs away. And three other readers want to use the circuit to locate their cars in large crowded parking lots. However, the most recent request comes from a fellow who needs a way to locate his deaf-mute son if they should become separated.

We sincerely wish that we could tell you that there's an easy way to determine the location of a transmitter. But, in fact, there is no simple way to do so. (Don't believe *everything* you see in the movies.) Finding the direction and distance of a transmitter from your position requires complex circuitry both at the transmitter and receiver locations. During the course of (too) many years, we've had experience both in the air and on the ground with a number of methods of locating a transmitter. Those methods fall into two categories: One requires the operator of the transmitter to send out specialized signals, and the other can be used with any type of transmission.

Using the specialized-signal method, an aircraft or some other type of vehicle can be equipped with receivers that show their location with respect to known transmitters. That information can be converted to give the transmitter location in any type of coordinates. Specialized transmitters may be located on satellites, at or near airports, or on seacoasts. Perhaps the oldest such system is the radio-beacon (AN), which operates below the broadcast-band frequencies. For many years, that system defined the "highways in the sky" for pilots. Then came the Loran system, which was more useful and accurate. The Loran system enabled ships and planes to determine their locations with respect to coastal transmitters. (See the **July 1983 Radio-Electronics** for a description of the Loran-C system.) Transmitting and receiving equipment was complex and bulky in those early days. More modern systems, such as omnirange and satellites, are even more complex. The construction and use of the latter-type systems is beyond even the most advanced hobbyist.

Therefore, we're now left with a more primitive system that requires no special signaling from the transmitter (any signal will do). This system has changed little from 25-years ago (when I participated in many hidden-transmitter or "fox" hunts). It wasn't all that easy then and still isn't. In any case, the system can give the searcher direction only (and he may be able to guess the distance from the strength of the signal). All that is required is a receiver with a one-way directional antenna. Constructing such an antenna can be difficult, but that depends on the frequency of the signals involved.

For best results, you really need two readings on the direction of the transmitter. They can be made simultaneously (by two receivers in different locations) or sequentially (by using one receiver and changing its location between readings). The second method assumes, of course, that the transmitter does not move in the time it takes to change locations. The two resulting directions are plotted (on a map), and simple triangulation gives the location of the transmitter. That process is illustrated in Fig. 1, where a line is drawn from receiver A in the direction of its strongest reading (100 degrees) and the same is done for receiver B for its 60-degree reading. The transmission originates where the lines cross.

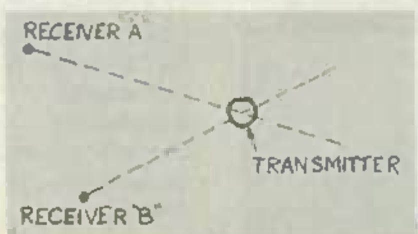

FIG. 1

However, there are two major drawbacks associated with even this simple location method. The first is the equipment—transmitter, receiver, and directional antenna. You can find helpful information and plans in various publications of the American Radio Relay League (Newington, CT 06111). Be advised, however, that they are dealing strictly with equipment for the amateur-radio frequencies that are operated by licensed hams. The other drawback is the license requirement. Anyone can own and operate a receiver. But a transmitter is something else. There is the serious matter of your right to transmit on any radio frequency. Our laws are based on the fact that the "airwaves" belong to everyone, who under the proper circumstances are entitled to use them free from unauthorized interference. That means that you must be licensed to put a transmitter on the air.

The only exceptions to the licensing requirements are certain carefully defined low-power operations that have a very limited range. Licensing requirements vary

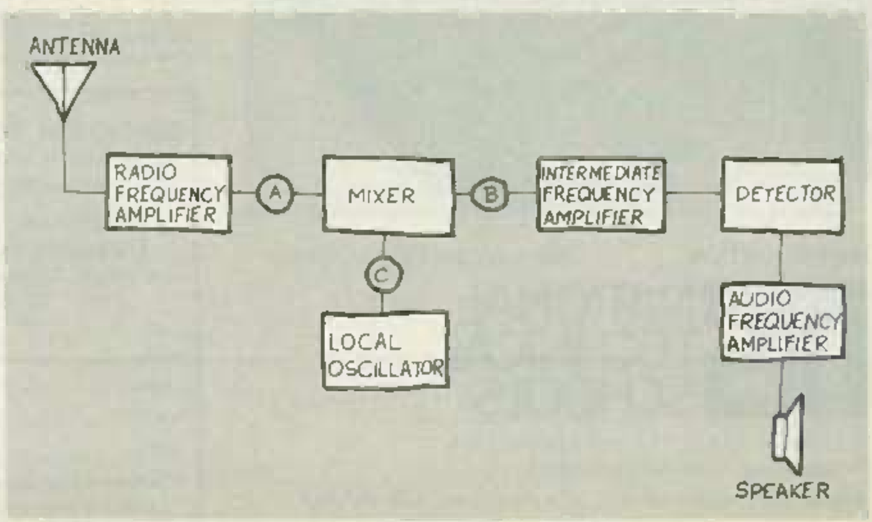

FIG. 2

from minimal (CB) to quite stringent, demanding a high degree of knowledge and proficiency. Also, even licensed transmitter operators are required to periodically identify themselves when transmitting. Therefore, we strongly advise you *not* to put an unlicensed transmitter on the air.

The long and short of it all is that using a transmitter and receiver to locate anything or anyone is not only a technically demanding operation but a highly regulated one. Regardless of the merits of your case, we cannot recommend that you undertake a venture of that nature unless you are prepared to devote a considerable amount of time and energy to it. Now let's turn to another communications problem.

Frequency readout

Don Hang (OH) has a communications receiver and is unhappy with the dial calibration. He has a digital frequency counter, but doesn't know how to use it for a frequency readout.

Let's take a look at a basic receiver. Figure 2 shows a simplified block diagram of such a radio. Note that three points (A, B and C) are labeled. Don, you are correct that the signal at point A is the very one to which you are tuned. You could couple your counter there and read the frequency directly but that's a ticklish operation. Extreme care must be taken so that the receiver's alignment isn't thrown so far off that proper tracking across the bands is impossible to achieve.

Point B cannot be used because the signal at that point is at the intermediate frequency or IF—usually 455kHz. If your reading were taken there, the display would always show the IF regardless of the tuned frequency. Actually, the best place to read the frequency is at point C. There, a bit of signal from the local oscillator can be picked off with fewer potential problems than at point A. Nevertheless, you must be careful; and even then it may still be necessary to realign the receiver. Because of that, the best procedure to follow is to use what is called a "gimmick" capacitor. That's nothing more than the very small capacitance created by twisting two short pieces of insulated wire together or, in this case, around the output lead of the local oscillator. The end of a wire crooked around the output lead of the local oscillator may bring out an adequate signal for your counter.

If the signal is not strong enough, you can make the coupling tighter by using another turn or two of wire. Caution: do not make it too tight or the alignment will be thrown off. A better method would be to place a broad-band amplifier stage between the "gimmick" and the counter to boost the signal to a sufficient level. All right—now that you have a signal that's strong enough to produce a reading on the

continued on page 107

COMPUTER CORNER

You've never tried a personal computer?

LOU FRENZEL

PERSONAL COMPUTERS ARE NO LONGER the new and glamorous things they used to be. In many respects they're really "old hat." They've been around for almost a decade now. The first practical ones appeared in the mid-1970's, several years after the introduction of the first 8-bit microprocessors. (**Radio-Electronics** published the first computer construction article in July, 1974.) The growth of the personal-computer field has been astronomical during the last seven or eight years and today they are used in millions of businesses and homes. Still, there's an astonishing number of people who have never used or even experienced a personal computer. Even many of those who work in electronics or some related field have never had the opportunity to try a microcomputer. In addition, recent studies show that the total home penetration of personal computers is only about 7%, though the home computer movement is well under way. That means that out of approximately 80 million households in the United States, about 75 million of them still do not have a personal computer.

As a reader of **Radio-Electronics**, you're more likely than the average person to be one of those who own a personal computer, or at least have access to one at work. Still there are many of you who have not yet taken the plunge. Perhaps you feel that you really don't need or want a computer: After all, what would you do with it? Then again, maybe you are one of those who are secretly afraid of microcomputers. That's a very common feeling and one that keeps many people from benefiting from microcomputers. The fear of the unknown or the fear of failure keeps many would-be computer owners from trying these fascinating machines. Regardless of your reason, there is really no excuse for *not* at least trying a microcomputer. The old adage that says "don't knock it until you've tried it" still holds true and is so applicable to this situation. Personal computers can be viewed as fascinating toys but they are also useful tools for accomplishing work. Now is the time to take a serious look at these machines that are literally changing the way we work and think. Why not join the 5-million-plus individuals that are expected to purchase a personal computer this year?

FIG. 1

The "computer literacy" machines

In the past, personal computers have typically been complex and expensive devices. But that's not so today! Thanks to technological developments and the high volume demand, prices have dropped considerably. A good personal computer will cost you much less than a good VCR or stereo system. In fact, today you can purchase a minimum-power personal computer for under a $100: And for between $100 and $200, you can get a powerful and useful one. For that reason, price should no longer be an obstacle. Also, complexity is no longer a valid argument. Most personal computers are so easy to use that even the youngest child should have little trouble. In fact, the average personal computer today is no more complex to use than a VCR or video game.

There are many people who have taken the approach that they'll learn something about computers (by reading magazines or books) first, and then buy one later. But it seems that they never get around to actually buying one. The best way to get started with personal computers is to jump right in and buy one. After all, there's nothing like hands-on experience for learning! Just keep in mind the rule that says: I hear, I forget; I see, I remember; I do, I understand. Computers are like bicycles in that you have to actually use one to learn how it works. No amount of listening to others or reading can get you there. You have to experience it for yourself.

The best way to get your feet wet is to purchase one of those, so-called, "computer literacy" machines. Those are the low-cost microcomputers you see advertised on TV or displayed in your local toy and department stores. There are some real bargains around because of the price wars currently going on in the low-end personal-computer market. Therefore, there's no time like the present to take advantage of the situation. Let's take a look at some of the machines that fall into the low-end category.

The lowest priced microcomputer on the market today is the Timex/Sinclair *1000* shown in Fig. 1. There are well over a million of those machines already in use today and hundreds of thousands of them are being sold every month. The standard Timex price is $49.95 but they can found on sale for as little as $29.95. At that price you get a complete ready-to-use computer that hooks-up to your TV (which is used as a monitor). An ordinary audio-cassette player/recorder can be used for loading programs and storing data. The Timex/Sinclair *1000* comes with a Z80 microprocessor. 2K of RAM (*R*andom *A*ccess *M*emory)and a BASIC interpreter in ROM (*R*ead *O*nly *M*emory). You can learn to program in BASIC (*B*eginners *A*ll-purpose *S*ymbolic *I*nstruction *C*ode) or you can try out a variety of useful programs and entertaining games. There is no cheaper or easier way to get started. The Timex computer is sold in just about any store where Timex watches are ordinarily sold. including most department and specialty stores.

If you find that you like the Timex computer. you can always expand it and make it much more useful. Specialty manufacturers provide a wide range of accessories to expand that popular unit. One such manufacturer is Memotech Corporation (7550 West Yale Avenue. Suite 200. Denver. CO 80227). who makes add-on memory packages with 16K. 32K. and 64K capacities. Memotech also furnishes a variety of I/0 interfaces such as the popular Centronic parallel printer interface and the RS-232 serial interface. Other available accessories include: an editor/assembler utility in ROM. a high-resolution graphics package. and even a 32-column dot-matrix printer and full-sized keyboard. On top of that. there are many software houses that publish software packages for the Timex *1000*. Timex also makes several other computers. such as the *1500* and the *2000*.

Another good choice is the Texas Instrument (TI) *99/4A*. Because TI has dropped out of the personal-computer market. you can get a *99/4A* package at an incredible discount. That's fantastic for a machine that uses the powerful TMS-9900 16-bit microprocessor and features 16K of RAM and BASIC in ROM. That computer uses a wide range of ROM program-cartridges and can use your TV set as a video display. TI also has several expansion devices for that computer on the market. including a memory-expansion module. I/0 interfaces. floppy-disk mass storage. and a speech synthesizer.

Another very popular low-priced home computer is the Commodore *VIC-20*. The *VIC-20* features the 6502 microprocessor. 5K of user RAM. and plug-in ROM cartridges. You should be able to find one on sale for less than $100. By the time you read this. their 16K version should be available for that same low price. Commodore and others publish a wide variety of game programs and other. useful software. The *VIC-20* features sound and excellent color graphics.

Radio Shack is a newcomer to the so-called "computer literacy" machine field. Although Radio Shack has been making computers for many years. they've only recently announced the addition of the low-cost *MC-10*. Their popular Color Computer models fall into the computer-literacy category but not the prices. However. their new *MC-10* Micro Color Computer is bargain priced at $79.95. It comes with 4K of RAM standard and can be expanded to 20K with a 16K plug-in module ($49.95). The computer also has good color graphics with eight colors. and sound. Both text and graphic characters are displayed in a 32-character by 16-line format. A BASIC interpreter is contained in ROM and the reference manual that comes with the machine teaches you how to program.

The Atari *600XL* is also worth considering. This one replaces Atari's previous low-end model *400* computer. Like the old one. the *600XL* also uses the 6502 CPU and can runs all *400* software. But. in contrast. it features 16K RAM and a standard keyboard. The *600XL* is priced at $149.50.

In a sense it doesn't really matter which microcomputer you buy. Your main objective is to learn and get some experi-

continued on page 107

STATE OF SOLID STATE

Stereo-sound IC

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

IF YOU'VE GROWN ACCUSTOMED TO THE big spatial sound of hi-fi stereo equipment, you probably find the monaural sounds of AM radios and TV sets somewhat less than enjoyable. With that thought in mind, Signetics has introduced the TDA3810, a spatial, stereo, and pseudo-stereo sound circuit. That audio-processor IC converts monaural-audio signals into realistic "pseudo-stereo" sound. It can also enhance the stereo effect when inserted in the audio-signal paths of FM-stereo radios where the apparent stereo separation is less than ideal because of limited speaker spacing (for example, in portables or in your car). It can also be added to most monaural TV and AM/FM radio circuits.

Figure 1 shows a schematic of a circuit using the TDA3810, along with a block diagram of the IC. The IC operates from a DC supply voltage ranging between 4.5 and 16.5 volts and draws a maximum of 12 mA. Its input impedance is typically 75,000 ohms. Minimum input-signal voltage (at pins 2 and 17) for the IC is 2-volts RMS rated at .2% total-harmonic-distortion (THD). Its output THD is rated at 0.1% (for frequencies between 40–16 kHz with an output voltage of 1 volt.) The IC's average voltage gain is about 2.4 dB in the spatial mode, and unity otherwise. Its channel separation is typically 70 dB.

The TDA3810 also provides automatic switching between the mono and stereo modes. And it also has manually controlled logic switching between the mono and pseudo-stereo modes. (Mode selection is determined by the settings of S1 and S2.) Two outputs (at pins 7 and 8) drive LED1 and LED2, which are used as mode indicators. There is also a muting circuit that keeps the LED indicators from flickering.

A monaural signal is fed to the paralleled left and right inputs (pins 2 and 17 respectively) where it splits to follow two signal paths. In one path, the signal is fed through to the output without modification. In the other, all frequencies between 300 Hz and 2 kHz are delayed for a frequency-dependent amount of time (for example, 500µs at 800 Hz) to produce a pseudo-stereo output. In the spatial mode, the stereo effect is enhanced by applying about 50% of the 180° out-of-phase feedback as crosstalk between the right and left channels. Additional information is available from: **Signetics Corp.**, PO Box 409, Sunnyvale, CA 94086.

8-bit analog-to-digital converter

Analog Devices recently introduced the AD673, a monolithic 8-bit analog-to-digital converter (ADC). This IC provides a microprocessor interface that performs an 8-bit conversion in 30 µs maximum. In addition, it has three-state output latches that are controlled by the data-enable input pin. The data-enable control allows the microprocessor to accept data whenever it is ready. Also included in this IC is a successive-approximation register, a Zener diode reference, a comparator, and

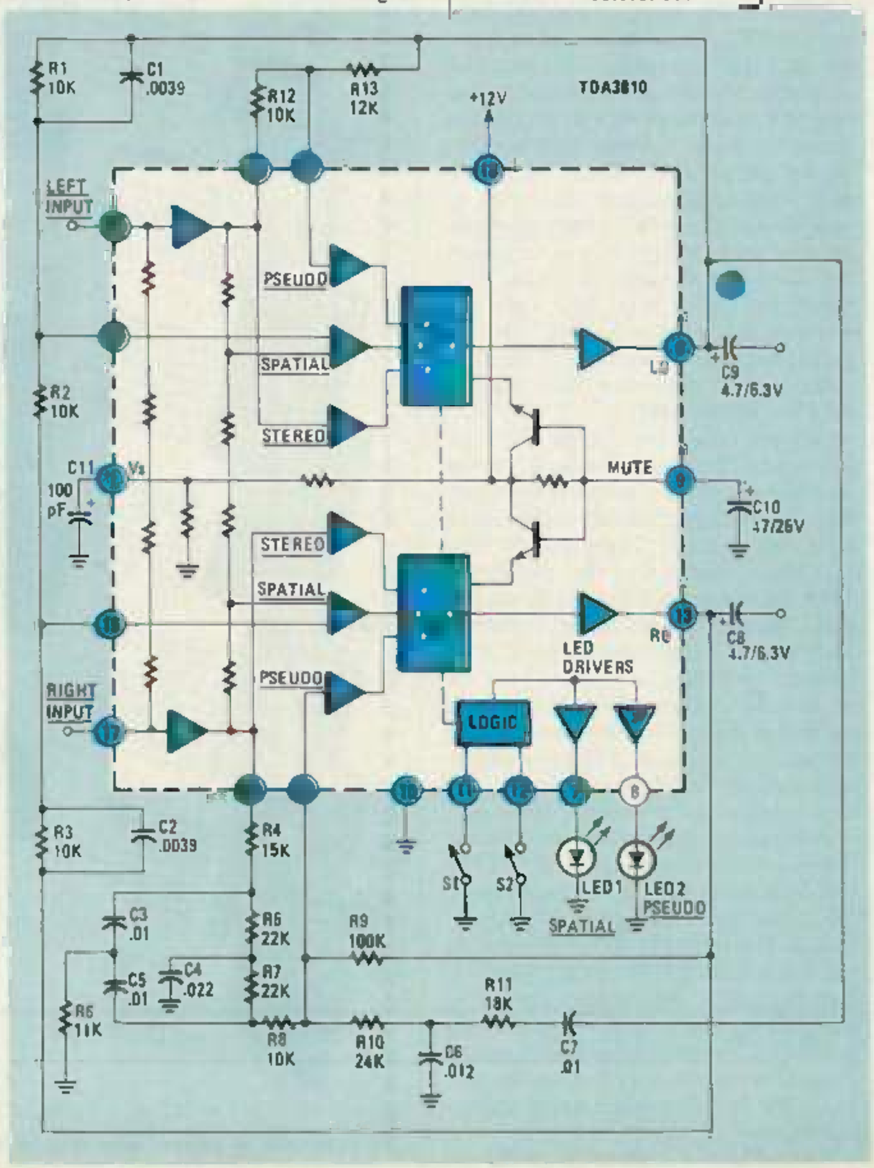

FIG. 1

a clock. The three-state output buffers specify 250 μs maximum access time. The IC is pin-programmable for either 0 to +10 volts or ±5 volts full-scale.

The AD673 is powered by two supply voltages: one, a positive 5-volt supply and the other can be either −12- or −15-volts. Its relative accuracy is guaranteed over the specified temperature range at ±½ LSB maximum. Maximum offset drift is also specified as ±½ LSB; maximum gain drift is ±2 LSB. The above specifications apply for temperatures ranging from 0 to +70°C for the "J" grade and −55°C to +125°C for the "S" grade. The IC is available in 20-pin plastic or hermetically sealed ceramic DIP packages. Commercial grade prices for the "J" series range from $7.90 to $12.50 in lots of 100. The "S" grade is priced at $38.20.—**Analog Devices**, Semiconductor Div., 804 Woburn St., Wilmington, MA 01887.

New technical data book

A new 1080-page databook, *Linear Integrated Circuits and MOSFET's* (SSD-240B) contains detailed technical information on RCA's broad range of linear IC's and small-signal MOSFET's. Included are many IC's for applications in both industrial and consumer electronics devices.

The first section, a general overall guide to available products, provides a complete index of types, photos of the many package types, product classifications and selection guides, listings of special terms and symbols, and a cross-reference showing RCA replacements for many industry types. This section is followed by technical data on devices grouped into categories including Operational Amplifiers, Voltage Comparators, Data-Conversion Circuits, Arrays, Power Control Circuits, Differential Amplifiers, Special-Function Circuits, Automotive Control Circuits, Audio Circuits, Radio Circuits, TV/CATV Circuits, and MOSFET's.

The final section covers device types supplied for military, aerospace and high-reliability applications and shows dimensional outlines for all package types. It also includes lists of current application notes on IC's and MOSFET's. Copies of the SSD-240 Databook may be purchased for $7.00 per copy from RCA Solid State Division.

NPN transistor arrays

RCA recently introduced two NPN transistor-array IC's that are designed for high-frequency applications up to 1.5 GHz. The two devices are high-quality versions of the CA3046 and CA3127E and operate over a temperature range of −55 to +125°C. Each array consists of five general-purpose silicon NPN transistors on a common substrate. The CA3246E array has three independent transistors, along with two differentially connected devices housed in a 14-pin plastic DIP package. The CA3227E consists of five independent transistors in a 16-pin package.

Each transistor in the array has a gain-bandwidth product (f_T) in excess of 3 GHz. That permits the transistors to operate effectively up to 1.5 GHz for use in VHF amplifiers and mixers, IF converters and amplifiers, and other similar devices. At 25°C ambient temperature, each transistor in the array can dissipate up to 85 mW. Maximum power dissipation for the package is 425 mW up to an ambient temperature of 75°C. Above 75°C, the package must be derated linearly at 6.67 mW/°C. The breakdown voltage for each transistor are: collector-to-emitter voltage (V_{CEO}) 8 volts, collector-to-substrate voltage (V_{CIO}) 20 volts, and collector-to-base voltage (V_{CBO}) 12 volts. Each unit can handle 20 mA of collector current.

In 1000-piece lots, the CA3246E is priced at $1.93 and the CA3227E is priced at $2.18. For more information and/or a data sheet (File No. 1345), write to **RCA**, Solid State Div., Box 3200, Somerville, NJ 08876. **R-E**

MAKING MEASUREMENTS

continued from page 79

Another problem when reading at a distance is the cost of long runs of thermocouple wire. This is partially solved by splicing the thermocouple to "extension wire", less expensive thermocouple wire specified over a narrower temperature range. The savings are particularly important when using platinum thermocouples, since the extension wires are made from nonprecious metals.

The low sensitivity of thermocouples requires good first-stage stability in the readout circuitry. For precision measurements, low-drift amplifiers or chopper-stabilized inputs must be used. (Chopper stabilization improves the DC drift of an amplifier.)

Thermocouples are linear enough that no linearization is needed for moderate accuracy over moderate temperature ranges. Nonlinearity above 0°C is generally 1% to 5%, depending on the thermocouple and the temperature range.

Thermocouple applications are almost limitless. The wires are available in large or small gauges, in cables using a wide variety of insulations and in ceramic insulating tubes for very high temperature use. The sensing junction, formed by welding the two wires together, may be put into enclosures such as those shown n Fig. 11. The junction may be welded, epoxied or glued directly to a surface or may be exposed directly to air or liquid for fast response. The temperature of molten steel, for example, is measured by plunging the two wires directly into the steel.

Integrated Circuits

Integrated-circuit temperature sensors are fairly new and are not at all standardized. At this time at least five device families exist, each unique in design and output. They generally make use of the fact that the voltage drop across a forward-biased diode or transistor junction decreases by about 2 millivolts per degree C. IC sensors are generally offered in transistor or IC packages; they are not yet available in the same variety of assemblies as other sensors.

Despite the lack of standardization, some generalizations are possible. Operating temperatures are similar to IC's: −55 to +150°C (−67 to +302°F) or some portion thereof. Accuracies generally are several degrees, requiring user calibration for tighter measurements. Selected sensors as close as ±1°C are available, but are expensive. Stability at high temperatures is not as good as with most other temperature sensors. IC's are linear, sensitive and easy to interface with readout circuitry. But look for specifications to improve in the future. R-E

SERVICE CLINIC

TV tuner and IF amplifier troubles

JACK DARR, SERVICE EDITOR

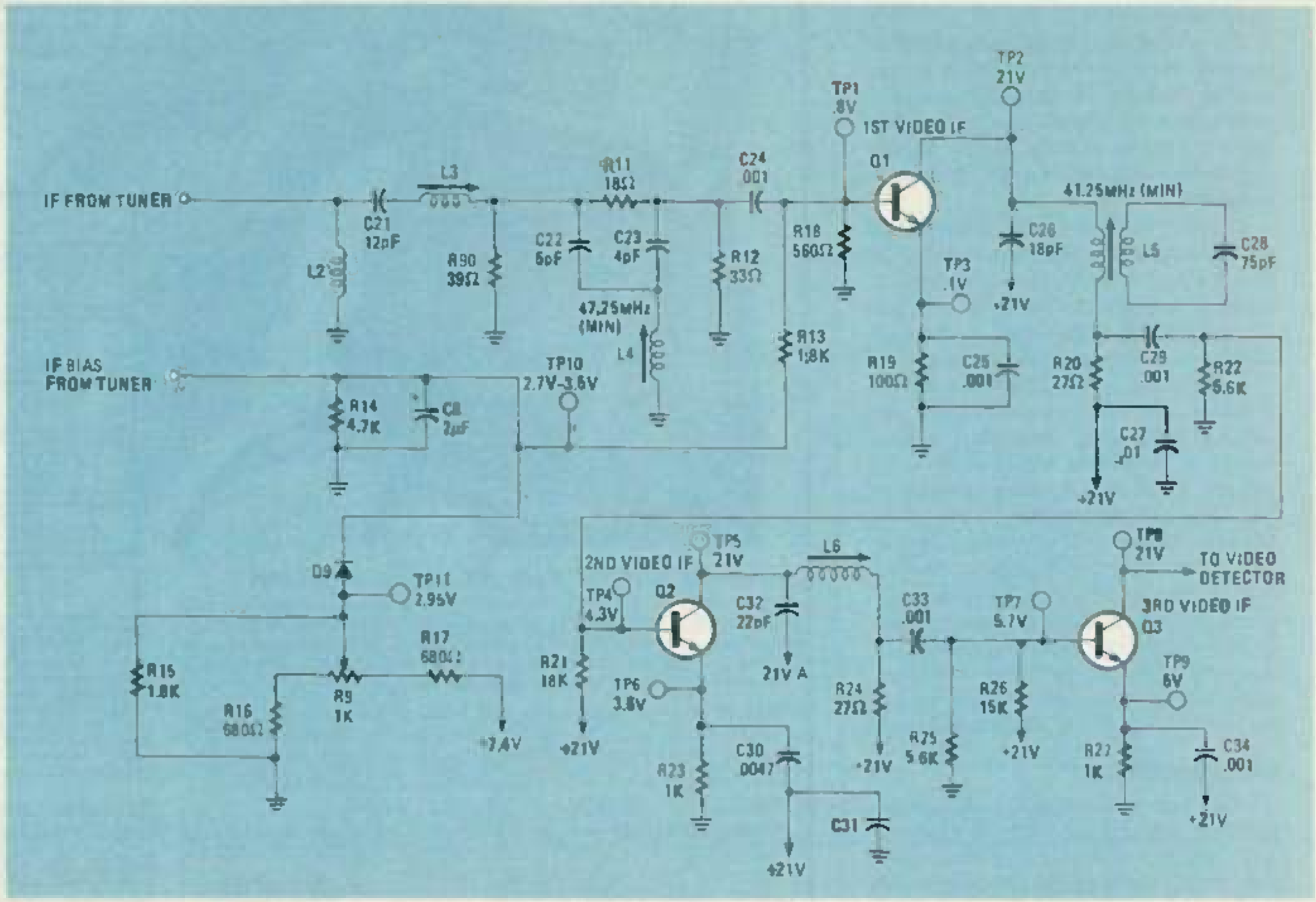

FIG. 1

THERE ARE TWO STAGES IN A TV SET THAT have always been hard to test. They are the IF (*I*ntermediate *F*requency) amplifier and the tuner sections. We're talking about IF's that use discrete transistors in their design, and standard tuners—the old-fashioned kind, with three-gang selector switches. Both of those sections give many TV repairmen lots of problems, but fortunately there's an easy and accurate way to check both of them. For the most part, the difficulty has been that both of those stages handle high frequencies and, as a result, trying to make tests on those stages upsets the operation of the circuitry involved. The answer to the problem is to find a test point that is not "hot." In the IF section, the points that can be used are the emitters of the three or four amplifier stages but the tuner section is something else. We'll turn our attention to the IF section first.

Testing the IF section

Figure 1 shows a schematic of a typical IF amplifier used in many TV sets. The IF amplifiers can be identified by the fact that each emitter goes to ground through a small resistor. In testing that section what we want to know is if the emitter voltage is present and if so, how close it is to being correct. For instance, (refer to Fig. 1) the emitter voltage of transistor Q2 should be 3.6 volts. If that voltage is zero we know that the transistor is open or not conducting for some reason. To use the emitter as a test point, simply connect your meter probes across the emitter resistor and measure the voltage. A digital meter is essential here because the normal voltages will be something like 2.74V, 1.28V, etc.—so a very accurate meter is necessary. The DC voltage is developed across the emitter resistor by the transistor's collector current; therefore, if the emitter voltage is correct, the collector and base voltages are also correct. If, on the other hand, you find a transistor that reads zero volts at its emitter, that transistor is probably open and should be replaced; if not, then some previous stage (component) is malfunctioning.

An open transistor can be replaced by a general-replacement transistor provided the right method is used. You must make sure that the replacement transistor is an electrical equivalent of the original. One thing to watch out for is the IF rating or the upper frequency cutoff point of the replacement transistor. It should be at least

50 MHz, or better still, 60 MHz or 75 MHz. If you cut it too close you may lose some badly needed gain. The voltage rating will be ample, since collector voltages are low. Another thing that should be mentioned is that there are two pin configurations in the TO-92 transistor-case style. One is the E-B-C and the other is E-C-B, with the base and collector pins transposed. You can usually find one with the same pin configuration; but if you can't, you can simply bend the base and collector leads to conform to the layout and then cover one or both with a small piece of spaghetti tubing (insulation).

You don't need to worry about throwing the stage out of alignment, either. We made test some years ago using a sweep generator and a scope, and the curves displayed for both the original transistor and a general replacement type were the same. In no way was there any deviation from the original curve (which I had drawn on the screen with a grease pencil!). So, the new one will work just as well as the original. Symptoms of IF transistor failure are similar to tuner problems; that is, both can cause a slick screen (no picture and no snow). If you want to pin it down a bit, pull the IF input plug and feed in the signal from a tuner subber. A picture indicates trouble in the tuner; no picture indicates a bad IF amplifier.

Tuner section

Tuners are a different kettle of fish. The problem here is not usually an electrical one, but in most cases a physical one. Many times the problem encountered will be the familiar and frustrating "I can see it but I can't get to it" syndrome. (I had one where the transistor that I had to reach was mounted between two wafers of the bandswitch (see Fig. 2), an area about 1.5 inches deep. And, as you may already have deduced, I had no tool that was small enough to fit into that area—especially not my soldering iron!) It's times like those that make you start looking for the address of the nearest tuner-repair service!

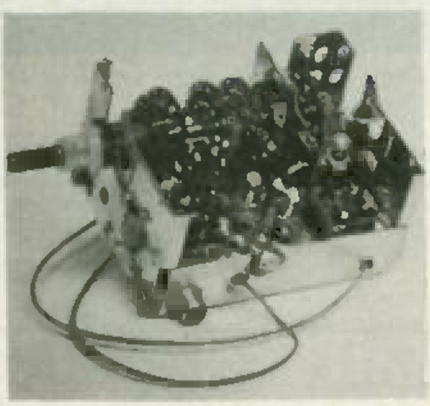

FIG. 2

Let's look at the symptoms of a set that *was* working, but has suddenly lost its picture—obviously some part has failed. However, the problem isn't necessarily in one of the tuned transformers, but is more likely to be a resistor, capacitor, or transistor. Here, what you have to do is locate the bad component—the next tests will help you to quickly do just that. Symptoms of tuner trouble will give you a good clue as to the location of the bad stage. For instance, if an RF stage goes out, you'll usually see "snow" on the screen but no picture or sound—the snow comes from the mixer stage. Also, a mixer-oscillator transistor going out will generally give you no sound and no picture with a "slick" screen (no snow).

Probably the easiest way to troubleshoot a TV's tuner section is through signal tracing. (Signal tracing is the process of injecting a signal into the input of a circuit and then following the signal path from the output to the input until you find the malfunctioning stage or component.)

To use that method, an RF signal source is needed. That source can be an RF generator or simply a TV antenna with a few modifications. To use the antenna as a signal source, one side of the antenna must be grounded and the other side connected to a small capacitor (about 200 to

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VIDEO ENTERTAINMENT—It couldn't be said all in one article so we compiled a 16-page special section covering the changing and growing field of entertainment in the home: new video components with screens from the gigantic to the tiny postage-stamp size, accessories that didn't exist last year, and tips on getting the most from what you own or plan to buy.

SATELLITE TV—The countryside is strewn with parabolic tracking dishes installed by home owners to pull-in the countless television channels transmitted back to earth by satellites poised in space in geosynchronous orbits. You, too, can enjoy the programming selection—and much of it is commercial-free, too!

MOBILE TELEPHONES—What was once a status symbol for the idle rich is quickly becoming a working tool for the common man. Cellular technology promises more channels with a little help from applied computer technology.

DIGITAL AUDIO DISCS—Laser rays are bringing new noise-free, pulse-encoded audio programming to your stereo system embedded in a plastic disc immune to strawberry jam, sandpaper, and desert heat.

MAIL ORDER BUYING—You've heard the bad points, including the myths. Now, here are the facts and economics of buying mail order that will be an asset to your business or hobby.

PLUS—There's so much more, we have space only to mention an electronic guitar tuning project, theory on digital filters, how to make inexpensive computer cables, build a programmable home thermostat, tips on buying pocket-size shortwave receivers, stereo audio for TV, all about VLF active antennas, news on pagers, how to restore antique radios, and ...

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300 pF). Now, touch the open end of the capacitor to the input of the mixer transistor, usually the base. If the signal is passed on to the CRT, the mixer/oscillator stages are working. The picture will be pretty snowy but it does show that the signal can come through and that that section is operational.

Once you find that mixer/oscillator stages are OK, go to the collector of the RF amplifier transistor. If the signal gets through that stage, the interstage coil, switch, etc., are good. If not, you could have a bad contact in the switch or an open coil. If the switch and coil check out OK, next go to the base of the RF amplifier transistor or the emitter—if it happens to be a common-base circuit. If you lose the signal between the collector and the input, you have a defective RF amplifier. The signal-tracing method can also be used to troubleshoot other sections in the TV set with the proper signal source. For instance, the audio section can be traced-out using an audio-signal generator or signal tracer.

These tests will work on the majority of older sets—that is, any TV set that was made before they started to make all the IF's in one IC. That covers a multitude of sets! They're the ones that are growing older, and hence more likely to fail. So the market is still there. Good luck! R-E

SERVICE QUESTIONS

NO RASTER

I have a Magnovox T991 that has no raster. Sound and HV are OK. I've changed the video delay module and the IF module. What next?—R.K., Chicago, IL

The RGB and the chroma modules also can cause brightness problems, but changing them is haphazard and costly. Measure your kine socket voltages. Focus voltage at pin 1 should read 5.5 kV. Pin 10 should read between 450 and 800 volts, depending on the setting of the master screen control. Pin 9 is a fixed 50 volts. Typical voltages on the three cathodes should be about 175 volts, but will vary widely depending on brightness and background settings. If those voltages go above 190V, the kine will be cut off. See what's missing and find out why.

NO PICTURE

On a Sylvania EO-3-1, while the raster is on the tube I get a full screen with no video, but after a few seconds, the vertical height gets smaller and finally goes into a white line. TA20 of the power supply shows 37.1 volts. I measure only 17.0 volts.—L.S., Brunswick, OH

You're mistaken about TA20 calling for 37.1 volts. It's TA22 that should read that voltage, while TA20 calls for 24.5 volts. That's an important point to clarify. Those two voltage sources, as well as several others, are supplied by Q502, the regulator. The IF strip depends on the 22.8-volt source and the vertical outputs depend on the 32.8-volt source, both coming out of Q502 as well. Since you are getting 17.0 where you expect 24.5 volts, I suspect that something is pulling down the whole supply. Try lifting the different loads until you find one that brings the voltage up. That's where you will find your problem.

INTERMITTENT SWEEP

I had two cases of intermittent sweep with the GE AC-B chassis and I fixed them both. Now I have another AC-B that loses horizontal sync sometimes after three hours, other times after five minutes.—B.O., Jersey City, NJ

You didn't say, but I'll bet the two you fixed had poor solder connections around the griplets in the vertical circuits. I will also bet you have the same problem now—this time in the sync circuit. Unfortunately, those griplets, which connect top-of-board signal paths to the bottom of the board, are not referred to in the sche-

continued on page 106

COMMUNICATIONS CORNER

Digital RFI problems

HERB FRIEDMAN, COMMUNICATIONS EDITOR

HIGH TECHNOLOGY OFTEN CREATES A multitude of unforeseen problems. For example, back in the days when we were told that we should be seen and not heard, we got rid of insects in the vegetable garden by stomping on them, or we simply shared what mother nature had provided—we got what the insects didn't destroy. In time, we built an arsenal of chemicals to kill the insects. They did the job but they also destroyed the land, killed fish and birds, etc. The same problem often occurs in electronics. (You pay for what you get.)

In electronics, many of us grew up on Pyranol capacitors, a tremendous breakthrough in capacitor technology. Unfortunately, the stuff that makes it a great insulator and coolant can also harm birds, fish, game, and people. It's not our intention to start any arguments, but rather to simply point out the way the real world works. Remember that there is no such thing as a "free lunch." Every new "breakthrough" in the state-of-the-art hurts someone or something.

The latest "breakthrough" to cause unforeseen and extensive problems is digital communications or more precisely, digital anything. Back in the days when we simply stomped on garden insects, there were only two major forms of RFI (*R*adio *F*requency *I*nterference) as far as the general public was concerned. The first type was harmonics and spurious emissions from amateur-radio transmitters that wiped out some TV channels—usually Channels 2 and 4 (see Fig. 1). The other type of RFI was hash or electrical noise from the local utility's powerline hardware, such as "pole pigs" (powerline transmission transformers) and capacitor banks that jammed or wiped out radio communications from below the broadcast band to well up into the TV channels. And if you were lucky enough to escape the hash caused by powerline hardware, your neighbor's vacuum cleaner or mixer was certain to throw you a zinger every once in a while. But all that was easily handled: amateur-radio operators simply cleaned up their transmitters. Recently, however, the FCC for the most part has just ignored powerline and appliance hash.

But digital RFI is something else. It's hard to avoid and often hard to clean up.

FIG. 1

but it certainly can't be ignored because it's starting to permeate everything. Digital RFI, rather than the marketplace, might well determine whether some fantastic new communication technology will ever become viable.

Digital noise generators

Turning to home entertainment, the distributors of high-fidelity equipment see the digital disk as the gizmo that will eventually revive the Hi-Fi industry. But the engineers who design the systems know that the 41-kHz sampling rate is going to produce harmonics right up into the broadcast band. Without extensive shielding and RFI suppression (a technology not presently germane to Hi-Fi equipment), we might well be listening to our neighbor's latest records instead of the local DJ. That's because the signals from your neighbors digital-disc recording might be radiated into the air, superimposed on the radio transmission, and picked up by your radio receiver.

And now we come to the "biggies:" videotext, the computerized transactional services such as banking and shopping at home, and teletext. Between allowing AT&T to enter digital services via the telephone system, the transactional services through cable TV, and the recent approval by the F.C.C. for digital teletext encoding on TV signals, it's conceivable that eventually most homes will have digital signals running throughout the house wiring—radiating into places where they don't belong. Already engineers and technicians are worried about whether the other digital services will affect theirs; after all, it takes just a glitch or two to wipe out a simplified (non-redundant) digital transmission.

Digital RFI

Digital RFI comes about because harmonic generation is indigenous to the very waveforms used in the digital process. Whether the waveform is narrow or wide it starts off with "square" edges, as shown in Fig. 2-a. The leading and trailing edges are steep wavefronts that, if you recall from your early studies in electronics, are efficient generators of odd-order harmonics. Then there's also the digital repetition rate. Computer hardware such as that used for videotext and transactional services operate in the range of approximately 300 Hz to 19 kHz, and are controlled or determined by digital signals in the 2 MHz to 5 MHz range. Essentially, we're generating RFI from the mid-audio range well up into the RF region (Fig 2-b). And we're feeding much of that interference through unshielded cables to recorders, printers, video dis-

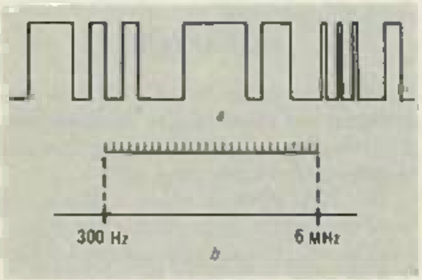


FIG. 2

plays, telephone equipment, and powerlines. (Powerlines? Yes powerlines.) Have you ever heard what a commonly-used digital remote-controlled light switch does to broadcast reception?

In actual fact, we haven't begun to experience the effects of consumer-equipment digital RFI on home and commercial communications systems. It might well determine just how far we can go with computerized high-tech devices in the years to come. R-E

TELEPHONE DIALER

continued from page 86

pulsing out the digits to the phone interface. It will function with both rotary dial and pushbutton phones. Any length phone number is placed in the DATA statement at line 1000, with commas separating each digit. The last number entered is "55." That is used to flag the end of the phone number.

To dial, lift the telephone receiver and listen for a dial tone. Then type the letter "A" at the keyboard. The program will print each digit of the phone number as it's dialed.

To test the dialer without connecting the telephone to the interface circuit, listen to the relay as a phone number is being dialed. When dialing is in progress, the pulses generated by the program can be heard.

Modifications

Though as shown in Table 1, the BASIC program is limited to dialing one phone number, it may be modified for dialing several numbers rather easily. To do that, the program can be used as a subroutine, with a phone-number access program written around it.

The BASIC program simply uses the OUT command to pulse the remote-control relay, which is addressed at I/O port FF. To activate the cassette remote-control relay, the number 4 is output to port FF (see line 180). To deactivate the relay, a "0" is output to port FF (see line 200). **R-E**

"But Marge—think of the terrific reception that we'll get!"

SERVICE QUESTIONS

continued from page 103

matic so they are difficult to locate. Monitor the sync-clipper transistor, in and out, with a scope and voltmeter. Once you know where the signal is being lost, the rest becomes easier.

NO RASTER

I get no raster on an RCA CTC48. I've changed the three output modules and the chroma module. Still nothing. Can you Help?—G.M., Walled Lake, MI

The MAL001A/B video module, or more specifically, an open first video amp transistor (Q3) could be cutting off the outputs. Although the brightness limiter (Q302) usually causes too-much-brightness problems, it must be considered.

DARK BAND ON SCREEN

I own a tube-era Sanyo color TV set that has a dark band across the top of the screen. I have replaced filters without luck. Could you suggest a cause?—B.D., Miami, FL

Yes, a filament-to-cathode leak in one of the signal tubes. Any tube—from the RF amp to the video output—could be causing your problem. **R-E**

COMPUTER DIGEST

VOL. 1 No. 1 May 1984

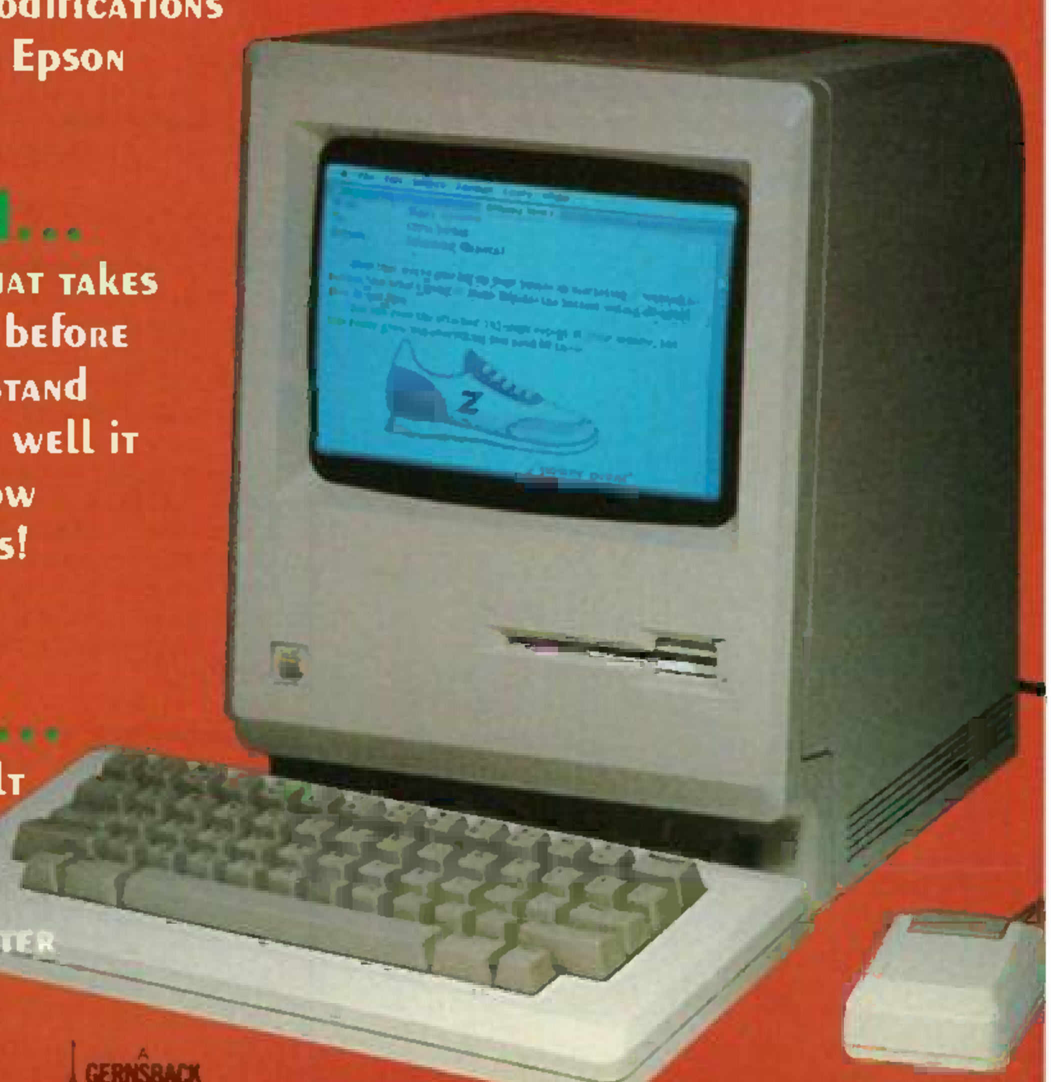
NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

LISA — PC — MACINTOSH — PEANUT

Quick comparison of these four popular computer systems

UPGRADING BUDGET PRINTERS...

Graphics and tractor feeds are easy and inexpensive to add to your system. Here's a bunch of practical modifications you can make to your Epson or Smith-Corona



MACINTOSH...

A shiny new Apple that takes several careful looks before you can really understand what it can do—how well it can function—and how inexpensive it really is!

CP/M FOR BEGINNERS...

It really isn't difficult to use! And once you know how, it can be easier and better than many other so-called user-friendly operating systems

A GERNSBACK PUBLICATION

CONTENTS

Vol. 1 No. 1 May 1984

FROM THE PUBLISHER

Welcome to **ComputerDigest**. This is Volume 1, Number 1 of what we intend to make a long series of continuing publications. Our purpose is to bring you something that you cannot get elsewhere currently: a broad look at what is happening in computers from the viewpoint of the electronics professional.

That means that **ComputerDigest** is not written for the typical computer operator or hobbyist. It is written for the electronics professional—engineer, technician, or hobbyist—who has his feet solidly placed in the field of electronics. To sum it up—the typical **Radio-Electronics** reader.

Because of that slant, that orientation, we are different! However, we do not replace any other computer magazine. In fact, if we are successful in obtaining permission to reprint articles from other computer magazines, we may well serve as an introduction to what those magazines have to offer. In fact, you may blame us—**ComputerDigest**—some time in the future for causing you to subscribe to so many other publications.

But for now, as Byron Wels, our editor points out on his facing page—we need to know what kind of magazine you want **ComputerDigest** to be. We need to compare your input with our plan, making modifications where we can to make the two pictures overlap. So do write. We'll read your letters, respond to them as quickly as possible, consider all of your suggestions carefully, and go on to make **ComputerDigest** a really great publication.

I know I've said it before, but it is important so I will repeat myself one more time. **ComputerDigest** is an added section in **Radio-Electronics.** Note that the pages are numbered separately. It takes no editorial space away from any R-E reader. If you like reading R-E, but are not interested in computers, just ignore the section. If you do like it, you can tear it out and save it as a separate publication.

ComputerDigest is our investment in the future of electronics. Join with us and learn more about this existing exploding field. You are an electronics professional today, and that means you're going to have to know about computers.

Sincerely,

LARRY STECKLER
PUBLISHER

EDITORIAL

Another Computer Magazine!

No! This one is different. Really different!

Considering the numbers of computer magazines available today, you could go broke trying to read them all. What's more, the amount of time you would use up just going through all of them would keep you from getting anyplace near your computer.

That's why **ComputerDigest** is here.

We do read all the magazines in the field, and we read them very carefully. When we see an article that we feel is important to you, we pull it out and put it aside. Then, once a final selection is made, each of those articles is read again and carefully edited to carve off the fat and leave only that which is necessary to make it readable and informative.

When we can't get permission to reprint an article, we assign one of our own authors to do a story that fully covers the subject in our own style and format. In this issue, every article is original with us. Next month, we hope will start showing carefully selected and edited reprints.

You gain two ways. First you don't have to buy those magazines you don't really need. Second, you get to preview a lot of magazines you may have been considering subscribing to. If you like the kind of articles they publish (after you preview one or two in **ComputerDigest**) you can subscribe, knowing that it is a magazine you will want.

Naturally, we can't operate in a vacuum. We need some input from you too. We'd appreciate your comments, and we hope we'll be able to get a letter column started with the next issue. So do drop us a line and give us the benefit of your thinking. We need and want your help to make **ComputerDigest** a more helpful, valuable publication for you.

We know you'll like what you find in the pages that follow, and that you will be looking forward to our next issue. We feel that we have an excellent opportunity to serve, and we intend to take an aggressive stance to accomplish that purpose.

Thank you for joining us here, and we hope we'll be talking to you again, and often, in the future.

BYRON G. WELS
EDITOR

COMPUTER DIGEST

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IBM vs

Although there are more than two computer
Apple—always seem to dominate the headlines.
machines

When you talk to the experts, all you're going to get is confused. Most people who already own computers compare other computers to those they have. It's something like buying a new car. It takes a bit of getting used to. If you're switching from a stick shift to an automatic you're going to have some adjustment problems. And the additional little gadgets on the new car will probably remain unused until you get accustomed to their being there!

Got a keyboard with the legends printed right on the keys? You might not like having the legends off to the top of the key, on a separate insert. But once you get used to it, who knows? You might even learn to like it.

What we're trying to say, is that while a lot of information is available when it comes to making major decisions, we'd suggest that you do not base an important decision on a superficial factor.

Because most of us like to comparison shop, here's a good jumping-off place for you:

Apple's Macintosh

This personal computer will solve all kinds of problems for anybody from a schoolperson to a business manager. It comes with a mouse, and offers a 32-bit (internal architecture) microprocessor and bit-mapped graphics. You get many of the advantages of the Apple 32 supermicro at an excellent price.

Apple's Lisa

There are three, count 'em, three Apple Lisa's. The Lisa 2, the 2/5 and the 2/10. If you want Apple, and want more Apple than you can get in a MacIntosh, go for the Lisa series. Again, the more Lisa you get, the better off you will be, so we advise investing the most you can afford to make your first expense your last. All the Lisa's come with a mouse, and as you'll see from the specifications, they keep getting more and more powerful...

TABLE 1

Apple Macintosh

Microprocessor	MC68000
Memory	64K ROM 128K RAM
Disk drives	One 3½ inch microfloppy
Disk storage	400K per disk
Keyboard	58-key detached (numeric keypad optional)
Size	9.7 (width) × 10.9 (depth) × 13.5 (height) inches
Weight	16½ pounds (without keyboard or mouse)
Other comments	Mouse, independent clock/ calendar, two RS-232/RS-422 serial ports, built-in video monitor, sound/voice generator

TABLE 2
Apple Lisa 2

Microprocessor	MC68000
Memory	16K ROM, 496K RAM
Disk drive	One 3½-inch microfloppy
Disk storage	400K per disk
Keyboard	76 keys with numeric pad
Size	18.7 (width) × 15.2 (depth) × 13.8 (height) inches
Weight	48 pounds
Other comments	Three slots, two serial ports, one parallel port, built-in speaker with software-controllable tone generator.

APPLE

manufacturers, the same two—IBM and Let's compare what their most popular offer.

TABLE 3
IBM PC

Microprocessor	8088
Memory	40K ROM, 16K (standard) to 256K RAM
Disk drives	Up to two 5¼-inch diskette drives (optional)
Disk storage	160K per diskette
Keyboard	detached, with 6-foot cable, 83 keys, auto repeat
Size	20 (width) × 16 (depth) × 5.5 (height) inches
Weight	21 pounds (without drives) 28 pounds (with two drives)
Other comments	Cassette I/O, five expansion slots, built-in speaker, BASIC interpreter. RF modulator or video monitor must be purchased separately.

TABLE 4
IBM PCjr

Microprocessor	8088
Memory	64K ROM, 64K RAM
Disk drives	one 5¼-inch double-sided drive (optional)
Disk storage	360K on a double-sided diskette
Keyboard	cordless infrared keyboard with 62 chicklett keys
Size	13.9 (width) × 11.4 (depth) × 3.8 (height) inches
Weight	6 pounds (without drive) 9 pounds (with one drive)
Other comments	Cassette I/O, two joysticks. Cord for keyboard is optional. Display is 40 columns, 80 columns with upgrade that also increases RAM to 128K. (Both that upgrade and disk drive are included with the enhanced version. Connector for TV is optional, direct and composite video are standard.

APPLE's MACINTOSH (above) and IBM's PCjr—two new machines generating a lot of excitement.

IBM's PCjr.

Many have taken to calling this "the Peanut," and it's a truly innovative unit with some features that tickled our fancy—like the cordless keyboard that is coupled to the system unit via infrared signals to provide a degree of freedom heretofore unavailable. It's an excellent, low-priced starting unit, and will do a workmanlike job for the small office or for the home.

IBM's PC

There are two PC's from IBM. The PC and the PC XT. Chances are that when you visit your local dealer, if you ask to see the *jr* it won't be long before he's selling you "up" to a PC or an XT. Both are excellent values, and sufficiently powerful to do any sort of job that you'd call on a desktop unit for. There's a vast array of software available for both, and the specifications speak exceedingly well for these units.

MACINTOSH: a new variety of apple.

Apple's long-awaited new business computer has arrived. Let's take a look at what it has to offer.

MARC STERN

■No one will know for some time the impact that the *Macintosh* will have on computer users and the computer industry—but we'd be willing to bet that it will have a major effect. The *Macintosh*, with its MC68000 microprocessor, icons, and mouse, (we'll explain shortly) may be an example of how all computers will be designed in the years to come.

To be sure, the *Macintosh* isn't the first small computer to use the MC68000. For example, Radio Shack's *Model 16*, which was introduced a couple of years ago, and Apple's *Lisa* both use it. But the *Macintosh* is the first system to use the power and capability of that microprocessor in a computer that costs under $2500.

Just what do you get for your $2500? You get the main unit, the keyboard, and the mouse. The main unit includes a 9-inch black-on-white display (512 × 342 pixels), the microprocessor and related circuitry, (including 128K RAM and 64K ROM), a 3.5-inch Sony microfloppy-disk drive that can store up to 400 kilobytes; two RS-232/RS-422 serial ports, and built-in sound and speech hardware. That's quite a bit of power in a lightweight (17-pound) unit.

Icons and a mouse

Perhaps the most important features of the *Macintosh* are those that make it easy for almost *anyone* to use it. With the mouse (a desk-top "roller controller") and icons (graphic representations of a command or function), you can do a great many things without knowing the first thing about operating systems or command structures. All you have to do is move the mouse on the desk, and the screen pointer (cursor) moves to a picture (icon) that indicates the action you want to take. Then, you push the single button on the mouse and the system goes to work.

For example, if you want to open a file, you simply point to a file-folder icon, push a button on the mouse, and a file is opened. Or, if you want to create some text (provided the proper application program is in the disk drive) you then point to the appropriate picture or menu command at the top of the screen and you are in the text-processing mode. During this time, the computer is handling all the tasks without requiring you to remember any commands to control its operating system.

That ease of use points the way the personal computer world is likely to go. It seems almost inevitable that the personal computer of the future will be easy to use yet powerful. It's likely the personal computer of the future will take only a few hours or so to learn adequately so you can use it for whatever purpose you have in mind.

The *Macintosh* is a logical progression of the small computer-system. In the last decade, since the first, "primitive" microcomputers became available, the industry has advanced a step at a time from 4-bit to 8-bit to 16-bit and to 32-bit architecture. Each step in this progression has brought with it an increase in power and capability.

Eight-bit microprocessors, with their 16 address lines, can directly address a maximum of 64K (actually 2^{16} or 65,536) memory locations. However, that figure was the upper limit of its capability. Some 8-bit-based systems do claim the ability to address more memory, but they are using fancy memory and timing techniques (bank selecting) to achieve that affect.

For its time and for most purposes, that was more than adequate for many computer users. It was a fairly simple setup, requiring only 16 address lines, eight data lines, and various control-bus lines. But that simplicity had its drawbacks, especially for systems and program developers, who just love more and more computing power. The 64K limit of memory addresses and the relatively primitive level of instructions available limited them in what they could do.

Fortunately, the 16-bit microprocessor began to make its appearance. Here is a device which can directly address more than a megabyte of memory (2^{20} bytes). Of course, it is a bigger, more powerful device. It uses 20 address lines plus a 16-line data bus for its 16 internal data registers, and lines for timing and other control functions. System designers and programmers can do a great deal more with it because not only can it support far more memory, it also has a richer instruction set.

Although it was the type of device which could do cartwheels in the eyes of developers, it was also a device which required more support circuitry than an 8-bit microprocessor. So, of necessity, the motherboard in a 16-bit computer became much more complex.

And that brings us to the *Macintosh* and its 32-bit internal architecture, the next step in the microcomputer revolution. Unlike its predecessors (such 8-bit devices as the Z80 or 8080 and such 16-bit microprocessors as the 8086/8088), the MC68000 is packaged in a 64-pin flat pack with 24 address lines, 16 data lines, and 20 control lines. It has a 32-bit internal architecture (its has seventeen 32-bit data and address registers) and it has the capability of directly addressing 16 megabytes with its 24 address lines.

Macintosh's only limitation at the moment is the amount of RAM available: 128K. Unless a program designer wants to move applications routines in and out of memory with constant use of the single disk drive (a second optional drive is available), most routines will actually be single tasks. When Apple upgrades the *Macintosh* to a promised 512K of RAM in the fall, then multitasking and true concurrency will be available.

Still, Apple's unique way of handling input and output makes it seem as if *Macintosh* is capable of concurrency. You are able to call up two concurrent applications under the main program and have them resident on screen, with one of the executing. Much of this is due to the fact that a large part of the *Macintosh*'s operating program is stored in read-only memory and is called for by the disk-based applications program. Because it is, very little RAM is wasted holding the operating system and thus the entire 128K is available for use.

But this is getting away from the point here which is that *Macintosh*'s microprocessor points the way to the future and it is a logical step in the microcomputer revolution.

16 or 32 Bits?

You might have noticed that whenever we said "32-bit," the word "architecture" always followed. Although Apple markets the *Macintosh* as a 32-bit computer, there are some who would debate that terminology, preferring to call it, instead, a 16-bit computer. The reason is the number of data lines. The 68000 uses 16 data lines (rather than 32) to bring data to its 32 registers. The result is that the device must make two 16-bit fetches, which slows things a bit. However, once the data are inside the processing unit, they are processed in a 32-bit manner. So what kind of computer is the *Macintosh*? It is a 16/32-bit machine. The MC68000 uses special timing routines for data input, so it works nearly as fast as a true 32-bit microprocessor—although Motorola (the microprocessor's manufacturer) calls it a 16-bit device. For convenience, though, we'll continue calling the *Macintosh* a 32-bit machine. Just remember, we're referring to the microprocessor's internal architecture.

Macintosh comes with 192K of internal memory, which consists of the 64K ROM that stores many of the operating system primitives and device drivers, as well as other system and device calls, and 128K of RAM. Mass storage is via a 3.5-inch microfloppy diskette, which holds 400K of information on a single-sided double-density disk.

When you open the system box you will find all of the *Macintosh*'s memory and processing power is on one motherboard running along one side of the box. This board contains the CPU, RAM and ROM. It also contains the connectors for the mouse controller, as well as the connector for the optional external floppy disk drive. Further, it also contains dual serial ports to interface a printer and modem. The system also contains a built-in, battery-driven clock/calendar and the sound/speech generation chip.

With the exception of the 68000 CPU and microfloppy diskette drive, the basic *Macintosh* outline is pretty similar to many other small computer systems on the market. But Apple has done something that is unique. For a better understanding of this, it's only necessary to take a look at the architecture of the system, as well as the user interface to see why *Macintosh* is innovative.

Unique architecture

At the heart of this system is the 68000 CPU and its memory. In the *Macintosh*, the RAM data-output lines are connected to a different bus from that used by the rest of the system, increasing operating speed. The RAM has three different entry ways, each of which give the CPU, screen display and sound-generation hardware separate periodic access to the data and address buses so that sound, video and the current task that the 68000 is performing appear concurrently executing to the user.

The ROM, which contains low-level graphics primitives, operating system routines, and user-interface

THE *MACINTOSH* WILL NOT take up too much room on your desktop. Its "footprint" (not including the keyboard or mouse) is 10 × 10 inches.

A VARIETY OF ACCESSORIES is available for the *Macintosh*, including an outboard drive, a numeric keypad, printer, modem, and carrying case.

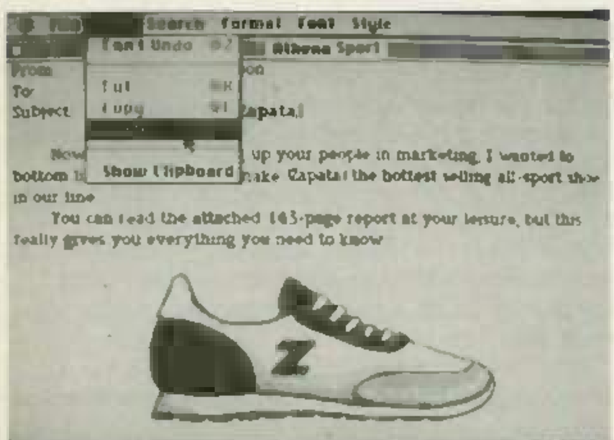
routines, is directly connected to the system bus and is used only by the CPU. Because of the way its software is encoded and stored—in low memory locations—the ROM-based subroutines function as extensions of the 68000 instruction set and operate at system speed. Therefore, the ROM is always accessed at 8 MHz.

Video memory appears as a linear array of 10,944 16-bit words of data. Because of the arrangement of video memory with the rest of the system, RAM access time slows to about 3.5 MHz during the horizontal video refresh period. That prevents video glitches.

A key to the *Macintosh* system, though, is the serial bus. It is through this bus that most peripherals will interface with *Macintosh*. It can run in two modes, the first using an external clock which allows data transfer at up to one megabit-per-second; the second mode uses an internal clock and allows data to be transferred at up to 230 kilobits-per-second. That is the speed at which most peripherals will transfer their data.

It is through this latter feature that *Macintosh* implements "virtual" slots. Rather than relying on conventional slots as has been Apple's policy with its tremendously successful *Apple II+* and *IIe* lines, the company interfaces each piece of peripheral equipment in a daisychain manner off the serial bus. Each peripheral has its own power supply and will use the 230-kilobit data-transfer rate.

While a closed bus might seem to be a disadvantage, virtual slots do have some advantages that become apparent. For starters, it means the system box can remain closed, thus preventing radio-



A MEMO CAN easily be illustrated with graphics. Note the window near the top corner of the sereen.

frequency interference (RFI) problems that have troubled many other manufacturers. Further, since there are fewer mechanical connections in a serial interface than on a typcial add-on computer card, there are fewer places where mechanical troubles can occur. And, since each peripheral will use its own power supply, the power requirements of the *Macintosh* can be kept low and stable, and the company doesn't have to worry about beefing up the supply to handle future peripherals. In that way, costs are kept down. Finally, for software developers, the virtual-slot system means that the memory map will always remain the same—there will be no peripheral cards inserted into memory that will change the mapping itself. Therefore, developers can be assured the programs they write will run, without worrying about whether company X's peripheral card will change things.

One last feature of the system architecture is its simplicity. Using programmable logic-arrays, large-scale and very large-scale integration techniques, Apple has been able to keep the IC package count to about 50. That not only helps to keep the computer's size and cost down, it helps to ensure reliability.

The user interface

The second key to *Macintosh*'s uniqueness is the user interface. It is simple to learn and easy to use. Rather than relying on the traditional operating system approach with its rather cryptic A> (or whatever) prompt, followed by the need for a command or series of commands, Apple has chosen the mouse and screen graphics and menus as the way someone will be able to access and use any of the applications which he may need.

The windowing capability allows several documents to be displayed on screen simultaneously. The windows can be moved, expanded or shrunk. This means that numbers, words and pictures can easily be cut and moved around and repasted elsewhere.

Since *Macintosh* uses an unchanging memory and access format, all programs—will use the same command structure in the same way. No longer is it necessary to learn and releam new commands as new programs are acquired. This means that software designers are forced into standardization that is seldom seen in the microcomputer world.

With the *Macintosh*, there's no more worry about learning long, complicated command strings or the like. And, rather than taking 20 to 40 hours to master the machine, Apple estimates it will take 10 or less. Also, the software allows the system to share files across several programs and it gives software developers direct access to its many features through a "developer's toolbox."

Future trends

What is in store for the future of *Macintosh* is still up in the air and several questions remain with it. Like it has done before, Apple has introduced a system that is totally incompatible with the systems it already has on the market—although it will "talk" with the *Lisa* (it is *upward compatible*—meaning that the *Lisa* can run *Macintosh* software, but not the other way around).

Further, since there is no compatibility with the near industry-standard MS-DOS operating system and since there is likely to be none, there have been questions raised about its future in the business market. Also, it comes totally without software—not even BASIC is included when you buy it, so you must start adding to the system's price at the start. (Apple, however, will throw in word-processing and graphics software if you buy the computer within 100 days after its introduction date of January 24, 1984.)

In conclusion, the future of the *Macintosh* is still unclear. Yes, many people and the company are ecstatic about the machine, but there is still some uncertainty around. Whatever the outcome, one thing is for sure, *Macintosh*'s impact on the small computer-systems market is likely to be felt for years.

YOUR KEY TO CP/M

HERB FRIEDMAN

Here's a CP/M primer that's perfect for beginners others who need to know about that operating system on a non-technical level.

It often appears that CP/M is the bogeyman of personal computing. Some colleges short on funds take in substantial extra income with rather expensive "How to use CP/M" adult education courses. Highly paid consultants will come to your home or office any hour of the day or evening to give you personal training in CP/M. Magazine authors suggest you consult the local "CP/M expert" to work out your problems. And computer stores offer as an excuse to users who wiped out all traces of their software from a hard disk that "it's your fault if you misuse CP/M."

Why is CP/M so difficult to use? In truth, it's not difficult at all; it's often easier to use than most of the so-called user-friendly operating systems.

Most difficulties in using CP/M arise because the system has remained essentially the same while the hardware, the program software, and the type of person using the software has changed dramatically. Many of the original CP/M concepts no longer pertain to how the modem personal computer is generally used. But once you understand CP/M in terms of modem hardware and software and your own technical level, you will find that it becomes a delight to use.

What's CP/M?

CP/M, an acronym for Control Program for Microcomputers, is only a disk operating system with a fancy name. It's primary purpose is to create disk files and then permit the user to use the files in any desired manner. For example, the output from a disk file could be directed to a printer, or another disk drive to make copies, or another computer, or a modem, or a paper punch—anything at all.

On the opposite side of the coin, CP/M allows almost anything to be used to create the disk file. The input could come from a keyboard, a teletype machine, a CRT terminal, a card reader, paper tape—again, anything.

Some of those devices and uses might sound strange because you have not heard of them or your computer has no provisions for them; and that's a good part of the reason some users have difficulty using CP/M. CP/M was never intended for the modem personal-computer or the typical person using it today. The fact that it remains the leading 8-bit computer operating system is a testimonial to how well it was initially thought out, touching bases that hadn't even been thought of in the late 1970's.

CP/M was intended for a "personal computer" that, like the mythical kingdom of Camelot, lasted for one brief instant in time. It was written for a central computer to which other equipment—called "peripherals"—were connected. Depending on the particular installation the input to the computer could be from any of several devices such as a teletypewriter, a video terminal consisting of a keyboard and CRT display, batch processor, a telephone line, a paper-tape reader, virtually anything. Similarly, the computer could feed any number of devices, among them a high-speed line printer, slow speed letter-quality-printer, several disk drives, paper-tape punches, teleprinters, even another computer. Hence, CP/M was designed to accommodate all those various peripherals, and numerous software routines commonly used by "data processing" technicians were built into CP/M so the user could easily use the peripherals.

Today, however, the typical personal computer rarely connects to that much hardware. Nor does the user need the software functions that go with the hardware; yet the functions remain in CP/M. If you call a function not implemented for your particular computer, either nothing happens, your information gets directed to places unknown to you, or the keyboard locks up. If you just don't use the features there won't be any problems. We'll cover what not to use a little later.

Also, the documentation was intended for the computer scientist/engineer/technician, and even some of them had difficulty understanding it. For many applications-oriented users of personal computers, inconsequential hassles become insurmountable problems because the user doesn't understand the technically-oriented documentation.

To make life easier and simpler for those of you who aren't computer experts, and don't care to become experts, we're going to cover CP/M from a strictly non-technical applications-oriented viewpoint. Some of you will undoubtedly gnash your teeth and shout to the world "that isn't right." Gnash away! This short course in CP/M is intended strictly for those who want to use their computer, not write the next multi-megabyte integrated word processor/spreadsheet/graphics program.

Note: To avoid confusing computer keyboard commands, the punctuation—the periods, commas, colons, etc.—which are by normal convention located within parentheses will be shown outside the parentheses.

Drives and user areas

As stated earlier, CP/M is a disk operating system. It will write and read disk files on any of up to 16 individual or "dual identity" disk drives which are alpha labeled as "A:", "B:", "C:", etc. The colon (":") is part of the disk drive hardware identification; without it CP/M has no idea what you are talking about, and the lack of the colon is the reason why what should be an ordinary copy command can result in inaccessible disk files. While a disk drive can be assigned any letter (within reason), because of the way modern personal-computer software is written, the main drive, the so-called primary default drive, is always A: and the second drive is always B: You could have your second drive designated C: but a lot of commercial software wouldn't have the vaguest idea what to do. Unless you modify the software that is the way it must be done; otherwise, you will end up with software that won't run, or software that simply erases it's own records. (Self-erasure is very common to hard disks where A: and B: are the same disk mechanism.)

Take note that some programs permit the user to eliminate the colon when specifying disk drives, and some so-called "utility" software permit the user to use CP/M without the colon. Using a colon at one time and not at other times causes more problems than the convenience is worth because omitting a colon at the wrong time can "crash" (ruin) a file. Try to do it CP/M's way at all times—use the colon even if you don't have to.

The basic CP/M system that handles the filing and retrieval of disk data has several inherent command functions. The most commonly used command is DIR (for "directory"), which will cause the display device to show a directory of the disk files. The directory can be "keyed" so that only a desired group of files appears at any one time.

One of the attractive features of CP/M is that it can create up to 16 individual "user areas" on a single disk that are keyed to individual directories for each user area. "User area" is essentially an invisible tag applied to one or more disk files, and the computer always "comes up" in user 0 when CP/M is first booted up.

You enter a user area from the command line—when the "A>" shows on the screen—by typing USER 1, USER 5, etc. Since the computer automatically comes up in user 0, the command USER 0 need be entered only when leaving some other user area.

User areas work this way: Assume your disk drive will record 200K bytes of data. Any program written to the disk is placed in the user-0 area and a DIR command will display a listing for all the disk files. If all the files were simply written to the disk, the directory would appear as shown in Fig. 1. But let's assume you don't want the directory listing cluttered with a string of unrelated files; you would like them arranged into homogeneous groups. For example, you would like only the CP/M utility programs—PIP, STAT and XDIR—to be available on boot up, with MBASIC and all its related programs with the .BAS extension listed independent of both the CP/M utilities and the database program with its individual data files and prompt screens. Figure 2 shows how only the CP/M utilities would be displayed.

```
    DIR
A: CARDFILE COM : MBASIC   COM : LABEL2   BAS : MAILPAC  BAS
A: FAMILY   BAS : BOOKEEP  BAS : CHECKS   BAS : CHECKS82 BAS
A: INSURE84 BAS : PIP      COM : CARDFILE PRM : CARDFILE DAT
A: STAT     COM : XDIR     COM : COMMEX   COM : MITE     COM
A: FILES    DOC : FLS      COM
A>
```

FIG. 1—THIS TYPICAL DIRECTORY display shows the CP/M utilities, MBASIC and its files, and a *Cardfile* database with its files.

```
  DIR
A: PIP      COM : STAT     COM : XDIR     COM
A>
```

FIG. 2.—THIS IS HOW we would like the computer to "boot up," with a DIR showing only the utility files.

What you can do to avoid the clutter is to tag each individual file by assigning it a user area tag. As shown in Fig. 3, we could place the MBASIC file and its programs in user-2 area by first typing USER 2. Anything done from here on will have the USER 2 tag, so if we now move (write) MBASIC and its related programs to the disk they will all have the USER 2 tag. All programs created by MBASIC will also automatically get the USER 2 tag.

```
  USER 2
A>DIR
A: MBASIC   COM : LABEL2   BAS : MAILPAC  BAS : FAMILY   BAS
A: BOOKEEP  BAS : CHECKS   BAS : CHECKS82 BAS : INSURE84 BAS
A>
```

FIG. 3—MBASIC AND ITS FILES should have their own exclusive tagged directory.

To keep our database files separate we might give them a USER 5 tag. From the "A>" command prompt we type USER 5. Everything we do will now get the USER 5 tag. If we write our database, in this instance *Cardfile*, to the disk, the program and all its generated prompts and files will be tagged USER 5 (see Fig. 4).

```
  USER 5
A>DIR
A: PIP      COM : CARDFILE COM : CARDFILE PRM : CARDFILE DAT
A>
```

FIG. 4—A DATABASE PROGRAM, such as *cardfile*, and its files could similarly have its own tagged directory.

If you now go back to the "boot up" condition by typing USER 0, you would see only the CP/M utilities, as shown in Fig. 2.

In Fig. 2, the computer has been "booted" so it "comes up" automatically in the the user 0 area and a DIR command produces the response NO FILE. In Fig. 3 the computer has "come up," we have first entered USER 2 and then DIR. Notice we have a directory listing of MBASIC and its files. In Fig. 4 we have entered USER 5, then DIR, and we get only a directory of the *Cardfile* files.

There is normally no way a single DIR command will list files from other user areas unless special software has been provided, and this is not usually done except for the computers with hard-disk drives such the *Kaypro 10*. Kaypro provides a special directory program that will list all files regardless of their user area. (There are available special utility programs that simplify getting directories and moving from user area to user area, but they are a subject for another time.) In fact, because hard-disk drives contain so many files it's often difficult to locate a desired file unless they are organized in homogeneous user area. In fact, a full directory listing for the software that comes bundled with the *Kaypro 10* would take almost four full screens to display. That does not include any user-generated files. Using user areas simplifies loading programs—it's certainly a lot easier to locate and use the desired files from a user area than trying to dig them out from the "full directory."

While the user areas are often a decided convenience you must keep in mind that the user area on the default drive, the control drive determines the user area on all other drives. If you copy a program from drive A: to a disk on drive B:, or C:, or whatever, it will be copied to the same user area from which it came. Same thing if B: is the default drive. Often, the user will be in a user area, say user 4, and copy a program to a backup disk in drive B:. Sometime later, forgetting that a user area was used during the backup, the user calls for a DIR on the backup disk and the screen shows NO FILE, because DIR checks the 0 area of B: and the files have the USER 4 tag.

In Part 2 of this series we'll show how to move programs between user areas. For now keep this point in mind: It is easy to move files from any user area into the one being used. It is difficult, often almost impossible for a non-programmer to move a file from the assigned user area into any other because the original CP/M made no provision to do it easily.

Utilities

Because CP/M is a "universal" program it is always specifically enhanced by the computer manufacturer for a particular computer. That is done through special utility programs that are supplied with CP/M, as well as by utilities supplied by Digital Research, the outfit that wrote CP/M. Some are invaluable for day to day work; others can cause the total destruction of the disk files if used by a non-programmer—they shouldn't even be on the average user's work disk because they were intended for computer scientists, technicians, and programmers. The TV technician using a personal computer for business, the dentist keeping patient records, the service shop using a spreadsheet program for financial projections, and the wheeler and dealer doing stock transactions from home have rare or no need for some of the supplied utilities; again, all they can do is damage the disk data or confuse the user.

The Digital Research utilities are: ASM, DDT, ED, LOAD, DUMP, STAT, EXSUB, SUBMIT, SYSGEN, and PIP. ASM is an assembler for those who write assembly programs; you probably don't need it so erase it from your working disk (not from the master or backup copy of CP/M). DDT is also for software experts and is used primarily to modify program code. Normally, it can also be erased from the working disk; but even if you haven't the vaguest idea of what DDT is all about, it is required one single time if you want to use user areas. In Part 2 we'll give you a short seven-statement routine for DDT that you don't have to understand at all, but it will open up user areas to you—and then you can forget all about it.

ED is a rudimentary line-oriented editor that wasn't even good in "the good old days;" kill that one also. LOAD and DUMP are also for computer science types; you will probably never use them so kill them from the work disk. SUBMIT is a way to automatically link commands, as is XSUB. Many software houses supply their programs in SUBMIT or XSUB format under a different name. For beginners and application-oriented users it's best to avoid those programs until it's you who are the local CP/M expert.

SYSGEN is the program that is used to place the CP/M system on other disks. Leave it on the work disk. STAT means "statistics." It will tell you almost anything you want to know about a disk or the programs stored on the disk, such how much free space is available on the disk; how much disk space a program takes up (or needs if you're making a copy); the devices connected to the computer; the condition (setup characteristics) of the devices. STAT is important, and you should hands-on experiment with it until you can use all its "bells and whistles."

PIP—an acronym for Peripheral Interchange Program—is the utility that moves files from place to place and it is the keystone of CP/M. Unfortunately, PIP works on two levels: very-easy-beginner and difficult-to-understand mumbo-jumbo *technese*. (Technese is a language whose purpose is to insure that outsiders don't understand what's going on. For example, social workers speak technese, educators speak technese, etc.) In Part 2 of this series we will cover PIP strictly on the beginner level. Be prepared to follow along "hands on" because you'll be the local "CP/M applications-software expert" when you're finished.

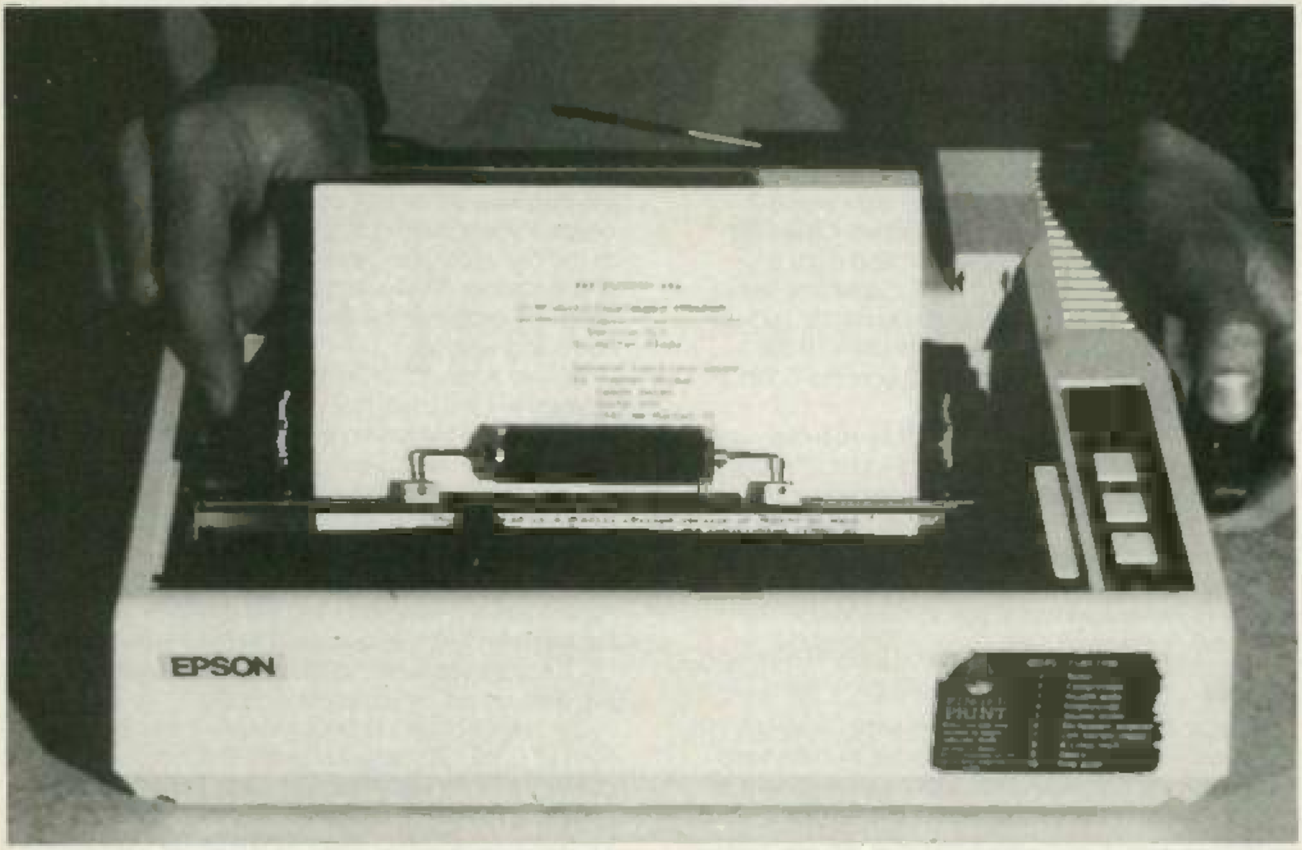
The manufacturer's utilities generally include some form of CONFIG (configure) utility, and either a FORMAT utility or a COPY utility that will either format a disk or copy one complete disk to another disk. That should be on the same work disk as SYSGEN. The command FORMAT (or FORMAT through the COPY program) places invisible magnetic "tracks" and other information on blank (new) diskettes so they can be used to store disk files. You cannot store information until a disk is formatted. If the disk isn't formatted there is no personal computer using any operating system that will know the disk exists. That is a point often forgotten, if ever known, by many "toy store" computer salespersons.

The CONFIG program is a means whereby the user can assign different technical attributes to various "ports"—the connections for a printers, modem, or whatever. It is generally not needed on the work disk since once CP/M is configured, meaning "set up" for particular hardware or software there is rarely any need to change things.

If the manufacturer provides other utilities they are generally intended for his particular computer, or specific software, and aren't really part of CP/M.

Next time, we'll PIP and STAT through several disks and user areas. Be prepared by having a few SYSGEN'ed disks available.

Upgrade Your Budget Printer



Many low-priced printers can be easily upgraded to give them new features and greater flexibility. Here's a look at some of the upgrade kits currently available for two of the most popular of those printers.

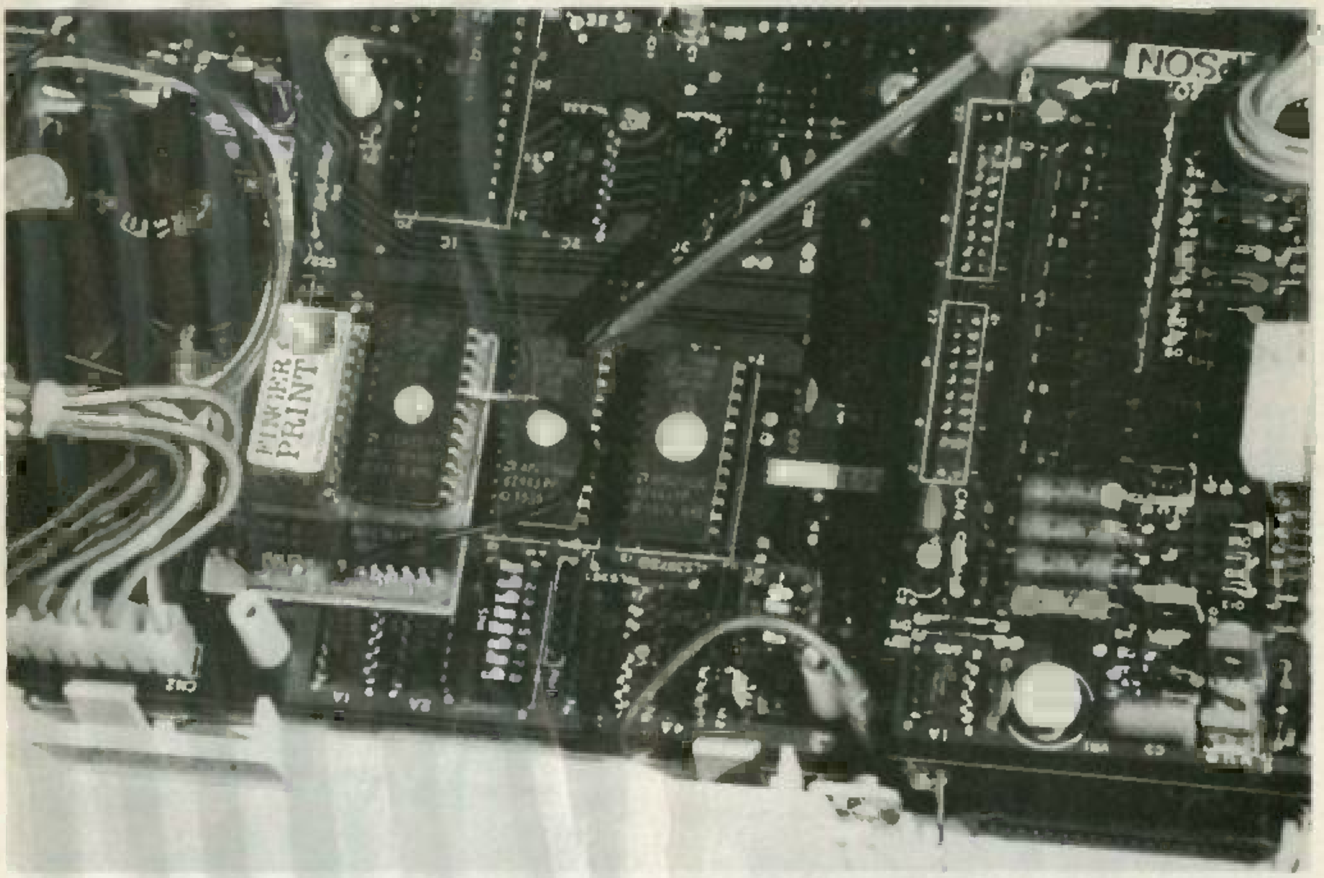
HERB FRIEDMAN

If you have been into personal computing from its "hobbyist" days, or have built your system on a tight budget, it's odds-on that you have either an Epson *MX-80* matrix printer or Smith-Corona *TP-1* (or *TP-2*) daisy printer. Either, or both, have probably given you years of trouble-free service, but lately you find that more and more software can't be used with your printer, or you want to upgrade the computer but find your printer can't quite hack it as an up-to-date printer with the new computer hardware.

Essentially, what you have is still functional equipment that's been made obsolete by modern software, or by modern uses for a personal computer.

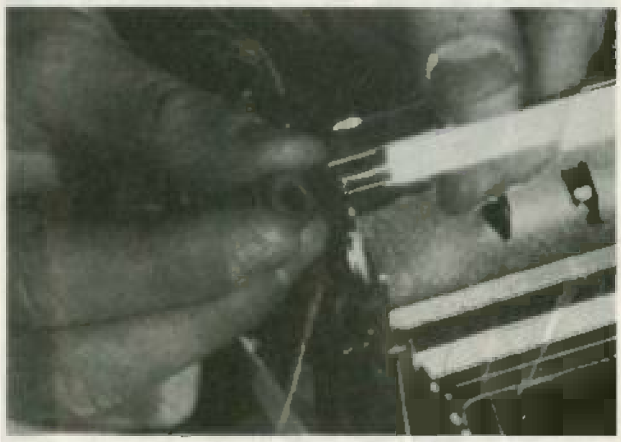
The Epson *MX-80* printer, which could be used with any computer having a Centronics-compatible parallel printer output, was intended primarily for the Radio Shack *TRS-80 Model 1*, the most popular computer of its day, hence the *MX-80* featured a Radio Shack graphics mode. Much of the modern software, however, is written for the graphics mode of the newer *MX-80* printers, which has the graphics capability for the present most popular 8-bit computers, the Apple *II* and *IIe*. Even if the software is for other than Apple computers the graphics will most likely be intended for the graphics capability of the most recent version of the *MX-80*.

The *MX-80* (and its clones such as the Texas Instruments and IBM printers) accommodates only tractor-feed paper. If you want to print on single sheets, such as letterhead, the only way to do it is to use a special plastic tractor/pin feed "carrier," some of which are prone to damage the printhead when pushed



THE *FINGERPRINT* assembly snaps into ROM socket 1B, while the ROM that normally goes in that socket is installed on the *Fingerprint* assembly.

AN ADHESIVE MYLAR LABEL you affix to the front of the printer lists the new functions provided by the *Fingerprint*.



TO ADD the *Micro-Grip* single sheet feed to the *MX-80* you simply remove the collar securing the drive bar on the left side.

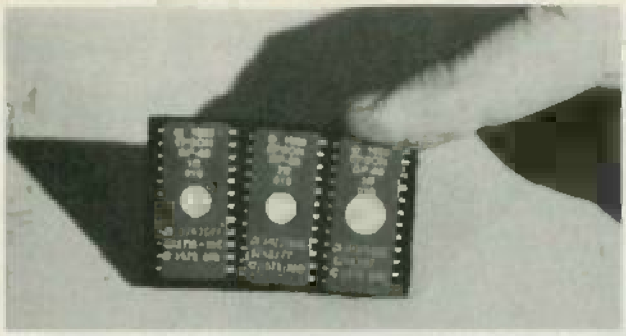
schedules, even business stationary—which includes letterheads and envelopes. To insure precise alignment of the printing, continuous forms must be tractor or pin fed.

So what we have is a popular tractor-feed matrix printer that needs at least new graphics capability and the ability to feed single sheets, and a daisy printer that needs a tractor feed in order to accommodate continuous forms. Let's see what we can do to satisfy those important needs.

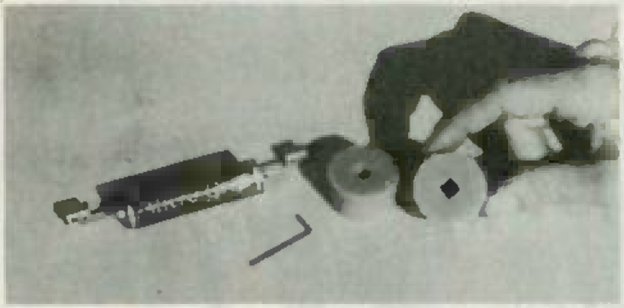
Upgrading the printers

Regardless of why you purchased the *MX-80* or *TP-1* in the first place, user-installed retrofit kits are available that will upgrade either printer to accommodate modem needs. While some of the retrofits are better or more convenient than others, we know those discussed here will really work exactly as promised because we actually tried them out.

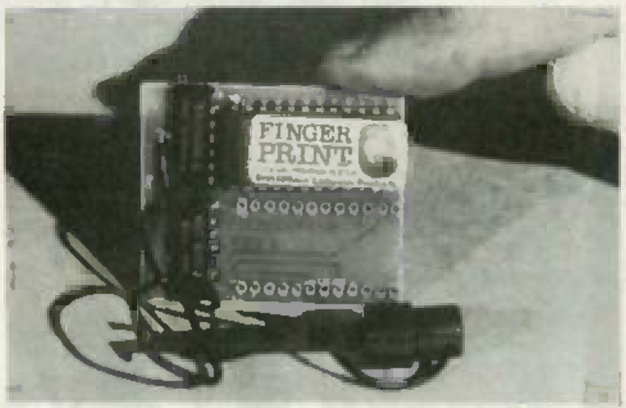
The first of the user-installed *MX-80* retrofits was Epson's own *Graftrax*, which consisted of three ROM's, two of which plugged into empty sockets in the base of the printer while the third replaced an existing ROM. Among other things, the *Graftrax* upgrade provided for dot-addressable graphics, italics printing, and even more important, backspacing. It was terrible



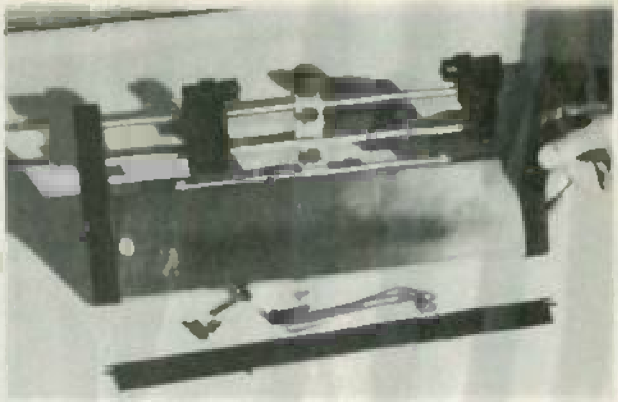
EPSON'S OWN *Graftrax-Plus* upgrade consists of three ROM's supplied on a strip of conductive foam



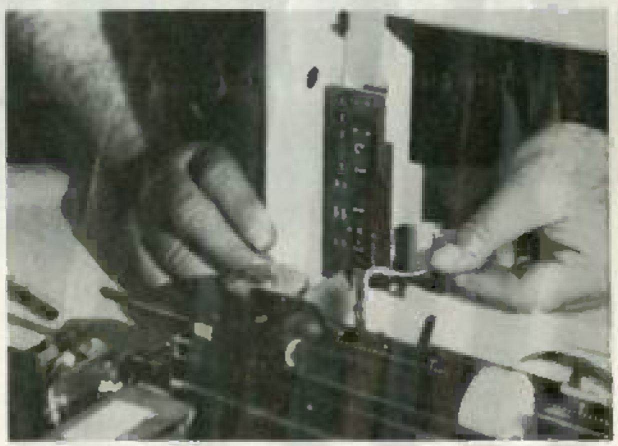
THE *MICRO-GRIP* single sheet upgrade kit. Its use does not interfere with tractor operation.



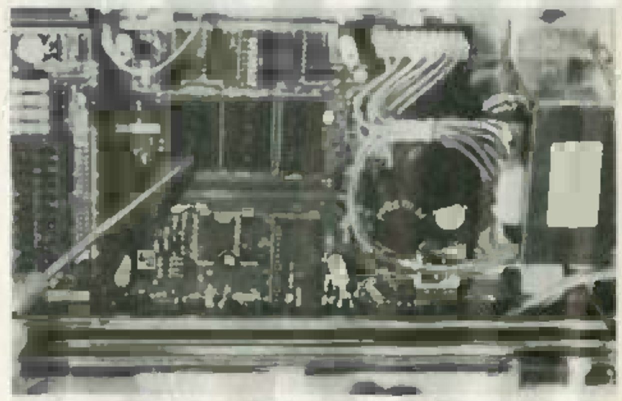
THE *FINGERPRINT* module plugs directly into an Epson ROM socket. The existing ROM is moved to the empty socket on the board.



THE PASSIVE TRACTOR FEED upgrade kit for the Smith-Corona printers. The main section is supplied as a complete assembly.



EPSON TELLS YOU to work on the printer with the cover attached, but don't do it—"pull the plug" instead.



THE THREE ROM sockets located in the base of the *MX-80* printer. If you have an original *MX-80* two of those are empty and one is filled.

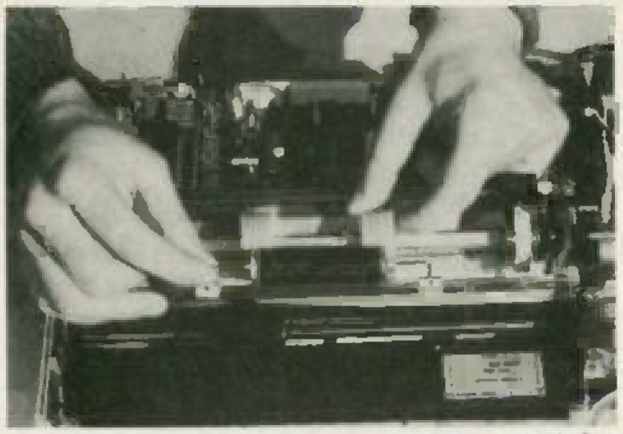
through the printer mechanism. While the original *MX-80* has a host of features such as compressed or enhanced printing it lacks a backspace, which precludes underscoring from some of the less expensive (but otherwise excellent) word processors that are available.

The "letter quality" Smith-Corona daisy printer TP family, which consists of the *TP-1* and the newer *TP-2*, is the "buy of buys" when it comes to letter-quality printers for home-and-family and small businesses. The *TP-1* was the first under-$1000 daisy printer, which by early 1984 was selling for as little as $250. Thousands upon thousands of personal computer users who could not otherwise possibly afford a letter quality daisy printer struck gold in the *TP-1/TP-2*—the price might very well be the reason you decided to get a letter quality printer even though you already had a matrix printer. (If a type 251 ribbon is used—which was not mentioned in the early documentation—the *TP-1* can produce "camera ready" print quality the equal of machines costing well over $1000 because it is essentially the printer end of a Smith-Corona electronic typewriter with an accessory interface for computer output.)

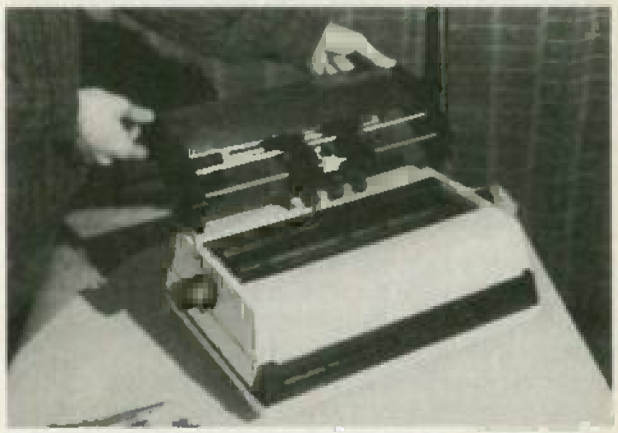
The problem with the *TP-1* and the *TP-2* is that they were intended for single-sheet documents such as business letters, etc., which is logical because it is really the printer mechanism from a typewriter. But today, much modern software is intended for continuous forms printing, such as checks, labels, IRS

SLIDE THE ORIGINAL plastic paper guide roller from the driver bar and slide the two Micro-Grip rubber rollers on the bar. Then replace the collar.

WHEN WORKING ON the Smith-Corona *TP-1*, you cannot separate the casing top because the leads to the fan are too short.

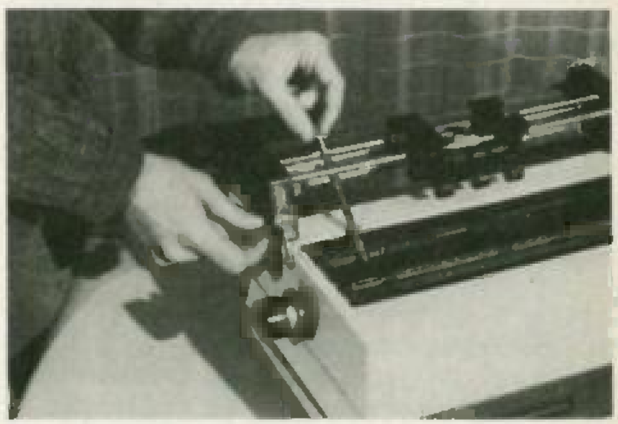


ATTACH THE PRESSURE roller assembly to the paper bail and the single sheet retrofit is finished.



IT APPEARS TO BE permanently installed, but the tractor mechanism goes on and off in seconds.

A SINGLE SHEET being printed by the *MX-80*. Be certain the pin-feed mechanisms are against the sides of the paper it feeds straight.



SLIDE THE SUPPLIED GAUGE—actually a notched rod—on the drive bar, tighten two screws, and the tractor assembly is adjusted for use.

backspacing because the printhead returned to the extreme left and then advanced for each backspace, but it was adequate for general word processing: underscore, kerning, etc. Unfortunately, a graphic printout would cycle the head continuously until the drive motor could be heard slowing to a crawl.

The latest retrofit available from Epson dealers is *Graftrax-Plus*, which gives your old model *MX-80* the advanced features of the latest model. Among the *Graftrax-Plus* highlights are the Apple-compatible graphics (no more Radio Shack *Model 1* graphics); a true backspace that puts graphic printouts in high gear and relieves the strain on the printer's printhead-drive motor; a "fine print" that can be used for superscripts and subscripts; automatic perforation skipover (no more program listings printing on the perforations); and a continuous underscore that can be turned on and off from within a program or word processor. (A continuous underscore is formed simultaneously with the character; the head does not backspace for the underscore.)

The *Graftrax-Plus* retrofit kit consists of three ROM's and the latest Epson-with-Graftrax printer manual—which explains all the "bells and whistles." The *Graftrax-Plus* retrofit has the same kind of installation as for the original *Graftrax* upgrade—just plug the ROM's into the correct sockets. One "caveat" however: The Epson instructions leave the top of the printer attached when you open the printer by separating the top and bottom; it has you delicately balancing the cover on its end. If you look closely you'll see the wires to the switches in the cover are attached through a connector. Mark the orientation of the connector with a pencil or pen and then separate the connector and put the cover in a safe place until you're finished.

Pushbutton control

As long as you have the printer open consider a retrofit called *Fingerprint* (Dresselhaus Computer Products, 837 E. Alosta Ave., Glendora, CA 91740), which allows the three printer control pushbuttons to also program ten operating modes: compressed print; double-wide; emphasized; double-strike; perforation skipover; left margin indent; 8 lines/inch spacing; itallics, and fine print. For example, just touch the printer's ON-LINE button twice and the printer shifts to compressed type without any commands from the computer.

Fingerprint is supplied on a small printed-circuit board that swaps for the ROM in a socket 1B, the one that's replaced in the *Graftrax* retrofit. Instead of substituting for the ROM in socket 1B, install the *Graftrax* ROM in the *Fingerprint* socket and then snap the *Fingerprint* assembly into socket 1B. You clip two attached *Fingerprint* leads where indicated and you now have both the *Graftrax* and the *Fingerprint* retrofits, and with virtually no extra effort required on your part.

Single sheets

If you quit now you'll have one heck of a matrix printer, but you can go one step farther and add a real single-sheet feed by installing a *Micro-Grip Friction Feed* (Bill Cole Enterprises, Box 609, Wollaston, MA 02170). The *Micro-Grip* retrofit does not interfere with the tractor operation, but it does permit single sheets to be fed directly through the printer without the need for a plastic carrier.

The *Micro-Grip* kit consists of three components: two rubber rollers that replace the existing Epson paper guide roller (which is sandwiched between the two tractor pin feed mechanisms), and a rubber-roller pressure assembly that clamps to printer's paper bail—the bar that holds the paper down for printing.

To install the *Micro-Grip* retrofit it is necessary to very slightly dismantle the printer's feed mechanism so the rubber rollers can be fitted to the tractor-drive bar (instructions are provided in the kit). It is, however, a minor disassembly, and the whole installation shouldn't take more than 10 or 15 minutes. Just be certain you don't push or bend anything while you are doing the work—do everything very, very gently.

When you see the *Micro-Grip* installed you won't believe it will work, but it does. The only problem is the paper tends to skew, and the instructions on how to "fine tune" the paper feed really don't do much of anything. You'll spend more time fussing with the "fine tuning" than printing. Just ignore the "fine tuning" instructions. Instead, gently slide the tractor pin-feed devices against the sides of the paper and apply their locks, thereby locking them in position against each side of the paper. The pin feed assemblies will guide the paper so it rolls through nice and straight. The adjustment of the pin-feed mechanisms are "permanent" as long as you keep using single sheets. To use continuous form tractor paper you simply slide the two rubber rollers to the side and reset the tractors, or leave the rollers where they are and pull the paper bail (with its roller) away from the paper; the Epson will print on continuous tractor feed forms just as well without the bail.

Installing a tractor feed

The tractor feed upgrade for the Smith-Corona *TP-1/TP-2* isn't really a retrofit because it does not really become a permanent part of the printer, it can be easily removed in seconds. The tractor feed mechanism, which is available from some (not all) Smith-Corona dealers and the Smith-Corona service centers is a "passive" tractor feed, meaning it's really a guide that insures precise registration even though the paper is really driven by the normal platten mechanism—just like a single sheet.

While installing the tractor feed upgrade can be a user-performed task, Smith-Corona does not provide the first three pages of the documentation with the kit; the pages that show how to do it yourself. Smith-Corona service centers will do the installation for $10 if you deliver the printer to the center.

What's missing are these instructions. First, remove the casing top by loosening two screws at the top front and then prying the top out of the three clamps in the base, thereby separating the casing top from the base. The three clamps are across the rear of the base; you'll need to use a large screwdriver as a pry bar and you'll swear you're breaking the case but that's what it takes to release the three clamps at the back of the casing. Don't disconnect any wires even though they are short; just flip the cover up.

Use common sense and remove the combination dust cover and paper rest, and install the supplied black metal strip (which is called an "electronics cover") so it spans the two screws that originally held the paper rest's pivots—remove the rest with its pivots. Remove the hinge-screws that hold the paper rest to the casing top. Drive out the hinge pins into which the screws fit and gently drive in the new, supplied, hinge pins with a small soft-face hammer—or the back end of a screwdriver. That's it—reassemble the cabinet.

The supplied documentation shows how to install and adjust the tractor mechanism itself, all of a 10 minute job at the very worst. A special gauge is provided in the kit for alignment of the tractor mechanism. The whole project looks much more difficult than it is. Actually, separating the back of the casing top from the base will be the most difficult part of the upgrade.

With the tractor-mechanism upgrade the *TP-1/TP-2* can accommodate either single sheets, tractor-fed sheets, or tractor-fed forms and labels. As with the Epson retrofits, you lose nothing; you only gain.

NO WRONG NUMBERS

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TABLE 1—JUMPER POSITION

Desired Code Number	Pin Number, IC2
2	4
3	7
4	10
5	1
6	5
7	6
8	9
9	11

TABLE 2—R14 AND R17 SETTINGS

Desired Code Number	R14 Setting (Read at TP2)	R17 Setting (Read at TP1)
1	697 Hz	1209 Hz
2	697 Hz	1336 Hz
3	697 Hz	1477 Hz
4	770 Hz	1209 Hz
5	770 Hz	1336 Hz
6	770 Hz	1477 Hz
7	852 Hz	1209 Hz
8	852 Hz	1336 Hz
9	852 Hz	1477 Hz

know about the project. In that case, tell them to call during a certain time and leave the project turned off. If they become curious and ask why a particular time, simply tell them that's the only time you'll be home.

You may also wish to have the project respond to some code number other than 7. In those cases switch jumper JU1 on the decoder board as shown in Table 1 and adjust R14 and R17 for the frequencies shown in Table 2. R-E

HOBBY CORNER

continued from page 93

counter, how does it compare with the reading on the receiver dial? Not so good, huh? Let's see how far off it is. Tune to a station of known frequency (perhaps one of the WWV signals). Comparing the known frequency with the counter reading will show that the difference is the intermediate frequency of the receiver (probably that 455 kHz, again).

Now, repeat the comparison with the receiver tuned to various stations on the different bands. Aha!...On some bands the counter shows a reading of 455 kHz above the station frequency and on others it's below. Make a note of which bands are above and which are below. Now you're in business, Don. Just add or subtract the IF from the counter reading and you will have an accurate digital readout of the tuned station's frequency. If the adding and subtracting is too much trouble, you can try your "gimmick" capacitor on the output of the RF amplifier. Use only a very light coupling. It's almost certain that you'll need one or two broad-band amplifier stages to boost the signal enough for the counter.

Those of you who do not have a counter may wish to refer to one of the ARRL publications for construction details of digital frequency readouts (see above for the ARRL address). It's not a simple piece of equipment to build. In fact, you may prefer to buy a counter and hook it up according to the above instructions. R-E

COMPUTER CORNER

continued from page 95

ence.

Once you discover whether or not you like it or whether it can be useful to you, you can make your decision as to what to do next. Most people really take to computers once they realize that they are not so mysterious. Very often they find that those low-cost machines just don't have the power or versatility for their needs, but that's really OK. Your next purchase can be one of the larger and more powerful machines.

On the other hand, if you find that you really don't take to personal computers or that you can get along without them, that's fine! Since you didn't pay very much for the machine, you can put it on the back shelf with little or no guilt. Or you may want to give it away to one of your kids, a relative, or a friend to get them started in computing. In any case, now is the time to act. R-E

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

THE HHC USER GUIDE, by Jonathon Sachs, Soft River Software, with Rick Meyer; Osborne/McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710; 192 pages, including appendicies, glossary, and index; 6½ × 9¼ inches; softcover; $14.95.

The HHC is a portable computer manufactured by Panasonic, Quasar, and Olympia. It is distributed by Quasar Corporation and Olympia Corporation. An HHC from any of those companies can work equally well with peripherals, software, and capsules distributed by any of the other companies. (At the time this book went to press, the authors had no data on the availability of Olympia's specific peripherals and software, because Olmypia is the newest distributor of the HHC.)

This guide presents easy-to-use operating instructions for the HHC multipurpose system. There is a complete description of HHC peripherals, including thermal printers, programmable memory extenders, and video adapters. It discusses many of the HHC-packaged application programs, such as electronic mail, financial forecasting, time management, and sales-order entry. It also covers the HHC programming languages: MBASIC, SnapBASIC, and SnapForth, the high-level language of the HHC's operating system.

CIRCLE 121 ON FREE INFORMATION CARD

THE BEGINNER'S BOOK OF ELECTRONIC MUSIC, by Delton T. Horn; TAB Books, Inc., Blue Ridge Summit, PA 17214; 376 pages, including appendicies, glossary, bibliography, and index; 5 × 8½ inches; softcover; $12.95.

This book tells how one can create one's own synthesized live or recorded sound using home-built circuitry or commercially available equipment. There is also an extensive listing of available electronic music recordings and a complete buyer's guide to commercial synthesizing equipment (modular, normalized, pre-set and computerized).

Sound and acoustic principles are thoroughly reviewed and there's a detailed look at sound sources for electronic music—oscillators, noise generators, and recorded sounds. The reader is told how new sounds can be created by additive or subtractive synthesis, and the fundamentals of using filters, amplifiers, modulation, controllers, and other devices to manipulate musical sounds. There's also practical advice on setting up one's own electronic-music studio.

CIRCLE 122 ON FREE INFORMATION CARD

ELECTRONICS PROTOTYPE CONSTRUCTION, by Stephen D. Kasten; Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268; 398 pages, including appendicies and index; 5-3/8 × 7-1/4 inches; softcover; $17.95.

This book is concerned with construction techniques for converting schematics and ideas into functional electronics prototype units. It is divided into four major parts:

Wire-wrapping, deals with methods, boards, hardware, power supplies, and tools.

Printed-circuit boards: covers double-sided PC boards, camera-ready artwork, photo-resist techniques, etching, electroplating, soldering, drilling, assembly, cleaning, and protective coatings.

Graphic Techniques: tells about photofabrication, photographic principles, photo masks, darkroom equipment, screen printing, transparencies, 35mm photography, and 35mm photographic reduction.

Hardware packing: explains enclosures, parts layout, wiring, front panels, fabrication tools, machining holes, and cabinet finishing.

CIRCLE 123 ON FREE INFORMATION CARD

MAKING INFORMATION SYSTEMS WORK FOR YOU, by Trevor J. Bentley; Prentice-Hall, Inc., Englewood Cliffs, NJ 07632; 178 pages, including index; 6 × 9 inches; softcover; $8.95.

Trevor J. Bentley is one of the foremost authorities on management-information systems today. As an accountant in years past, he often provided information that managers didn't know how to use. Later, as a manager, he often received unneeded information.

This book presents a formula for defining management's information needs. There is very little technical language, and the technical aspects that are important were supplied by Irvine H. Forkner. The two authors together provide inside tips to help the reader better understand the use and value of information systems, plus practical advice on making the whole process run more smoothly. From the preliminary cost of owning and operating a system to information analysis and documentation, this book covers what the reader will need to know in order to get the best results from an information system.

CIRCLE 124 ON FREE INFORMATION CARD

COMMODORE 64 COMPUTING, by Ian Sinclair; Prentice-Hall, Inc., Englewood Cliffs, NJ 07632; 133 pages, including appendix and index; 6 × 9 inches; softcover, $12.95 (also available in hardcover, $19.95).

This book provides a clear, plain-English guide to BASIC programming on the Commodore *64*. From connecting your machine to your TV receiver to program design using color graphics and sound, the all-important information necessary for a working knowledge of what the Commodore *64* can do is provided. There is also step-by-step instruction on how to convert programs written for the Commodore *PET* and how to use the CP/M option.

The book is illustrated with examples that show how to do sprite graphics, color commands, and programming for sound. R-E

CIRCLE 125 ON FREE INFORMATION CARD

NEW LIT

CONNECTOR CATALOG is 16 pages designed to help customers meet EMI/RFI requirements, including FCC Docket 20780. Catalog FCC-1 provides product descriptions, performance characteristics, electrical data, contact arrangements, mounting and terminations, assembly data, and tips on how to select and order the proper connector and "black box" to meet your particular EMI/RFI requirements.

Products are grouped by type in this catalog, which features more than 45 black-and-white photographs of the D subminiature shielded D series, D subminiature transverse monolith filter connector, and extruded and die-cast shielded black boxes. Those products have applications in computers and computer peripherals, electronic games, telecommunications, medical electronics, and business machines, where signals generated are typically in the 10-kHz to 1000-MHz range. Free upon request.—**ITT Cannon,** 10550 Talbert Ave., Box 8040, Fountain Valley, CA 92708.

CIRCLE 131 ON FREE INFORMATION CARD

ELECTRONIC PARTS CATALOG is 48 pages, illustrated partly color, and covers a full range of electronics parts and supplies. Included among the products listed are such things as AC adaptors, battery chargers, capacitors, DC adaptors, earphones, fuses, heat sinks, joysticks, meters, microphones, PC boards, power supplies, relays, semiconductors, LED displays, speakers, switches, telephone accessories, terminal strips, video accessories, wire, and many others. Free upon request.—**All Electronics Corp.,** PO Box 20406, 905 S. Vermont Ave., Los Angeles, CA 90006.

CIRCLE 132 ON FREE INFORMATION CARD

SWITCH/DISPLAY MODULE CATALOG is 12 pages and covers a line of decade *Multicount* switches combined with display modules. On-board decoders, memory, and other circuitry in TTL or CMOS logic make these switches suitable for applications such as counting and timing measurements, generation of selectable clock signal, and position control. Free upon request.—**Interswitch,** 700 Airport Boulevard, Burlingame, CA 94010.

CIRCLE 133 ON FREE INFORMATION CARD

"CONNECT IT" CATALOG is 8 pages in full color, describing Vaco's new solderless-connection program. The program includes new terminal packaging and displays, plus new terminal merchandising and sales aids, including a display poster, salesman's sample case, and catalog.

Other new products introduced in this catalog are ratchet crimping tools, 3-way vaconnectors, and a new coax stripper. The catalog is free upon request.—**Vaco Products Company,** 1510 Skokie Blvd., Northbrook, IL 60062. R-E

CIRCLE 134 ON FREE INFORMATION CARD

CONTROL COMPUTER

continued from page 74

about 15mA in the low state and about 10mA in the high state. The output capacity can be increased by using IC4, an open-collector Darlington array. The generous sink capacity of this device makes it handy for controlling relays. A snubber diode is included in the package, which is important if you will be switching any type of inductive load. Without it, the inductive kickback would cause intermittent problems when running a program (or it could destroy the computer outright).

Digital I/O—8-bit port

The next type of I/O consists of 8 parallel bits—often referred to as a byte-wide I/O port. The byte-wide port is a natural extension of the microprocessor data bus and, as such, it is the most convenient method of transferring data to or from peripheral devices, such as printers, voice synthesizers, or BCD thumbwheel switches.

Unfortunately, that's all we have room for this time. Among other things, we'll look at the byte-wide port in more depth in the next, and final, installment of this article. R-E

NEW IDEAS

continued from page 38

of the IC3. They are paralleled to provide enough current to drive IC4, an MOC3031 optically-coupled triac driver. When the triac is turned on, current will flow through the triac and the lamp or appliance that is connected to its terminals, turning it on, too.

The touchplate can be made from a one-inch square piece of copper-clad board with a 4-inch piece of wire soldered to it. It should be connected to capacitor C2, as shown. Once you have it all together, the next step is to make sure that it works. To do so, close switch S1 (labeled CAL) and connect a lamp to the load terminals. Now, apply power and adjust potentiometer R5 down from its maximum resistance until the lamp comes on. Bring your hand near the touchplate to insure that the lamp extinguishes. If everything is OK, open S1; the lamp should alternately switch on or off when the touchplate "switch" is activated.

For safer and more stable operation, a low-voltage supply can be used (with R10 adjusted accordingly). However, it will be difficult to mount the switch behind a wall plate if you do that.

The MOC3031 triac driver was selected because of its low drive-current requirements. The less expensive MOC3010 can be used instead of the MOC3031 if zero-voltage switching is not desired. In that case, resistor R11 must be changed to 180 ohms. Switch S1 and resistor R9 are an optional aid and are used in setting up the threshold for operation.—*Stephen Dubinsky*

NEW IDEAS

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

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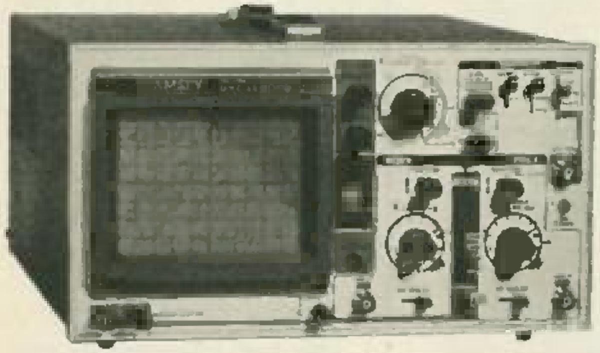

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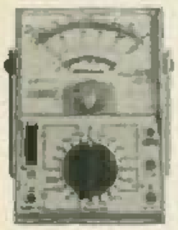

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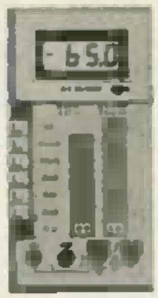

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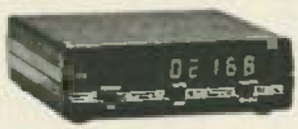

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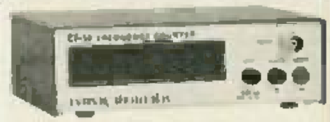

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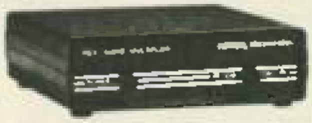

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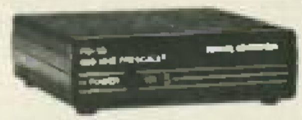

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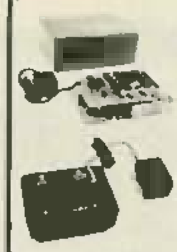

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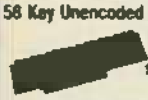

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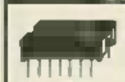

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LM747CN-14	.19	SN75454N	.49
LM747N H	.79	SN75491N	.89
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74S04	.60	74S135	1.15	74S257	1.29
74S05	.62	74S136	1.40	74S258	1.20
74S08	.40	74S138	1.00	74S260	.75
74S09	.40	74S139	1.20	74S280	2.79
74S10	.42	74S140	.73	74S287	2.00
74S11	.42	74S151	1.29	74S288	2.55
74S15	.42	74S153	1.29	74S373	3.10
74S20	.42	74S157	1.00	74S374	3.10
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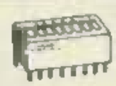
74S30	.42	74S160	2.79	74S471	7.95
74S32	.49	74S174	1.49	74S472	7.95
74S38	1.10	74S175	1.49	74S473	7.95
74S40	.40	74S188	2.00	74S474	8.95
74S51	.42	74S194	1.40	74S475	8.95
74S64	.46	74S195	1.09	74S570	6.75
74S65	.46	74S196	1.00	74S571	6.75
74S74	.99	74S240	2.75	74S572	8.95
74S86	.72	74S241	2.79	74S573	6.95
74S112	.73	74S242	2.80	74S940	2.90
74S113	.72	74S243	2.80	74S941	2.90
74S114	.72				

DIP SWITCHES



2 Position	$.90	7 Position	$1.39
4 Position	1.10	8 Position	1.40
5 Position	1.29	9 Position	1.65
6 Position	1.35	10 Position	1.69

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7400	$.19	7475	$.38	74181	$1.80
7401	.19	7476	.34	74182	.80
7402	.19	7479	4.60	74183	.80
7403	.19	7480	.49	74184	.80
7404	.18	7482	.95	74185	.69
7405	.23	7483	.45	74188	3.20
7406	Call	7485	.55	74187	2.95
7407	Call	7486	.30	74170	1.40
7408	.24	7489	1.75	74172	4.75
7409	.18	7490	.35	74175	.80
7410	.18	7491	.45	74174	.80
7411	.24	7492	.45	74175	.80
7412	.24	7493	.35	74176	.80
7413	.29	7494	.60	74177	.80
7414	.60	7495	.50	74178	1.24
7416	Call	7496	.80	74180	.75
7417	Call	7497	2.80	74181	1.75
7420	.18	74100	2.80	74182	.75
7421	.35	74107	.24	74184	2.25
7422	.29	74109	.37	74185	2.25
7423	1.10	74116	1.25		
7425	.29	74121	.29		
7426	.29	74122	.39	74190	1.15
7427	.30	74123	.45	74191	1.15
7428	.45	74125	.45	74192	.75
7430	.18	74126	.44	74193	.75
7432	.30	74128	.50	74194	.75
7437	.25	74132	.45	74195	.69
7438	.29	74136	.75	74196	.75
7439	1.10			74197	.75
7440	.19	74141	.65	74198	1.29
7441	.79	74142	2.95	74199	1.29
7442	.45	74143	4.50	74221	1.19
7443	.65	74144	2.95	74251	.60
7444	.65	74145	.59	74273	1.95
7445	.79	74147	1.80	74276	1.80
7446	.75	74148	1.19	74279	.75
7447	.65	74150	1.09	74283	1.40
7448	.79	74151	.49	74284	3.80
7450	.19	74152	.67	74285	3.80
7451	.19	74153	.49	74290	.80
7453	.19	74154	1.19	74298	.85
7454	.19	74155	.59	74365	.65
7459	.25	74156	.79	74366	.65
7460	.22	74157	.49	74367	.65
7470	.29	74158	1.65	74368	.65
7472	.29	74159	2.49	74385	1.49
7473	.29	74160	.79	74393	1.80
7474	.34			74490	1.80

74LS00

74LS00	$.20	74LS113	$.30	74LS245	$2.00
74LS01	.25	74LS114	.39	74LS247	1.10
74LS02	.20	74LS122	.49	74LS248	1.10
74LS03	.25	74LS123	1.19	74LS249	1.19
74LS04	.25	74LS124	2.75	74LS251	1.40
74LS05	.25	74LS125	.80	74LS253	1.40
74LS08	.25	74LS126	.49	74LS257	.80
74LS09	.25	74LS132	.89	74LS258	.80
74LS10	.30	74LS136	.49	74LS259	2.95
74LS11	.30	74LS138	.80	74LS260	.65
74LS12	.33	74LS139	.80	74LS261	2.49
74LS13	.39	74LS145	1.25	74LS266	.59
74LS14	.59	74LS148	1.40	74LS273	1.75
74LS15	.35	74LS151	.79	74LS275	4.40
74LS20	.25	74LS153	.59	74LS279	.60
74LS21	.29	74LS154	1.70	74LS283	.80
74LS22	.29	74LS155	1.19	74LS290	.89
74LS26	.40	74LS156	1.40	74LS293	.90
74LS27	.39	74LS157	1.40	74LS295	1.10
74LS28	.40	74LS158	1.40	74LS298	1.19
74LS30	.25	74LS160	1.80	74LS324	1.75
74LS32	.30	74LS161	1.40	74LS347	1.80
74LS33	.55	74LS162	1.40	74LS348	1.95
74LS37	.35	74LS163	1.40	74LS352	1.19
74LS38	.39	74LS164	1.40	74LS353	1.19
74LS40	.25	74LS165	1.40	74LS363	1.49
74LS42	.50	74LS166	2.48	74LS365	.80
74LS47	.79	74LS168	1.15	74LS366	.99
74LS48	.79	74LS169	1.15	74LS367	.80
74LS51	.25	74LS170	1.90	74LS368	.80
74LS54	.29	74LS173	.80	74LS373	2.00
74LS55	.30	74LS174	.80	74LS374	2.00
74LS73	.39	74LS175	.69	74LS375	.80
74LS74	.30	74LS181	2.20	74LS377	1.95
74LS75	.39	74LS190	1.15	74LS385	1.95
74LS76	.39	74LS191	1.15	74LS386	.65
74LS78	.44	74LS192	.89	74LS390	1.80
74LS83	.90	74LS193	.90	74LS393	1.95
74LS85	.60	74LS194	1.15	74LS395	1.70
74LS86	.39	74LS195	.95	74LS399	2.35
74LS90	.57	74LS196	.80	74LS424	2.95
74LS92	.49	74LS197	.80	74LS668	1.29
74LS93	.60	74LS221	1.16	74LS670	2.20
74LS95	.79	74LS240	1.20	81LS95	1.00
74LS96	.89	74LS242	1.99	81LS96	1.00
74LS107	.39	74LS243	1.50	81LS97	1.00
74LS109	.39	74LS244	1.99	81LS98	1.00
74LS112	.39	25LS2521	2.85	25LS2569	4.95

CMOS

4000	$.29	4037	$1.95	4089	$2.95
4001	.24	4040	.75	4093	.45
4002	.24	4041	.75	4094	2.95
4006	.79	4042	.65	4098	2.29
4007	.25	4043	.85	4099	1.95
4008	.95	4044	.80	14408	12.95
4009	.39	4046	.80	14409	12.95
4010	.39	4047	.80	14410	12.95
4011	.24	4048	.80	14412	12.95
4012	.24	4049	.35	14415	8.95
4013	.35	4050	.34	14419	4.95
4014	.75	4051	.75	4501	.39
4015	.39	4052	.75	4502	.95
4016	.35	4053	.75	4503	.65
4017	.65	4055	3.95	4505	8.95
4018	.79	4056	2.95	4506	.75
4019	.39	4059	9.25	4507	.95
4020	.69	4060	.85	4508	1.95
4021	.80	4066	.39	4510	.79
4022	.80	4068	.39	4511	.79
4023	.29	4070	.35	4512	.79
4024	.80	4071	.29	4514	1.19
4025	.25	4072	.29	4515	1.79
4027	.45	4073	.29	4516	1.49
4028	.65	4075	.29	4518	.85
4029	.75	4076	.75	4520	.75
4030	.45	4077	.35	4555	.95
4031	3.25	4078	.35	4556	.90
4032	2.15	4081	.29	4566	2.25
4034	1.21	4082	.29	80C95	1.50
4035	.79	4085	.85	80C97	1.25

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2.000MHz	2.95	4.000MHz	2.95	8.5536MHz	2.95	18.000MHz	2.95
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2101	256 x 4	(450ns)	1.95
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2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	.99
2102L-2	1024 x 1	(250ns) (LP)	1.49
2111	256 x 4	(450ns)	2.49
2112	256 x 4	(450ns)	2.99
2114	1024 x 4	(450ns)	8/9.95
2114-25	1024 x 4	(250ns)	8/10.95
2114L-4	1024 x 4	(450ns) (LP)	8/12.95
2114L-3	1024 x 4	(300ns) (LP)	8/13.45
2114L-2	1024 x 4	(200ns) (LP)	8/13.95
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TC5516	2048 x 8	(250ns) (cmos)	9.95
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)	4.75
HM6116-3	2048 x 8	(150ns) (cmos)	4.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8	(120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8	(300ns) (Qstat)	34.95
HM6264	8192 x 8	(150ns) (cmos)	49.95

LP = Low Power Qstat = Quasi-Static

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UPD411	4096 x 1	(300ns)	3.00
MM5280	4096 x 1	(300ns)	3.00
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/7.95
4116-200	16384 x 1	(200ns)	8/12.95
4116-150	16384 x 1	(150ns)	8/14.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
MK4332	32768 x 1	(200ns)	9.95
4164-200	65536 x 1	(200ns) (5v)	5.95
4164-150	65536 x 1	(150ns) (5v)	6.95
MCM6665	65536 x 1	(200ns) (5v)	8.95
TMS4164-15	65536 x 1	(150ns) (5v)	6.95

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)	5.95
TMS2516	2048 x 8	(450ns) (5v)	5.50
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns) (5v)	5.95
2732	4096 x 8	(450ns) (5v)	4.95
2732-250	4096 x 8	(250ns) (5v)	8.95
2732-200	4096 x 8	(200ns) (5v)	11.95
2732A-4	4096 x 8	(450ns) (5v) (21vPGM)	6.95
2732A	4096 x 8	(250ns) (5v) (21vPGM)	9.95
2732A-2	4096 x 8	(200ns) (5v) (21vPGM)	13.95
2764	8192 x 8	(450ns) (5v)	6.95
2764-250	8192 x 8	(250ns) (5v)	7.95
2764-200	8192 x 8	(200ns) (5v)	19.95
TMS2564	8192 x 8	(450ns) (5v)	14.95
MCM68764	8192 x 8	(450ns) (5v) (24 pin)	39.95
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5v = Single 5 Volt Supply 21vPGM = Program at 21 Volts

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PE-14		9	6,000	83.00
PE-14T	X	9	6,000	118.00
PE-24T	X	12	9,600	175.00
PL-265T	X	30	9,600	255.00
PR-125T	X	25	17,000	349.00
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4.0	2.95
5.0	2.95
5.0688	2.95
5.185	2.95
5.7143	2.95
6.0	2.95
6.144	2.95
6.5536	2.95
8.0	2.95
10.0	2.95
10.738635	2.95
14.31818	2.95
15.0	2.95
16.0	2.95
17.430	2.95
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18.432	2.95
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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	4541	2.64
4009	.39	4543	1.19
4010	.45	4553	5.79
4011	.25	4555	.95
4012	.25	4556	.95
4013	.38	4581	1.95
4014	.79	4582	1.95
4015	.39	4584	.75
4016	.39	4585	.75
4017	.69	4702	12.95
4018	.79	74C00	.35
4019	.39	74C02	.35
4020	.75	74C04	.35
4021	.79	74C08	.35
4022	.79	74C10	.35
4023	.29	74C14	.59
4024	.65	74C20	.35
4025	.29	74C30	.35
4026	1.65	74C32	.39
4027	.45	74C42	1.29
4028	.69	74C48	1.99
4029	.79	74C73	.65
4030	.39	74C74	.65
4034	1.95	74C76	.80
4035	.85	74C83	1.95
4040	.75	74C85	1.95
4041	.75	74C86	.39
4042	.69	74C89	4.50
4043	.85	74C90	1.19
4044	.79	74C93	1.75
4046	.85	74C95	.99
4047	.95	74C107	.89
4049	.35	74C150	5.75
4050	.35	74C151	2.25
4051	.79	74C154	3.25
4053	.79	74C157	1.75
4060	.89	74C160	1.19
4066	.39	74C161	1.19
4068	.39	74C162	1.19
4069	.29	74C163	1.19
4070	.35	74C164	1.39
4071	.29	74C165	2.00
4072	.29	74C173	.79
4073	.29	74C174	1.19
4075	.29	74C175	1.19
4076	.79	74C192	1.49
4078	.29	74C193	1.49
4081	.29	74C195	1.39
4082	.29	74C200	5.75
4085	.95	74C221	1.75
4086	.95	74C244	2.25
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	14.95	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
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7483	.50	74195	.85
7485	.59	74197	.75
7486	.35	74198	1.35
7489	2.15	74221	1.35
7490	.35	74246	1.35
7492	.50	74247	1.25
7493	.35	74259	2.25
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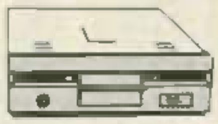

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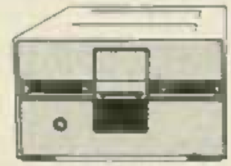

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* MOLDED FROM DURABLE SMOKED PLASTIC WITH FRONT CARRYING HANDLE

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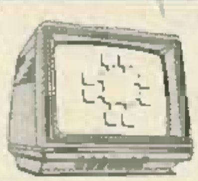

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COLOR	
BMC BM-AU9191U COMPOSITE 13"	$279.00

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STATIC RAMS

2101	256 x 4 (450ns)	1.90
5101	256 x 4 (450ns) (cmos)	3.90
2102-1	1024 x 1 (450ns)	.88
2102L-4	1024 x 1 (450ns) (LP)	.98
2102L-2	1024 x 1 (250ns) (LP)	1.45
2111	256 x 4 (450ns)	2.45
2112	256 x 4 (450ns)	2.95
2114	1024 x 4 (450ns)	8/9.90
2114-25	1024 x 4 (250ns)	8/9.95
2114L-4	1024 x 4 (450ns) (LP)	8/11.95
2114L-3	1024 x 4 (300ns) (LP)	8/12.45
2114L-2	1024 x 4 (200ns) (LP)	8/12.95
2147	4096 x 1 (55ns)	4.90
TMS4044-4	4096 x 1 (450ns)	3.45
TMS4044-3	4096 x 1 (300ns)	3.95
TMS4044-2	4096 x 1 (200ns)	4.45
MK4118	1024 x 8 (250ns)	9.90
TMM2016-200	2048 x 8 (200ns)	4.10
TMM2016-150	2048 x 8 (150ns)	4.90
TMM2016-100	2048 x 8 (100ns)	6.10
HM6116-4	2048 x 8 (200ns) (cmos)	4.70
HM6116-3	2048 x 8 (150ns) (cmos)	4.90
HM6116-2	2048 x 8 (120ns) (cmos)	8.90
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.90
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.90
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	9.95
2-8132	4096 x 8 (300ns) (Qstat)	33.95

LP = Low Power   Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	1.95
UPD411	4096 x 1 (300ns)	2.95
MM5280	4096 x 1 (300ns)	2.95
MK4108	8192 x 1 (200ns)	1.90
MM5298	8192 x 1 (250ns)	1.90
4116-300	16384 x 1 (300ns)	8/10.75
4116-250	16384 x 1 (250ns)	8/10.95
4116-200	16384 x 1 (200ns)	8/11.90
4116-150	16384 x 1 (150ns)	8/13.95
4116-120	16384 x 1 (120ns)	8/26.95
2118	16384 x 1 (150ns) (5v)	4.90
4164-200	65536 x 1 (200ns) (5v)	CALL
4164-150	65536 x 1 (150ns) (5v)	CALL

5V = single 5 volt supply

EPROMS

1702	256 x 8 (1us)	4.45
2708	1024 x 8 (450ns)	3.90
2758	1024 x 8 (450ns) (5v)	5.90
2716	2048 x 8 (450ns) (5v)	3.90
2716-1	2048 x 8 (350ns) (5v)	5.90
TMS2516	2048 x 8 (450ns) (5v)	5.45
TMS2716	2048 x 8 (450ns)	7.90
TMS2532	4096 x 8 (450ns) (5v)	5.90
2732	4096 x 8 (450ns) (5v)	4.90
2732-250	4096 x 8 (250ns) (5v)	8.90
2732-200	4096 x 8 (200ns) (5v)	10.95
2764	8192 x 8 (450ns) (5v)	9.90
2764-250	8192 x 8 (250ns) (5v)	13.95
2764-200	8192 x 8 (200ns) (5v)	23.95
TMS2564	8192 x 8 (450ns) (5v)	16.95
MC68764	8192 x 8 (450ns) (5v)(24 pin)	38.95
27128	16384 x 8Call	Call

5v = Single 5 Volt Supply

74LS00

74LS00	.23	74LS92	.54
74LS01	.24	74LS93	.54
74LS02	.24	74LS95	.74
74LS03	.24	74LS96	.88
74LS04	.23	74LS107	.36
74LS05	.24	74LS109	.38
74LS08	.27	74LS112	.38
74LS09	.28	74LS113	.38
74LS10	.24	74LS114	.38
74LS11	.34	74LS122	.44
74LS12	.34	74LS123	.78
74LS13	.48	74LS124	2.85
74LS14	.58	74LS125	.48
74LS15	.34	74LS126	.48
74LS20	.24	74LS132	.58
74LS21	.28	74LS133	.58
74LS22	.24	74LS136	.38
74LS26	.28	74LS137	.98
74LS27	.28	74LS138	.54
74LS28	.34	74LS139	.54
74LS30	.24	74LS145	1.15
74LS32	.28	74LS147	2.45
74LS33	.54	74LS148	1.30
74LS37	.34	74LS151	.54
74LS38	.34	74LS153	.54
74LS40	.24	74LS154	1.85
74LS42	.48	74LS155	.68
74LS47	.74	74LS156	.68
74LS48	.74	74LS157	.64
74LS49	.74	74LS158	.58
74LS51	.24	74LS160	.68
74LS54	.28	74LS161	.64
74LS55	.28	74LS162	.68
74LS63	1.20	74LS163	.64
74LS73	.38	74LS164	.68
74LS74	.34	74LS165	.94
74LS75	.38	74LS166	1.90
74LS76	.38	74LS168	1.70
74LS78	.48	74LS169	1.70
74LS83	.59	74LS170	1.45
74LS85	.88	74LS173	.68
74LS86	.38	74LS174	.54
74LS90	.54	74LS175	.84
74LS91	.88	74LS181	2.10

74LS189	8.90	74LS363	1.3
74LS190	.88	74LS364	1.9
74LS191	.88	74LS365	.4
74LS192	.78	74LS366	.4
74LS193	.78	74LS367	.4
74LS194	.68	74LS368	.4
74LS195	.68	74LS373	1.3
74LS196	.78	74LS374	1.3
74LS197	.78	74LS377	1.3
74LS221	.88	74LS378	1.1
74LS240	.94	74LS379	1.3
74LS241	.98	74LS385	1.9
74LS242	.98	74LS386	.4
74LS243	.98	74LS390	1.1
74LS244	1.25	74LS393	1.1
74LS245	1.45	74LS395	1.1
74LS247	.74	74LS399	1.4
74LS248	.98	74LS424	2.9
74LS249	.98	74LS447	.3
74LS251	.58	74LS490	1.9
74LS253	.58	74LS624	3.9
74LS257	.58	74LS640	2.1
74LS258	.68	74LS645	2.1
74LS259	2.70	74LS668	1.8
74LS260	.58	74LS669	1.8
74LS266	.54	74LS670	1.4
74LS273	1.45	74LS674	9.6
74LS275	3.30	74LS682	3.1
74LS279	.48	74LS683	3.1
74LS280	1.95	74LS684	3.1
74LS283	.68	74LS685	3.1
74LS290	.88	74LS688	2.3
74LS293	.88	74LS689	3.1
74LS295	.98	74LS783	23.9
74LS298	.88	81LS95	1.4
74LS299	1.70	81LS96	1.4
74LS323	3.45	81LS97	1.4
74LS324	1.70	81LS98	1.4
74LS352	1.25	25LS2521	2.7
74LS353	1.25	25LS2569	4.2

6500

1MHZ

6502	4.90
6504	6.90
6505	8.90
6507	9.90
6520	4.20
6522	7.90
6532	9.90
6545	21.50
6551	10.85

2 MHZ

6502A	6.90
6522A	9.90
6532A	10.85
6545A	26.95
6551A	10.95

3 MHZ

6502B	13.95

6800

68000	58.95
6800	3.90
6802	7.90
6808	12.90
6809E	18.95
6809	10.95
6810	2.90
6820	4.30
6821	3.20
6828	13.95
6840	11.95
6843	33.95
6844	24.95
6845	13.95
6847	10.95
6850	3.20
6852	5.70
6860	9.90
6862	10.95
6875	6.90
6880	2.20
6883	21.95
68047	23.95
68488	18.95

6800 1MHZ

68B00	9.95
68B02	21.25
68B09E	28.95
68B09	28.95
68B10	8.90
68B21	8.90
68B45	18.95
68B50	5.90

8000

8035	5.90
8039	8.90
INS-8060	16.95
INS-8073	49.95
8080	3.90
8085	5.90
8085A-2	10.95
8086	28.95
8087	CALL
8088	38.95
8089	88.95
8155	6.90
8155-2	7.90
8156	6.90
8185	28.95
8185-2	38.95
8741	38.95
8748	49.95
8755	23.95

8200

8202	23.95
8203	38.95
8205	3.45
8212	1.75
8214	3.80
8216	1.70
8224	2.20
8226	1.75
8228	3.45
8237	18.95
8237-5	20.95
8238	4.45
8243	4.40
8250	9.95
8251	4.45
8253	6.90
8253-5	7.90
8255	14.95
8255-5	18.95
8257	7.80
8257-5	8.80
8259	6.85
8259-5	7.45
8271	38.95
8272	38.95
8275	28.95
8279	8.90
8279-5	8.00
8283	8.45
8284	14.95
8286	6.45
8287	6.45
8288	24.00
8289	48.95

Z-80

2.5 Mhz

Z80-CPU	3.90
Z80-CTC	4.45
Z80-DART	9.95
Z80-DMA	13.95
Z80-PIO	4.45
Z80-SIO/0	15.95
Z80-SIO/1	15.95
Z80-SIO/2	15.95
Z80-SIO/9	15.95

4.0 Mhz

Z80A-CPU	4.90
Z80A-CTC	4.90
Z80A-DART	10.95
Z80A-DMA	15.95
Z80A-PIO	4.90
Z80A-SIO/0	15.95
Z80A-SIO/1	15.95
Z80A-SIO/2	15.95
Z80A-SIO/9	15.95

6.0 Mhz

Z80B-CPU	12.95
Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	18.95

ZILOG

Z8132	33.95
Z8671	38.95

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1791	23.95
1793	26.95
1795	48.95
1797	48.95
2791	53.95
2793	53.95
2795	58.95
2797	58.95
6843	33.95
8272	38.95
UPD765	38.95
MB8876	28.95
MB8877	33.95
1691	18.95
2143	17.95

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AY3-1014	6.90
AY5-1013	3.90
AY3-1015	6.90
PT-1472	8.90
TR1602	3.90
2350	8.90
2651	8.90
TMS60**	5.90
IM6402	7.90
IM6403	8.90
INS8250	9.95

INTERFACE

8T26	1.54
8T28	1.84
8T95	.88
8T96	.88
8T97	.88
8T98	.88
DM8131	2.90
DP8304	2.24
DS8835	1.94
DS8836	.98

VOLTAGE REGULATORS

7805T	.74	7905T	.84
78M05C	.34	7908T	.84
7808T	.74	7912T	.84
7812T	.74	7915T	.84
7815T	.74	7924T	.84
7824T	.74	7905K	1.44
7805K	1.34	7912K	1.44
7812K	1.34	7915K	1.44
7815K	1.34	7924K	1.44
7824K	1.34	79L05	.78
78L05	.68	79L12	.78
78L12	.68	79L15	.78
78L15	.68	LM323K	4.90
78H05K	9.90	UA78S40	1.90
78H12K	9.90		

C.T = TO-220 K = TO-3 L = TO-92

DIP SWITCHES

4 POSITION	.84
5 POSITION	.89
6 POSITION	.89
7 POSITION	.94
8 POSITION	.94

IC SOCKETS

	1-99	100
8 pin ST	.12	.10
14 pin ST	.14	.11
16 pin ST	.18	.12
18 pin ST	.19	.17
20 pin ST	.28	.26
22 pin ST	.29	.26
24 pin ST	.29	.26
28 pin ST	.39	.31
40 pin ST	.48	.38
64 pin ST	4.20	call

ST = SOLDERTAIL

8 pin WW	.58	.48
14 pin WW	.68	.61
16 pin WW	.68	.57
18 pin WW	.96	.89
20 pin WW	1.04	.97
22 pin WW	1.34	1.23
24 pin WW	1.44	1.30
28 pin WW	1.64	1.44
40 pin WW	1.94	1.75

WW = WIREWRAP

16 pin ZIF	6.70	call
24 pin ZIF	9.90	call
28 pin ZIF	9.95	call

ZIF = TEXTOOL (Zero Insertion Force)

CRYSTALS

32.768khz	1.90
1.0 mhz	4.90
1.8432	4.90
2.0	3.90
2.097152	3.90
2.4576	3.90
3.2768	3.90
3.579535	3.90
4.0	3.90
5.0	3.90
5.0688	3.90
5.185	3.90
5.7143	3.90
6.0	3.90
6.144	3.90
6.5536	3.90
8.0	3.90
10.0	3.90
10.738635	3.90
14.31818	3.90
15.0	3.90
16.0	3.90
17.430	3.90
18.0	3.90
18.432	3.90
20.0	3.90
22.1184	3.90
32.0	3.90

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100 PCS.	2.00
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SINGLE SIDED DOUBLE DENSITY (WITH JACKETS AND HUB RING)

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Joy Stick

Cooling Fan

Disk Drive

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- AN-236 1.29
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- AN-253 .71
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- AN-262 .78
- AN-264 1.00
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- AN-362 .75
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- AN-5132 1.46
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- HA-1319 1.21
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- HA-1339 1.13
- HA-1339A 1.13
- HA-1342A 1.16
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- HA-1366WR .66
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- HA-1368R .94
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- HA-1377 1.20
- HA-1377A 1.20
- HA-1388 1.41
- HA-1389 .95
- HA-1389R .95
- HA-1392 1.28
- HA-1394 1.67
- HA-1397 1.71
- HA-1398 1.63
- HA-11211 .57
- HA-11215 2.14
- HA-11221 1.60
- HA-11227 .46
- HA-11229 .83
- HA-11235 1.06

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- LA-1111P $ .48
- LA-1130 .71
- LA-1150 .35
- LA-1201 .40
- LA-1210 .61
- LA-1222 .25
- LA-1230 .50
- LA-1231N .69
- LA-1240 .63
- LA-1245 .65
- LA-1320 .54
- LA-1352 .98
- LA-1354 .53
- LA-1357 1.34
- LA-1363 .64
- LA-1364 .71
- LA-1365 .50
- LA-1367 1.53
- LA-1368 1.27
- LA-1369 1.17
- LA-1385 .78
- LA-1387 1.84
- LA-1388 1.64
- LA-1390 1.61
- LA-1460 1.16
- LA-1464 1.46
- LA-2100 1.14
- LA-2101 1.16
- LA-2200 .75
- LA-3101 .60
- LA-3110 .32
- LA-3115 .35
- LA-3120 .35
- LA-3122 .60
- LA-3130 .33
- LA-3133 .60
- LA-3150 .30
- LA-3155 .59
- LA-3160 .29
- LA-3161 .30
- LA-3201 .33
- LA-3210 .26
- LA-3300 .78
- LA-3301 .68
- LA-3350 .23
- LA-3361 .45
- LA-3365 .44
- LA-3370 .64
- LA-3375 .78
- LA-3380 1.20
- LA-4030 .75
- LA-4031P .55
- LA-4032P .69
- LA-4050 1.09
- LA-4051P 1.13
- LA-4100 .35
- LA-4101 .41
- LA-4102 .41
- LA-4110 .49
- LA-4112 .43
- LA-4120 1.14
- LA-4121 1.06
- LA-4125 1.09
- LA-4126 1.07
- LA-4135 .75
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- LA-4140 .31
- LA-4160 .53
- LA-4170 .53
- LA-4175 .53
- LA-4182 .86
- LA-4185 1.14
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- LA-4200 .64
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- LA-4220 .59
- LA-4230 .93

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- LA-4400 1.50
- LA-4420 .64
- LA-4422 .75
- LA-4430 .53
- LA-4440 1.20
- LA-4460 1.38
- LA-4461 1.38
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- M-51515BL 1.43
- M-51516 1.16
- M-51517 1.21
- M-51518 1.06

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- MB-3715A 1.01
- MB-3730M 1.29
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- TA-7210 1.78
- TA-7212 .77
- TA-7214 1.69
- TA-7215P 1.28
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- TA-7223P 1.10
- TA-7224 1.64
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- 2SD-669 .25
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- 2SD-718 .83
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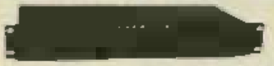
SOLID STATE STEREO REVERBERATION AMPLIFIER



Specifications: • Total harmonic distortion less than .05% • Frequency response 10 Hz to 50K Hz -1dB • S/N Ration 90dB • Reverberation time 0 to 3 sec • Input 150MV/50K ohm • Max. input 2V • Accepts input from tape, phono, or aux.
Includes and LED Reverb Level display. Kit comes with all electronic components, transformer and instructions, and 19" rack mount cabinet.

Model TA-2400 .... $89.95

AMATEUR MICROWAVE Receiver System 1.9-2.5 GHZ

MICROWAVE RECEIVER SYSTEM

- Commercial grade construction • Sturdy Parabolic aluminum reflector antenna • High gain 30 dB • Line of sight distance 45 miles!
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Microwave Preamp! NEW KIT

Use with PS-3 Kit. Adds 20-25 db gain to boost reception distance.

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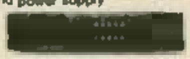
Phono: 2MV a7K ohms **Aux:** 130MV 50K ohms **Tuner:** 130MV 50K ohms **Tape:** 130MV 50K ohms. **Graphic Equalizer Control:** 10 Band Slide Control **Frequency Bands:** 31.5Hz 63Hz 125Hz 250Hz 500Hz 1KHz 2KHz 4KHz 8KHz 16KHz also with on panel selector for Phono, Tuner, Aux 1 and Aux 2. **Power Supply:** 117 VAC. Kit comes with all electronic components, transformer, instructions and a 19" rack mount type metal cabinet.

TA-2500 (Kit) $119.00

20 STEP LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 40 3-color LED sto indicate sound level output of your amplifier from -57 dB to 0 dB. Comes with an attractive silk screen printed panel. Has selector switch to allow floating or gradual output indicting. Kit includes all parts. Front panel and power supply.



TY-45 (Kit)
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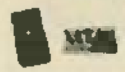
SPY EAR

A very popular device designed to listen to sounds & voices through rooms or 3 ft. thick concrete walls.
Place listening sensor against wall and earphone in ear. Adjust volume control! Clearly hear things you may not want to!

CM-8 .... $89.95

INFRA-RED REMOTE CONTROL SWITCH KIT

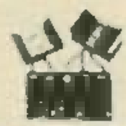


Infra-red Remote Control switch can be used to control appliances up to 500 W.
The TK-41 has affective control up to 10 meters. No antenna needed. Features latest IC controller which excludes interferences from light or AC pulse signal.

TK-41 Kit $24.95

STEREO AMP KIT 160 Watt Total 80W + 80W

This is a solid state all transistor circuitry on board stereo amplifier. Power output employs 2 pairs of matching Derlington transistors. T.H.D. less than .05% between DC to 200 KHZ. Power supply requires 30 VCT 2 amp · FMR



TA-802
$39.95

Transformer (optional)
$9.95

LOW TIM DC STEREO PRE-AM KIT TA-2800

Incorporates state of D.C. design that gives a frequency response from OHz 100KHz + .5dB • Features tone defeat switch, loudness, treble, midrange, bass, balance • Contains quad BiFet op-amp to develop T.H.D. of .005% at rated output • Input sensitivity phone 2.5 MV tuner, aux, tape play 100MV/100K • Power supply ± 15 volt DC at 2A. Kit comes with regulated power supply, all you need is a 15-20 VCT 2 amp XFMR

TA-2800 ONLY $44.50
XFMR
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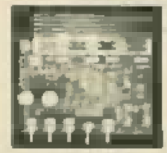
FEATURES:
- 25 dB gain!
- Kit

Your reception will dramatically improve! This unit will enable you to pull in signals you never knew were there! For both indoor and outdoor use. Input and output impedance 75 ohm. No adjustment. Easy assembly.

JH-0 Kit $23.95

TA-1500 200 WATT/CHANNEL STEREO AMP & PREAMP KIT



More power for stereo blaster! 100 watts/channel, stereo preamp built-in. Trebel, midrange, bass, mic volume. Balance and volume are standard controls on the preamp. Mic input allows you to use it as a P.A. **Specifications:** 100 w x 2 into 8 Ohms. **Freq. Range:** 0-100Khz ± 3dB. **Thd:** .01%. **S/N Ratio:** 80 dB. **Sensitivity:** 3 mu into 42K. **Power Requirements:** 24-40 VAC

TA-1500 .... $72.00

160 WATT DC STEREO AMP/PREAMP KIT

The TA-800 is an 80 watt/channel preamp and power amp with tone control, high, middle and bass controls. Volume and balance control are built-in. On board power supply requires only 60 volt C.T. XFMR. **Specifications:** 50W x 2 into 8 Ohms. **Freq. Range:** OHZ-100 Khz ± 3dB. **Thd:** .01%. **S/N Ratio:** 80 dB. **Sensitivity:** 3 mu into 47 K. **Power Requirements:** 24-40 VAC.

TA-800 .... $65.00

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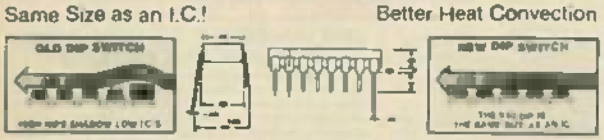

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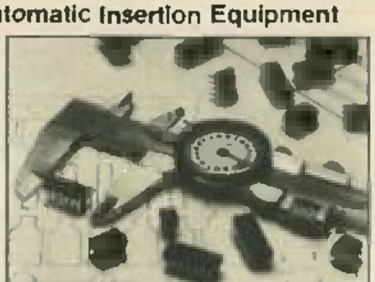

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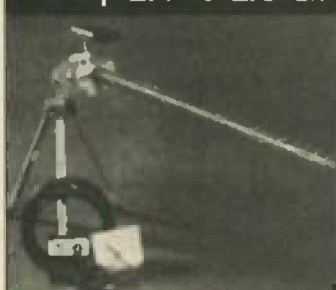

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CIRCLE 65 ON FREE INFORMATION CARD

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NO TRANSFORMER REQUIRED. UHF-VHF-FM-CB CHANNEL. IDEAL FOR COLOR-FM MULTIPLEX & ALL TV-FM FUNCTIONS. MADE OF UNION CARBIDE. MOISTURE PROOF WEATHER SEALED POLY JACKET

W-0350 50 FT WT 1 LB $3.40
W-0355 50 FT WT 1 LB $3.70
W-0360 100 FT WT 2 LB $6.70

NPN POWER TRANSISTOR

80 VOLT 7 AMP 115 WATT
HFE 15-60 TO-3
GREAT REPLACEMENT FOR AUDIO AMPS, POWER SUPPLIES, ETC.
49¢ 10/$4.00 100/$40

8/16 TRACK TAPE HEADS

INSTRUMENTATION MFR PAID OVER 1,000 PER HD WITH A RESPONSE >80,000 HZ AT 7 1/2 IPS. THE HOBBYIST PERFORMS 8 TRACKS ON 1" TAPE. TWO HEADS CAN BE STAGGERED TO GET 16 TRACKS

NEW UNUSED $35 EACH
P-8 8 TRK RECORD
P-9 8 TRK PLAY

THIS BATCH IS NEW, REMOVED FROM EQUIPMENT IN LITTLE OR RASH, NOTHING SERIOUS
YOUR CHOICE $15 EACH
P-5 1/2" DIGITAL REC/PLAY
P-6 1/2" ERASE
P-7 1" RECORD
P-8 1" PLAY
P-1 3 HEAD SURPRISE LIST
ALL 7 TRK HEADS

CABLE TV MIDBAND Converter

Z-1085 WT 3 LB
DOES NOT DESCRAMBLE
NEW LOW PRICE $9.95

BRAND NEW PRODUCTION ACL UNIT TAKES THE HIDDEN CHANNELS ON MIDBAND AND MOVES THEM TO CHANNEL 7 THRU 13. SWITCH SELECTS NORMAL OR MIDBAND. JUST PUT IN LINE WITH YOUR CABLE AND SWITCH BACK & FORTH. 115VAC WITH OUTLET FOR YOUR TV. ONLY TWO CONNECTIONS IN & OUT. OVERALL SIZE IS 5 X 8 5/8 X 2" HIGH

AC ADAPTERS

GREAT DEAL ON ADAPTERS FOR YOUR DECODERS AND PROJECTS. SIZES ARE APPROX 2 X 2 X 1 1/2" YOUR CHOICE

12VAC 300MA — 6 FOOT CABLE TERMINATED IN A 2.5mm PLUG — T-6192
18VAC 250MA — 6 CABLE, STRIPPED & TINNED LEADS. UL LISTED — T-6194
24VAC .46 AMP — SCREW TERMINAL OUTPUTS — T-0120

YOUR CHOICE $2.95 EACH WT 0.5 LB

5 VOLT 18 AMP POWER SUPPLY

$49
P-1206 WT 12 LB
POWERTEC MODEL 2005-1850 FEATURES ADJUSTABLE VOLTAGE, CURRENT LIMIT, OVERVOLTAGE PROTECTION. BRAND NEW

C 126 D

400 VOLT 12 AMP SCR
TO-220 CASE
99¢ 10/$9

WIREWRAP IC SOCKETS

		1	10	100
S-1405	14 PIN	55	49	41
S-1605	16 PIN	60	54	45
S-1805	18 PIN	75	68	57

24 VDC 2.3 AMP POWER SUPPLY

LAMBDA TYPE LDS-Y-24. FEATURE 120/240 VAC OPERATION, VOLTAGE & CURRENT LIMIT ADJ. REMOVED FROM EQUIPMENT, GREAT CONDITION - GREAT FOR DISC DRIVES. ORDER TODAY!!
P-1E20 WT 5 LB $29

MODULAR PHONE JACK

A-5308 WT 0.1 LB 2/$1
STANDARD TELEPHONE JACK HAS 5-1/2" COLOR CODED LEADS TERMINATED IN SPADE LUGS. AT THIS PRICE YOU CAN PUT A PHONE IN EVERY ROOM

8 OHM 5 Watt WEATHERPROOF 5" PAGING HORN

$6.95 WT 1.2 LB S-1450
SUPER QUALITY ANODIZED ALUMINUM HORN AT A BARGAIN PRICE! 8 OHM, 5 WATT, INDIVIDUALLY PACKAGED

DIP RELAY 5VDC SPST

NORMALLY OPEN
R-1210 WT 0.1 LB $1.95

ELECTRONIC BARGAINS

IF YOU'RE NOT ON OUR MAILING LIST, YOU'RE MISSING OUTSTANDING BUYS ON THE FINEST IN ELECTRONIC PARTS FOR THE BUILDER. IN 8 YEARS OVER 250,000 HOBBYISTS HAVE DISCOVERED WHERE TO FIND USEFUL, UNIQUE OR DOWNRIGHT STRANGE ELECTRONICS AT GIVEAWAY PRICES
WHY NOT SEND FOR OUR CATALOG TODAY — IT'S FREE!

LM 384 5W AUDIO AMP

Po = 5.5 w
THD = .25%
BW = 450 KHz
Av = 34 db
Vcc = 28 VDC MAX
14 PIN DIP 39¢
STOCK UP NOW!
DATA SHEET 25¢

Ammonium Persulfate ETCHANT

FAST & EASY TO USE. JUST ADD WATER & ETCH. TURNS BLUE WHEN FULL OF COPPER. 1 LB MAKES 2 GALLONS
W-2240 $1.95 LB 10 LBS/$17.00

POWER SUPPLY

12-15 VOLT 1.6 AMP
COMMERCIAL POWER SUPPLY STANDARD POWER TYPE SPS 30-15. BRAND NEW, INDIVIDUALLY BOXED. 115V/230V INPUT. VOLTAGE REGULATED, CURRENT LIMIT
SUPER SPECIAL $15
Z-3015 3 LB

LARGE RED LEDS

L-1466 WT 0.1
10/$1 100/$9
PRIME, BRIGHT UNIFORM LED'S ARE GREAT FOR LIGHTING UP YOUR PROJECTS. 0.170" DIA. 0.300" LONG. FULL LEADS, FLANGELESS DESIGN

DIAMONDBACK ELECTRONICS COMPANY

PO BOX 12095 Dept 102
SARASOTA, FLA. 33578
Phone Orders (813) 953-2829

CONTINENTAL US ADD $1.60 FOR THE FIRST LB & 50¢ FOR EACH ADDITIONAL LB. FLA ADD 5% TAX. WEST COAST ADD $1.00 FOR THE FIRST POUND & 50¢ FOR EACH ADDITIONAL POUND

MAIL ORDER $7 MINIMUM
COD & CREDIT CARD $15 MINIMUM

CIRCLE 24 ON FREE INFORMATION CARD

QUALITY SPECIALS

SOPHISTICATED I.C.'S

DATA SHEETS ARE PROVIDED FREE WITH ALL INTEGRATED CIRCUITS LISTED BELOW

PART #	DESCRIPTION	PRICE (ea)
[illegible]	TOUCH SENSITIVE LIGHT DIMMER SWITCH. MOMENTARY TOUCH TO SENSOR PLATE TURNS LIGHTS ON OR OFF. PROLONGED TOUCH GRADUALLY DIMS OR BRIGHTENS. A SLOW CLOCK INPUT ALLOWS AUTOMATIC SLOW DIMMING TO OFF. IDEAL FOR SOLVING CHILD'S FEAR OF DARK BEDROOM	[illegible]
[illegible]	CMOS DIVIDER IC HAS TRUTH TABLE SELECTABLE INPUT TO YIELD DIVIDE BY [illegible] OUTPUTS	[illegible]
[illegible]	D.C. TO [illegible] MHZ SIX DECADE UP COUNTER WITH 7 DECADE LATCH AND MULTIPLEXED BCD OUTPUTS AND DIGIT STROBES. ACCESS TO [illegible] LATCHES ALLOWS ATTACHMENT OF PRESCALERS FOR COUNTING TO [illegible] MHZ	[illegible]
[illegible]	[illegible] AUTOMOTIVE MARINE AND THEFT DIGITAL LOCK CIRCUIT. HAS [illegible] DIGIT COMBINATIONS WITH [illegible] MICROAMP STANDBY. SAVE MODE FOR FAULT [illegible]	[illegible]
[illegible]	MULTIPLIER DETECTOR IC FOR ANALOG SIGNAL PROCESSING. CONTAINS 4 QUADRANT ANALOG MULTIPLIER MODULATORS AND INDEPENDENT HIGH GAIN OP AMP. DIFFERENTIAL X-Y INPUTS. APPLICATIONS FOR PHASE DETECTION [illegible] PLL DESIGN IN SYNCH AM DETECTION [illegible] TRIANGLE TO SINEWAVE CONVERSION [illegible]	[illegible]
[illegible]	PRECISION WAVEFORM GENERATOR IC PRODUCES SINE, SQUARE, TRIANGLE, SAWTOOTH OR PULSE WAVEFORMS WITH MINIMUM EXTERNAL COMPONENTS FROM [illegible] HZ TO [illegible] MHZ FOR PRECISION TEST INSTRUMENTS	[illegible]
[illegible]	HIGH FREQUENCY [illegible] LOOP (PLL) IC FOR BOTH ANALOG AND DIGITAL COMMUNICATIONS [illegible] DEMODULATION, FREQUENCY SYNTHESIS [illegible] MODEMS, ETC. TTL ECL/LOGIC COMPATIBLE	[illegible]
[illegible]	INTRUSION ALARM [illegible] TRANSCEIVER IC. NEEDS IR LED, PHOTO DIODE [illegible] PARTS TO BE COMPLETE OPTICAL TRANSCEIVER [illegible] OPEN TO AMBIENT LIGHT [illegible] ALARMS	[illegible]

HALL EFFECT DEVICES

PART #	DESCRIPTION	PRICE (ea)
[illegible]	HALL EFFECT [illegible] RANGES TOO SMALL TO OPERATE [illegible] OUTPUT IS A LINEAR FUNCTION OF MAGNETIC FIELD INTENSITY. MONOLITHIC IC INCLUDES HALL CELL, AMPLIFIER AND VOLTAGE REGULATOR FOR 4.5 [illegible] VDC SOURCE. HIGH SENSITIVITY AND FLAT RESPONSE. 8 PIN [illegible]	[illegible]
[illegible]	SAME AS [illegible] BUT WITH PROVISION FOR NULLING THE OUTPUT OFFSET VOLTAGE. 8 PIN DIP	[illegible]
[illegible]	HALL EFFECT SENSOR WITH DIFFERENTIAL OUTPUT A LINEAR FUNCTION OF MAGNETIC FLUX. SUPPLIED WITH INDIVIDUAL CALIBRATION CHART AT 25 DEGREES CELSIUS & 5 VOLTS FOR CALIBRATING, TESTING AND ALIGNING MAGNETIC SENSING DEVICES. 8 PIN DIP	[illegible]

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NE564	2.75
LM 301	.49
LM 565	.95
MC 1330	1.25
MC 1350	1.15
MC 1458	.49
MC 1496	1.00
LM 1889	1.75
7805	.80
7808	.50
7812	.80
7815	.80
7818	.80
MV 2109	.69
2N2222	.30
MC 1349	1.79

SPECIALS ON PRIME IC's

NE564
$2.75 ea. 10/$25. 100/$195

LM1889
$1.75 ea. 10/$16.50, 100/$150

MC1496
$1.00 ea. 10/$9, 100/$75

DELUXE PARTS ASSORTMENTS

#1 Resistors & Trimpots
55 ¼ watt 5% resistors & 5 PT-15 10K trimpots. 1 each - 51, 75, 100, 470, 1.5K, 3.6K, 51K, 470K, 13-1.2K, 2-220, 3-100K, 6-330, 6-12K, 7-910, 8-3.3K, & 14-4.7K
$4.50 ea. 10/40.00

#2 Capacitor "A"
Monolythics - 1-560pf, 7-.1 mfd & 1-.22 mfd Silver Micas - 2-10pf, & 1 each of 43pf, 110pf, 560pf, 1200pf, 3000 or 3300pf
$4.95 ea. 10/45.00

#3 Capacitor "B"
Mylars 4-.001, 2-.047, 29-.01 Radial lytics 3-10 mfd 16V, 1-1000 mfd 50V, 1-2200 mfd 35V Disc Caps 1 each of 5, 12, 27, 36, 110, 330pf, 2-120pf, 3-39pf, 3-220pf, and 1 Vari Cap 5-35pf
$7.50 ea. 10/70.00

#4 Coil & Choker
1 each of 15, 33, and 100 (uh) micro henries chokes, 1-variable RF coil (same as #49A537MPC)
$3.25 ea. 10/30.00

#5 IC's Sockets, & Semi's
1 each of: NE564, LM565, MC1330, MC1350, MC1496, LM1889, 7812, 7818, 2N2222A, MV2109, heat sink 2-MC1458, 8-1N4002, 4-8 pin, 2-14 pin, 1-16, & 1-18 pin socket
$13.88 ea. 10/125.00

#6 Misc Hardware
LED & holder, fuse & holder, line cord, grommet, SPST switch, DPDT switch, 2-F61 conn. & lugs, knob, 4-spacers, 6-screws & nuts, 2'RG-174, matching transformer w/nut
$5.95 ea. 10/57.50

ASTEC VIDEO MODULATOR
Video & Audio Inputs
Chan 3 or 4 Output
Model UM1285-8
W/specs $8.25

UHF TUNER
Mechanical Detent Tuning
Chan 14-83 12 VDC 300 Ohm Input
45 MHZ output $2.95 ea. 4/10.00

SILVER MICA CAPS
10 PF, 43 PF, 110 PF, 560 PF,
1200 PF, 35¢ ea, 10/3.00, 100/25.00
3000 PF 80¢ ea, 10/7.00, 100/60.00

VOLUME DISCOUNT

$ 10.00 - 499.00	NET	1000.00 - 4999.00	-5%
500.00 - 999.00	-2%	5000.00 & up	-10%

"F" CONNECTORS
F-59 20¢ ea. 10/1.50, 100/10.00
F-61 35¢ ea. 4/1.00, 100/22.00
F-81 35¢ ea. 3/1.00, 100/29.00

UHF AMP KIT
25db Gain Stripline PC board using (2) BFR-90's
Complete (no enclosure) $10.95
Power supply for above $3.49

THUMBWHEEL TRIMMER POTS VERTICAL MOUNT
OHMS 500, 1K, 2K, 5K, 10K, 25K
50K, 100K, 200K, 500K, 1 MEG
4/$1.00 100/$20.00

FUNCTION GENERATOR KIT
Uses XR-2206 IC 1 Hz to 100 kHz.
Complete with PC Board & all parts except power supply and enclosure $19.95

BYPASS CAP SPECIAL
.1 MFD - 50vDC 100/$5.00 1000/37.50

VERNIER PANEL POTS
Multi-turn, ¼" shaft
500 ohm, 1K, or 10K $4.49

BRIDGE RECTIFIERS
35A 200 PIV $2.00
25A 100 PIV $1.50
3A 400 PIV $1.00

MYLAR CAPS
50 volts

.001 mfd	10¢ ea.	
.01 mfd		100/7.00
.047 mfd		1000/48.00
.1		

MISC. SPECIALS
2200 mfd 40V Axial Cap 79¢
470 mfd 16V Radial Cap 10/1.00
10 mfd 35V Radial Cap 12/1.00
7808 8 volt Regulator 49¢
28 Pin IC Socket 10/1.00

POWER TRANSFORMERS
Pri: 115V AC
Sec: 24 volts @ .350 A
Dim: 2¼ x 1⅞ x 2 H
$1.95 ea. 10/$15.00 100/$125.00

10 TURN POT
10K ohm, Panel Mt.
$6.95

DIGITAL VOLTMETER KIT
3 DIGIT, 0 to 99.9 VDC.
Uses CA3161E & CA3162E
Complete with PC Board and parts, except power supply and enclosure. $24.95

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75/300 Outdoor/Indoor
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1K — 5K R/A — 10K
99¢ ea.

SOLID CARBIDE PC DRILL
#55 1/8 in. SHANK FOR USE WITH DREMEL TOOL
Special 79¢ ea 10/5.00

RF COIL
Same as #49A537MPC
$1.25 ea 10/10.00

CIRCLE 90 ON FREE INFORMATION CARD

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AY-3-1015

AY-3-1015 Single-Supply UART. Full-duplex universal transceiver accepts asynchronous serial characters and converts to a parallel format, and vice versa. Selectable baud rate, bits per character, stop bits and parity. 4.75-5.25VDC. 40-pin with specs, data. Reg. $5.95. 276-1794 .... Sale 3.69

AY-5-8116 Dual Baud Rate IC. Generates the full spectrum of asynchronous/synchronous data communication frequencies for use with UARTs such as #276-1794, above. On-chip oscillator requires crystal, available separately. Single 5 VDC supply. 18-pin with specs, data. Reg. $8.95. 276-1795 .... Sale 5.55

Voltage Regulator ICs

Type	Adjustable	Cat. No.	Each
LM723	0 to 40 VDC	276-1740	.89
LM317T	1.2 to 37 VDC	276-1778	2.79

Type	Fixed Output	Cat. No.	Each
7805	+5 VDC	276-1770	1.59
7812	+12 VDC	276-1771	1.59
7815	+15 VDC	276-1772	1.59
7905	−5 VDC	276-1773	1.59
7912	−12 VDC	276-1774	1.59

4000-Series CMOS ICs

Type	Cat. No.	Each
4001	276-2401	.79
4011	276-2411	.79
4013	276-2413	.99
4017	276-2417	1.49
4023	276-2423	.99
4049	276-2449	.99
4066	276-2466	.99

TTL Digital ICs

Type	Cat. No.	Each
7400	276-1801	.59
7404	276-1802	.79
7408	276-1822	.79
7447	276-1805	1.19
7490	276-1808	.89

Replacement Transistors

Type		Cat. No.	Each
2N1305	PNP	276-2007	1.19
MPS2222A	NPN	276-2009	.79
PN2484	NPN	276-2010	.89
MPS3904	NPN	276-2016	.69
TIP31	NPN	276-2017	.99
TIP3055	NPN	276-2020	1.59
MPS2907	PNP	276-2023	.79
MJE34	PNP	276-2027	1.49
2N3053	NPN	276-2030	.89
MPS3638	PNP	276-2032	.79
TIP120	NPN	276-2068	1.29
2N3055	NPN	276-2041	1.99
MJ2955	PNP	276-2043	2.19
2N4124	NPN	276-2057	.59
2N4401	NPN	276-2058	.59
MPSA06	NPN	276-2059	.59
MPSA13	NPN	276-2060	.59
MPSA42	NPN	276-2061	.69
MU4891	UJT	276-2029	.99
2SD313	NPN	276-2048	1.79
2SC945	NPN	276-2051	.79
2SC1308	NPN	276-2055	7.95
2N3819	N-FET	276-2035	.99
MPF102	N-FET	276-2062	.99

Operational Amplifiers

Type		Cat. No.	Each
741	(Single)	276-007	.79
MC1458	(Dual)	276-038	.99
LM324	(Quad)	276-1711	1.29
TL082	(Dual)	276-1715	1.89
TL084	(Quad)	276-1714	2.99
LM3900	(Quad)	276-1713	1.39
LM339	(Quad)	276-1712	1.49

Audio Power Amplifiers

Type	Cat. No.	Each
LM383/TDA2002	276-703	3.19
LM386	276-1731	1.09
TA7205AP	276-705	2.99
LM380	276-706	1.59

Tantalum Capacitors

- 20% Tolerance
- Standard IC Pin Spacing

µF	WVDC	Cat. No.	Each
0.1	35	272-1432	.49
0.47	35	272-1433	.49
1.0	35	272-1434	.49
2.2	35	272-1435	.59
10	16	272-1436	.69
22	16	272-1437	.79

Electrolytic Capacitors

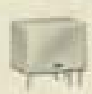
Axial Leads

µF	WVDC	Cat. No.	Each
4.7	35	272-1012	.49
10	35	272-1013	.59
22	35	272-1014	.69
47	35	272-1015	.69
100	35	272-1016	.79
220	35	272-1017	.89
470	35	272-1018	.99
1000	35	272-1019	1.59
2200	35	272-1020	2.49
3300	35	272-1021	2.99
4700	35	272-1022	3.59
470	50	272-1046	1.59
1000	50	272-1047	1.99
2200	50	272-1048	3.49

PC-Mount Leads

µF	WVDC	Cat. No.	Each
220	16	272-956	.79
470	16	272-957	.89
1000	16	272-958	.99
4.7	35	272-1024	.49
10	35	272-1025	.59
22	35	272-1026	.69
47	35	272-1027	.69
100	35	272-1028	.79
220	35	272-1029	.89
470	35	272-1030	.99
1000	35	272-1032	1.59
100	50	272-1044	.89

Mini SPDT Relays

A  B  C 

$1^{1}/_{32} \times {}^{3}/_{4} \times {}^{1}/_{4}$" $^{3}/_{4} \times {}^{9}/_{16} \times {}^{3}/_{8}$" $^{9}/_{16} \times {}^{25}/_{32} \times {}^{1}/_{2}$"

Fig.	Coil	Contacts	Cat. No.	Each
A	5 VDC	1A, 125 VAC	275-240	1.99
B	5 VDC	2A, 125 VAC	275-243	2.49
C	5 VDC	3A, 125 VAC	275-246	2.99
C	12 VDC	3A, 125 VAC	275-247	2.99

Computer Connectors

Repair or "roll your own" extension cords and save!

Type	Positions	Cat. No.	Each
Solder Sub-D Male	9	276-1537	1.99
Solder Sub-D Female	9	276-1538	2.49
Hood for Above	9	276-1539	1.99
Solder Sub-D Male	15	276-1527	2.49
Solder Sub-D Female	15	276-1528	3.49
Hood for Above	15	276-1529	1.99
Solder Sub-D Male	25	276-1547	2.99
Solder Sub-D Female	25	276-1548	3.99
Hood for Above	25	276-1549	1.99

Power Transformers

120VAC Primaries

Type	Volts	Current	Cat. No.	Each
Mini	6.3	300 mA	273-1384	2.59
Mini	12.6	300 mA	273-1385	2.79
Mini	25.2	300 mA	273-1386	2.99
Mini	12.6 CT	450 mA	273-1365	3.59
Mini	25.2 CT	450 mA	273-1366	3.99
Std	6.3	1.2A	273-050	3.79
Std	12.6 CT	1.2A	273-1505	3.99
Std	25.2	1.2A	273-1480	4.39
H.D.	12.6 CT	3.0A	273-1511	5.99
H.D.	25.2 CT	2.0A	273-1512	6.29
H.D.	18.0 CT	2.0A	273-1515	6.99

Dynamic Transistor Checker

Tests in or Out of Circuit

Only **14^95**

The quick, easy way to test small-signal and power types and match similar transistors. Lamp indicates relative gain, opens and shorts. Output for meter or scope, too. $2^{3}/_{4} \times 4^{3}/_{8} \times 1^{3}/_{16}$". Requires "AA" battery. 22-025 .... 14.95

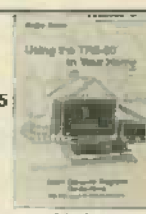
21-Range Digital Multimeter

59^95

Continuity Beeper Also Indicates Over-Range —Really Saves Time!

Zero-adjust for precise low-resistance measurements. "Diode check" for testing semiconductors. Overload protected. Measures to 1000 volts AC, 500 volts DC, 200 mA AC and DC, resistance to 20 megohms. $6^{3}/_{8} \times 3^{1}/_{8} \times 1^{3}/_{8}$". With spare fuse, leads. Requires two "AA" batteries. 22-191 .... 59.95

Home Computer Programs



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CIRCLE 61 ON FREE INFORMATION CARD

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume any responsibility for errors that may appear in the index below.

CIRCLE 36 ON FREE INFORMATION CARD

)K's Hot Tip for Desoldering Problems

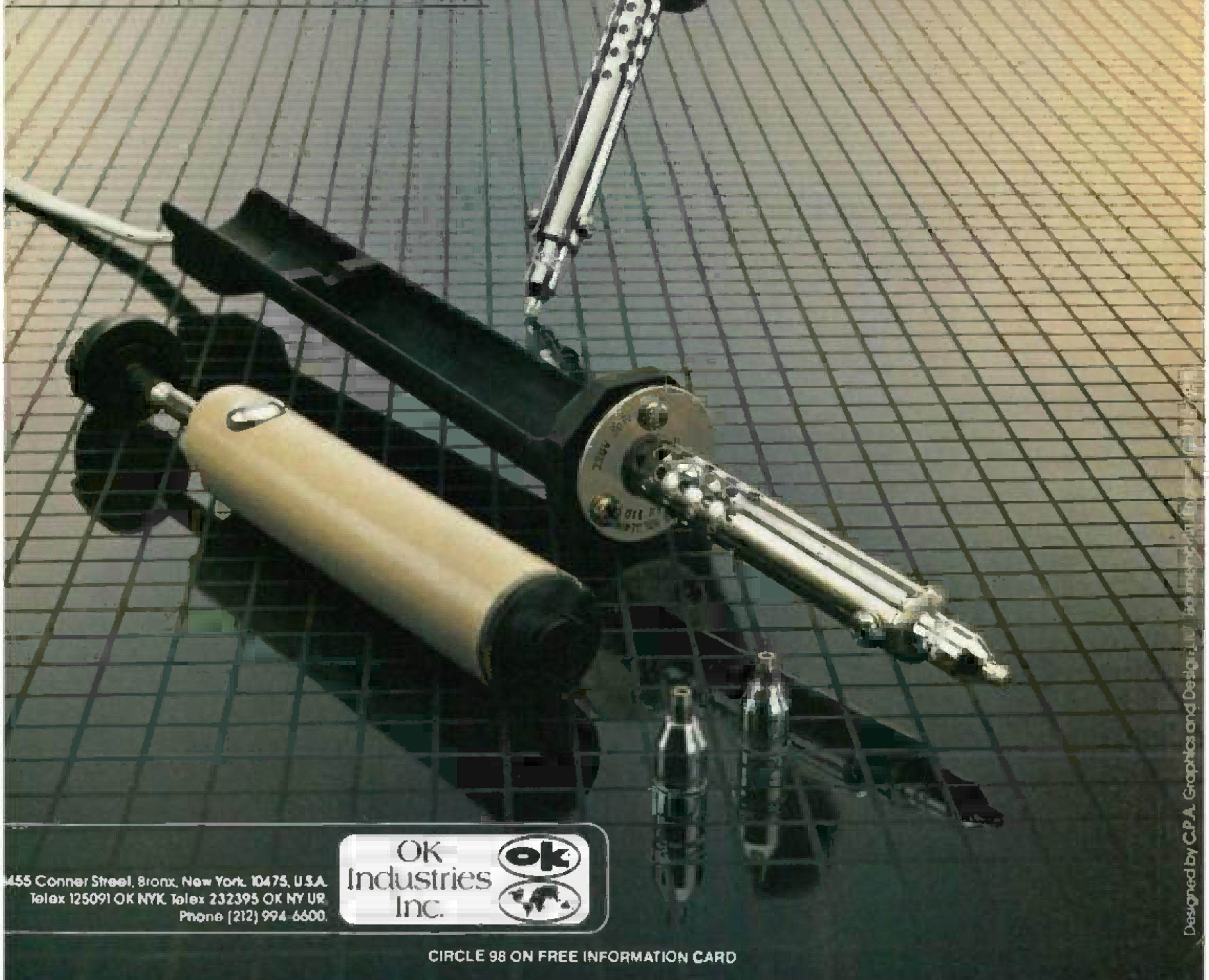
A-6 DESOLDER IRON

*volutionary new electric desoldering iron combines the ease and
rtability of a hand-held, manual, desolder pump, with performance of
industrial desolder station. This unique AC powered compact tool
itures portable, one-hand desoldering eliminating the need for
parate soldering iron and desolder pump. No shop air required.
sential for all tool kits, field service technicians, and repairmen, as well
production applications. Vacuum chamber is easily removed for
aning or replacement. Replacement tips available. Tool is supplied
th SAT-6-059 tip; diameter .059 inch (1.5mm).*

EATURES:

Self contained suction power and heating element.
Economical.
Lightweight 4oz. (113gms).
Compact size 10¼ inches (26cm).
Replacement nozzles available.

ODEL NO.	INPUT VOLTAGE	
SA-6-115	115V AC 50/60Hz	
SA-6-230	230V AC 50/60Hz	
NOZZLE	NOZZLE HOLE DIAMETER	
	INCH	MM
AT-6-059	.059	1.5
AT-6-070	.070	1.77



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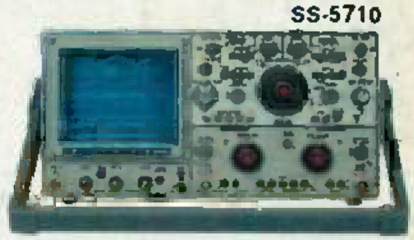
SS-5710



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