

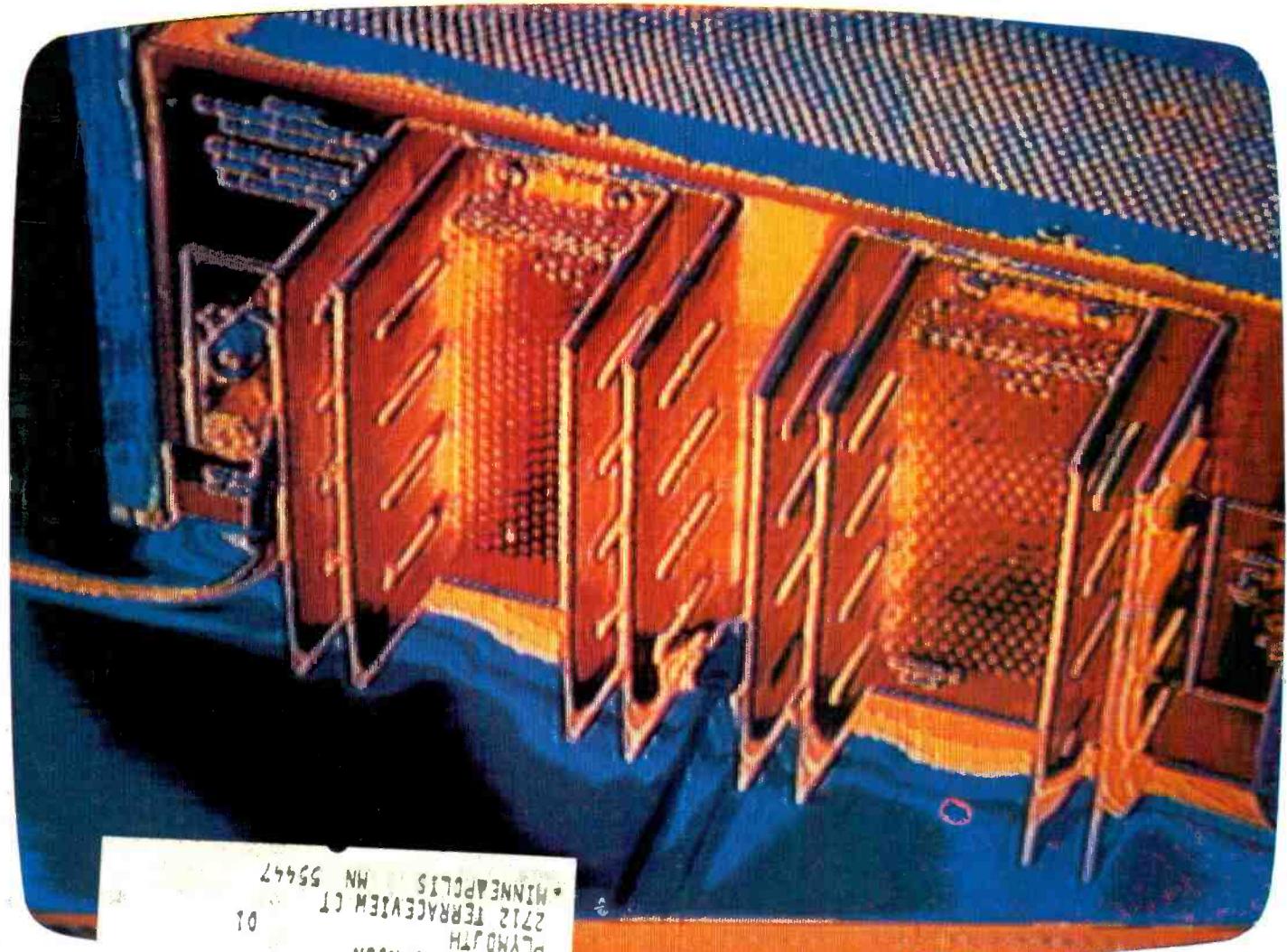
# Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

JANUARY 1981/95¢

Build a Car Battery Trickle Charger  
Developing a Computerized Phone Dialer  
How to "Type" Morse-Code Signals

## PE Tests 8 Audio Power Amplifiers



490664 JHN 27121095 0410 JAN81  
MR ROGER JOHNSON  
PLYMOUTH  
2712 REARACEVIEW CT  
MINNEAPOLIS MN 55447  
01

CARL WARREN EXAMINES:

Heath's H-89 "All-In-One" Computer





# Edison had over 1,800 patents in his name, but you can be just as inventive with an Apple.

Apple is the company with the brightest ideas in hardware and software *and* the best support — so you can be as creative with a personal computer system as Edison was with the incandescent bulb.

## How Apple grows with you.

With Apple's reliable product family, the possibilities of creating your own system are endless. Have expansion capabilities of 4 or 8 accessory slots with your choice of system.

Expand memory to 64K bytes or 128K bytes. Add an A to D conversion board. Plug into time sharing, news and electronic mail services. Use an IEEE 488 bus to monitor lab instruments. Add 4 or 6 disk drives — the 5 1/4", 143K bytes, high-speed, low-cost drive that's the most popular on the market.

## Apple speaks many languages.

Since more than 100 companies create software for Apple, you'll have the most extensive library in the personal

computer world. Want to write your own programs? Apple is fluent in BASIC, Pascal, FORTRAN, PILOT and 6502 assembly language.

There's even a series of utility programs called the DOS Tool Kit that not only lets you design high-resolution graphic displays, but lets you work wonders with creative animation.

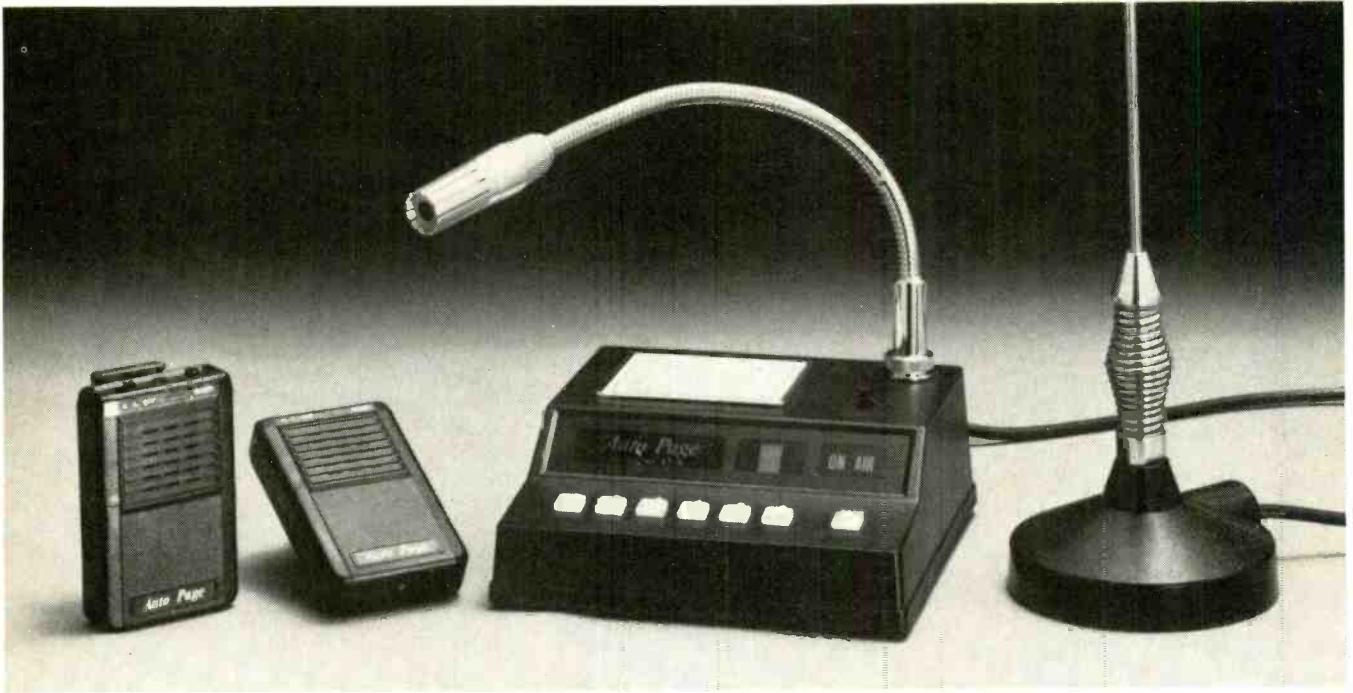
## More illuminating experiences in store.

You won't want to miss all the Apple products being introduced at your computer store all the time. Don't let history pass you by. Visit your nearest Apple dealer or call 800-538-9696. In California, 800-662-9238. Or write: Apple Computer, 10260 Bandley Drive, Cupertino, CA 95014.

**apple computer inc.**



CIRCLE NO. 3 ON FREE INFORMATION CARD



# Beep Free

*Doctors use them and so do many businessmen. The pocket beeper now takes a giant step forward with the introduction of the own-your-own system.*

You're away from your desk in a meeting. Suddenly your pocket beeper starts beeping. You pull it out of your pocket, press a button and you hear your secretary's voice with a message.

"Big deal," you say. "What's so special about that. There are thousands of pagers like it in use." Yes, but this one is different.

#### TOTAL CONTROL

In the first place, you own the entire system. You own the transmitter and the beepers. Secondly, the system is inexpensive. It costs less than leasing one traditional beeper for a year. And finally, it solves the problems that other pagers can't solve—but more on that later.

The new Auto Page paging system consists of a transmitter that sits on your secretary's desk. When a call comes in, she presses a button which sends out a signal to your paging device. The antenna rests on your secretary's file cabinet and plugs easily into the transmitter so there's no installation.

#### MAKES NO SENSE

But like many breakthrough products the Auto Page System has limitations. The system was designed for office, factory, farm or home use. So its range is limited to one mile with voice and two miles with tone.

For doctors who are constantly on the road, the Auto Page does not make sense. For the business person, however, who moves frequently through an office or factory, the system is ideal.

Instead of using expensive paging or loud speaker systems, you can locate and communicate with your staff in privacy no matter where they are within your premises.

#### SERIOUS THOUGHTS

You can use up to six different pagers, each on different channels, and the entire system with two beepers costs only \$395.00.

Once you own the system there are no further costs. Conventional pagers rent for up to \$25.00 per month so in eight months the Auto Page System with two pagers would pay for itself and from then on your secretary can literally 'beep free.'

Each additional beeper costs \$75.00 or the equivalent of a three month lease on the typical beeper. But you can't compare a typical beeper with the Auto Page. The Auto Page has voice transmission. The typical beeper does not. The Auto Page is a totally personal system that can be used anywhere. The typical beeper must be used near a big city. And finally, the typical system is expensive—many times the cost of the Auto Page System.

#### HERE AND THERE

We suggest that before you decide to purchase, you experience the freedom and convenience of personal paging. Order a system from JS&A on our 30-day trial. Give a beeper to each member of your staff. See how easy it is to set up a system (just plug it in). And then actively use it for a month. If personal paging is not the most convenient and efficient way to communicate, return it anytime within 30 days for a prompt and courteous refund.

We've tested our system at construction sites, in large buildings, on farms, in the country, with motel operators and several small businesses. Based on our personal observations and sales success, we are convinced that the Auto Page System of personal paging is the future of paging.

JS&A is America's largest single source of space-age products—further assurance that your modest investment is well protected. Service should not be required for many years as the Auto Page is totally solid state, but if service is ever required, just pop your receiver or transmitter in its mailing carton and mail to the Auto Page service-by-mail center which will promptly repair and return your unit.

To order your system, send your check or money order for **\$395.00** for a system with two beepers and \$75.00 for each additional beeper up to six (Illinois residents add 6% sales tax) to the address below. Please add \$4 for postage and handling. Credit card buyers may use our toll-free number below.

We'll send you a transmitter, antenna, beepers, one-year limited warranty and complete instructions.

Personal paging and low-cost personal communications are nicely packaged in a system that will make your company more efficient from the very first day you test our system. Order one for your test at no obligation, today.



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# Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

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## SC-2 gives your cartridge more than The Finger!

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CIRCLE NO. 16 ON FREE INFORMATION CARD

# "Panasonic Color TV. So life-like, they play as brilliantly as I do."

*Reggie Jackson*

"When it comes to watching me, nothing makes me look better than a Panasonic color TV. Every Panasonic, from our 7" (meas diag) battery-operated portable to our big projection TVs, creates a picture that's so bright, so sharp, so colorful, it's really life-like. So life-like, you'll feel you're at the ballpark with me. And what's better than that?

"I'll tell you: The two Panasonic CinemaVision projection TVs give you a picture that's not only life-like, but life-size. Our new rear projection CinemaVision (CT-4500 shown below) puts a 45" screen (meas diag) in a slim, trim body. Now you won't have to fill your room to get a roomful of picture. And you can control your CinemaVision from anywhere in the room. Because it has a

16-button synthesizer remote control. Synthesizer tuning, found in many Panasonic color TVs, uses computer technology. So you can go directly from the channel you're on to the channel you want, without having to go through all the channels in between.

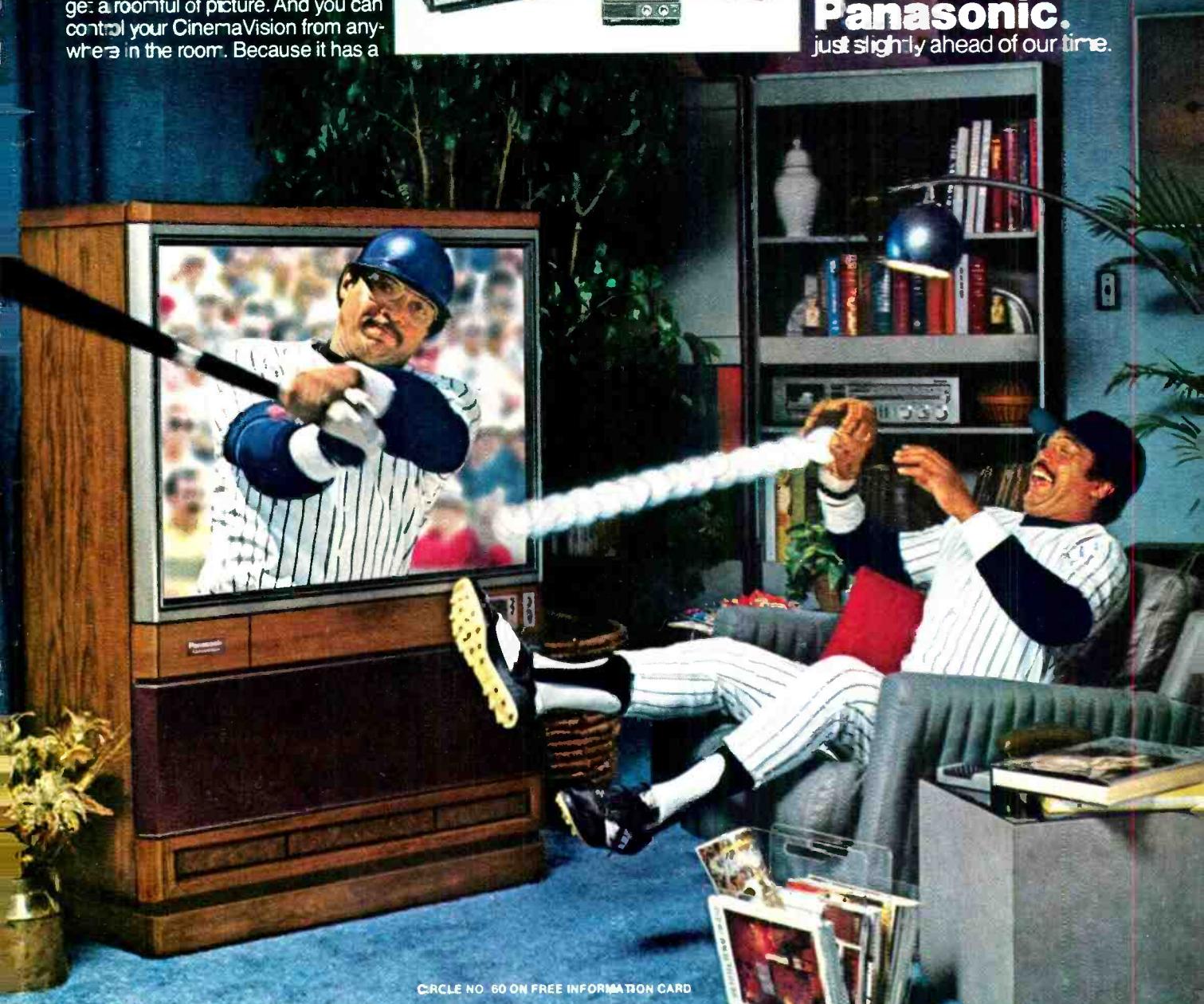
"Panasonic CinemaVision and our other EC color TVs make me look great. Whether it's a 7", 10", 12", 13", 19", 25", 45" or 5-foot Panasonic TV (all meas diag), you'll get a picture that's so life-like, you'll feel like you're part of the picture.

"That's why I say Panasonic color TVs play as brilliantly as I do."

TV pictures simulated. Cabinetry is simulated woodgrain.



**Panasonic.**  
just slightly ahead of our time.



CIRCLE NO. 60 ON FREE INFORMATION CARD

# "Here's the best news yet about Fluke Digital Multimeters.

**Now you can carry one home."**

Right now, in selected electronics supply stores across the country, Fluke is introducing a new line of low-cost DMM's: the Fluke Series D. With their distinctive dark cases and full range of accessories, these five DMM's are designed to meet the test and measurement needs of the uncompromising service technician, home hobbyist, student or working engineer.

Fluke perfected the handheld DMM and set tough standards for accuracy and reliability that have made analog meters obsolete, and other digitals seem clumsy by comparison.

You've probably heard about their superior electrical performance, mechanical

ruggedness and environmental endurance. And now you can see for yourself at your favorite electronics dealer why Fluke DMM's have become the professional's choice the world over.

## Series D Handheld Models.

**D 800:** Fluke's lowest-priced DMM, easy to operate, with six functions, 24 ranges and 0.5% dc voltage accuracy. Guaranteed a full year by Fluke. A sure-fire solution to basic measurement needs. \$125.\*

**D 802:** Basic dc accuracy of 0.1% and conductance for high resistance measurements to 10,000 MΩ make this multimeter a solid price/performance value. \$179.\*



If your dealer doesn't carry Series D Multimeters yet, call this number. We'll be happy to tell you who does. 1-800-426-9182

**D 804:** A powerful, versatile handheld DMM with nine functions, 26 ranges, 0.1% basic dc accuracy and more. Direct temperature readings in °C with K-type thermocouples; peak hold on voltage and current functions; even an audible indicator for instant continuity and logic level detection. Available January 1981. \$229.\*

#### Series D Bench/Portables.

**D 810:** By means of a Fluke-built hybrid converter, this multi-purpose DMM delivers True RMS measurements of ac voltage and current with speed and precision. Also features conductance, 0.1% basic dc accuracy, an extra 10A range and diode test. \$259.\*

**D 811:** Same performance features as the D 810 with the added convenience of battery power. Rechargeable "C" size Ni-Cad batteries deliver up to 40 hours continuous operation. \$299.\*

#### Series D Accessories.

A wide range of accessories to extend the measurement capabilities of your Series D Multimeter is available, including temperature and current probes, carrying cases, deluxe test leads and thermocouples.

With Series D Multimeters so easy to find and economical to own, Fluke has made selecting the right DMM much simpler. This is your opportunity to own a Fluke.



**From the world leader in DMM's. Now we've designed one for you.**



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\*suggested U.S. list price.

For technical data circle no.

**FLUKE**

# NOW CLEANING YOUR OWN DISKETTE HEADS COULD SAVE YOU A \$40 SERVICE CALL. AND A LOT MORE.

The recording heads on your diskette drives may be dirty—and that can cause you a lot of grief. There's the serviceman you have to call when the machine doesn't perform. (You know how much service calls cost these days!) There's machine down-time. Idle data entry clerks. All the other delays a cranky machine can cause.

And that service call might not even be necessary.

## 3M solves the problem in seconds—and leaves your heads

### "Computer Room Clean"

This Scotch\* head-cleaning diskette kit lets you clean the read-write heads on your 8" or 5 1/4" diskette drives. In just 30 seconds, without any disassembly mess or bother, the heads can be completely cleansed of dirt, dust, magnetic oxides—all the things that can get into your machines every day. And foul them up.

Just saturate the special white cleaning pad in its jacket with the cleaning solution. Then insert the jacket into the diskette drive and turn it on. Your machine does the rest. The



heads are microscopically cleaned without wear, without abrasion.

This 3M head-cleaning diskette kit has been evaluated and approved by major diskette drive manufacturers. It's the best possible way to clean your heads without service calls or machine teardowns.

At only \$1 per cleaning—it's the best insurance you can get.

This fast-cleaning new Scotch kit comes with everything you need (including special fluid, applicator tip, cleaning diskettes) to handle up to 30 cleanings. That's only about a dollar a cleaning.

With the Scotch head-cleaning diskette kit, you could save yourself a lot more than just a service call. So try this remarkable kit today. For the name of



the dealer nearest you, call toll free: 800-328-1300. (In Minnesota, call collect: 612-736-9625.) Ask for the Data Recording Products Division.

CIRCLE NO. 35 ON FREE INFORMATION CARD



A Scotch cleaning diskette shown before use, and after 15 cleanings of recording heads.



# 3M



# EDITORIAL

## Across My Desk

We're continually inundated by mail, happily. Some of it contains interesting information that's filed for reference or stored in one's head for general-knowledge purposes on what's happening in the broad field of electronics. Here's a sampling of some of the latter.

- For the *Guinness Book of World Records*, Mitsubishi is now making available a color monitor that's capable of up to 1,800 lines of resolution, exceeding the old record of 1,200 lines.

- France has initiated an electronic telephone directory system that gives a visual displays of telephone numbers sought; entry is through an alphanumeric keyboard. Reports are that the French phone company expects to eliminate conventional telephone directories and phone "information" service by distributing more than 30-million free terminals over the next ten years.

- PE reported on cordless telephones in its December 1980 issue. These are short-range phones, typically with ranges up to 300 yards. However, there is a long-range portable telephone that provides nationwide outgoing/incoming phone service on the market. Called the "Travel Phone," from Travel Electronics, Costa Mesa, CA, it is available on a lease/purchase plan. \$3,895 and it can be yours!

- Video cassettes with three-dimensional capability have been released by MCA ("Creature from the Black Lagoon" and "It Came From Outer Space"). Special glasses must be worn, of course.

- The world's first "computerized" motorcycle was announced by Yamaha (Model SECA 750). Actually, it's a computer monitor mounted between handlebars that displays seven functions: sidestand, brake fluid level, engine oil level, battery level, headlight, taillight and stoplight conditions, and fuel condition. If trouble is detected, information is posted on an LCD display.

- A third video disc system is truly in the making, as General Electric, Matsushita, JVC, and Thorn EMI announced formation of jointly owned companies to launch the VHD (video high density) disc system in the U.S. in late 1981.

- A Japanese electronics company is reported to be constructing a factory in which electronic robots will be used to produce more robots. Robots are now priced from \$10,000 to \$150,000 or more. You can lease one for about \$1,000 per month. There are only about 10,000 robots in use throughout the world today, but it's projected that as many as 200,000 robots may be sold annually by 1990.

- The FCC finally made its "Computer

II" decision, one that will doubtlessly affect the computer business ever after. It gives total freedom to AT&T to enter the computer field in direct competition with other companies in the computer industry. Consequently, the phone company will now be able to enter the future, gigantic field that merges telephone lines with computer technology for data, advertising, and other information. This deregulatory decision has been castigated by computer industry spokesmen.

Obviously, there's a *potpourri* of mail that comes across my desk. This includes reader requests for circuit redesign for special purposes (sorry, we simply don't have the people power to provide such a consulting service), parts supplier names for specific devices (again, unless it's a very special part from one of our projects that was not offered in kit form, we cannot generally ferret out who stocks what in which area), and a host of others that cannot be considered reasonable requests. We do handle a lot of mail, but we caution you to include a stamped, self-addressed envelope if you wish to get a reply. Thanks for your understanding.

*Art Salsberg*

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Learn to service, repair, and install everything from microwave antennas to two-way radios...from radar sets to TV transmitters.

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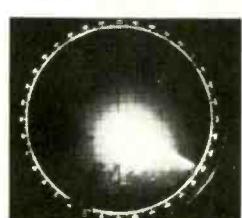
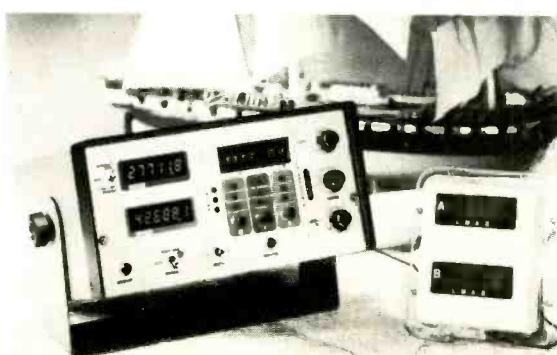
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Radar

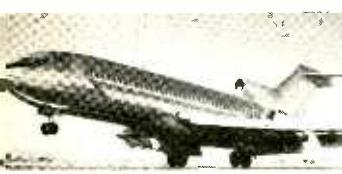
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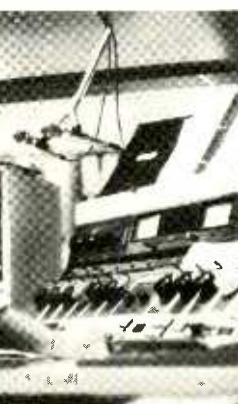
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**CB Radio**



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you can go on the air with your VHF transceiver.

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CIRCLE NO. 53 ON FREE INFORMATION CARD

## LETTERS

### Windshield Wiper Control

Thanks for the article on the design of an intermittent controller for a windshield wiper (August 1980). Readers will want to know that on some older cars, the cam-operated brake/park switch arm is internally connected to the wiper motor A+ on "park," not to the on-off switch. The return wire on these cars is in the "ground" or "park" contact.—P. L. Esmay, Tucson, AZ.

### Capacitor Symbols

Why do your magazine's schematic diagrams show ceramic (and other non-polarized) capacitors with one curved plate, indicating a nonexistent polarization of some mysterious kind?—Clyde E. Wade, Jr., Little Rock, AR.

We make one side of all capacitors curved in accordance with the standards of the American National Standards Association and the Institute of Electrical and Electronics Engineers. Traditionally, this curved side is drawn on the side of the circuit that is closest to ground potential, whether the capacitor is polarized or not. If it is polarized, we add a plus sign to one side to indicate the polarity.—Ed.

### Vocal Analyzer Connections

In "Build a Vocal 'Truth' Analyzer" (April 1980), the second paragraph on page 70 reads "Connect and solder the positive lead of *B1*'s battery connector to the hole A-pad on the circuit board, the negative lead to the hole B-pad." Shouldn't the latter connection be to the pad next to the cathode of *LED1*? The A and B pads are connected together.—Daniel Narbone, Elmwood Park, NJ.

Correct. The component layout shows the proper connection.—Ed.

### Hams and SWLs vs. OTHB

Regarding the "DX Listening" column of September 1980 on the USAF use of SWBC bands for OTHB radar, I am a SWL and an amateur operator and I don't understand how you think hams can move around to avoid such interference. The ham bands have very few useful kHz at any given time because of propagation. The broadcast bands have MHz after MHz that can be used to handle lots of signals.—R. Damato, Scituate, MA 02066.

Those "nonvoice" signals of CW, RTTY, and facsimile can suffer harmful interference just as easily as voice. Also, while it may be easy for two or three hams to change frequency, it is not easy for regular gatherings of 20 or more hams on a net to switch. What happens if OTHB pops up in the middle

of an emergency operation?—R. DeMatta, Milton, MA.

Glenn Hauser, our shortwave columnist, is obviously biased toward SWL, while ham operators favor amateur radio. Our columnists do not necessarily reflect the views of our editors, some of whom are hams and others SWLs.—Ed.

### Video Paddle Game

"Electronic Games: Space-Age Leisure Activity" (October 1980) presented a fascinating history of electronic games, but I wonder if it was correct in attributing the invention of the video paddle game to Ralph Baer. Other articles have credited the design of the first practical paddle game to Nolan Bushnell of Atari.—W. Green, Albany, NY.

U. S. patent # 3,993,861, Nov. 23, 1976, on digital video modulation and demodulation, lists Ralph H. Baer as the inventor and includes 18 claims. He holds earlier patents relating to games, too. There's a license agreement for these patents between Sanders Associates and Magnavox and for rights to sublicense these patents, which other game makers do.—Ed.

### A Two-Header

I'm a retailer who just got delivery of Panasonic's PV-1400 VCR, reviewed in your November issue. But it's a two-head machine, not a four-head one as you noted.—John Caig, New York, NY.

We're red-faced about this one. We requested a four-head machine, were told that there was only one prototype in the country, and it was finally received—the PV-1400—quite late in our schedule. Tests were made on the supposed four-head machine, which we discovered to be a two-header when publicity material was later received. Panasonic's four-head machine is its Model 1750.—Ed.

### Cordless Telephones

In the Sampler Table in my article "PE Examines Cordless Telephones" (December 1980), the Radio Shack ET-310 should be listed as Simplex, and it does not have redial capability.—Jules Gilder.

### Too Much Mistracking

There would appear to be something amiss with the mistracking diagram (Fig. 5) in the article "Phonograph Playback, It's Better than You Think" (November 1980) since the stylus paths are clear out of the grooves in some points.—R. Arata, Merrick, NY.

A printing error caused inaccurate registry of the colored lines. This threw the lines indicating the stylus paths out of place. The colored lines should have appeared approximately  $\frac{1}{8}$  in. to the left.—Ed.

### New Price for High-Com II

In your excellent review of our High-Com II Noise Reduction System (October 1980), the retail price quoted for the unit should be \$480.—J. LeFevre, Nakamichi USA Corp.

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The personal computer is the ultimate

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# NEW PRODUCTS

Additional information on new products covered in this section is available from the manufacturer. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.

## Acutex Phono Cartridge



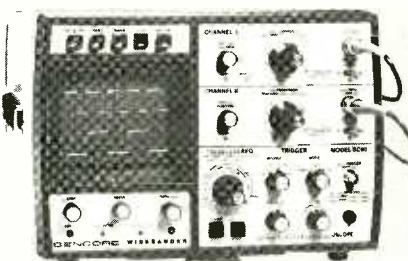
The Model 320 STR by Acutex is a new phono cartridge that employs a titanium cantilever and an induced-magnet transduction system. Its VITAL STR™ 0.3 × 1.6 × 0.5 mil stylus is said to have a symmetrical, elliptical contact area and effective tip mass of 0.5 mg. Rated frequency response is 20 to 20,000 Hz ± 0.75 dB; separation is 33 dB at 1 kHz and 29 dB at 10 kHz; IM distortion at +6 dB is 1.2%; channel balance is within 0.5 dB at 1 kHz; and output voltage is 3.5 mV at 5 cm/s and 1 kHz. The Saturn V headshell, into which the cartridge plug-mounts (no hardware or electrical connectors necessary) to maintain correct geometry, is optional. \$195; Saturn V headshell \$20.

CIRCLE NO. 86 ON FREE INFORMATION CARD

## Communications Satellite Antenna

Vidiark Electronics Development Co. offers a 12-foot dish antenna, the Octasphere, for reception of signals from synchronous communications satellites. According to the manufacturer, the Octasphere has a shallow spherical curvature (7 1/4" deep at 6' from the center), an f/d ratio of 1.25, and focal length of approxi-

## Sencore 60-MHz Scope

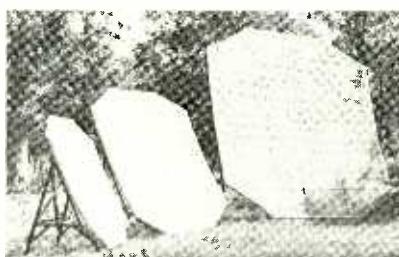


Sencore, Inc.'s model SC60 "WideBand" dual-trace scope is said to have 60-MHz bandwidth, and to be usable to 100 MHz. Using ECL logic and differential

amplifiers in the triggering circuit, it is claimed that sync is reliable with as little as 1 cm of true deflection throughout all settings of the timebase switch. No peaking coils are used in the vertical amplifiers. Rated sensitivity is 5 mV/cm on both channels; measurement capability is up to 1.6 kV peak-to-peak with full protection to 2 kV; and risetime is 6 ns. Delayed signals permit viewing leading edges on both traces. Both channels can be summed or subtracted, and the 5-MHz vector (X-Y) response is said to have 3° or less phase shift. Video sync separators allow use with video waveforms. \$1,695.

CIRCLE NO. 89 ON FREE INFORMATION CARD

mately 14.5'. It has a galvanized steel frame and a reflector surface of aluminum mesh. The recommended base (not supplied) consists of four concrete pads, each 12"D × 12"W × 24"H. The anten-



na can reportedly provide usable signals simultaneously from all satellites within a field of view of as much as 40°. A given satellite is selected by positioning a feed horn/LNA at the appropriate point in front of the reflector, which remains fixed. \$750. An optional sheet-metal feed horn designed to mate to a WR-229 waveguide is available for \$28.

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## KEF Loudspeaker System

The KEF Model 303 Series II is a two-way loudspeaker employing a 7.9" bass

driver and a 1" soft-dome tweeter in a 0.6 ft³ sealed enclosure. Claimed on-axis frequency response is 70 to 20,000 Hz ± 3 dB at 6.6'; directional characteristics within ± 2 dB of axial response to 10 kHz—± 20° horizontal, ± 5° vertical; and sensitivity 86 dB SPL on axis at 3.3' when driven by 1 watt of pink noise.



Rated maximum output is 103 dB SPL typical, power handling is 50 watts of program material, and rated maximum continuous sinusoidal input is 20 V rms from 20 Hz to 2 kHz and 10 V rms from 2.5 kHz to 20 kHz. Minimum recommended amplifier power is 10 watts/channel and nominal load impedance is 8 ohms. Rated system Q is 0.7 and resonance is 68 Hz. Enclosure dimensions are 20" × 10.4" × 9". Standard finish includes black or brown base, top, and grille. Optional, interchangeable grille sleeves are available in a choice of seven colors.

CIRCLE NO. 91 ON FREE INFORMATION CARD

## Miniature Workbench Vise

The Mini Vise is a small (3" high) vise designed to hold items being assembled or repaired. The body of the Mini Vise is made of plastic, and the 1 1/2" long vise grips are metal. It attaches to a smooth

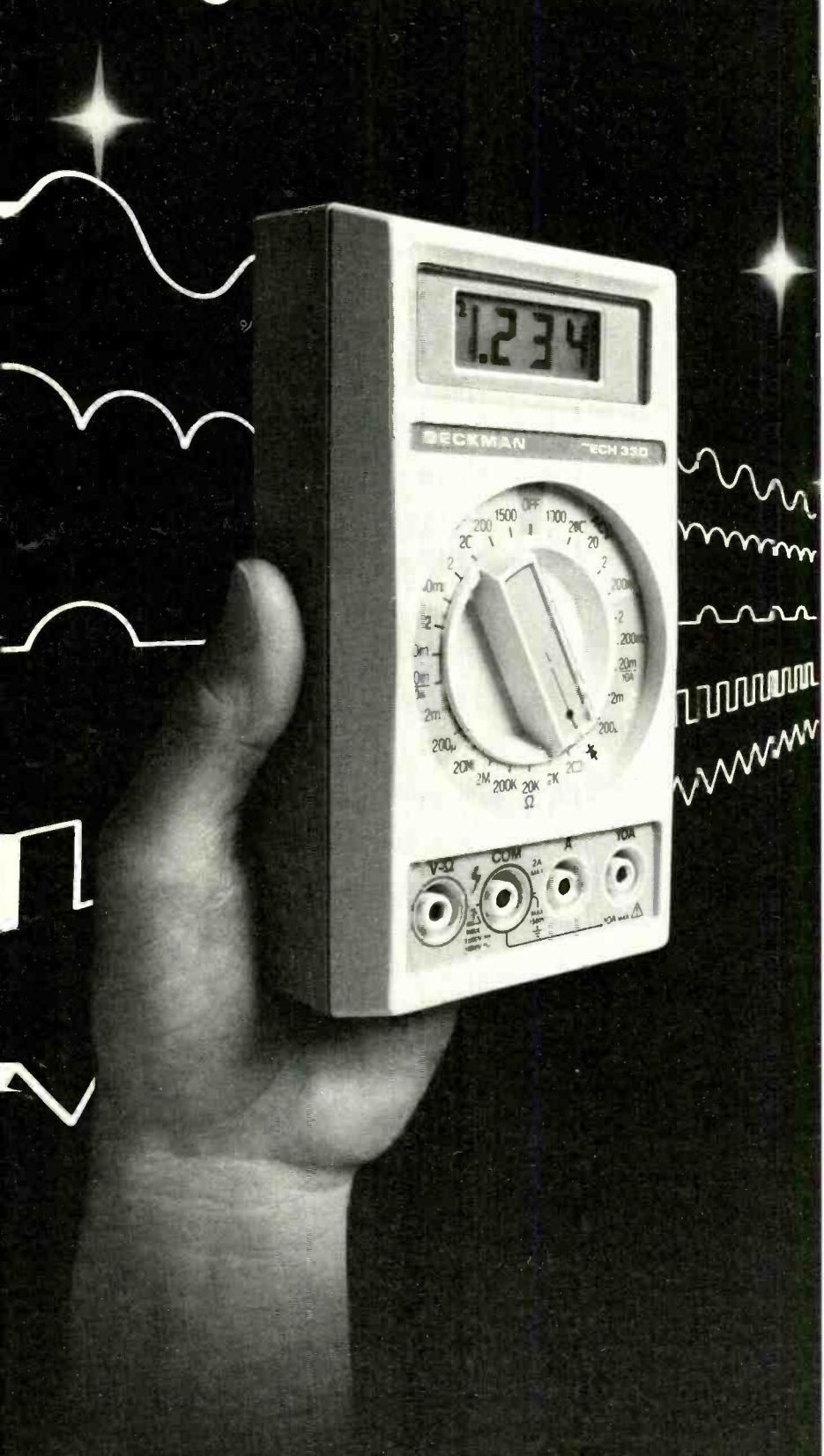
## New S-100 Bus Computer

The Cromemco "System Zero" is an S-100 bus computer featuring a Z80A, 1K of RAM, and 3K Control BASIC in ROM. Three slots are available for expansion. A special version, System Zero/D, used with floppy disks, features a Z-80A, 64K of fast RAM, and a 16FDC disk controller that permits use of high-capacity drives storing 390K bytes on a 5 1/4" diskette. The controller has an on-board operating system (RDOS-2) that enables

reading or writing single-sided, double-sided, single-density, or double-density diskettes. Software features a system diagnosis for the memory, controller, and drives. Software support includes RPG II, FORTRAN, COBOL, 32K Structured BASIC, 16K BASIC, LISP, and a host of utilities. System Zero (Model CSO) is \$995; System Zero/D (Model CSO/D) is \$2995.

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# Beckman brings a new dimension to hand held Digital Multimeters



## True RMS capability at an affordable price

Now you can measure the exact power content of *any signal* — regardless of waveform. Beckman delivers the new TECH™ 330 multimeter with true RMS capability and many more fine performance features for just \$210.

Unlike most multimeters calibrated to read only the true power content of sine waves, the TECH 330 extends its true RMS capability to give you accurate readings of both sine and non-sine waveforms.

True RMS makes a significant difference in accuracy when measuring switching power supplies, flyback power circuits, SCR or TRIAC controlled power supplies or any other circuit generating a non-sine signal.

The TECH 330 also accurately measures the entire audio band up to 20 kHz. But that's not all you can expect from Beckman's top-of-the-line multimeter.

Measurement Comparison Chart

Waveforms (Peak = 1 Volt)	Average Responding Meter	Beckman TECH 330	Correct Reading
Sine Wave	0.707V	0.707V	0.707V
Full Wave Rectified Sine Wave	0.298V	0.707V	0.707V
Half Wave Rectified Sine Wave	0.382V	0.500V	0.500V
Square Wave	1.110V	1.000V	1.000V
Triangular Sawtooth Wave	0.545V	0.577V	0.577V

You also get 0.1% basic dc accuracy, instant continuity checks, 10 amp current ranges, a separate diode test function, 22 megohm dc input impedance, and an easy-to-use rotary switch.

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Enclosed in a rugged water-resistant case, the TECH 330 can take a 6-foot fall onto concrete and still perform up to spec. And to further ensure reliable, trouble-free operation, the TECH 330 gives you 1500 Vdc overload protection, RF shielding, 2000-hour battery life, gold switch contacts, and fewer electronic components to worry about.

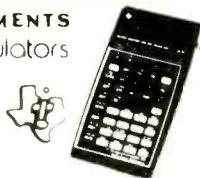
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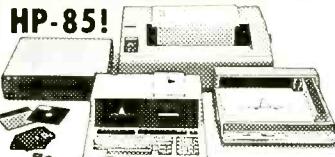
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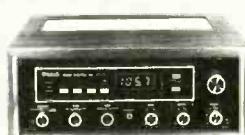
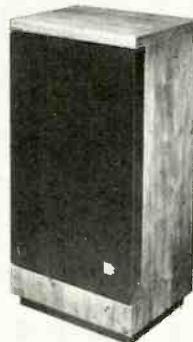
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**new products**

surface by means of a vacuum-grip base. \$2.95. Address: Heart's Desire, Box 4763, San Diego, CA 92104.

**Front/Back  
Radar Detector**

Leisure Time Development Associates announces availability of the Radar Intercept radar detector. Manufactured by JR Microwave Systems, the Radar Intercept is a dual-band (X and K) radar receiver that is said to respond to signal sources either in front of or behind the vehicle in which it is installed (or both). It can be mounted on the vehicle's sun visor and is activated when the unit is rotated to a vertical position. The dual conversion receiver has a rated sensitivity of -107 dBm/cm² on the X band and -90 dBm/cm² on the K band. Its antenna has a rated gain of 11 dBi, a horizontal beamwidth of 50°, and a vertical beamwidth of 25° on both X and K bands. Size is 5.7" W × 3.3" H and 1" D, and it draws 225 mA at +12 to +16 volts. \$279.95.

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**Micro Seiki Belt-Drive  
Turntable**

Micro Seiki's new Model MB18 is a semi-automatic, belt-drive turntable with a low-mass straight tonearm and a detachable carbon-fiber headshell. It incorporates a servo-controlled motor whose speed can be adjusted over a range of ±5%. A strobe is included to facilitate accurate speed adjustment, and soft-touch push-buttons allow the user to select an operating speed of either 33⅓ or 45 rpm. The turntable's base is ebony finished and has feedback-suppressing feet. Rated wow and flutter is less than 0.03% and S/N greater than 73 dB. \$275.

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(Continued on page 18)

POPULAR ELECTRONICS

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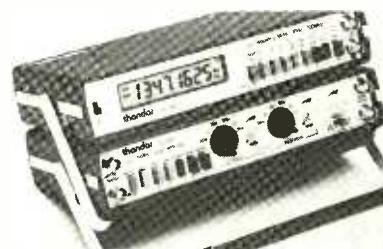
## new products

### Micro Bus Design System

Bishop Graphics has announced its new "E-Z Bus" design system, intended to aid in design of microprocessor interface circuits. It consists of bare, shaped, and drilled circuit boards, pressure-sensitive copper foils in a variety of shapes that adhere to the bare circuit boards, wrapped-wire sockets, and related components and hardware. The bare circuit boards or "E-Z Bus Cards" are available in configurations that are compatible with the Apple II, Commodore PET, Super KIM, TI 980, Altair 8800, IMSAI 8080, DEC, Heath, Motorola, Intel SBC80, National BLC80, and S-100 systems.

CIRCLE NO. 94 ON FREE INFORMATION CARD

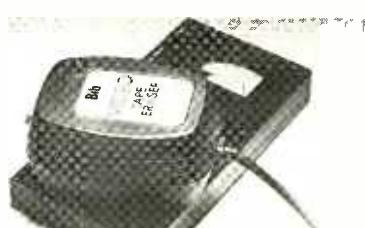
### Frequency Meter/Pulse Generator



The Sinclair Thandar Model TF-200 frequency meter is battery-operated and has an 8-digit LCD display. Low-frequency input range is from 10 Hz to 20 MHz with a sensitivity of 10 mV; high-frequency input range is from 15 to 200 MHz with a sensitivity of 30 mV. The unit also has a totalizing mode to 20 MHz, five gate periods from 0.01 to 100 seconds, an external dc input jack, and a rear-panel jack for an external timebase. Internal crystal oscillator stability is better than  $\pm 3$  ppm from 18° to 28°C. \$394. The Thandar Model TG-105 Pulse Generator operates with pulse widths from 100 ns to 10 ms, and repetition rates from 200 ns to 20 ms. The output automatically goes to ground if the selected pulse width exceeds the period. Additional controls include external or manual trigger, free-run mode, and inverted output. Outputs include sync, TTL (fan-out of 20), and a 50-ohm output adjustable from 0.05 to 5.0 volts. \$219.

CIRCLE NO. 95 ON FREE INFORMATION CARD

### Videocassette Eraser



Bib announces its new Model VE-3 Video Cassette Eraser, a handheld, line-powered device designed to quickly and thoroughly

erase previously recorded video cassettes. It is said to generate magnetic flux density of 2420 gauss at a distance of  $1/8$ " and to have a built-in thermal cutout to ensure operating safety. A pushbutton switch activates the eraser circuit. \$47.50.

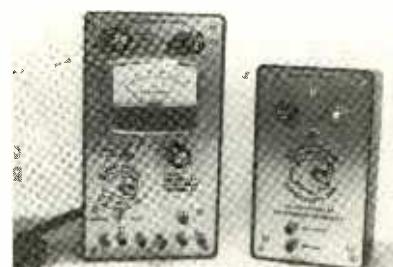
CIRCLE NO. 96 ON FREE INFORMATION CARD

### Double Track/Density 5 1/4" Disk Drives

Shugart Associates has announced two new 5.25-inch disk drives having 96 tracks per inch. The SA410 (single-sided) and SA460 (double-sided) drives feature unformatted capacities of 500K bytes and 1M byte, respectively, using double-density recording. The drives incorporate helical cam V-groove leadscrew for head positioning to improve access time, a single-point ball follower to minimize hysteresis and friction, and a fast-starting dc spindle motor to allow the drive to be shut down when not in use. Track-to-track access time is 6 ms. An integral tachometer for speed control, "door open or disturbed" signal, and an active "in use" indicator are provided. Rated performance includes transfer rates of 250K bits/s for double-density, average access time of 160 ms, average latency of 100 ms, 1 soft-read error per  $10^9$  bits, 1 hard-read error per  $10^{12}$  bits, and 1 seek error per  $10^6$  bits. \$325 for the SA410; \$400 for the SA460.

CIRCLE NO. 97 ON FREE INFORMATION CARD

### Solar Controller Differential Thermostats



Wolfway Product Consultants Inc. announces availability of two differential thermostats for use in solar-heating and hot-water systems. The company offers Standard and Professional Models in assembled or kit form. Each model employs a 10-ampere triac that energizes a motor or some other load when two remote sensors detect existence of a given differential temperature between the medium in a solar collector and that in a storage tank. Assembled units have a preset triggering differential that can be readjusted. The Professional Model includes a 0° to 100° C dual-range analog thermometer, three additional sensors and input jacks so that additional points in the system can be monitored, plus an alarm circuit that can monitor any of the five sensors. Both models are housed in plastic cases with aluminum front panels. Professional Model

Watch technology may never be the same. Meticulous precision—thanks to the science of quartz—is now a remarkably common virtue. Alarms and stopwatches are turning up in more and more timekeepers. Even calculators have begun to find a place on people's wrists.

But the fact remains: all this available genius has never appeared in one under \$200 timepiece—until now.

Introducing the new Megasonic calculator alarm chronograph. Only \$89, and only available through The Sharper Image.

#### A world exclusive: keys that talk back.

Megasonic engineers have come as close as anyone can to building an error free calculator.

First, they recessed all twenty keys. Meaning you can perform calculations with any pointed object—pencil, ball-point pen, even a felt tip pen—without slipping. And every key is metal reinforced, making it virtually impervious to wear.

Next, they went to the trouble of backing the entire keyboard with electronic sensors: every time a key is touched, a short beep tone confirms the entry. Audibly reassuring you that every number has been entered correctly. (No other wrist calculator, regardless of price, provides this feature.)

By the way, this electronic mathematician gives you the usual four functions—and a lot more. Like automatic discounts, mark ups, percentages, powers, reciprocals, and a full floating decimal. Plus a time display that's always visible, even during calculations.

#### The orchestra that never forgets.

Megasonic's wake up/appointment alarm is equally extraordinary.

Instead of annoying beeps, it attracts your attention with a musical masterpiece: Schubert's *The Trout*. And if you wish, this orchestral wonder will repeat the alarm every 24 hours—automatically.

You can also choose to have every hour punctuated with a two tone chime, on the hour.

And armed with a quartz crystal vibrating 32,768 times a second, this uncompromising chronograph delivers a host of other timing treats. Like 15 second-a-month accuracy. A day/date calendar. A 1/100 second stopwatch, with lap times, reset, and a beep to confirm stops and starts. There's even a choice between 12 or 24 hour time format—ideal for travelers.

Incidentally, you'll find all these features squeezed into a profile that's slimmer than a lot of conventional watches.

#### Great expectations.

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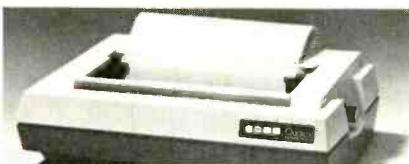
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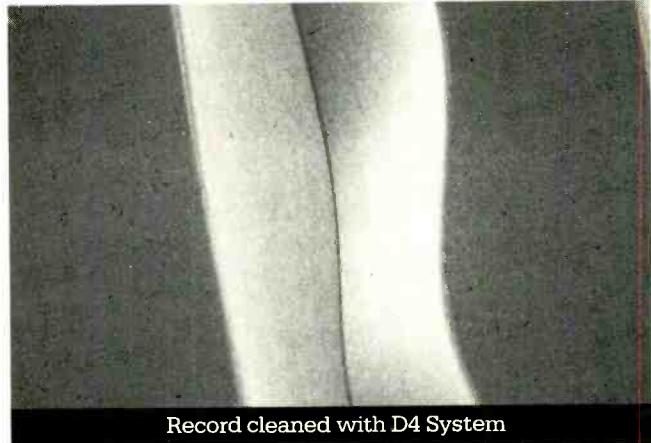
Electron microscopy (Figure 1) shows the principal cause of record wear: small particles of microdust, deposited from the air by gravity, are ground along the record groove by the stylus. Surface noise goes up. Sound quality goes down.



Record etched by dust held to surface by "slick" treatment

Figure 1

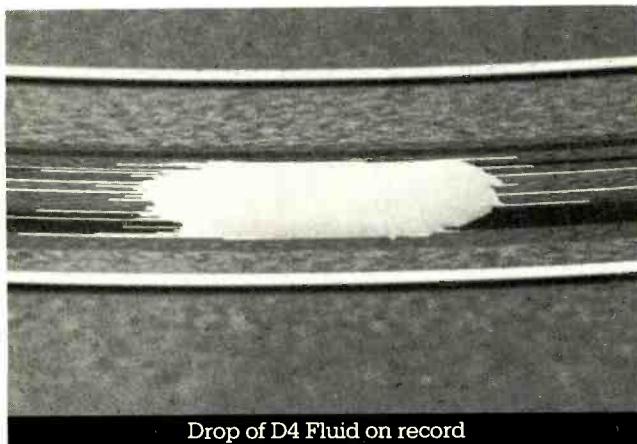
In some record care products, organic solvents are used rather than water. Organic solvents such as ozone-gobbling chlorofluorocarbons, petroleum distillates (hexane, heptane) and alcohol concentrates are indeed speedy extractors and delivery solvents. They evaporate fast. Some organic solvents can dissolve vinyl stabilizers. Organic solvents may leave a "slick" looking record by treating the disc with other compounds carried in the solvent mix. In doing so, record contamination may also be dried back onto the disc in a nice even layer. Dust is often "held" to the record surface by "treatment".



Record cleaned with D4 System

Figure 3

Electron micrograph (Figure 3) shows a record cleaned with the Discwasher D4 System. High technology record care leaves only a clean surface.



Drop of D4 Fluid on record

Figure 2

Figure 2 shows a drop of the aqueous Discwasher D4 Fluid, literally lifting dust and contamination out of record grooves. The extraordinarily complex D4 Fluid uses water pure enough for kidney dialysis, along with eleven chemically engineered additives that still results in lower dry-weight residue than most tap water. This formula is amazingly high in cleaning activity, uniquely safe for vinyl and vinyl additives, and preferentially "carries" contamination into the new Discwasher D4 pad.



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# ENTERTAINMENT ELECTRONICS

By Harold A. Rodgers  
Executive Editor

## Miscellany

**Digital Recordings and Stress.** Opponents of digital recording have criticized it on grounds as naive as the undesirability of "chopping the sound up into pieces" and as sophisticated as phase shift caused by multipole anti-aliasing filters. But when J. Diamond asserted in a talk delivered to the Los Angeles AES convention last May that digital recordings produce symptoms of stress in human beings, he created quite a stir. Diamond supported his contention by demonstrating that the extended arms of volunteer subjects could be pushed down more easily when digitally recorded music was played.

**A New Imaging System.** Since the introduction of the Carver Sonic Hologram, devices intended to enhance the imaging of stereo music systems seem to have caught the fancy of the public and designers alike. The latest entry to this relatively new marketplace is the Model IR2100 Image Restoration Control from Sound Concepts, available at a suggested price of \$250. Here is the manufacturer's description of the circuitry: "Previous units delay, rolloff, invert and cross-couple each channel into the other. The resultant comb filtering of the frequency response is maximized in the center where the (cancellation)

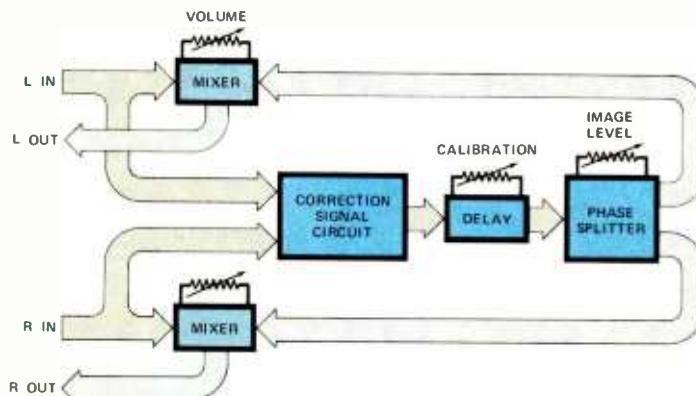


Fig. 1. Block diagram of the Sound Concepts Image Restoration Control.

Dissatisfied with the methodology used in the demonstration—notably, the lack of controls, the criterion for stress, and the fact that the test was not even single-blind—Nelson Morgan, now of National Semiconductor attempted to duplicate Diamond's results with a more carefully designed experiment. He reported his findings in a letter to the editor, published in the September JAES. Morgan used galvanic skin response and basal skin resistance as criteria indicative of stress, and had musical examples that were identical except for the way in which they were recorded. Analyzed statistically, Morgan's data show no correlation whatever between digitally recorded music and stress. That leaves digital sound in the small category of pleasures that are not bad for one's health.

process is least required and the uneven response most noticeable. By processing the directional information only (L-R signal), the IR2100 achieves the image expansion and focus with minimum side effects. Since the lower frequencies are predominantly monaural [sic], they are not processed or accentuated by the IR2100, and a highpass filter removes rumble which is a vertical or L-R signal. It is also possible to raise the image level and substantially amplify the correction signal to enhance the spaciousness of particular recordings, whereas doing that with conventional techniques would make them sound more monophonic. The complementary nature of the circuit also tends to keep the combined response of the two channels flat even at the extremes (of frequency)." A simplified block dia-

gram of the unit is shown in Fig. 1.

The device is housed in a box small enough to be hand-held that is connected to the TAPE OR EXTERNAL PROCESSOR loop of the system control center and to its own ac-adaptor type power supply by a long "umbilical" cord. Protruding from the box are slide controls for VOLUME and IMAGE and a rotary control for CALIBRATION. A two-position switch bypasses the unit when the enhancement is not desired. Two LEDs are used: One is near the volume control, which is always active, and is on when power is supplied to the unit; the other shows when the image enhancement is in use.

Setting of the CALIBRATION depends on the distance between the speakers and the location of the listening position with respect to the plane of the speakers. Instructions for this adjustment are spelled out in the manual. Once the CALIBRATION is correctly set, the user can adjust VOLUME and IMAGE (the level of the correction signal) without ever leaving his chair. This is important, for the optimum corrected image occurs only at the listening position for which the unit is calibrated.

To examine the workings of the system in more detail, refer to Fig. 2. We see that the signal arriving at the left ear is that from the left speaker,  $L$ , plus a delayed signal from right channel  $R'$  that because of its greater path length is somewhat weaker. The relative attenuation of the right signal is  $\alpha_2$ . When the corrective signal is applied to the two channels in advance with the relative attenuation  $\alpha_2$  as shown in the diagram, the signal algebra given applies. Note that the prime ('') operator represents a delay and distributes over a sum in parenthesis. That is,  $(L - R)' = L' - R'$ .

As we can see from the expression (1) for  $L_T$ , the signal reaching the ear

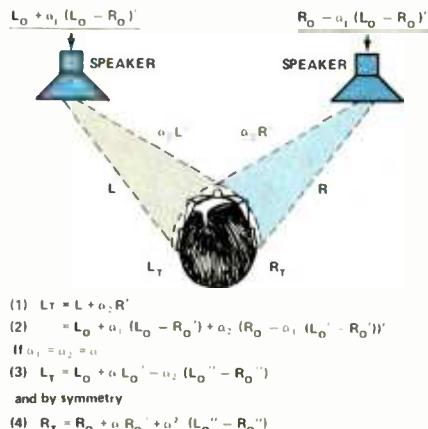


Fig. 2. Diagram and equations detailing the operation of the Image Restoration Control.

contains a large number of components. When the correction signal is set to precisely the level that best cancels interaural crosstalk,  $\alpha_1 = \alpha_2$ , expressions (3) and (4) apply, and the

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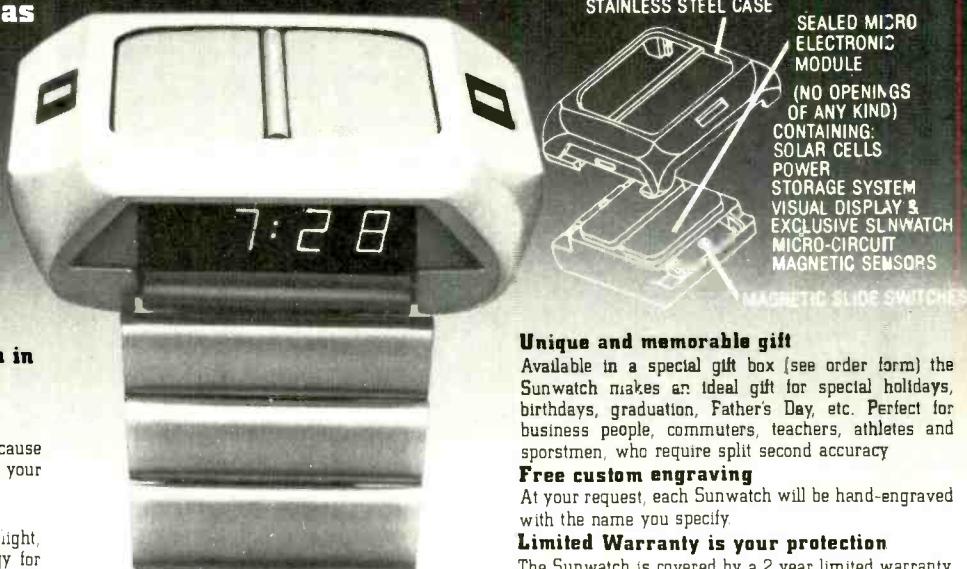
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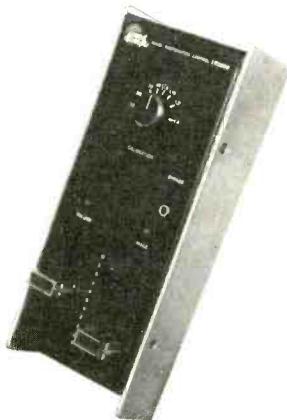
Any system with an internal tape loop can connect to the 801. Component systems can insert the 801 between pre-amp, other accessories, and the amplifier. There's a built-in tape monitor button on the 801, so you don't lose your existing tape monitor facility. The 801 works on any stereo or mono source - FM, tapes, records, AM, TV. You can record selections via the 801 and replay them on conventional home-use stereo equipment.



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number of signal components is reduced. However, a delayed version of the original signal is introduced into each channel ( $\alpha L_0'$  into L and  $\alpha R_0'$  into R).  $L_0$  and  $R_0$  are the original signals recorded in the respective channels. The signals having the coefficients  $\alpha^2$  are relatively weak since  $\alpha$  is less than 1.

Since the mixing of a signal with a delayed version of itself implies comb filtering, the frequency response for left-only and right-only signals is not flat. The location of the peaks and nulls depends on the setting of the delay control and the amplitude of the ripple on the setting of the image control. On the other hand, for centered signals,  $L + R$ , the correction signal is zero, meaning that there is no comb filtering of the center image.



**Sound Concepts  
Image Restoration Control.**

In practice, as the analysis predicts, the device works best when the delay and image controls are precisely set. An alternative method of adjustment, not mentioned in the instructions, may be somewhat more convenient. Disconnect one channel—say, the right—of the input signal fed into the Image Restoration Control. Then adjust the CALIBRATION so that the sound comes from as far to the left as possible. Do the same with the IMAGE control. These controls interact in their subjective effect, so the procedure should be repeated several times for optimum results. Finally, reconnect the right channel.

To experience the best performance the Image Restoration control can deliver, the listener must be located exactly at the point for which it is adjusted. Solitary listening, therefore, is the main application. The image produced under these conditions gives a good impression of depth and of location of sound sources. It extends slightly outside of the loudspeaker locations, though not as far as the image produced by some other devices of this general type. However, the residual comb filtering does impart a coloration to sounds, particularly those arising at the extreme left and right. Most often, if the recorded signal contains a reasonable amount of reverberation,

the effect is slight. And adding delayed signals via an outbound delay "box" and two auxiliary speakers to the sides or rear of the room tends to mask the coloration very nicely. ◇

CIRCLE NO. 104 ON FREE INFORMATION CARD

## AUDIOFILE RECORDINGS

By Harold A. Rodgers  
Executive Editor

**STRAVINSKY: The Rite of Spring.** Lorin Maazel conducting the Cleveland Orchestra. Telarc DG-10054. This stunningly recorded disc is a welcome addition to Telarc's digital series. The sound is clean and detailed while retaining a good sense of ambience and perspective. During those passages in which the winds "play catch" with melodic fragments, the listener is made privy to the game—an unusual privilege, considering the complexity of the textures.

Part of this clarity is undoubtedly a result of the manner in which the work is performed. Tempos seem a little more relaxed than would generally be considered orthodox, which gives the ear time to digest this elaborate musical "meal." On the other hand, the slower pace robs the work of some of its compelling energy and drive. Nonetheless, the essential spirit of the work remains well intact. Whether this, or any other one interpretation of this modern classic, could be considered definitive seems highly questionable. Though Stravinsky himself may have been uncomfortable with the idea, the work provides ample room for differing opinions.

**SPYRO GYRA: Morning Dance.** Nautilus NR 9. The stature achieved by this album in its first release makes critical comment virtually superfluous. Selections from it have received so much air play that any jazz aficionado that does not know it well must have just returned from a vacation on Alpha Centauri. On the other hand, there is a degree of musical expressiveness and inventiveness that makes it all sound fresh.

An essential part of the good news about this album is the quality of its production. Half-speed cutting extracts details from the master tape that one would hardly believe were there. And if the surfaces are not the quietest I have encountered from a jazz disc, they must be awfully close. Nautilus, on the basis of history, can expect this disc to be a winner, and production as careful as this could hardly detract. ◇

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"On the basis of subjective experience, I can attest that the Omnisonic product works quite well. It seems to remove virtual sound sources from the plane of the loudspeakers and distribute them at various positions in the listening space, adding a sense of front-to-back dimension at the same time. At times, some sounds appear to come from in back of the listener, which is a startling effect, given that sound is being radiated only from the front. Another effect the device produces is a greatly increased sense of ambience or 'spaciousness.' "

Harold A. Rodgers  
Executive Editor  
POPULAR ELECTRONICS  
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# Audio Product of the Month

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## Acoustic Research AR93 "High Tech" Speaker System

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high performance at minimum cost

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**M**ODEL AR93, part of Teledyne Acoustic Research's "High Tech" series of speaker systems, is a spin-off of the company's widely acclaimed top-of-the-line AR9, and incorporates many of its features. The 93 is designed to offer the consumer a maximum of performance at the lowest possible price. To this end, the cabinet is made of unfinished particle board, painted flat black and covered with a sleeve of acoustically transparent black grille cloth that slips over the cabinet like a giant stocking, and is drawn snug and stapled at the top. The top and bottom of the floor-standing cabinet are covered by black molded plastic plates, the bottom one including small supporting "feet." Input terminals are concealed under the cabinet.

Electrically, the system is a three-way design built with four drivers (two woofers are used). Designed to be driven to comfortable listening levels by power amplifiers in the 30-to-60-watt range, the AR93 can safely handle as much as 125 watts of continuous musical program material. Nominal system impedance is 6 ohms.

The AR93 measures 30 $\frac{5}{8}$ " H  $\times$  14" W  $\times$  10 $\frac{3}{4}$ " D and weighs 50 lb. Suggested retail price is \$249 each.

**General Description.** An obvious similarity between the AR93 and the AR9 lies in their use of twin side-firing woofers at the bottom of the cabinet. When the speaker is placed against a wall, this arrangement elim-

# Brainchild

**Yesterday** — Remember the first Heathkit Analog Computer (1957)? Or the Heathkit Single-Sideband Transmitter (1958)? How about the Heathkit Multiplex Adapter for FM stereo reception (1960)?

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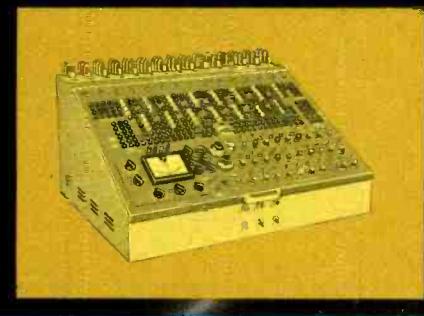
**Today** — Today's brainchildren include the popular Heathkit All-In-One Computer, a complete computer system with disk storage, smart terminal, two Z80 microprocessors — all in one compact unit.

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inates the usual mid-bass cancellation and reinforcements due to the reflections from the rear wall. In the AR93, the woofers are 8"-diameter cone drivers in a fairly sizable enclosure (1.77 cubic feet, or 50 liters).

Also reminiscent of the AR9 is the vertical alignment of the midrange and high-frequency drivers on the center line of the front panel. The 8" midrange driver, which takes over from the woofers at 350 Hz, is housed in a separate sealed enclosure. At 2,000 Hz there is a crossover to the tweeter, which is a 1 1/4" cone unit. Its voice coil is cooled and damped by ferrofluid injected into its magnetic gap.

Although the recommended location for the speaker is with its back against a wall, alternate placements are acceptable as long as both woofers are at least 2 feet from any wall surface they may face. If the back of the speaker cannot be placed against a wall, it should be at least 2 ft away.

The crossover network, despite its apparent simplicity, aims at performance typical of more elaborate and expensive networks. Separation between the woofers and midrange driver is provided by a series network in which the impedance characteristic of each driver is used to help achieve a 12 dB-per-octave crossover for its neighbor with the minimum number of components. The high-frequency rolloff of the 8" midrange driver comes from its own mechanical parameters, without additional circuit elements; the matching 6 dB-per-octave slope for the tweeter crossover is obtained with a single capacitor.

An additional goal of the design of the crossover network and drivers was to provide a reasonably uniform and acceptably high-impedance characteristic for the system. The rated minimum impedance of the AR93 is 4.5 Ω, with a value of 6 Ω overall.

Another feature that has carried over from the AR9 (with some modifications) is the "acoustic blanket." In the AR9, this was a layer of acoustically absorbent material surrounding the middle- and high-frequency drivers to absorb high-frequency side radiation. This energy would otherwise undergo diffraction at the enclosure

edges and give rise to delayed reflections, blurring the stereo image and roughening frequency response. In the AR93, strips of absorbent material surrounding the tweeter at a distance of several inches perform a similar function.

**Laboratory Measurements.** Far-field measurements of the output from a pair of AR93s were made with the speakers about 3 feet from the rear wall of the room. Measurements made with the speakers against the wall yielded very similar results. Low-frequency response was measured in the near field of one of the woofers to eliminate possible room effects.

Smoothed far-field frequency response was quite flat up to about 7,000 Hz, rising slightly at higher frequencies (this is to some degree a characteristic of our test environment and instrumentation) and reaching +5 dB at 18,000 Hz. The close-miked woofer response was flat from about 80 to 250 Hz, sloping off at higher frequencies as the crossover network came into play. Low-frequency output peaked to about +4 or +5 dB at 70 Hz before falling off at lower frequencies at the expected 12-dB-per-octave rate.

The near- and far-field curves fit together unambiguously at about 350 Hz, resulting in a composite frequency response of ±3.5 dB from 40 to 20,000 Hz. Considering that the principal deviations from flatness were at the frequency extremes, where they are most affected by measurement uncertainties and room acoustics, this is an exceptionally uniform response. Tweeter dispersion was especially good for a cone driver, as the response curves measured from the left and right speakers (on the axis of one and about 30 degrees off the axis of the other) diverged only moderately above 10,000 Hz. Tone-burst response was also very good, showing little sensitivity to frequency or microphone position changes.

Woofers distortion was measured at a constant 2.83-volt drive (nominally 1 watt into an 8-ohm load) and also at a level 10 dB higher (8.94 volts). At the lower level, the readings were ex-

tremely low in the midbass region and somewhat higher at lower frequencies. When the drive was increased to the higher level, distortion roughly doubled. Details are shown in Table I. Note that at 30 Hz with a 10-watt drive, the distortion spectrum is dominated by the relatively benign second harmonic.

System impedance reached a minimum of about 4.5 ohms at 20 Hz, and between 100 and 200 Hz. There was a resonant rise to 10 ohms at 50 Hz and a broad rise to about 12 ohms in the vicinity of 2,000 to 3,000 Hz. Average impedance over the audio range appeared to be about 6 ohms. System sensitivity, rated at 87-dB sound pressure level at 1 meter on axis from 1-watt input, was checked with a 2.83-V random-noise signal in an octave band centered at 1 kHz. Measured sensitivity was 88 dB SPL.

**User Comment.** In our listening room, the recommended placement (against the wall) tended to over-emphasize the lower frequencies. We preferred the sound with the speakers about three feet from the wall. As with any speaker, some experimentation is called for before deciding on a final position.

The AR93 is relatively uncolored in sound. Its very potent deep bass response does not cause heaviness and is not apparent until the program calls for it. When we made critical comparisons of the AR93 against some much more expensive, very flat speakers, we could hear a trace of added brightness in the AR93. This tended to confirm the slightly emphasized high-end response shown in our measurements, at least in our listening room. However, this rise in response was never noticeable when listening solely to the AR93, but only in close comparison with other speakers.

We noted with interest and approval that AR does not provide any user-adjustable tweeter or midrange level controls on the AR93. We have usually found such controls capable only of degrading overall response. In our experience, all necessary response alterations are possible via amplifier tone controls, whose function, in turn, cannot be performed by driver level controls. To our ears, the AR93 provides an exceptionally well-balanced, clean, musical sound, regardless of which of its suggested placements is used.

Although we were not able to compare the AR93 to other similarly priced speakers, our past experiences suggest that it would rank at or near the top of its price class in overall sound quality. Its appearance is somewhat stark and utilitarian, but if you are more concerned with good sound than a handsome furniture finish, a pair of AR93 speakers can go a long way toward providing true high-fidelity sound at moderate cost. ◇

Julian D. Hirsch

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TABLE I—WOOFER DISTORTION

Frequency (Hz)	1 watt (2.83 V into 8 Ω)		10 watts (8.94 V into 8 Ω)		
	Harmonic content dB)		Harmonic content dB)		
	Second	Third	Second	Third	
100	-55	-60	0.20	-46	-54
90	-52	-60	0.27	-42	-50
80	-48	-58	0.42	-42	-60
70	-56	-53	0.28	-39	-57
60	-36	-43	1.8	-33	-44
50	-34	-36	2.7	-31	-29
40	-30	-49	3.2	-23	-31
35	-23	-45	7.1	-17	-30
30	-17	-45	14.1	-13	-30

# COMPUTER BITS

By Carl Warren

## Backup May Be On Your Mind

**A**S A result of the growing number of Winchester disks being used for prime storage in microcomputer based systems, a need for backup has arisen. Numerous manufacturers are touting so-called streaming methods that employ magnetic tape. This backup philosophy, unfortunately, offers more disparities than it does possibilities. Among these are included:

- Inability of the streamer to accept data faster than 30 ips (30K bytes/s). This is primarily for 1/4-in. 3M cartridge drives. Drives that employ 1/2-in. reel-to-reel tape are able to handle fast data rates, but you pay the price.
- Although the 3M data cartridge works well in start-stop operations, it appears to be almost a detriment for streaming operations. The reason for this is that in a streaming environment, even at 30 ips, the tape is traveling at an unusually high rate for its design. As a consequence, the tape can lose its tension, causing a fluttering against the head; this produces both soft and hard errors.

There is an alternative to streaming tape drives, though, and it is available now. It is the Corvus Mirror®. The Mirror permits up to 100M bytes of removable back-up storage by using a Panasonic NV 8208 video cassette recorder and a Corvus controller. The Mirror is designed to back up the Corvus 10M byte Winchester drive and interface to a host of computer systems, including Apple, TRS-80, S-100, LSI-11 and Heath H89.

Essentially, 532 byte blocks of data are sent to the video recorder and, in the process, are transformed into video signal format as shown in the accompanying photo.

The advantage of the Mirror over other methods of backup, including floppies, is that individual blocks of data can be searched for on the tape, with specific portions either updated or written out to the disk. The only advantage streamers have over this device is speed. But speed is relative, especially when no real product exists and flexibility is at a minimum.

The Mirror is currently priced at \$790. This is the controller only and doesn't include the video recorder, which the company will sell to you but recommends that you buy elsewhere. A Corvus spokesman pointed out that

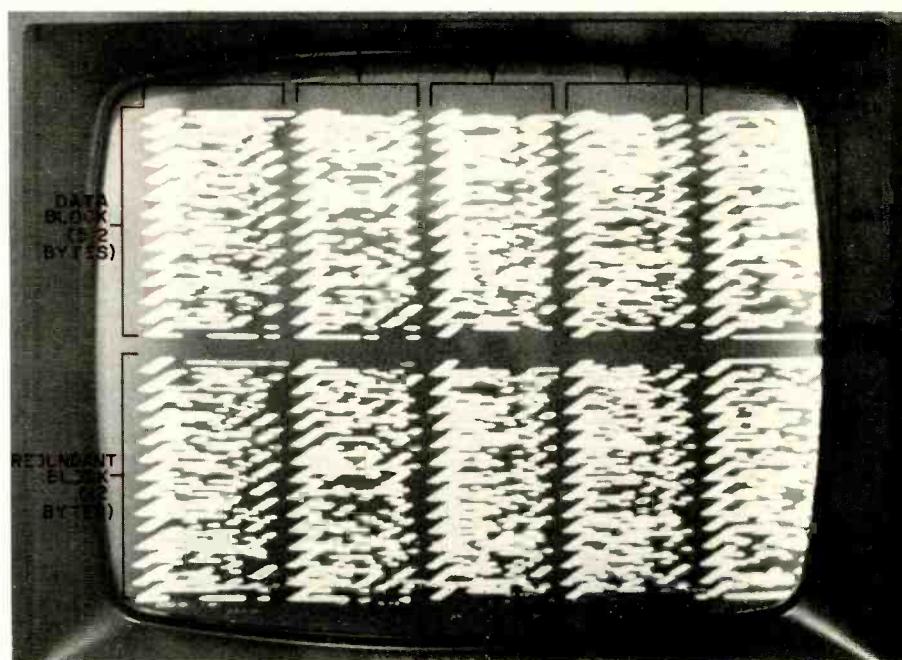
the Panasonic unit is back-ordered, and lead times aren't being given. Therefore, you might latch on to a less expensive device and forego the remote control operation. Manual operation takes only ten minutes of your time, at the longest, but can save you around \$1000.

**Get Your System Ready.** Those of you that have a Radio Shack TRS-80 will want to get your system ready to run nonmodified CP/M. This is important if you want to follow along with the various topics I'll be discussing in the next few months.

To update your system, you'll want



Corvus Mirror and VHS tape system provide tape backup for 8-in. drives.



Digital data, transformed by the Corvus controller, looks like video data with specific attributes. (Copyright 1980, Corvus Systems)



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## computers

Mapper I from Omikron. This \$199 piece of magic plugs into the TRS-80 MPU socket, and the processor is plugged into the mapper board. The board reorganizes TRS-80 memory to zero base, thus permitting the use of normal CP/M. Working in concert with Mapper I is Mapper II. This \$109 interface, including cable, permits the installation of 8-in. floppies.

Using these together you can switch between TRSDOS or CP/M and build up some reasonably large data bases for yourself.

**Short Software Reviews.** I mentioned a few months back that Microsoft's Consumer Products Div. was offering a number of unique packages for the TRS-80. For game lovers, there is Adventure (\$29.95). I can't say much about it, but my friend Ed Teja, who is a game nut, says this is a good one and makes for an enjoyable evening.

Typing Tutor (\$14.95) is an excellent tutorial program; it should be since it was written by Al Baker. You can learn to type from this, if you don't know how, or upgrade your skills.

Level III Basic (\$49.95) for the TRS-80. This software really represents unqualified slickness. Level III is designed for TRS-80's without disks, but gives you the same features adapted to tape.

The Editor/Assembler (\$29.95) is another nice piece of work, and also resides on tape. It's a good solid tool with few bells and whistles, but includes everything you need for most small-system designs.

**Some Hints.** In the December issue, I started telling you about the conversion of BASIC. I offered a challenge, more or less, for you to come up with possible methods to convert a simple program. Well, if you're working on it but not sure what to do, here are some hints:

- Use the IF... THEN... ELSE... statements to test data.
- String operators MID\$, LEFT\$, and RIGHTS\$ are used to take words apart and put them back together again.
- Remember that two files exist: the source file (code to be converted) and the target file (converted code).

For all practical purposes, this is all you really need to know for developing the translation construction. I'd also suggest that you draw a flowchart that shows where you want to get to.

**Build a System.** A few months ago, I suggested the possibility of assembling a single board computer (SBC). One such possibility, among others, is the Motorola 6809D4.

The D4 unit incorporates the MC-6809 microprocessor, a very powerful

monitor called D4BUG, and flexibility in adding memory both RAM and ROM. The system can be expanded with ease, using the optional card cage and accessories like memory boards and I/O boards.

Because the system is built around a 6809, it is easy to program and offers more power than you will find in similar systems that use co-processors to achieve 16-bit power in an 8-bit world.

A reasonable system can be built for well under \$1000, and systems languages, editor/assembler, BASIC and others are available from Motorola. Furthermore, a very tiny BASIC language, called VTL-09, which is designed after the 6800 implementation created by Frank McCoy and Gary Shannon for the Computer Store in 1977, is available. Instructions on using the language may be found in *The MC 6809 Cookbook*, published by Tab Books.

You might want VTL-09 since it is a fairly powerful BASIC-like language and is ROMable. For those of you who take advantage of the code, it's free, it can't be sold, and programs written for it must be given away. VTL-09 is not a commercial venture. The use of the code for the cookbook and free distribution of it for the 6809 were made possible by Dick Heiser of the Computer Store, Santa Monica, California.

## MORE INFORMATION

For additional information about products and services mentioned here, contact the companies directly.

### Corvus Systems, Inc.

2029 O'Toole Ave.  
San Jose, CA 95131  
408-946-7700

### Microsoft, Consumer Products Div.

10800 NE 8th St., Suite 507  
Bellevue, WA 98004  
206-454-1315

### Omkron

1127 Hearst St.  
Berkeley, CA 94702  
415-845-8013

### Motorola, Inc.

3501 Ed Bluestein Blvd.  
Austin, TX 78721  
512-928-6000

### Tab Books

Blue Ridge Summit, PA 17121  
717-794-2191

# Popular Electronics Tests



## Heathkit H89 Microcomputer

**T**HE Heathkit H89 microcomputer is an all-in-one system that is compact, expandable, and flexible, with software backup. Furthermore, it's available in kit or assembled versions. The H89 (also known as Z89 in the Zenith version) offers a number of features that make it highly versatile. Among these are:

- Dual Z80 microprocessors, separate for CRT terminal control and main system processing.
- A fully interlaced 12-in. raster-scan monochrome CRT that permits an 80 × 24-line display for a total of 1920 characters. (A nonscrolling 25th line, under software control, can be used for special function displays such as identifying the upper row of user-defined keys.)
- The 80-key, typewriter-format keyboard generates upper- and lower-

case letters on a 5 × 7 dot matrix. Lower-case letters having descenders use a 5 × 9 dot matrix, while up to 33 graphic elements can be created using an 8 × 10 dot matrix. A 12-key dual-purpose numeric cluster is also provided. In the normal mode, these produce the numerals 0 through 9. In their other mode, they provide useful secondary functions such as cursor up, down, left, right and home, carriage return, back space, line feed, tab (standard 8-column), etc. Editing functions include inserting and deleting characters or lines, while erase includes page erase.

□ Most operating parameters (underline/block cursor, reverse video, graphics, baud rate, etc.) are preset via internal switches. By taking the system off line (one keystroke), the user can make temporary changes via

the keyboard. When the system is turned off and re-powered, all functions automatically return to the Preset switch selections.

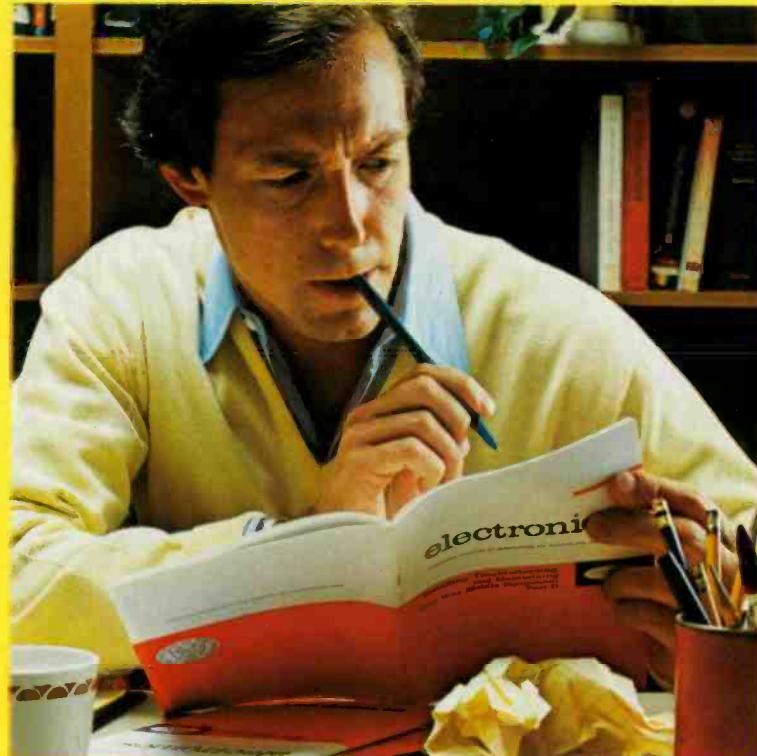
□ Package size is 13" high, 17" wide, and 20" deep. The system operates from 120/240 volts ac, 50/100 Hz. The case is formed from structural foam plastic that combines lightness with strength. A fan provides a cooling air flow. A slide lock, one on each side, allows easy entry to the cabinet interior.

□ A 5.25-in. single-density, hard-sector 40-track Siemens floppy-disk system is built-in with each diskette storing 100K bytes. A controller supports the two additional drives in the optional outboard H77 disk system.

□ The H47 dual 8" disk drive (kit is \$2595, with \$3500 for the wired

(Continued on page 38)

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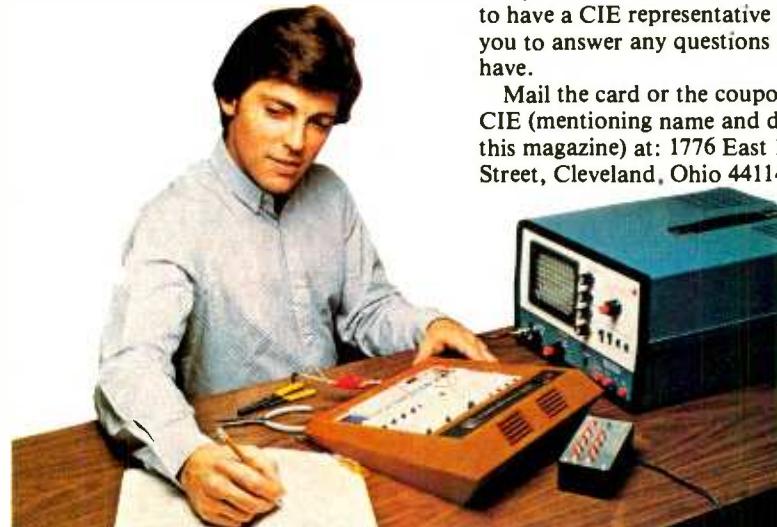
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version) features a pair of REMEX double-density, double-sided drives that support up to 1.2 megabytes/diskette.

□ Although it comes with 16K of RAM, the system has the ability to support up to 48K bytes of RAM simply by plugging the RAM chips into the sockets provided. (In conjunction with the 8-in. drive option, Heath will soon have a 16K-byte RAM add-on available to bring the system up to 64K, with a zero-base memory map.)

□ There is provision for serial op-

tion devices such as the Heath H14 line printer via an add-on RS-232C serial adaptor. (Use of this board also permits system-to-system communication using a modem.)

□ Software support is available from Heath and the Heath Users Group (HUG).

In addition, the H89 provides some functions that aren't readily evident. One of these allows it to be used as a terminal in a timesharing operation or as a front-end preprocessor. The basic system—with integral terminal, 16K

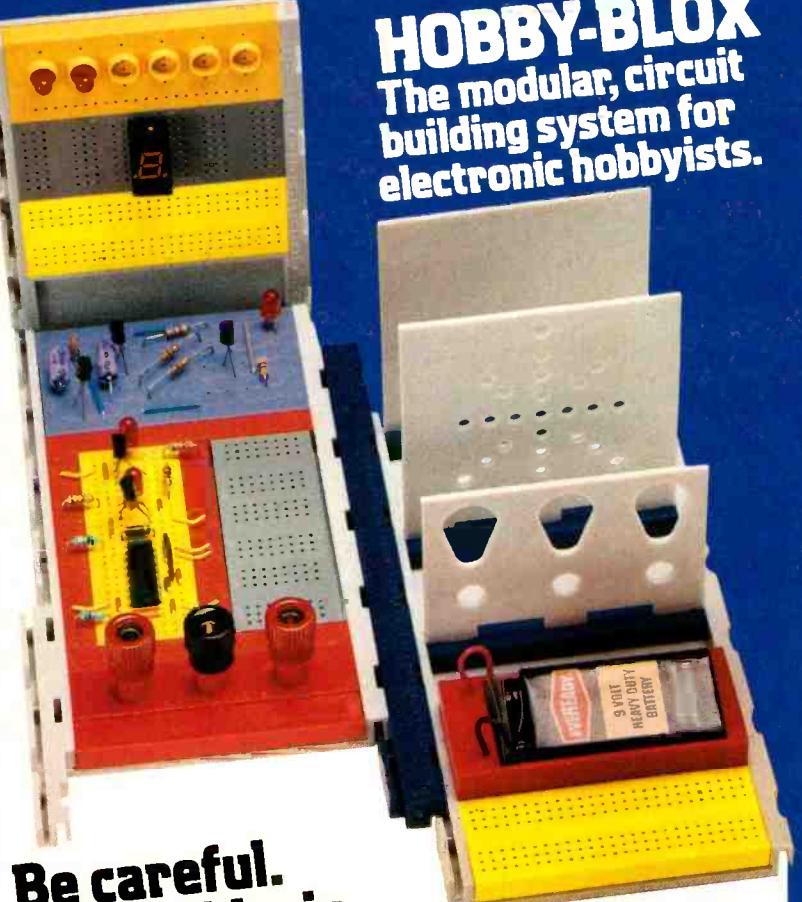
of RAM, H88-5 audio cassette interface, and a single 5 1/4" disk drive—costs \$1,695 in kit form; assembled, with 48K of RAM and a serial I/O port (but less an audio cassette interface), it is \$2,895. Options include a 16K RAM expansion kit (H88-2) for \$95; an assembled two-port serial I/O interface card (H88-3) for \$100; an assembled outboard floppy-disk drive (H77) for \$595 and a dual floppy-disk drive (WH87) for \$1,195; a modification kit (H88-6) for connecting the WH87 and other options to the H89 for \$50; an HDOS plus extended Benton Harbor BASIC, which requires 16K (32K recommended), a two-pass absolute 8080 assembler, text editor, debugger, and several utility programs (H89-17) on disk for \$150; and a Microsoft BASIC (H8-21) which requires 32K minimum RAM (48K recommended) for \$150.

**Software.** The HDOS is a very versatile library of utilities that looks like an excellent combination of a DEC operating system and CP/M. It requires 16K of RAM. Among the features are a 9-element debugger for machine-language programs, a text editor with a full range of commands, and an assembler for 8080 code that, when used with 16K of RAM, allows 350 user-defined symbols. HDOS (version 1.6) supports three disk drives.

Benton Harbor BASIC occupies about 13K of RAM and is full-featured. It includes 73 general-purpose commands and has 25 error messages. It will accommodate strings to 255 characters in length and accept variables consisting of a single letter or single letter with a digit (0-9). Both HDOS and BASIC must be on the same diskette to save a BASIC program. At least 16K of RAM is required for operation. This BASIC program will not accept a line having a syntax error.

Microsoft BASIC runs under HDOS and requires a minimum of 28K of RAM (32K is suggested). It features 116 statements, commands, and functions; has 23 general error messages and 16 error messages for disk operation. It also features 16 special-function characters. The BASIC contains provisions for single/double precision (16 digits), full editing, array erase, swap variables, trace/untrace, line width, a full complement of disk file operations, and all the capabilities associated with Microsoft BASIC. Other languages are available for the computer, including FORTRAN and COBOL.

**Building the Kit.** Construction of the H89 from a kit requires about 28 hours of assembly time. The process is straightforward and, as expected, provided no surprises. Before construction began, it was necessary to update the construction manual with some 15



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pages of errata supplied by Heath to deal with typos and parts changes.

Assembly is greatly simplified since Heath supplies all logic assemblies completely wired and tested. This includes terminal-logic, main-CPU (with 16K bytes of RAM and system ROM), disk-controller, and cassette interface. Not only does this save assembly time, but it also relieves you of having to debug a system assembled from scratch. Assuming you wire the power supply, keyboard, and CRT circuit assemblies correctly and interconnect all cables properly, the preassembled logic boards should allow your H89 system to come up the first crack out of the barrel.

Most of the assembly you perform in putting together the H89 is mechanical mounting hardware, fastening and soldering connector pins to cable harnesses, and mounting and interconnecting subassemblies.

Even with extreme care taken during assembly, difficulties can arise, naturally. These can result from infant mortality of parts—only the preassembled boards (terminal controller, main processor board, and subcards like the disk controller) are already burnt-in. Specifically, I experienced a problem with insulating the video amplifiers on the heat sink. In this case, the mounting bolt of the IC caused a short to the heat sink, causing the circuit to blow. A call to Heath's service center produced a cure—new parts (free of charge), including insulating material for the mounting bolts.

**CRT Electronics.** The driving electronics for the CRT consist of the high-voltage section and fully interlaced vertical and horizontal circuits. The CRT is controlled by the terminal logic circuit board. This board provides seven functional blocks that include power supplies, keyboard encoder and configuration logic, terminal processor (Z80), master clock and system logic, communications, CRT and memory control, display memory, character generator, and video control logic.

The master clock, operating at a nominal 12.288 MHz, is crystal-controlled. In practice, the clock was found to operate at approximately 12.8 MHz with no adverse effect on the system.

The best resolution test for a CRT terminal is to first make sure that the brightness and focus are properly adjusted, then create a "test pattern" by filling the screen with lower-case "m's. The bottom dots of the three small vertical lines that form the "m" create a light-dark-light pattern across each line on the crt. This is the maximum number of pixels developed by the circuit. To check resolution, note that each dot and "undot" are clear and distinct across the line from the top left corner of the display to the

lower right corner. Poor high-frequency response of the amplifier results in blurring images. By noting any size changes in the vertical and horizontal directions, the "m" pattern can also check vertical and horizontal linearity. Of course, there should be no dimensional changes over the screen. The CRT brightness control can be operated to check both screen brightness and dot "blooming" that tends to reduce resolution. The black-and-white Heath display passed these tests with flying colors.

One minor problem we noted is that the screen surface of the CRT is sufficiently reflective to make glare from room lights annoying. This can be easily avoided by using an anti-glare filter, such as Heath's new Pannelgraphix HCA-3 for \$8.95.

### Z80 Keeps Terminal On Track.

The Z80 processor in the terminal logic examines data and decides what to do with it. This CPU operates at 2 MHz and keeps track of terminal I/O, terminal personality (the H89 can be configured to emulate a DEC VT 52 terminal), and the location of the cursor. Operations of the terminal logic CPU are guided by an onboard ROM. This firmware program provides the ability to tell the terminal how to act under certain conditions, plus supporting the Z80 in performing general "housekeeping."

The terminal ROM, flexible as it is, does appear to have a bug in the transmit page function. Although the function appears to exist, adequate documentation doesn't. But according to a Heath system engineer, the problem is being solved in new updates of the ROM and by making the ROM software available in listed form.

**Main CPU is a Z80.** The terminal portion of the H89 communicates with the computer section via serial ports at selected (switches or software) rates up to 9600 baud. The main CPU logic board incorporates another Z80 microprocessor, system software ROMs for controlling the computer, system RAM (up to 48K bytes), and the system backplane that uses Molex pin connectors to allow

use of additional boards such as serial interface, disk controller, and cassette.

The main CPU board has a built-in interrupt structure in various levels to accommodate peripherals and program requirements. Interestingly, the flexibility of the main board makes it possible to change system ROMs to emulate almost any system. American Micro Systems, Inc. (AMI) uses the H89 as a development system (called the Phoenix 1), for example, operating totally through software.

**Testing the System.** Determining power of the software and hardware can be a difficult task. I decided that, although timing tests that establish the running speed of various BASICs served a purpose at one time, how fast BASIC executes makes no difference in processing of data. Consequently, I chose a different form of system test involving the use of CP/M, CBASIC, and Micro-AP's Selector III. (Note that, "as is," the H89 will not run standard CP/M without circuit changes that will be covered in an upcoming review of the H89/Magnolia system. The changes are related to system firmware in the memory field, not operating speed.)

Selector III was chosen because it is a good data manager and would exercise the RAM, disks and system software. Furthermore, Selector allows the user to create a large data base, manipulate it, print hardcopy reports, sort it, and make selective retrievals. CP/M and CBASIC were necessary for operation of Selector and allowed me to see how well the system worked with non-Heath software. The CP/M from Lifeboat Associates, patched to allow for the 4200<sub>16</sub> origin of memory, was used.

For the purposes of the test, a database of 200 records was created with each occupying 255 bytes. The test consisted of first asking Selector to find all records that had a particular code letter, then sort the list, print a selected list, print a label list, retrieve and update the first record, retrieve and update the last record, changing its code, then reselecting. During the course of operation, Selector does not re-order the entire list, but develops

The H89 computer with H77 dual-disk system and H14 line printer.



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## computers

Compuserve's "Micronet."

Further increasing the utility of the H89, with a storage capacity in the range of 10M bytes, is Magnolia Microsystem's interface that permits the H89 to operate the Corvus version of the IMI Winchester hard-disk system. The interface, card, drive with intelligent controller, and interconnecting cables are offered for \$5350. To make it all work, though, Magnolia's version of CP/M 2.2 is required, as is the zero base memory map PROM, for a total of \$295 more.

Heath is just beginning to offer the complete CP/M system, including assemblers, editors, and CP/M compatible Microsoft products such as COBOL, Fortran, and BASIC. It is thus possible for users to run any CP/M-based software. Also, the new Zenith Electronic Typing disk—a word processing system that requires 48K of RAM, dual-drive floppy capability and a printer—is available for \$395. (Discounts are offered if you are also buying a computer or printer from Heath.)

**The Bottom Line.** The basic H89 is an excellent general-purpose computer. With the addition of an optional dual disk drive and the software now becoming available, the H89 is indeed a formidable small computer.

Exotic peripherals such as speech I/O, music, color graphics, remote control, etc., made for use with S-100 systems are not compatible but Heath engineers are currently evaluating the offering of such add-ons.

We have lived with the H89 for a while now and feel very comfortable with it. Even the disk system is quieter than most. The keyboard has a nice professional feel to it, with its IBM-style keys and slightly angled positioning. Furthermore, there's a "clicking sound" on-off switch should the user wish to be certain that keys indeed make contact when pressed. Good display contrast is in evidence with the P4-phosphor CRT. Do add an inexpensive anti-glare filter, though. Also, since the floppy drive motor is not "on" all the time, greater longevity than usual may be expected for this device.

In sum, the Heath H89 computer is certainly modestly priced in kit form for what it offers. Its all-in-one construction saves space and eliminates a rat's nest of interconnection cords compared to "separates." Furthermore, its professional-type features make it a pleasure to work with for long periods of time.

What Heath offers is indeed top-notch and should serve exceptionally well for any serious computerist who is not strongly motivated toward games and home-device controllering. Moreover, it is appropriate for very small-business use where price is an object.—Carl Warren

# COMPUTER SOURCES

By Leslie Solomon  
Senior Technical Editor

## Hardware

**Apple Tablet.** The VersaWriter is a high-resolution color-graphics addition for an Apple II or Apple II Plus. The device consists of an 8½" by 11" Mylar plotting board having a clear plastic overlay. Attached to this board is a jointed drawing arm at the end of which is a magnifying lens with a crosshair. To use, the item to be copied is placed in the baseplate and "traced" using the crosshairs. As it is traced, the drawing appears in the CRT screen. Immediate software commands include color choice, width of drawing line, fill figure with color, draw a straight line between two points, use a different scale, edit, erase, smoothing factor (rounds off rough edges), store picture on disk, and more. Any picture can be stored as a shape table that can be manipulated as usual. Other programs include Textwriter enabling upper/lower case symbols, area/distance calculations, and calibration. \$252. Address: Peripherals Plus, 119 Maple Ave., Morristown NJ, 07960 (Tel: 201-538-3358).

**TRS-80 Expansion.** The Chatterbox peripheral for the TRS-80 features a COMM-80 Serial/Parallel Expansion Interface that includes an RS-232C interface, a parallel printer port, auxiliary expansion bus connector, power supply, and a modem. The device is completely hardware and software compatible with existing Radio Shack interfaces and application programs. It can also be used with the RS Expansion Interface to provide a serial port instead of adding the RS-232C board, or it can be used as a second port in systems already incorporating it. The serial/parallel port is address selectable and up to 16 COMM-80s can be attached to one TRS-80. The parallel port is 8 bits in and 8 bits out. COMM-80 (less modem) is \$179.95, the Chatterbox (COMM-80 plus modem) is \$259.95. Address: Hardside, 6 South St., Milford, NH 03055 (Tel: 603-673-5144).

**Typewriter Interface.** The DynaTyper is an electromechanical device that fits over the keyboard of almost any electric typewriter and is driven from an interface board. Other than mounting a pair of stick-on buttons,

there are no modifications made to the typewriter, and without the DynaTyper, machine can be used normally. Typing speed can reach the maximum at which the typewriter can operate. Each package contains an interface, power supply and software. The TRS-80, Apple, PET, Northstar, and Ohio Scientific versions are \$499, the GPIB system is \$489. Address: Rochester Data Inc., 3100 Monroe Ave., Rochester, NY 14618 (Tel: 716-385-4336).

**68xx Systems.** A new catalog, covering almost every peripheral for 6800/6809 systems is available. Items discussed include motherboards, power supplies, RAM and ROM boards, video and high-resolution boards, disk controllers, and a broad variety of I/O boards all for the SS50 and SS50C bus. Address: Gimix Inc., 1337 West 37th Pl., Chicago, IL 60609 (Tel: 312-927-5510).

**S-100 Printer Interface.** The I/O Master features two serial and two parallel ports as well as an 8-level interrupt control and dual interval timer. It supports OEM versions of NEC, Diablo, and Qume, as well as Centronics/Data Products printers. It allows driving a daisy-wheel printer at the full rated 55 cps. An asynchronous and synchronous RS-232 interface, crystal-controlled baud rates to 38,400, and external baud rates to 56k are featured. Complete software support including WordStar word processing system and CP/M\*2.0 is available. \$400. Address: MicroPro International Corp., 1299 Fourth St., San Rafael, CA 94901 (Tel: 415-457-8990).

## Software

**Health and Education Programs.** The Vista-Facts Series includes Growing Up, Talking about Sex, Drinking and Drugs, Birth Control, Your Blood Pressure, and Heart Attacks. They are available for Apple II, PET/CBM, and TRS-80 machines and are designed for use by families, schools, health education organizations, and the medical community. These programs have the approval of the Canadian College of Family Physicians. Each package comes with a 12- or 16-page manual containing illustrations and a glossary of medical terms. Each package is \$19.95. Address: Personal Software Inc., 1330 Bordeaux Drive, Sunnyvale, CA 94086 (Tel: 408-745-7841).

**Statistics Package.** NWASTAT-PAK is a multi-function statistics library for use with systems having CP/M and MBASIC. The package contains file utilities and computational programs. The file utilities allow the user to create, edit, and merge data files and select and scale data within files. The computational section contains programs for probability

calculations, single variable statistics, regression analysis, continuous and discrete distribution functions, means testing, nonparametric analysis and survey data, and contingency tables. Address: J.L. Cawley, Northwest Analytical, Inc., Box 14430, Portland, OR 97214 (Tel: 503-238-9760).

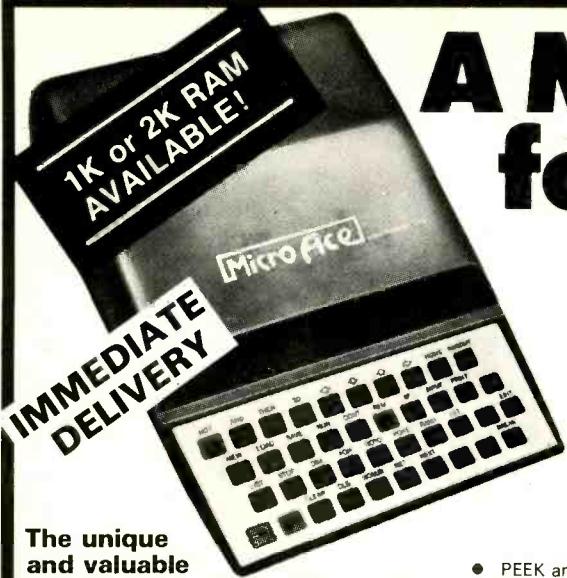
**Data Manager.** Information Master is a sophisticated, easy-to-use data manager for the Apple computer. The user can define, enter, edit, sort, and retrieve data and print report formats. The program includes screen formatting; error trapping; and ability to perform calculations, totals, subtotals, addition, multiplication, division and exponentiation. Files may be transferred or copied from one diskette to another even with one drive. Address: Tinka Bolding, High Technology Inc., Box 14665, Oklahoma City, OK 73113 (Tel: 405-840-9900).

**TRS-80 Self Taught BASIC.** This self-teaching guide is for learning how to program a Level II TRS-80 with no previous computer experience. Each chapter presents a single topic on BASIC, the TRS-80, or a program that is being developed. \$9.95 from all Radio Shack stores.

**AIM-65 Graphics.** The MTU K-1009-1C Text/Graphics Printout Program permits AIM-65 users to print text and high-resolution graphics with no modification to the computer or printer. Text print routine reproduces contents of the text buffer as 10 unbroken lines of up to 127 characters per line. Screen printout routine creates an exact image of a graphics display screen (in 8K memory) as a 300-wide by 200-high dot matrix. The Quick Print feature generates a 320 × 200 dot image on one paper strip. Quality Print generates the image as two 320 × 100 strips to be taped together. \$25. Micro Technology Unlimited, David B. Cox, 2806 Hillsborough St., Box 12106, Raleigh, NC 27605 (Tel: 919-833-1458).

**Color Accounting.** Using color as its key, Color Graphic Accounting uses a combination of color and graphics in the interpretation and display of accounting records generated through standard accounting functions of general ledger, accounts receivable, accounts payable, payroll, sales analysis, and inventory control. Use with Intecolor CP/M models. Address: The Rainbow Tree Corp., 1 West Court Square, Suite 30, Decatur, GA 30030 (Tel: 404-377-9921).

**PET Library.** The Jacksonville Area PET Society has a number of programs for the PET computer. They cover games, finance, ham radio, astronomy, music, graphics, and utility programs. Send a SASE to PET Library, 401 Monument Rd. #123, Jacksonville, FL 32211, for a three-page list.



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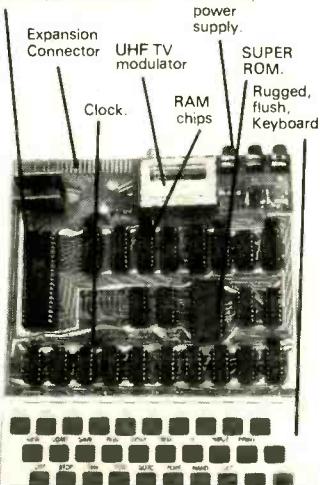
- Unique 'one-touch' key word entry: the MicroAce eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability — takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The MicroAce also has string input — to request a line of text when necessary. Strings do not need to be dimensioned.
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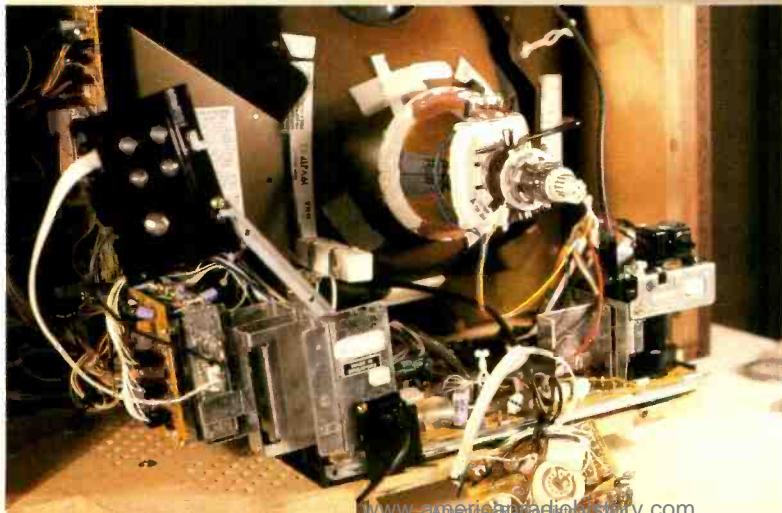
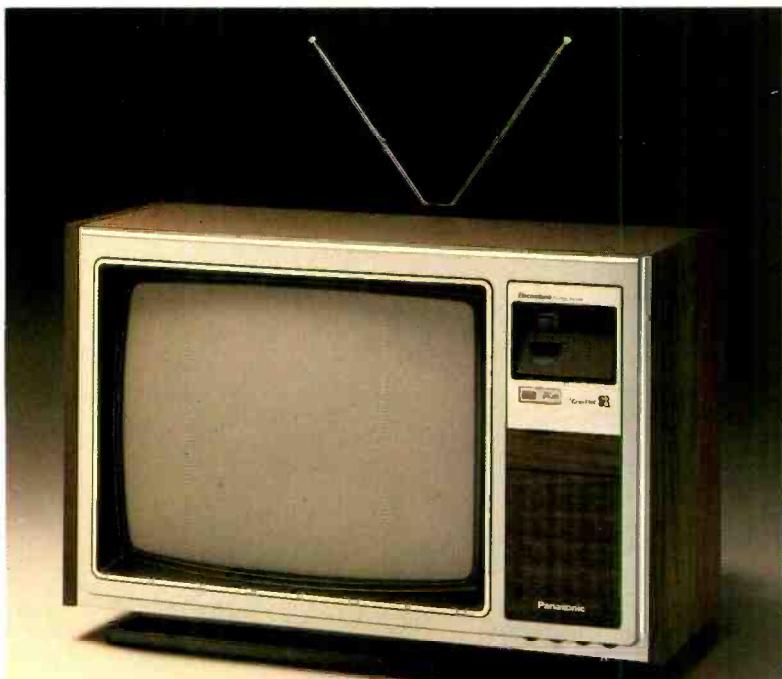
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# Popular Electronics Tests

## *Panasonic Model CT-9060 19" Color TV*

**Super picture conversion, good reproduction of colors, and convenient servicing are hallmarks of this table model.**

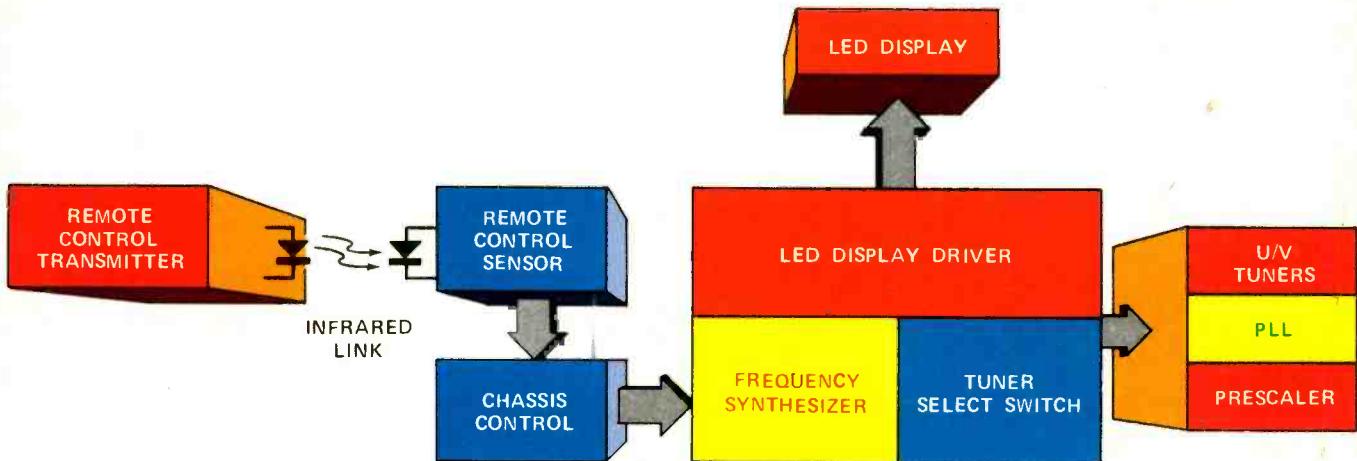


PANASONIC's Model CT-9060 is a full-featured 19-inch color-TV receiver. It offers "ColorPilot" (VIR), a sophisticated 16-button remote-control system with up/down scanning and random channel tuning, large LED channel display, and a light-sensor-controlled picture. Other features include a fast-warmup (6 seconds) picture tube, built-in whiteness enhancer (increases beam current to make whites appear whiter), CATV/MATV connector, a front-panel earphone jack, and an attractive simulated wood and brushed aluminum cabinet integrated atop a neat pedestal base.

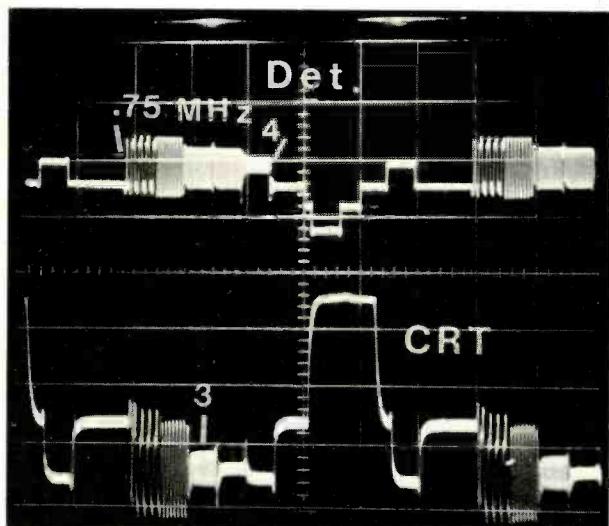
Dimensions are 18 $\frac{1}{8}$ "H  $\times$  19 $\frac{3}{8}$ "D  $\times$  26 $\frac{3}{4}$ "W; weight is 60 lb. Suggested retail price is \$629.95. Other color receivers with the same NMX-L22 chassis used in the CT-9060 are the CT-9050 and CT-9040, both without remote-control facilities and the latter with no VIR.

**General Information.** This set is built around 16 transistors and seven integrated circuits. ICs are used for video i-fs and detection, sound detection, and output, VIR, automatic fine tuning (aft), sync countdown and phase detection, luminance processing (video jungle), and chroma processing and demodulation.

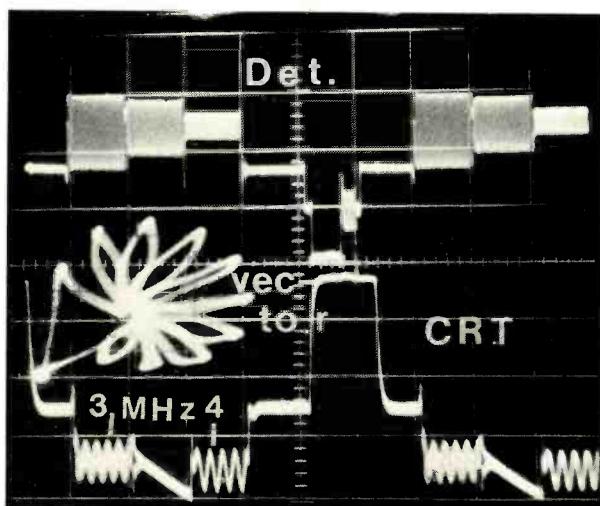
The CT-9060's modular chassis is very different from those in run-of-the-mill nondeluxe receivers. It features synthesizer, LED, remote-control, antenna, VIR, main, and CRT boards that are unpluggable and unscrewable. The only permanently



*Fig. 1. Block diagram of the Ct-9060 shows how the RemoCon system is linked to the receiver's up/down scan control.*



*Multiburst patterns at video detector and CRT showing luminance bandpass.*



*Swept chroma from 3.08 to 4.08 MHz at video detector output and CRT. Gated rainbow vector in center.*

mounted items are the CRT and a portion of the power supply. The main chassis also slides out for convenient servicing.

A couple of "safety" features in this transformerless receiver deserve mention. First, the power supply uses a half-wave rectifier, which allows one side of the ac line to be grounded. (The usual bridge rectifier leaves both sides of the ac line floating.) Secondly, this is the one set we've recently tested that has transformer coupling to the speaker/headphone arrangement, permitting the latter to be isolated from the potentially "hot" chassis itself.

**Technical Details.** Specific information on the receiver's up/down transmitter and remote random address and front-panel up/down tuning system was not available at the time we tested the CT-9060. However, this is one of several similar schemes employed by TV receiver manufacturers. It was not difficult, therefore, to draw up a block diagram of Panasonic's system (Fig. 1). Such remotes have a local oscillator that generates the various command frequencies to modulate an ultrasonic or, as in the case of Panasonic's CT-9060, infrared carrier. In the Panasonic set, a remote receiver and additional electronics process all on/off, up/down, mute, and channel/volume changes through its RemoCon (remote-control) system that is also linked with the receiver's up/down scan control.

A frequency synthesizer recognizes all transmitted impulses from RemoCon and keys an LED channel display driver and uhf/vhf tuner switch. According to channel selection, the appropriate tuner is activated and a

*(Continued on page 48)*

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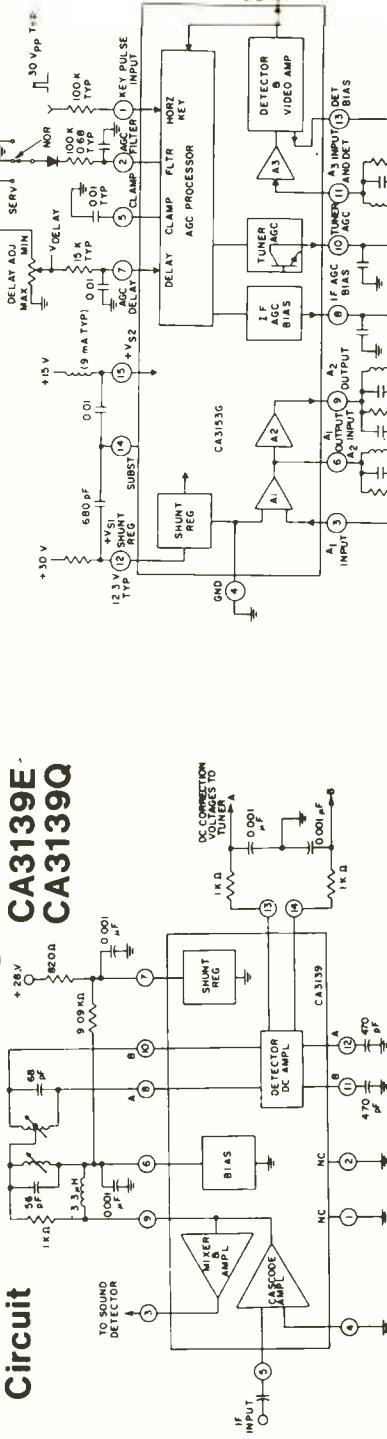
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## TV Automatic Fine Tuning Circuit

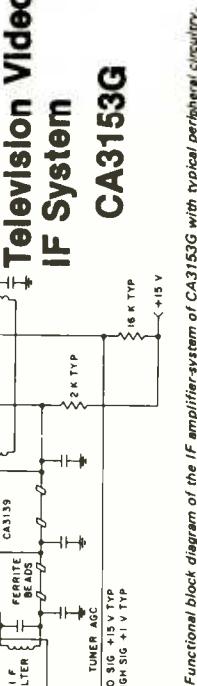
**CA3139E**  
**CA3139Q**



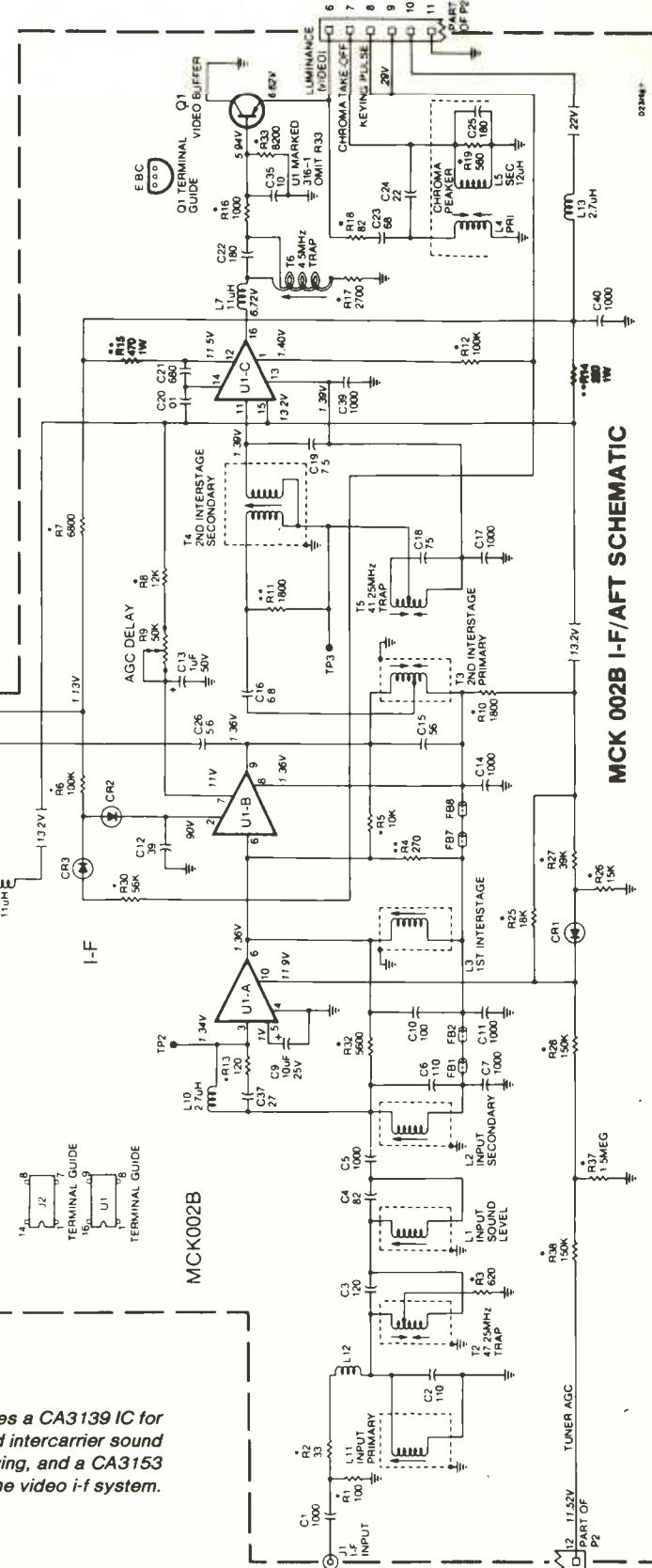
Block diagram and typical application of CA3139.

Fig. 2. The CT-9060 uses a CA3139 IC for automatic tuning and intercarrier sound mixing/amplifying, and a CA3153 for the video i-f system.

## Television Video IF System CA3153G



Functional block diagram of the IF amplifier system of CA3153G with typical peripheral circuitry.



MCK 002B I-F/AFT SCHEMATIC

phase-locked loop (PLL) and prescaler (usually a divide-by-256 arrangement) track the selected frequencies between 54 and 890 MHz, locking on the particular channel via feedback voltage correction. In such an arrangement, aft may or may not be used, depending on the accuracy of regulated voltage, tuner capture range, and overall effectiveness of the PLL. In this instance, aft is always on, regardless of ColorPilot engagement, and has a channel frequency capture range of  $\pm 1.5$  MHz. The 40-pin synthesizer chip is undoubtedly an LSI (large scale integration) device.

The CT-9060 uses a U.S.-made CA3139GMI RCA IC for automatic fine tuning and 4.5-MHz intercarrier sound mixing/amplifying and an RCA CA3153GMI serves as an i-f amplifier, video detector, and agc processor. This latter IC receives tuner signals immediately after conventional adjacent-channel LC trapping between i-fs and tuner. Both ICs are very similar or identical to those listed on the MCK 002B i-f/aft schematic for RCA's CTC 96 chassis. Therefore, we'll use the well-defined RCA diagram in Fig.2 to describe operation of the two ICs.

The CA3139E/Q aft actually consists of five circuits listed by RCA as: cascode amplifier, bias, intercarrier mixer/amplifier, aft detector/dc amplifier, and voltage regulator. Incoming signals enter U2-A from UI-B through a frequency restrictive capacitor and are amplified by three transistors for the mixer and amplifier.

Video i-f and sound carriers at 45.75 and 41.25 MHz are beat together and down-converted to provide the 4.5-MHz intercarrier from which high-frequency "tweets" are removed with a low-pass filter. After further amplification, sound information passes to the audio IC for detection and final processing.

In the meantime, the original video carrier continues through an RLC network and detector transformer, where applied bias controls aft "bow tie" width and, thereby, overall amplifier gain. The transformer is an ordinary tunable center-tapped discriminator that furnishes out-of-phase voltages to a differential peak detecting dc amplifier. This stage supplies filtered push-pull outputs that vary directly with the position of the 45.75-MHz video carrier on the i-f response curve, keeping the u/v tuners within a few kilohertz of video channel center frequencies. The shunt regulator has a single transistor and two reference zeners.

The CA3153 video i-f system, of course, has many more functions than just voltage amplification and control. It also provides an improved, fast-acting automatic gain control (agc), keyed sample-and-hold circuits, linear video demodulation (without synchronous detection) high-gain i-f amplifiers, and an internal shunt regulator. All these functions are contained in a 16-pin dual in-line plastic package.

Inputs arrive via the various adjacent-channel sideband traps through a peaking network and go into U1-A,

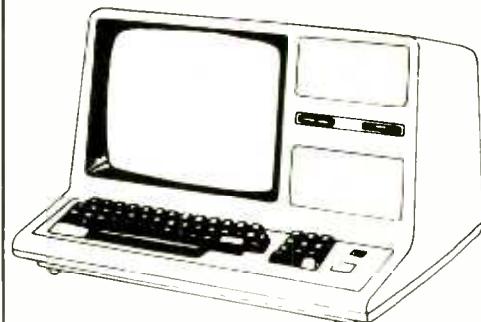
### MODEL CT-9060 PANASONIC RECEIVER LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity (min. signal for snow-free picture):	vhf (Ch. 6): -12.5 dBmV (-61.3 dBm) uhf (Ch. 30): -8 dBmV (-56.8 dBm)
Voltage regulation (line varied from 105 to 130 V):	Low voltage: 112-V supply—99% 123-V supply—93%
Luminance bandpass at CRT:	High voltage: 25-kV supply—93%
Luminance bandpass at video detector:	3 MHz
S/N at CRT:	4MHz
Horizontal overscan:	36.1 dB
Barreling & pincushion effects:	16%
Convergence:	None
Audio bandpass (3 dB down):	99.8%
Agc effective range	55 Hz to 900 Hz, 1 kHz to 5.5 kHz
Earphone outlet impedance:	>40 dB
Chassis power requirements (signal applied):	11.8 ohms
	85 W

Note: Instruments used in these measurements are from Tektronix, Sadelco, Data Precision, B8K-Precision, and Sencore. They include: Telequipment D66, D67A oscilloscopes; FS-3D-VU f/s meter; models 245, 1350, 1750 multimeters; types 2148, 1250, CG169 and VA48 color bar and signal generators; and a variable PR57 power supply.

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where there are two stages of i-f amplification and the first interstage transformer. The output from *U1-B* goes to the aft circuit discussed above and the second interstage transformer primary and 41.25-MHz soundtrap. From the latter, it goes to the succeeding stage's secondary and a diode-and-transistor detection system.

During horizontal blanking intervals, keying pulses reach *U1-C* coincidental with the horizontal sync pulse. These pulses charge an internal ca-

pacitor to a voltage proportional to the video signal magnitude and supply current to charge external agc filter capacitor *C12*. Keying pulses then effectively charge and discharge these capacitors.

There is also an internal noise gate, connected to the video output before the 4.5-MHz intercarrier sound trap, that reduces agc gain during noise spikes and turns on fully for large-amplitude noise interruptions. When this occurs, agc loop gain between *U1-*

*A* and *U1-B* is automatically reduced. An r-f agc delay for tuner applications is visible at the upper center of the diagram. The shunt regulator consists of several transistors in a feedback-loop configuration between ground and *V<sub>cc</sub>*.

**Comments.** We found the CT-9060's performance to be on a par with most of the other similarly priced color receivers we tested, with 3-MHz bandpass at the CRT. Its overall picture brightness was about average. And the "whiteness enhancer" feature did, indeed, accentuate the whites and helped in providing good color rendition.

The remote-control (RemoCon) and VIR (ColorPilot) both worked properly and are worthy of more than passing mention. VIR operates only when the vertical interval reference signal is broadcast, which is about 90% of the time on larger stations.

Picture convergence was phenomenally good! The yoke/picture-tube match in our sample receiver couldn't have been better.

The receiver's up/down tuning system doesn't permit random channel selection. However, pressing and holding the up or down button allows fast scanning of the channels in the direction selected. A minor annoyance is that there's a slight lag in the audio when tuning from one channel to the next. Voltage regulation might have been better, too, but the less-than-ideal regulation isn't too much of a problem because the picture bloomed and shrank only slightly at 135 and 95 volts ac, respectively.

You'll note from our test-result chart that we've now adopted the dBmV figure for tuner sensitivity instead of the dBm figures we've used in the past. This is because we have switched over to more accurate instrumentation, and it reads out in dBmV. For those of you who wish to make sensitivity comparisons between this and receivers we've already tested, the conversion from dBmV to dBm is as follows: dBm (at 75Ω) = -48.85 dB + dBmV.

Test results, super conversion, and generally good operation lead us to conclude that the Panasonic CT-9060 is a high-quality color-TV receiver. We're particularly pleased with reproduction of the reds, the important magentas and cyans in the picture, and the high audio volume that can be obtained without speaker-cone breakup.—Stan Prentiss.

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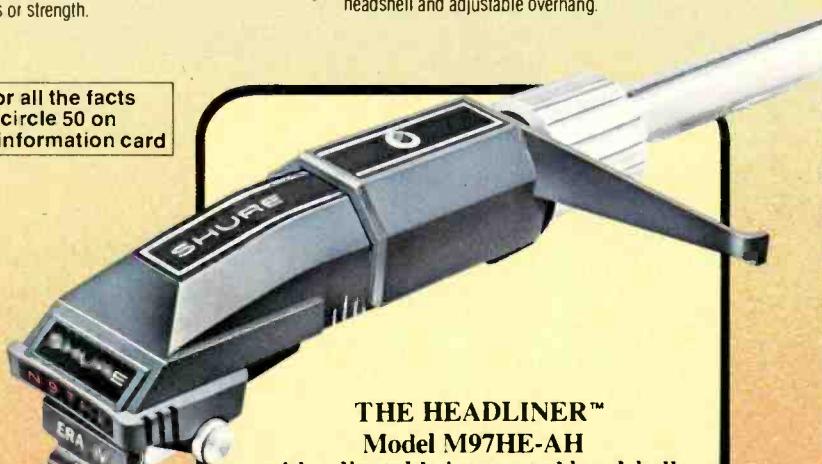
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PE-1-1

# PE TESTS EIGHT **AUDIO POWER AMPLIFIERS**

BY JULIAN D. HIRSCH

Hirsch-Houck Laboratories

AND HAROLD A. RODGERS

Executive Editor

**A**NYONE acquainted with the conclusion that we have reached over years of experience with power amplifiers—namely, that they are virtually indistinguishable in terms of sound when operated within their ratings of output power and load impedance—might wonder why we would bother to test them at all. The reason why we do is that in real-world applications, ensuring that ratings are not exceeded is not always an easy task.

Most of the ratings given power amps are based on their behavior when driving a purely resistive load, usually of 8 ohms. Even a cursory examination of the electrical characteristics of loudspeakers leads to the conclusion that such ratings are optimistic. Speakers as a rule do not maintain their nominal impedance ratings across the entire audio bandpass and

are most often reactive over at least part of the range. And while amplifiers are with few exceptions rated with 8-ohm loads, loudspeakers whose nominal impedances are as low as 4 ohms are common.

Taken together, these factors mean that a power amplifier can easily—

and unbeknownst to its owner—drive its output devices beyond their safe operating margins or, more likely, trigger its protective circuitry. Behavior of the unit under stress can, therefore, legitimately be regarded as an index of performance. With this in mind, we have added to the usual tests others designed to simulate stress. Note also that we have chosen not to report insignificant differences in distortion, and have established a measurement “floor” at 0.01%. This represents a distortion level 80 dB below the signal of interest, which includes a generous safety margin. Even with pure sine waves, distortion of 0.1% or less is not noticed by listeners.

Often, in reading a test report, one could easily conclude that the most important question it will answer is: “Does this product meet its specifications?” This obviously is of interest, but is not sufficient documentation of performance. While it is possible to check manufacturers’ specs against our data, our measurements are in most cases more comprehensive.

**How We Test.** To rate an amplifier for harmonic distortion, we run a series of tests at full power, half power, and  $\frac{1}{10}$  power at various frequencies distributed across the audio band. If



the worst-case figure is 0.01% or more, that datum is given along with the frequency and power level at which it occurred. Otherwise, we note that the figure is less than 0.01%.

Intermodulation distortion is assessed according to the IHF IM test. The amplifier is driven to full power by a signal consisting of 19- and 20-kHz tones of equal strength, and all detectable distortion products in the audio band are measured. Performance is considered acceptable when all products are at least -40 dB with respect to the desired signal.

Frequency response is measured via the common sweep-tone method at an output level of 1 watt. All of the amplifiers in the test were flat to within a small fraction of a decibel throughout the audio band and, in most cases well beyond. The differences found were not judged significant and will not be presented.

IHF slew factor is intended to check the response of an amplifier to out-of-band signals that may accompany an audio signal. It is measured by driving the amplifier with a 1-kHz

tone until rated power is reached, then increasing the frequency until the output waveform, as observed on an oscilloscope, departs from a sinusoid. The frequency at which this occurs is divided by 20 kHz to give the slew factor. Anything above 2 or so is probably satisfactory. Note that, if the amplifier incorporates a low-pass filter so that the waveform disappears before it becomes distorted, the slew factor is considered to approach infinity.

IHF dynamic headroom is a measure of amplifier behavior with signals that exceed its rated output for brief periods. It is measured with a repetitive test signal consisting of 20 cycles of a 1-kHz sine wave at one level followed by 480 cycles at a level 20 dB lower. The power level reached by the high-level burst just before clipping is referred to as the dynamic headroom of the amplifier and the ratio given in dB above rated power. Dynamic headroom of 3 dB is considered excellent.

The same test signal is used in checking recovery from overload. In this case, the drive signal is raised until the amplifier is subjected to 10 dB of overdrive by the high-level burst. Typically, when the drive level drops to  $\frac{1}{10}$  rated power, there is a short delay before the waveform resumes a sinusoidal shape. This is the overload recovery time. All amplifiers chosen for this report have recovery times in the range of 30  $\mu$ s or less. This is

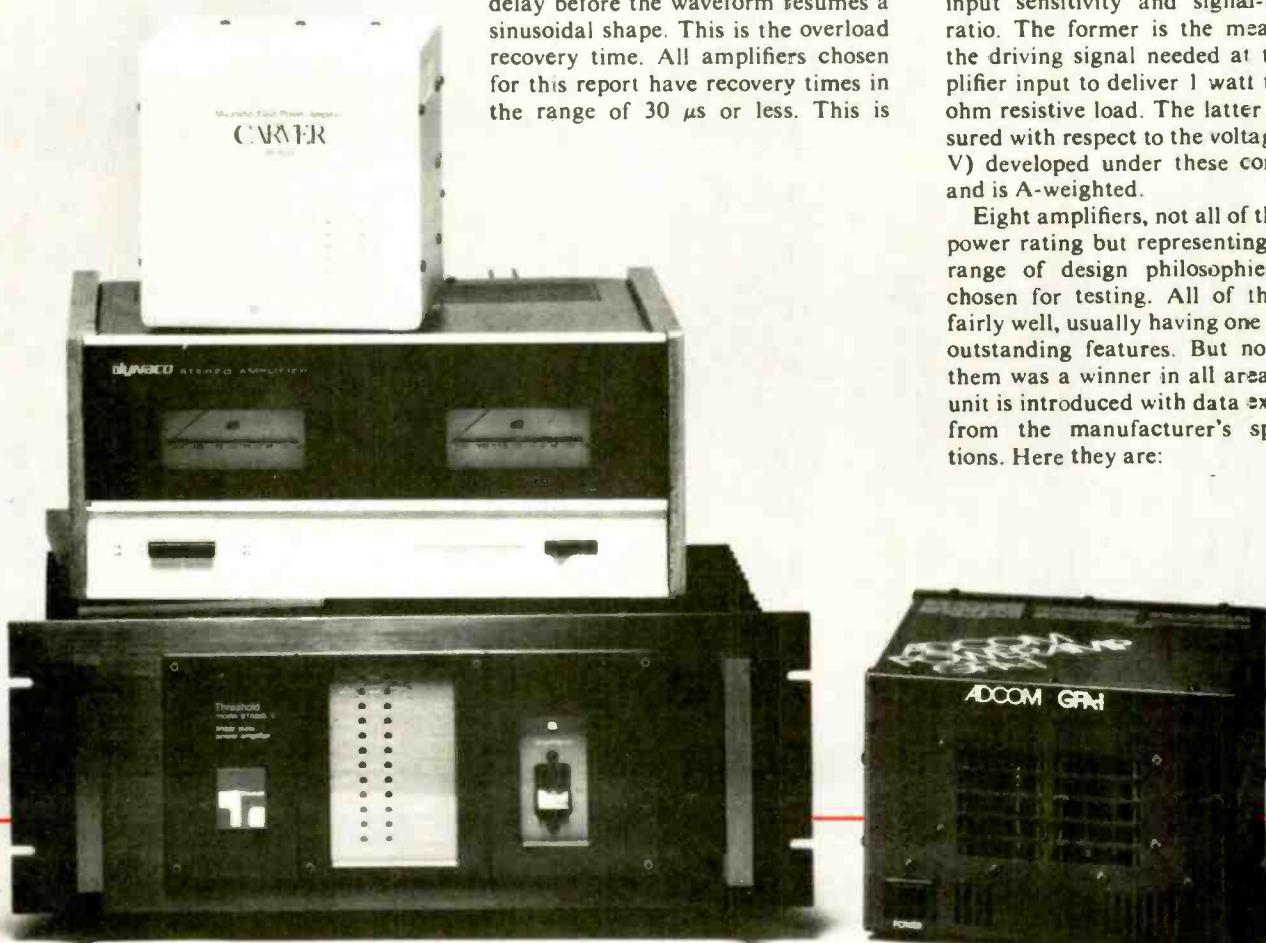
instantaneous as far as the ear is concerned; therefore these data have been omitted from the individual reports that follow.

Perhaps the most important use we have made of the dynamic headroom signal is in developing the voltage/current plots for each amplifier. These show the dynamic power available into 8-, 4-, and 2-ohm loads. One reason for using this signal is that in most cases it allows the tests to be made without triggering protective devices or blowing fuses. But equally important, this signal better approximates the waveforms the amplifier will handle in playing music. Steady-state power—which the FTC insists be used as the principal rating of amplifiers—has been verified in the harmonic distortion test.

As an additional test of ability to handle difficult loads, particularly those posed by electrostatic loudspeakers, we shunted the amplifiers' outputs with 3- $\mu$ F capacitors as they were driving low resistances and sometimes loudspeakers. In the lab, the test signal was a 10-kHz square wave. In the listening room, the signal, obviously, was music.

Additional factors we checked were input sensitivity and signal-to-noise ratio. The former is the measure of the driving signal needed at the amplifier input to deliver 1 watt to an 8-ohm resistive load. The latter is measured with respect to the voltage (2.83 V) developed under these conditions and is A-weighted.

Eight amplifiers, not all of the same power rating but representing a wide range of design philosophies, were chosen for testing. All of them did fairly well, usually having one or more outstanding features. But no one of them was a winner in all areas. Each unit is introduced with data excerpted from the manufacturer's specifications. Here they are:



## Apt 1

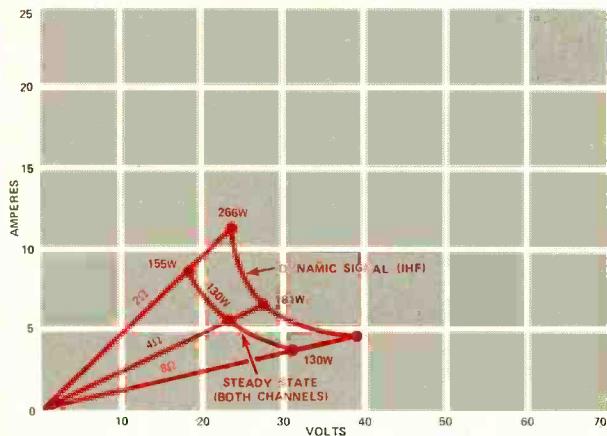


100 W/channel continuous into 4 or 8 ohms, 65 W/channel into 16 ohms, 20-20,000 Hz with no more than 0.03% THD, 150 W/channel into 2 ohms with no more than 0.05%, 200 W mono into 8 or 16 ohms; S/N (1 W) 80 dB; 3.12" H X 16.9" W X 10.19" D; suggested retail price \$641.

Apt has designed this amplifier to operate with a full reserve of headroom to all impedances from 2 to 16 ohms. A switch in the rear changes the power-supply voltage and current range to handle low-impedance loads without endangering the output transistors. The LED clipping indicators work very well; if they do no more than flicker from green to red occasionally, the amplifier is being used to its full capacity with no risk of any kind of distortion. This, plus the conservatively rated output section and the dual-voltage power supply, enables Apt to do away with conventional current-limiting circuits. Highly reactive loads do not bother this amplifier.

The Apt can drive 2-ohm loads with very high powers, and its high dynamic headroom rating (nearly 3 dB) applies under all load conditions. A warning red LED alerts the user that the impedance switch is set improperly (although no damage will come to the amplifier if it is set for "8-16 ohms" and one drives a 2-ohm load; under this condition it can pump well over 400 watts per channel into 2 ohms in 20-ms bursts).

Measured data: Harmonic distortion (8-ohm load, worst case) 0.028%, 20 kHz at full power; IHF IM distortion, second-order -94 dB, third-order -75 dB; IHF dynamic headroom 4.83 dB (see voltage/current plot); IHF slew factor 10; input sensitivity for 1-W output 92 mV; S/N (A-weighted) 89 dB.



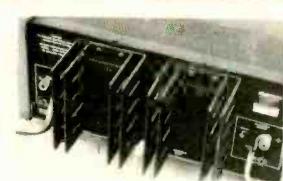
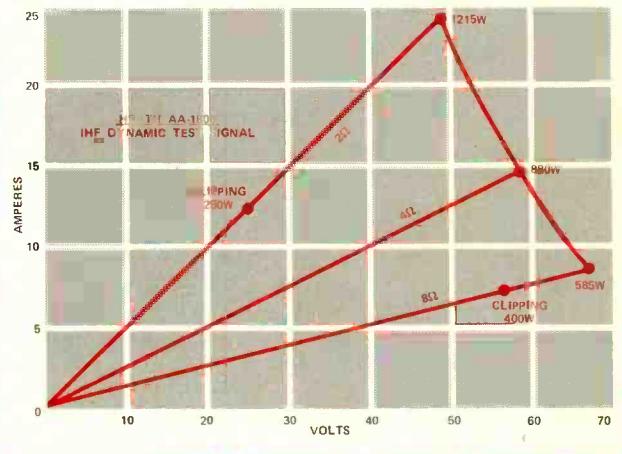
## Heath AA-1800



250 W/channel continuous into 8 ohms, 20-20,000 Hz with no more than 0.025% THD; S/N (1 watt, unweighted) 85 dB; 7" H X 19" W X 16 3/4" D; suggested retail price \$600 in kit form.

This is the giant of the group, yet it gets *very* hot in preconditioning and high-power testing. It will drive low-impedance loads, but can readily blow internal fuses if pushed to clipping into 4 ohms or less. Its real forte is dynamic power capability, in which it far outdistances the other amplifiers. From 585 watts into 8 ohms to an incredible 1215 watts into 2 ohms, this amplifier should be able to cope with any demand of recorded program material—even when digital systems enter the home. Due to a built-in power limitation at ultrasonic frequencies, slew factor could not be measured. Judging from the manual and from examination of the test sample, this kit is no job for a tyro.

Measured data: Harmonic distortion (8-ohm load, worst case) 0.02%, full power at 15 kHz; IHF IM distortion, second order -93 dB, third order -76 dB; IHF dynamic headroom 3.7 dB; IHF slew factor not measurable; input sensitivity for 1-W output 100 mV; S/N (A-weighted) >90 dB.



### Cover Illustration

The original photo was an infrared image of a stereo amplifier delivering power to test loads. The image was color-enhanced by Wilson/Lund, Melville, IL 61265, using its Electronic Graphics Generator (EGG). The EGG employs a video camera, video monitor, and a control panel with 48 dials. With the EGG, an art technician can introduce varying degrees of 16 colors into images of black-and-white or color copy or illustrations, videotape frames, or even small three-dimensional objects. What appears on the cover is a color photograph of the image produced on the EGG's video monitor.

## Carver M-400



200 W / channel into 8 ohms, 20-20,000 Hz with no more than 0.05% THD, 0.06% IM; S/N (A-weighted) 100 dB; 6 3/4" H, W, D; suggested retail price \$349.

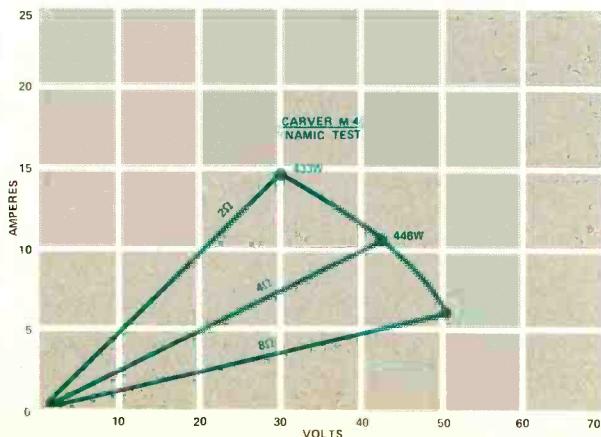
This little giant of amplifiers is really a fairly conventional class-AB circuit, with a very "smart" power supply—essentially, a super-efficient switching type, somewhat resembling the high-voltage flyback supply of a TV set. It is controlled by the signal envelope and supplies no more dc to the amplifier than is required by the signal (three voltage levels are available). Protective and monitoring systems are connected to the power supply, so that the amplifier will shut down in time to protect itself and the speakers against damage. Operation is inverted in one channel to equalize loads on the positive and negative supplies.

The M-400 has no heat sinking other than the metal case. Because of the low average power output of music signals, and the high efficiency of the design, it runs cool under normal conditions. However, continuous power tests heat up its small thermal mass rapidly, and it can shut down in moments. Extraordinary power demands will blow its 15-ampere line fuse. (This large rating is used because much of the current drawn from the power line is reactive.)

In continuous distortion tests, the Carver M-400 operated on a duty cycle of about 34%—50 seconds on, 95 seconds off and shut down repeatedly. It blew numerous fuses and became extremely hot at times, yet was never damaged. It is capable of enormous power, even into low-impedance loads. In the mono connection (with built-in bridging) it can deliver more than 500 watts to 8 ohms, and almost a kilowatt on peaks.

Considerable change in the 10,000-Hz square-wave output with a 3- $\mu$ F capacitor added to the 8-ohm load resulted from the low-pass filters in the amplifier outputs. These remove ultrasonic switching components arising from the power-supply operation, and their cut-off properties can be affected somewhat by loading. This produces no audible effects.

Measured data: Harmonic distortion (8-ohm load, worst case) 0.18%, 20 kHz at  $1/10$  power; IHF IM distortion, second order —86 dB, third order —64 dB; IHF dynamic headroom 2.0 dB; IHF slew factor >25; input sensitivity for 1-W output 92 mV; S/N (A-weighted) 85 dB.



## Adcom GFA-1

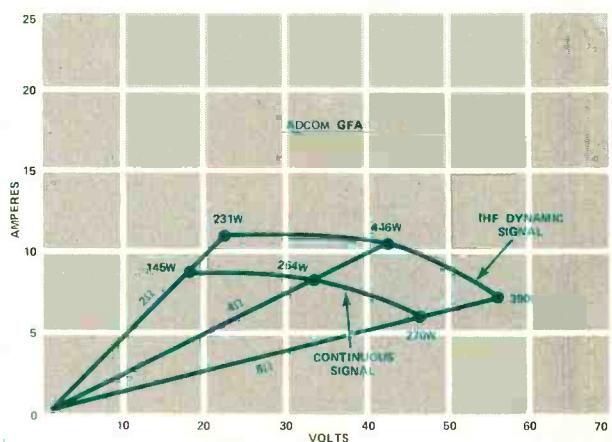


200 W / channel continuous into 8 ohms, 20-20,000 Hz with no more than 0.05% THD, 0.1% IM; 8 1/2" H X 10 1/2" W X 6 1/2" D; suggested retail price \$400.

High power is packed into the GFA-1's case by using two strapped (bridged) amplifiers per channel. This approach requires *isolation of all grounds* or the output transistors will be destroyed. (This made it impossible for us to measure IM.) No protection against this sort of mishap is provided. The amplifier's fan, just about the quietest we have ever found in a home-entertainment product, keeps the unit cool when reproducing music. In preconditioning and testing, however, it ran very hot and was repeatedly shut down by its thermal protection. Its duty cycle was 33%—2 minutes on, 4 minutes off.

Loading the outputs with 3  $\mu$ F in parallel with 8 ohms produces strong ringing at about 20 kHz, but no outright instability. However, the load reflects back into the input, producing the same sort of ringing waveform at the inputs that appears at the outputs. What this means is not clear. In listening tests we could hear nothing wrong with the sound of the GFA-1, and no change occurred with 3- $\mu$ F capacitors across the speaker lines.

Measured data: Harmonic distortion (8-ohm load, worst case) 0.097%, full power at 20 kHz; IHF IM distortion not measurable; IHF dynamic headroom 2.90 dB; IHF slew factor 7; input sensitivity for 1-W output 72 mV; S/N (A-weighted) 80 dB.



(more overleaf)

## Kenwood L-07 MII



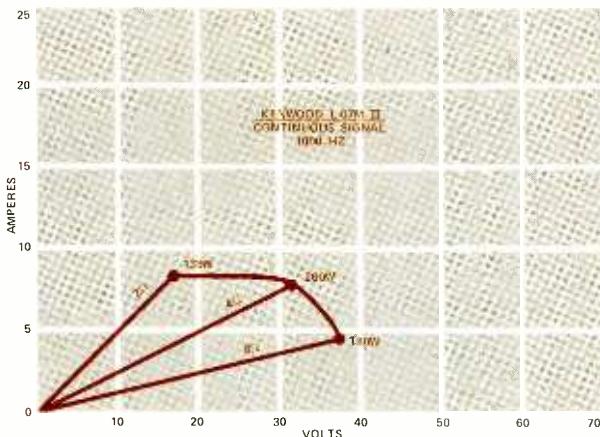
150 W (mono) into 8 ohms, 20-20,000 Hz with no more than 0.007% THD, 0.003% IM; S/N 120 dB; 6 3/32" H X 7 7/8" W X 15 1/32" D; suggested retail price \$600.

As this is a mono amplifier, two are needed for stereo. Not especially powerful in view of its size, it belongs to the "vanishing distortion" school of design. The load is fed via a meter length of heavy speaker cable, and some of the benefits of the amplifier are said to be sacrificed if any other link is used. (One can hardly dispute the desirability of short, heavy speaker leads.)

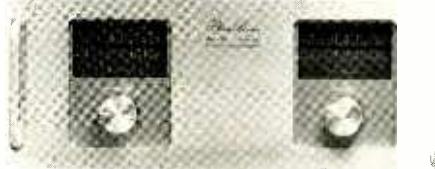
We heard no magic quality to the sound from a pair of these amplifiers, but they are easily as good as any others one might name. The 0.14-microsecond rise time we measured places response well into the MHz range, and it must be noted that the IHF IM distortion was the lowest we have yet measured.

A 3- $\mu$ F capacitor on the output produces ringing, which also reflects to the inputs. Oddly, the *dynamic* power output of the Kenwood amplifier with 4- or 2-ohm loads is *less* than the continuous output. A Kenwood spokesman verifies that this is characteristic of the protection circuitry.

Measured data: Harmonic distortion (8-ohm load, worst case) <0.01%; IHF IM distortion, second order below -96 dB, third order -90 dB; IHF dynamic headroom 1.25 dB; IHF slew factor >25; input sensitivity for 1-W output 80 mV; S/N (A-weighted) >90 dB.



## Phase Linear Model 400 Series II



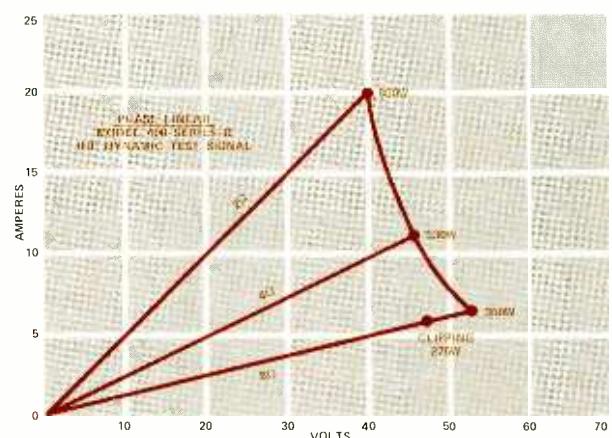
210 W/channel continuous into 8 ohms, 20-20,000 Hz with 0.09% THD and IM distortion; S/N 110 dB (IHF "A"); approx. 7" H X 19" W X 10" D; suggested retail price \$700.

Designing an improved model based on the original Phase Linear 400 is a task sufficiently formidable that we are neither surprised nor disappointed that in this case the redesign is largely cosmetic. Rated power has been increased by 0.2 dB to 210 watts and the distortion rating decreased to 0.09%. Under the new skin, however, lies much the same amplifier as before, as evidenced by the fact that our sample met the old distortion spec handily, but could not quite make the new one. (Everything was fine until 20 kHz, where harmonic distortion rose to about 0.2%.) Needless to say, this does not impair sonic performance of the unit in any way, especially since IM products—which, unlike harmonics of 20 kHz, lie in the audible range—are extremely well suppressed.

The rating for continuous power into 8 ohms leaves a good safety margin, but fuses blew before clipping could be reached into lower impedances. Dynamic tests showed the unit's true capabilities—800 watts per channel are available into 2 ohms! Addition of the shunt capacitors caused no significant alteration of the square-wave signal. The amplifier gets very hot in preconditioning, but stays cool in normal use.

The only oddity we observed was minor and relates to the LED output indicators. These, like the meters on the earlier version, are calibrated with 0 dB at only 70 watts.

Measured data: Harmonic distortion (8-ohm load, worst case) 0.21% ( $1/10$  power at 20 kHz); IHF IM distortion, second order -93 dB, third order -76 dB; IHF dynamic power 2.23 dB; IHF slew factor 3.2; input sensitivity for 1-W output 79 mV; S/N (A-weighted) 85.8 dB.



## Van Alstine MOS-FET 150



60 W/channel into 8 ohms, 20-20,000 Hz with no more than 1% THD; S/N 88 dB; 7'H X 14½'W X 11'D; price \$600 by mail order (\$675 with meters, \$300 when a Dyna 150, working or not, is sent as a trade-in).

Built from a recycled Dyna 150, though retaining only the chassis and power transformer, this amplifier impressed us with the simplicity of its design approach. The goal was to optimize the transient response of the amplifier while eliminating all forms of transient and slew-induced distortion. In realizing this, Van Alstine showed little concern for conventional specifications, as evidenced by the seemingly outlandish distortion rating.

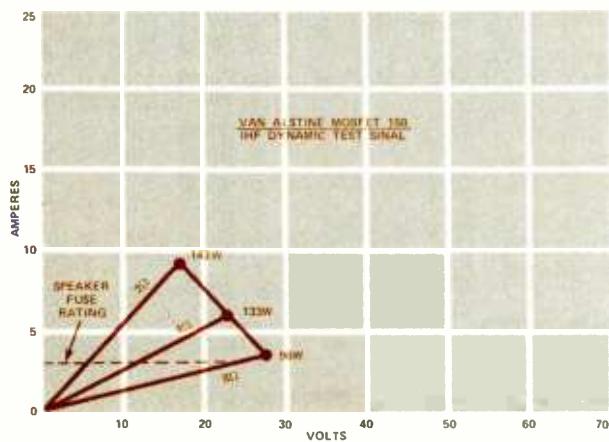
The unit is an all-FET amplifier having relatively low open-loop gain. There is considerable negative feedback at dc and low frequencies, diminishing with increasing frequency and disappearing altogether by 26 kHz.

The result shows in the IHF IM measurement. Odd-order IM products are more numerous of higher amplitude than on most amplifiers, and the 1,000-Hz difference tone is at only -73 dB. None of this is audible in any case, but we are not convinced that TIM/SID is audible either.

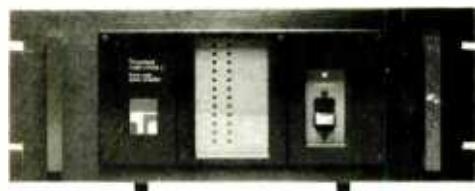
As one would suspect from a frequency response that is down 2.4 dB at 20,000 Hz, a 10,000-Hz square wave is quite rounded on its leading edge. Adding a 3- $\mu$ F capacitor improves the shape considerably. Nothing at the output of the amplifier reflects in any way to its input. A major design goal was total stability under any conditions. Stages are all balanced so that there are *no* transients at turn-on or turn-off. Furthermore, it is nearly immune to line voltage shifts. When you drive it to about 1 watt and watch the output on a dc scope, reducing the line voltage from 120 to virtually zero has absolutely no effect on the output. When the drive is increased so that the waveform clips, a slight increase of line voltage restores proper operation. The meters are accurate and the readings match in both channels—quite a rarity.

This is a relatively low-power amplifier, and fairly expensive for its power rating. On the other hand, if you have a Dyna 150 to be converted, the cost is very reasonable.

Measured data: Harmonic distortion (8-ohm load, worst case) 0.86%, full power at 20 kHz; IHF IM distortion, second order -74 dB, third order -50 dB; IHF dynamic headroom 2.02 dB; IHF slew factor >25; input sensitivity for 1-W output 30 mV; S/N (A-weighted) 85 dB.



## Threshold Stasis 3



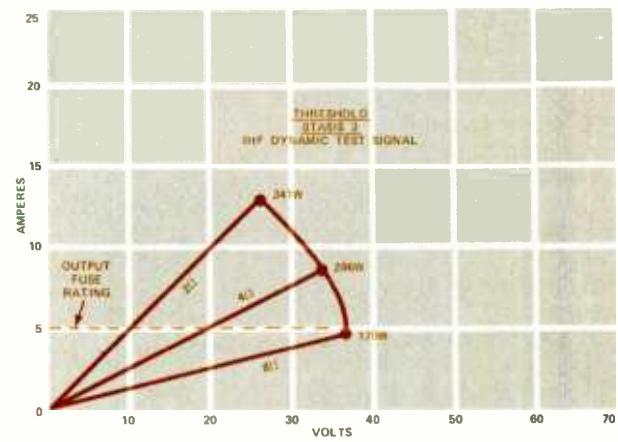
100 W/channel continuous into 8 ohms, 20-20,000 Hz with harmonic and IHF IM distortion less than 0.1%; S/N 103 dB; approx. 7'H X 19'W X 18'D; suggested retail price \$1,675.

Here is one superbly constructed and over-engineered amplifier. Its principal features are its unique circuit configuration (which eliminates overall negative feedback and makes the unit, theoretically, free of TIM) and its use of 16 output devices per channel (which makes fuses the only protective devices necessary). However, on penalty of serious high-frequency oscillation, input and output grounds *must be kept isolated*.

During our lab evaluation, the amplifier blew fuses in the slew-factor test, which is normally not highly stressful. Apparently, at ultrasonic frequencies, the half of the output stage that is supposed to be nonconducting cannot turn off rapidly enough. This leaves the stage effectively a short circuit across the power supply. (In normal circumstances, this is extremely unlikely to happen.) Once the signal was removed and the fuses replaced, the amplifier seemed free of damage. (We had some difficulties in removing blown fuses from the holders, but Threshold advises that this is being corrected.)

For its power rating, the price of the Stasis 3 is high indeed. If there is any performance advantage to its special design, our lab and listening tests failed to detect it. On the other hand, no sonic flaws were turned up either. Finally, the dual LED ladders respond rapidly and accurately, giving a useful display of instantaneous power output.

Measured data: Harmonic distortion (8-ohm load, worst case) 0.075% (30 Hz, 10 W); IHF IM distortion, second order -94 dB, third order -76 dB; IHF dynamic headroom 2.30; IHF slew factor >5; input sensitivity for 1-W output 125 mV; S/N (A-weighted) 89 dB.



(more overleaf)

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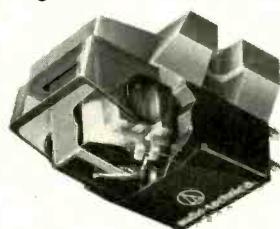
Of course it's easy to claim "good tracking"... everybody says it. Proving it is something else. Well, we guarantee that every new AT155LC will pass an objective test which easily exceeds the limits of most commercial pressings. Specifically, at 1.2 grams the AT155LC cleanly tracks the 80-micron band of a standard

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**General Comments.** It is our view that, aside from intangible factors, the real advantages of one amplifier over another lie in reliability, freedom from "glitches," and ability to drive any load one might conceivably apply. Last but not least is the obvious matter of power output.

No one would go wrong with any of these amplifiers. In fact, the overall level of performance for the group is almost astonishingly high. On the basis of our auditions, it seems doubtful that anyone in a double-blind test could distinguish between them. When we drove them hard, it was easy to separate the 100-watt class from the 200-watt class, especially when there were large dynamic power demands. Still, that calls for listening at levels that would be extremely high for the home.

Choosing one of the group over the others would be very difficult, yet each has its particular strength. The Carver is unquestionably the most ingeniously designed amplifier, in addition to being the cheapest. The Threshold is the "best built" in respect to workmanship and component quality, but has a price to match. The Adcom gives the Carver close competition in the dollars-per-watt race, and has no deficiencies in a normal home situation.

The Apt is a gem, a small, highly sophisticated amplifier that is not fazed by anything one connects to it—but it is expensive for its power. Phase Linear is a good value for the money—and is very powerful into low impedances. The Heath unit is almost overwhelming in its massiveness and power, and clearly the champion in dynamic power. Kenwood's has extremely large bandwidth and is extraordinarily low in distortion, though the audible benefits of those qualities are not clear. And a pair of them is quite expensive for the power rating.

Finally, Van Alstine's wins a special place for its near-ultimate simplicity and freedom from idiosyncrasies. It is very expensive, however, for a 60-watt amplifier, although the conversion cost from a Dyna 150 falls in the bargain category.

Ultimately, the choice between units may depend partly on appearance, how well the unit fits the space available, or some intangible factor. If this series of tests does nothing else, it demonstrates that modern, high-quality power amplifiers have a good deal in reserve for stress situations. ◇

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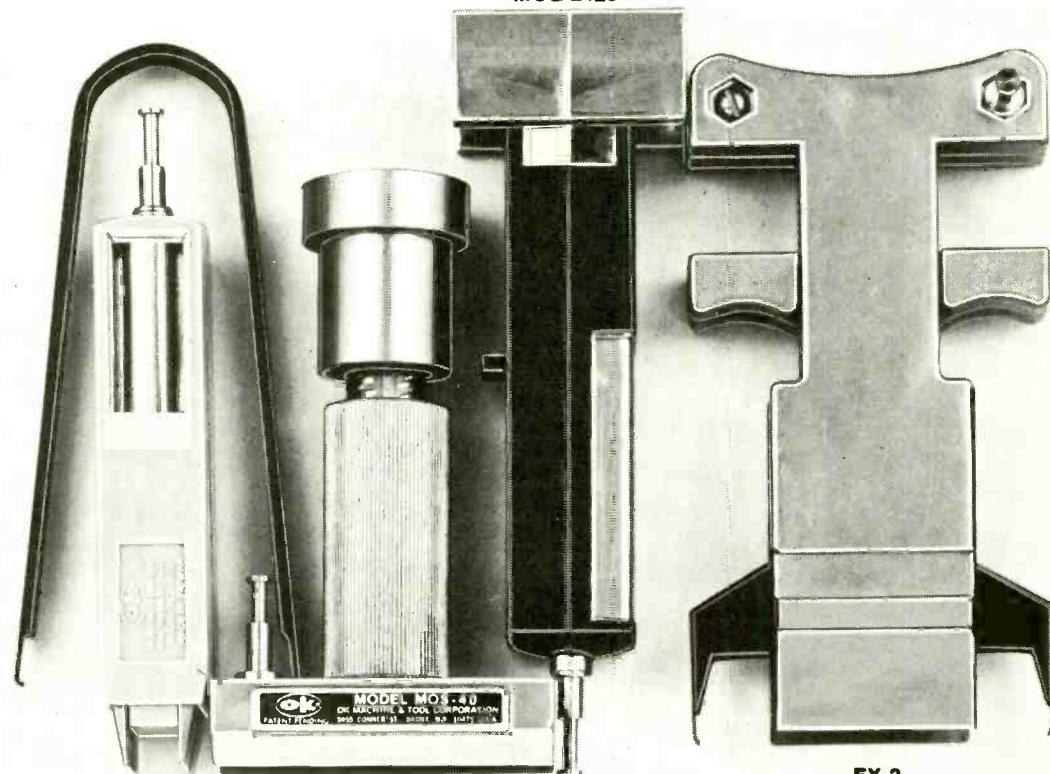
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**W**OULD you like to be able to send letter-perfect Morse at speeds ranging from 5 to 35 wpm without having to pound brass? You can, with the aid of the Morse-A-Keyer, which automatically converts ASCII data into perfectly formed Morse characters. When an ASCII keyboard is added, a complete CW keyboard keyer is obtained. A sidetone oscillator that lets the user hear the generated Morse is built-in, as is a reed relay that can be used to key a transmitter or transceiver. The Morse-A-Keyer offers the CW buff a means of conducting almost effortless Morse conversations. Used as a source of perfectly timed and spaced code characters, it is a valuable tool for Morse training sessions.

The Morse-A-Keyer employs low-power CMOS ICs and requires +5 volts dc at 120 mA. It accepts parallel data in seven-bit ASCII form from a microcomputer, an ASCII keyboard, or some other ASCII source and converts this data into Morse Code. The project can handle all standard alphabetical characters, as well as the Arabic numerals and common punctuation marks. In addition, the Morse-A-Keyer can generate special Morse characters such as **SK**, **KN**, **AR**,

and **AS** that do not have direct ASCII equivalents. A 16-character elastic buffer permits the user to type ahead of the transmitted text, which is sent at a rate selectable over the range of 5 to 35 wpm. Project cost is approximately \$70.00.

**About the Circuit.** The Morse-A-Keyer is shown schematically in Fig. 1. Data in seven-bit, TTL-compatible

ASCII form is applied to EPROM **IC12** via circuit points **E** through **K**. This data is encoded into a special set of parallel bits which appear at the output terminals of the EPROM (pins 4 through 11). The encoded bits are presented to an 8 × 16-bit shift register comprising **IC8** and **IC9** and are loaded into the register when a TTL-compatible strobe pulse is applied to circuit point **L**. A negative-

## BUILD A **MORSE-A-KEYER**

*Automatic Morse Code  
transmitting project*

BY GEORGE R. STEBER



## morse-a-keyer

going pulse can be used for this purpose if a jumper is connected between circuit points *J1* and *NS*. Similarly, a positive-going pulse can be used to strobe the input register if a jumper is connected between circuit points *J1* and *PS*.

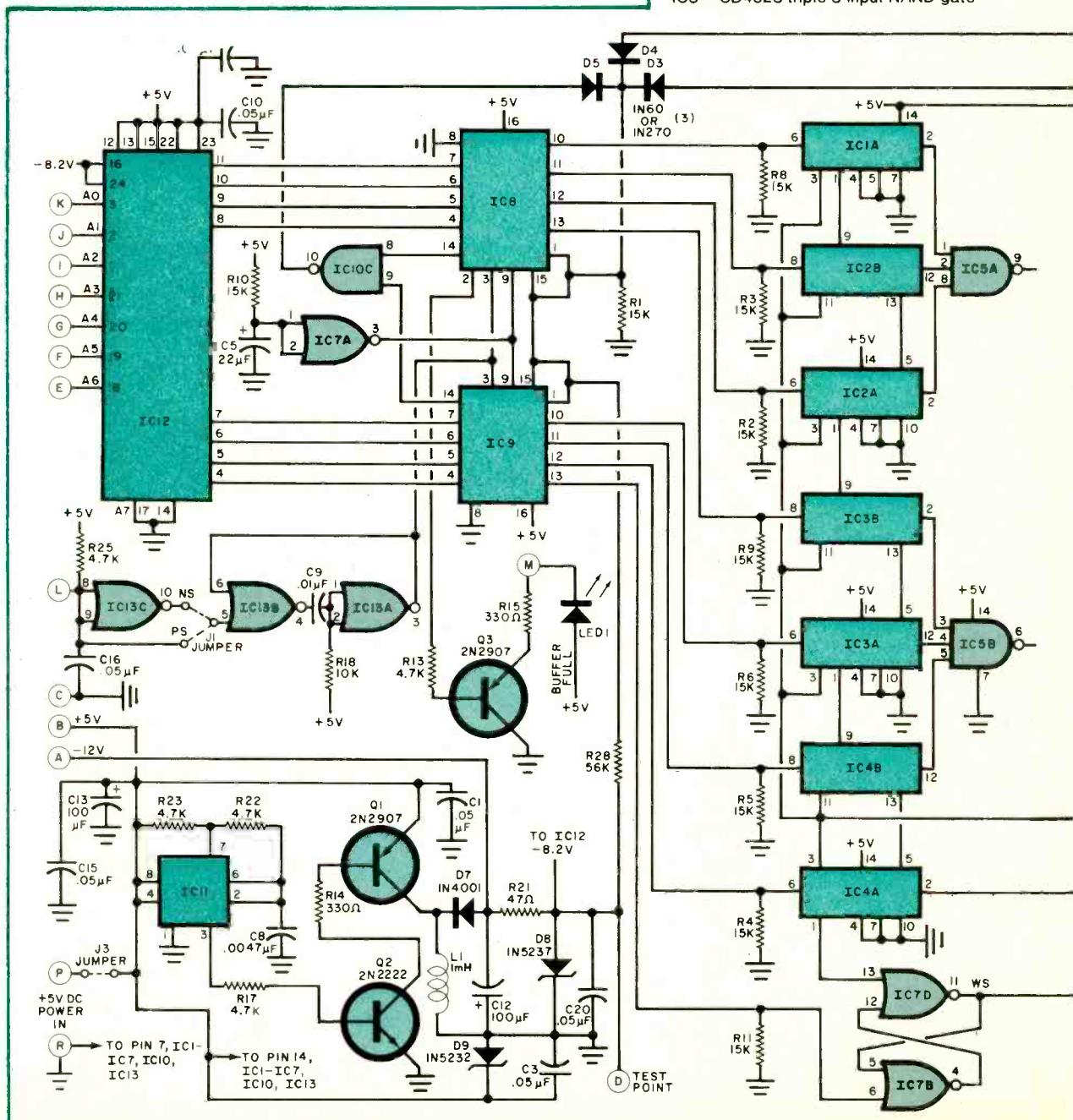
If no data has previously been loaded into the shift register, which is of the FIFO (first-in, first-out) variety, any new data that is loaded into it immediately ripples through to the output pins of *IC8* and *IC9*. If data is already present in the registers, it is advanced when pins 1 and 15 of *IC8* and *IC9* are brought to ground potential. The data at the output lines of the FIFO register

(pins 10 through 13 of *IC8* and *IC9*) is presented to a second shift register comprising *IC1A* and *IC2A* through *IC4B*. These ICs function as an 8-bit register that accepts parallel data from the FIFO register.

Triple three-input NAND gate *IC5* is used to detect whether there is data corresponding to a character to be Morse encoded present at the outputs of register *IC1A* and *IC2A* through *IC4B*. If such data does appear, pin 1 of NAND gate *IC10A* is raised to logic 1. This actuates the basic Morse clock that consists of gates *IC10A* and *IC10B* and their associated passive (RC) timing

## PARTS LIST

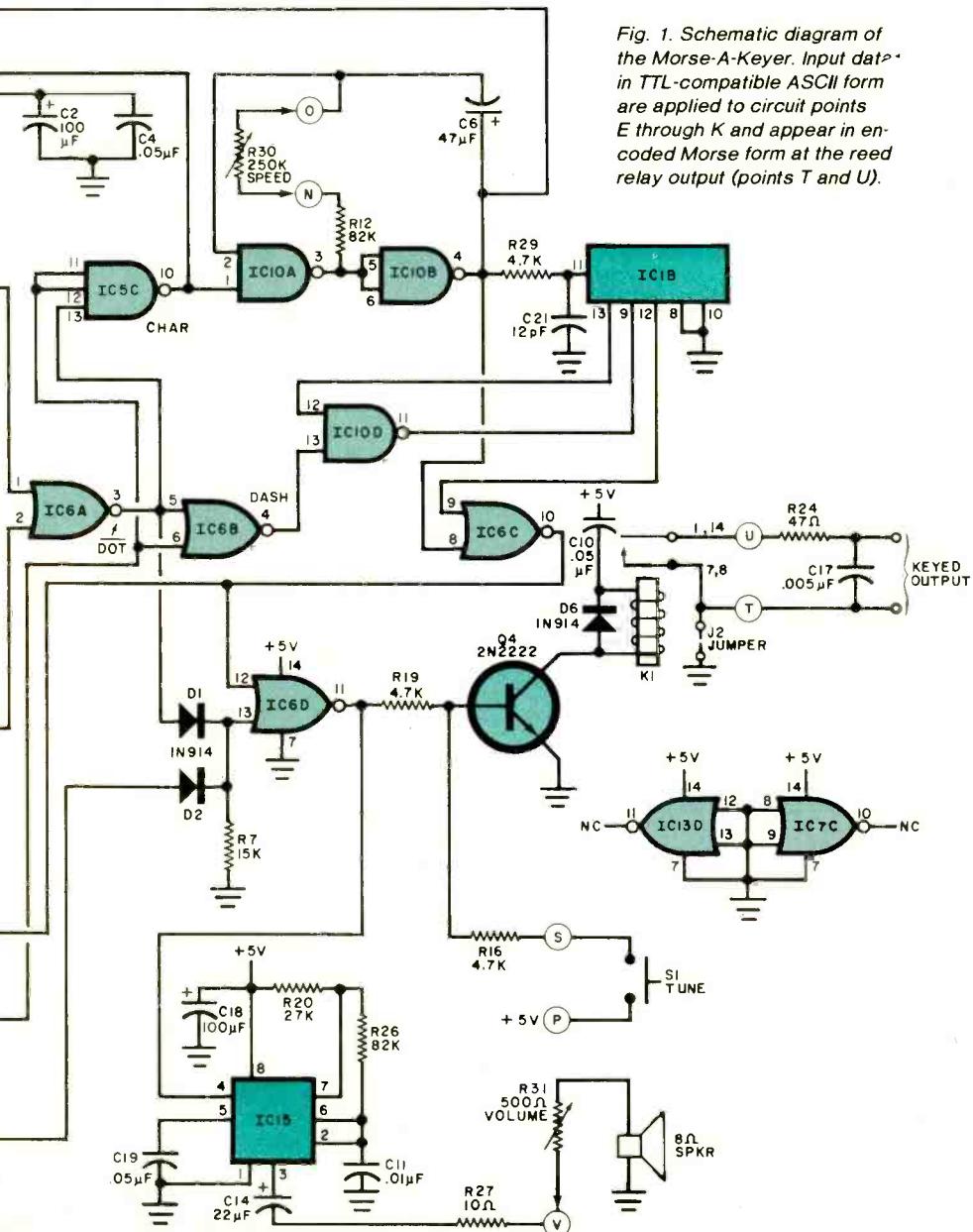
C1,C3,C4,C7,C10,C15,C16,C19,C20— 0.05- $\mu$ F, 50-V disc ceramic capacitor
C2,C12,C13,C18—100- $\mu$ F, 6-V electrolytic
C5,C14—22- $\mu$ F, 6-V electrolytic
C6—0.47- $\mu$ F, 6-V tantalum capacitor
C8—0.0047- $\mu$ F, 50-V Mylar capacitor
C9,C11—0.01- $\mu$ F, 50-V Mylar capacitor
C17—0.005- $\mu$ F, 200-V disc ceramic capacitor
C21—12-pF disc ceramic capacitor
D1,D2,D6—1N914 silicon diode
D3,D4,D5—1N60 or 1N270 germanium diode
D7—1N4001 silicon rectifier
D8—1N5237 8.2-volt zener diode
D9—1N5232 5.6-volt zener diode
IC1,IC2,IC3,IC4—CD4013 dual D flip flop
IC5—CD4023 triple 3-input NAND gate



IC6,IC7,IC13—CD4001 quad 2-input NOR gate  
 IC8,IC9—CD40105 FIFO shift register  
 IC10—CD4011 quad 2-input NAND gate  
 IC11,IC15—NE555 timer  
 IC12—1702A PROM  
 J1,J2,J3—Wire jumpers; see text.  
 K1—5-volt DIP reed relay (Gordos 527-831A-1 or equivalent)  
 L1—1-mH inductor  
 LED1—Red light-emitting diode  
 Q1,Q3—2N2907 pnp silicon transistor  
 Q2,Q4—2N2222 npn silicon transistor  
 The following, unless otherwise specified, are 1/4-watt, 5% carbon-composition fixed resistors.  
 R1 through R11—15 kΩ  
 R12,R26—82 kΩ  
 R13, R16, R17, R19, R22, R23, R25, R29—4.7 kΩ

R14, R15—330 Ω  
 R18—10 kΩ  
 R20—27 kΩ  
 R21, R24—47 Ω  
 R27—10 Ω  
 R28—56 kΩ  
 R30—250-kΩ, linear-taper potentiometer  
 R31—500-Ω, audio-taper potentiometer  
 S1—Momentary contact, normally open pushbutton switch (optional; for transmitter tuning purposes)  
 Misc.—Double-sided printed-circuit board, IC sockets or Molex Soldercons, appropriate input and output connectors, +5-volt power supply capable of furnishing approximately 120 mA, suitable enclosure, ASCII keyboard (optional), printed-circuit-board standoffs, 8-ohm dynamic speaker, hookup wire, solder, etc.

*Note: The following is available from Microcraft Corp., Box 513, Thienerville, WI 53092 (414-241-8144): Complete kit of parts including etched and drilled printed-circuit board, all items in Parts List including ASCII keyboard, power supply, and prepunched and lettered enclosure (No. MAK-K) for \$159.95 plus \$5.00 postage and handling. Also available from the same source: Kit including etched and drilled pc board and all parts that mount on it (No. EPK-K) for \$69.95 plus \$3.00 postage and handling; etched and drilled pc board (No. PCB-K) for \$12.50 plus \$2.00 postage and handling; preprogrammed 1702A PROM (No. PROM-K) for \$10.00 plus \$1.50 postage and handling. Wisconsin residents, add 4% sales tax.*



*Fig. 1. Schematic diagram of the Morse-A-Keyer. Input data in TTL-compatible ASCII form are applied to circuit points E through K and appear in encoded Morse form at the reed relay output (points T and U).*

components. Portions of *IC5*, *IC6*, and *IC7* function together to determine whether the data emerging from the register should be encoded as a dot, a dash, or an element space.

As each bit emerging from the register is processed, the remaining data in the register is shifted one position toward the output. This process continues until only one bit is left in the register (in *IC4A*). The Morse character is then rounded out with an element space and

applied to relay driver *Q4* via NOR gate *IC6C*.

A DIP reed relay is specified for use in this project. Its contacts are rated at 200 volts and 250 mA. These ratings are compatible with the keying lines of most CW transmitters and transceivers of contemporary design, especially those that employ grid- or base- or gate-block keying. However, the project should not be used to key any transmitter unless it has been verified that neither the volt-

age appearing across the keying line nor the current flowing through it exceeds the ratings of the relay contacts. If your transmitter will overstress the contacts of the specified relay, use one whose contacts have higher ratings. Any substitute relay should have a rated coil current less than the rated maximum collector current of driver *Q4*.

No matter what relay is used, be sure to include diode *D6* to suppress the high-voltage transients that appear across the relay coil when it is deprived of current. Otherwise, driver *Q4* is at risk. As the schematic indicates, the relay contacts are connected to circuit points *T* and *U*. Both can be left floating, or the contact connected to point *T* can be grounded by means of jumper *J2*. Capacitor *C17* and resistor *R24* are connected across the relay contacts to suppress arcing as they open and close.

A sidetone oscillator that allows the user to monitor aurally the generated Morse is built around 555 timer *IC15*. The timer operates as an astable multivibrator whose frequency of oscillation is determined by the values of fixed components *R20*, *R26* and *C11*. For the values specified, it is nominally 800 Hz. The output of the multivibrator is coupled via *C14* and *R27* to VOLUME control *R31* and thence to a small, 8-ohm dynamic speaker.

Because PROM *IC12* requires both positive and negative supply voltages, the project incorporates a low-power dc/dc converter. This eliminates the need for an external, bipolar supply. A 555 timer (*IC11*) functioning as an astable multivibrator forms the heart of the converter. It drives transistor *Q2* alternately into saturation and cutoff, and this transistor acts as a driver for *Q1*. Diode *D7* rectifies the voltage generated across *L1* into a negative dc level that is filtered by *C12* and regulated by zener diode *D8*. The resulting -8.2-volt output of the dc/dc converter is adequate to power the 1702A PROM.

The power requirements of the project are relatively modest—+5 volts at approximately 120 mA. Any number of power supply configurations are acceptable so long as the maximum voltage does not exceed +5.5 volts. It is therefore suggested that the supply include a +5-volt discrete regulating network or regulator IC.

**Next Month.** Part 2 of this article next month will include the printed-circuit board etching and drilling guides, the component layout, and the instructions for constructing and operating the "Morse-A-Keyer" as well as a truth table for programming the 1702A PROM.

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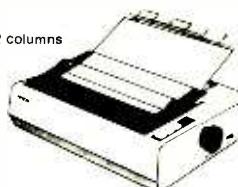
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**Construction.** The entire circuit can be mounted in a small metal enclosure using multilug terminal strips to support the components. Point-to-point wiring can be used. The ac line cord and the

output cable should be passed out of the enclosure via grommeted holes. A plug that fits the vehicle's cigarette lighter should be connected to the output cable. Make sure the polarity is correct.

**Operation.** Plug the ac line cord into a convenient outlet and plug the output cable into the cigarette lighter connector. Select either a FULL or TRICKLE charge via  $S_1$ , and verify that the LED glows in either position of  $S_1$ . If the LED does not glow, clean the contacts on the plug and the cigarette lighter and try again. If this fails, check for a wiring error. Should the battery be completely discharged (dome light does not light

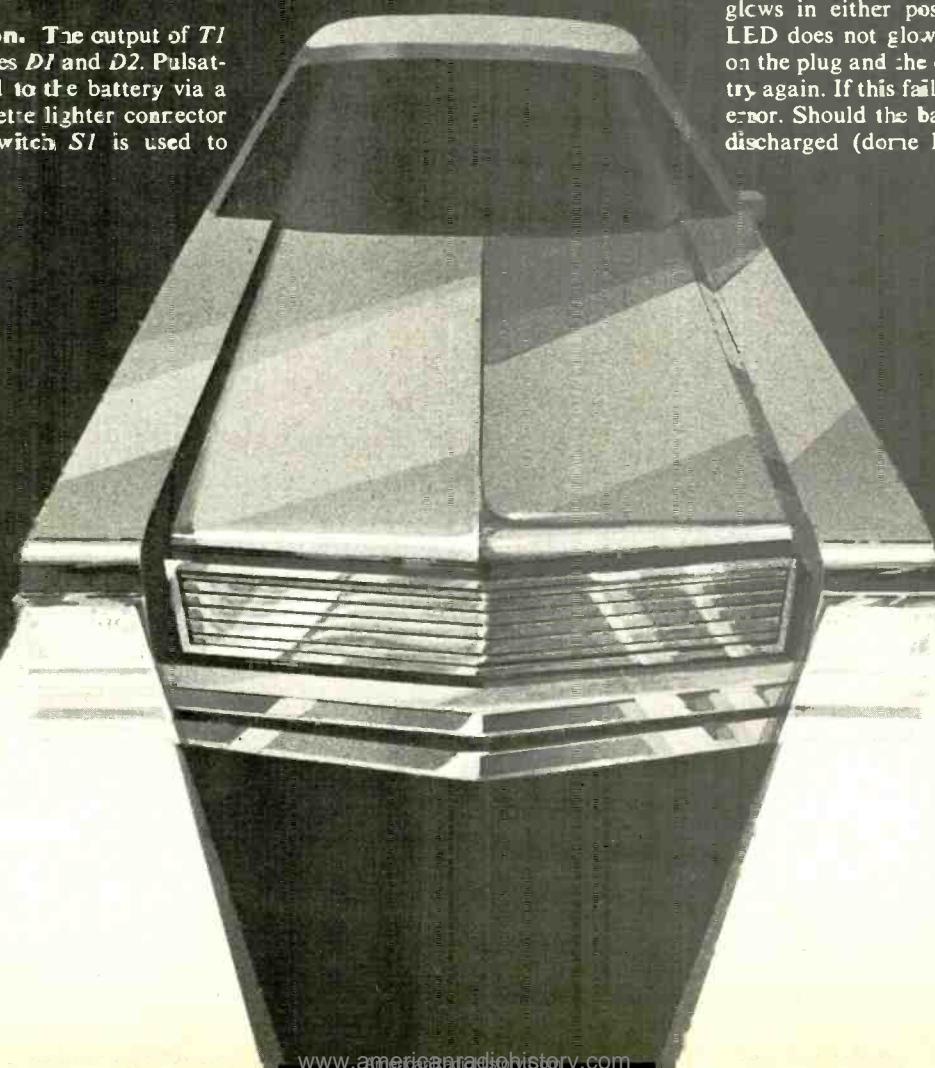
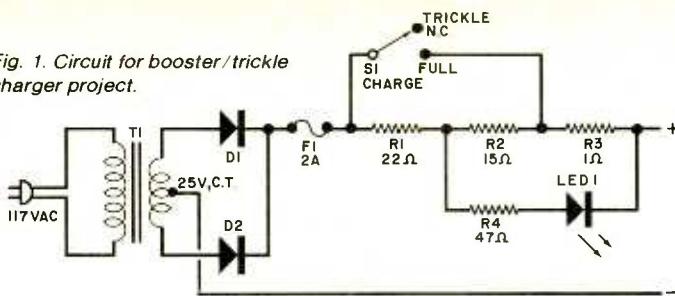


Fig. 1. Circuit for booster/trickle charger project.



### PARTS LIST

D1,D2—3-A, 50-V diode (Radio Shack 276-1141 or similar)	R1—22- $\Omega$ , 2-W resistor
F1—2-A fuse and holder	R2—15- $\Omega$ , 2-W resistor
LED1—Red light emitting diode	R3—1- $\Omega$ , 10-W resistor (Radio Shack 271-131 or similar)

R4—47- $\Omega$ , 1/2-W resistor  
 S1—Spst switch  
 T1—25-V, 2-A CT transformer (Radio Shack 273-1512 or similar)  
 Misc.—Suitable enclosure, multi-lug terminal strips, line cord, output cable, suitable cigarette lighter plug, mounting hardware.

# 2.

## ALARM SOUNDS IF YOUR HEADLIGHTS OR PARKING LIGHTS ARE ON WITH THE IGNITION OFF

BY C. R. BALL

HAVE you ever walked away from your car, left your lights on, and returned later to discover that your battery has run down? The circuit described here will end this problem. It will sound an alarm if you turn off your car's ignition while the headlights or parking lights are on. The alarm ceases when the lights are turned off.

**Circuit Operation.** The circuit, shown in Fig. 1, is based on a 555 timer IC. Diodes D1 and D2 are arranged as an OR gate so that either will pass positive voltage from its anode to IC1. Diode D3 blocks reverse current when the ignition alone is on. When the ignition and either the headlights or parking lights are on, little or no potential difference

exists across the powerpins of IC1, which remains inoperative.

If either the headlight or parking light circuit is alive, and the ignition line is off, the dc circuit for IC1 is complete. The oscillator starts, and sounds a warning tone via the loudspeaker. The tone's frequency may be changed by varying the values of R1, R2, or C1. Resistor R3 sets the loudness, and its value may be altered as desired.

Zener diode ZD1 may be required to provide a threshold to prevent the alarm from operating if there is a small potential difference in the dc supply circuit during normal operation. To determine the necessity and/or value of ZD1, with the headlights and ignition both on, measure the voltage between points H and I. If the voltage is more than 1.4 volts, the zener is required. The zener voltage should be slightly higher than the excess over 1.4 volts. For low voltages, one or more forward-biased silicon diodes can be substituted for the zener. Each silicon diode drops about 0.7 volt.

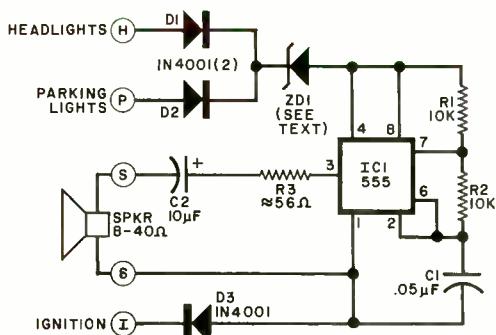


Fig. 1. With ignition off, and the headlights and parking lights on, alarm will sound.

### PARTS LIST

C1—0.05- $\mu$ F, 50-V Mylar capacitor	ZD1—see text
C2—10- $\mu$ F, 50-V electrolytic	Misc.—Suitable enclosure, interconnecting cables, mounting hardware.
D1, D2, D3—1N4001 or similar	<i>Note: Available from BallABS, Box 703, Duluth, GA 30136; kit of all parts except ZD1 and case (LO-1K) for \$10.50 plus shipping. Also available: pc board (LO-1) for \$2.50, assembled and tested without case (LO-1A) \$25.00.</i>
IC1—555 timer	
R1, R2—10,000- $\Omega$ , 1/4-watt	
R3—selected for volume, nominally 56 ohms	
SPKR—3.2-to-8-ohm, 2" speaker	

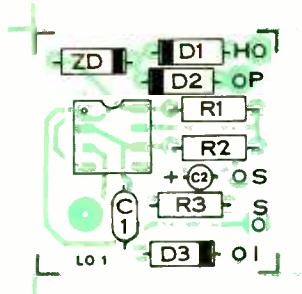
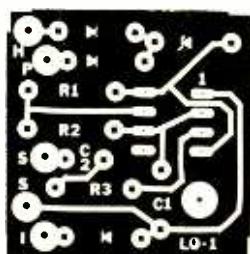


Fig. 2. Etching and drilling guide and component installation is at left.

**Construction.** The system can be assembled on a small piece of perf board, or on the pc board whose foil pattern is shown in Fig. 2. After completion, the board can be mounted in a small enclosure. Check the polarities of the IC and all diodes before applying power.

The small speaker is connected to the two pads marked S, the pad marked I is connected to the vehicle ignition lead (after the ignition switch), the pad marked H connects to the headlight power line, and the pad marked P goes to the parking light line.

To allow the lights to be used with the ignition off, an spst switch can be connected in series with D3 to defeat the alarm. If this switch is used, make sure that it is clearly identified so that it can be closed for normal operation.

BY RON REESE

### Store and automatically dial telephone numbers



**I**N THIS article we will develop an automatic telephone dialer based on the RCA 1802 microprocessor. The program works with either the "product board" introduced last month or the Elf II Computer (Giant Board and 4K Memory Board are required). This system will store 32 seven-digit telephone numbers and "dial" them at the touch of a few switches. A relay interfaces the computer to the telephone line. Normal telephone operation is not impaired.

Figure 1 is a simplified diagram of a microcomputer system with eight switches interfaced with an input port to the data bus and a relay driven from a serial output of the CPU. The input port isolates the switches from the data bus until the processor reads them.

**More About the RCA 1802.** This application of the 1802 processor uses all the elements discussed in the May 1980 article of this series plus two more—the X register and the stack.

**X REGISTER.** This is a four-bit register used to select any one of the 16 scratch-pad registers for use as a stack pointer. The X register is loaded by an instruction that will be discussed later.

**STACK:** The stack pointer (specified by the X register) is loaded with a memory address. This location starts the stack, which can be anywhere in memory as long as it is not used by the pro-

# A COMPUTERIZED AUTOMATIC TELEPHONE DIALER

gram for other purposes. The stack can be used to store data, perform logic and arithmetic operations, and transmit data to and from the input and output ports.

**More Instructions.** Eighteen of the 1802's 91 instructions were described in May 1980; eleven more will be introduced here. As before, the instructions will be broken down into categories and presented by the mnemonic, op code, name, and description.

**Control Instructions.** SEX-EN-Set X. This instruction loads the four-bit X register with the value N. For example, the instruction, E1 (1110 0001), would load 1 (0001) into the X register, making the 16-bit scratch-pad register-1 the stack pointer.

**Branch Instructions.** Short branch instructions require two bytes of data. The first byte is the op code, and the second is the address to which the processor will branch. We will add only one branch instruction. B2-32—Short Branch if D=00 (0000 0000). If the D register contains zero, the program will branch to the specified memory location. If D does not contain zero, the program advances to the next instruction in sequence.

**Memory Reference.** These instructions allow data to be loaded from memory to the D register.

LDN-0N-Load via N. This instruction loads the D register with the byte stored in memory at the address specified by register-N. If register-5 contains 0050 (0000 0000 0101 0000), and memory location 0050 contains FF when the instruction 05 is executed, then FF will be loaded into the D register. There is one restriction to this instruction—N cannot be 0.

LDA-4N-Load Advance. This instruction works like LDN, but after the data is loaded into the D register, the N register is advanced by 1. If, in the previous example, the instruction 45 had been executed instead of 05, then FF would be loaded into the D register the same as before, but register-5 would automatically be advanced to 0051. This instruction is useful when several sequential bytes must be transferred from memory to the D register. N can equal 0 for the LDA instruction.

**Register Operations.** These instructions perform operations on the sixteen 16-bit scratch pad registers.

GLO-8N-Get Low Register N. Places the data in the low-order half of the register designated by N, into the D register.

INC-1N-Increment Register N. Add 1 to the contents stored in the register specified by N.

**Logic Operations.** These instructions

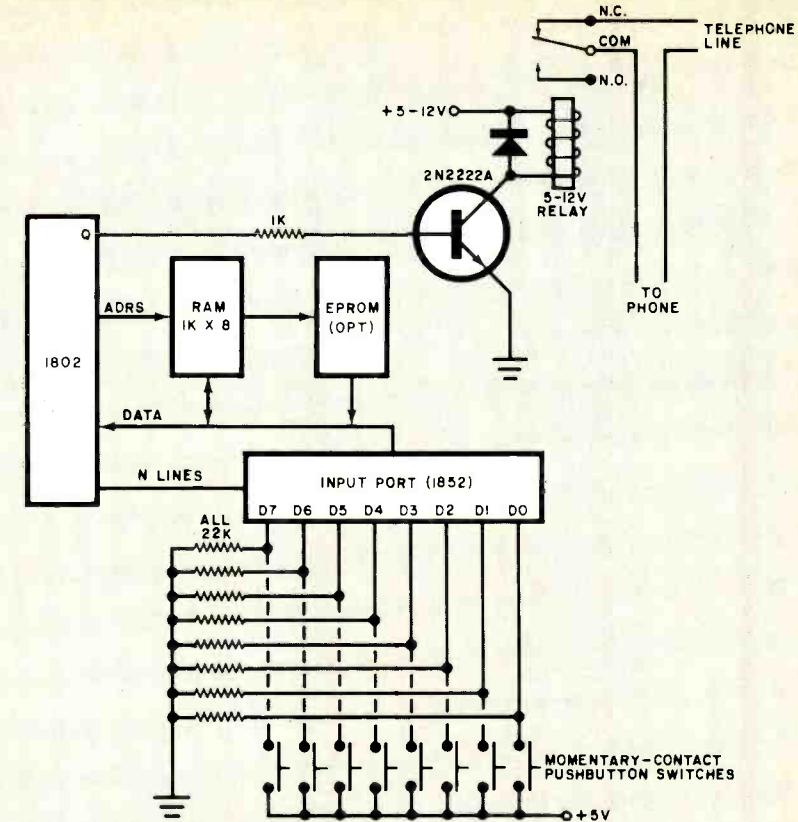


Fig. 1. An 1802 with switches interfaced to the data bus via an input port, and a relay driven from a serial output.

perform logic operations on the data in the D register. We use only one of the ten logic instructions.

SHL-FE-Shift Left. This instruction shifts the data in the D register to the left by one bit. The left bit of the data is shifted in the DF register and a 0 is shifted into the right-most bit. If the D register contained 21 (0010 0001), the instruction SHL would produce 42 (0100 0010) in the D register and a 0 in the DF register.

**Arithmetic Operations.** These instructions perform arithmetic operations on the data in the D register. This application uses two of the instructions.

SMI-FF—Subtract Memory Immediate. This is a two-byte instruction that subtracts the byte immediately following the FF op code from the contents of the D register. If the D register contained 0F (0000 1111), and the instruction were FF01, the processor would subtract 0000 0001, leaving the result, 0E (0000 1110), in the D register. If the number in the D register is less than the immediate data subtracted from it, a borrow will be generated and the DF bit will be set to logic 0. If the content of the D register is equal to or larger than the immediate byte, then no borrow will be generated and the DF bit will be set to logic 1.

SM-F7-Subtract Memory. SM is a one-byte instruction that involves the

stack in the operation. It is addressed by the stack pointer from the contents of the D register. The result is placed in the D register. Suppose the stack pointer contains the address 00FF, the memory location 00FF contains the byte 02 (0000 0010), and the D register contains 05 (0000 0101). The instruction SM(F7) would subtract 02 (on the stack) from 05 (contents of the D register) and leave the result, 03 (0000 0011), in the D register. The DF bit is effected in the same manner as the SMI instruction.

**Input/Output Byte Transfer.** These instructions are used to transfer a byte from an input port to memory and the D register or a byte from memory to an output port. We will use only the input instructions in this application.

INP 1-69-Input 1. This instruction transfers a byte from input port 1 to the stack and to the D register.

INP 2-6A, INP 3-6B, INP 4-60, INP 5-6D, INP 6-6E, and INP 7-6F are used to transfer a byte from the respective input port to the stack (memory) and the D register. If the program is run on an Elf II computer, INP 7 can be used to read the input port and INP 2 can be used to read the input port on the Product Board.

**Flowcharting the Problem.** The first step in programming is to define  
(Continued on page 74)

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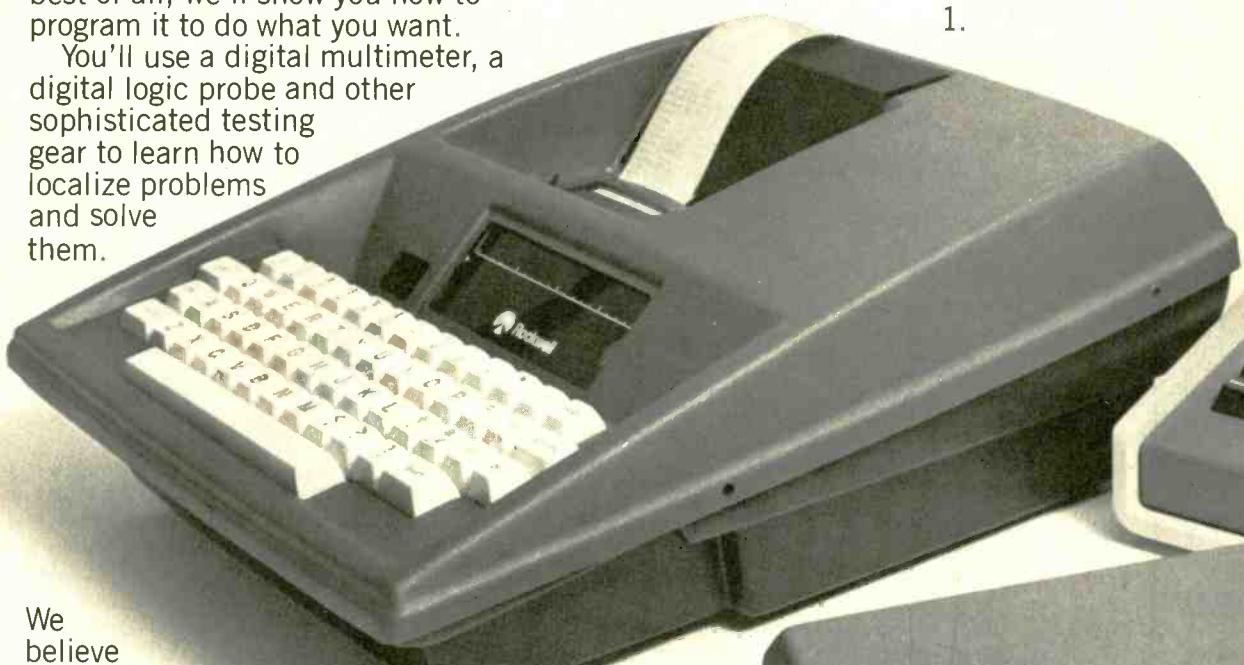
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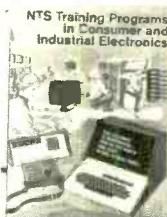
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## **telephone dialer**

the problem, using a flowchart. The flowchart helps to organize the solution to the problem and should describe it in all its aspects.

The flowchart (Fig. 2) should begin with a START block to clearly define its beginning. Referring to the hardware diagram in Fig. 1, we see that the output relay should be normally closed to keep the telephone connected to the line. Therefore, a block labeled RESET Q should follow the start block to de-energize the relay. Since the program requires the use of the stack, that should be initialized next. The input switches should be read via the input port until one of the eight switches is pressed, so a block labelled "Read Input Port" should be followed by the (diamond-shaped) decision block "Is Any Switch Closed?" In practice, the program will loop at this point until a switch is closed. In order to select 32 telephone numbers with only eight switches, all single switch closures and most two-switch combinations are used as valid inputs. The valid input combinations are shown in Fig. 3. After a switch closure is detected, the program should wait for about one second and re-read the switches. This delay allows time for pressing two switches. If it were not there, two-switch combinations would be hard to enter.

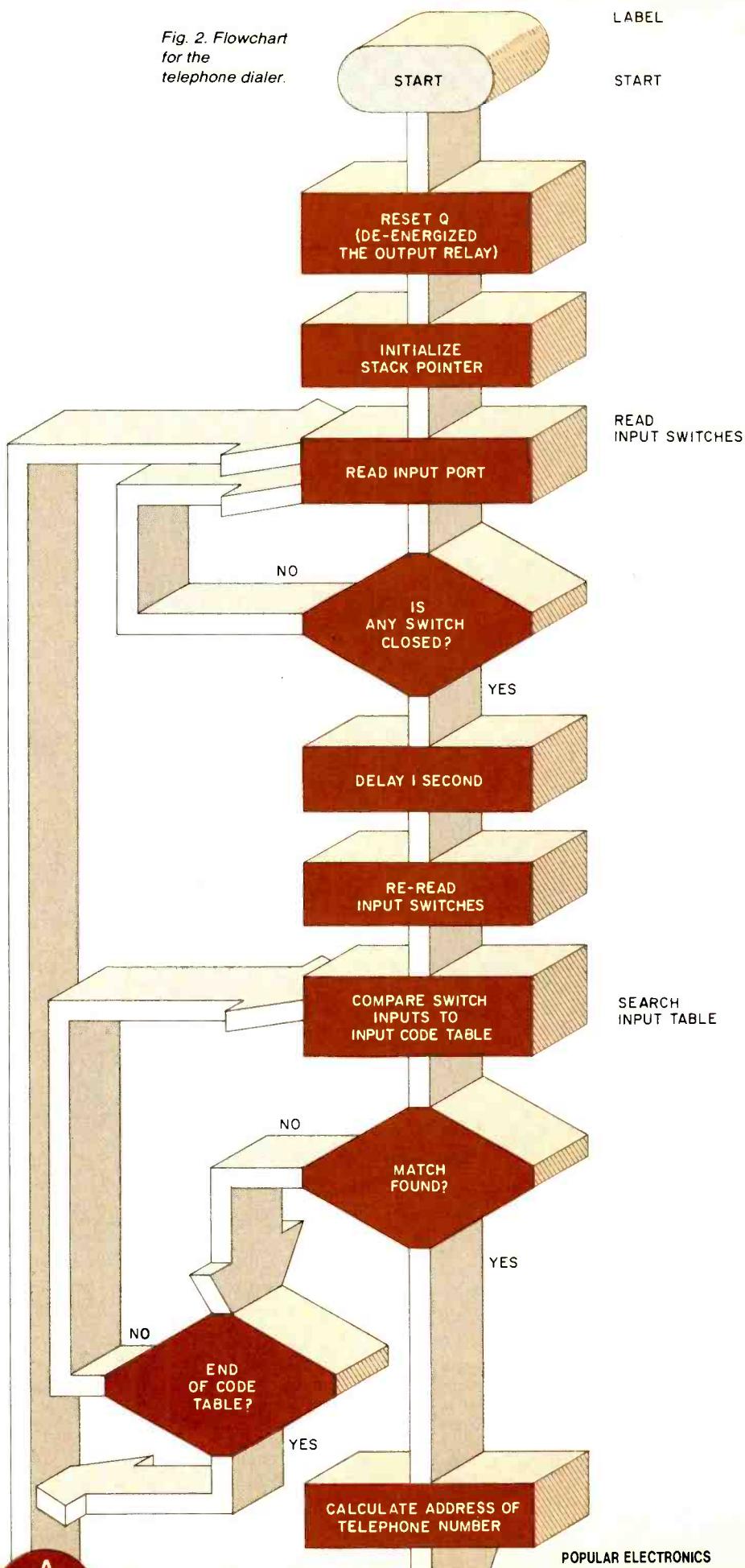
This program uses an input code table to determine if an input switch combination is valid and to calculate the address where the telephone number is stored. The input code table is 32 bytes of memory containing the valid combinations. When the switches are read, the switch closures are converted to binary logic levels by the input port. This digital representation of the switch closures is compared to the input code table until a match is found or until the entire table has been searched. This search is indicated in the flowchart. If a match is not found, the program returns to "Read Input Switches"; otherwise it calculates the address of the telephone number.

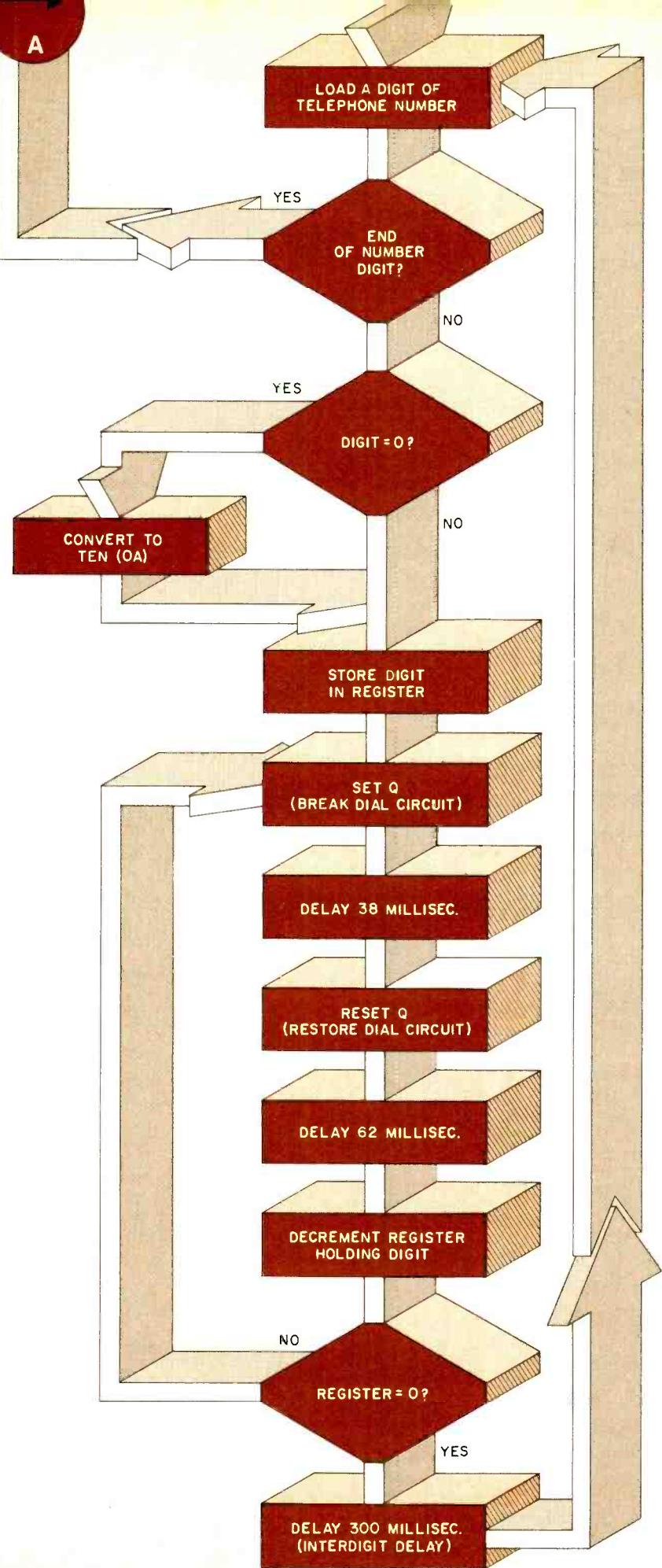
Next, the first digit of the telephone number is read from memory and is tested to see if it is an "end of number" digit. All telephone numbers must end with an "end of number digit", that is, any of the hex digits A, B, C, D, E, F. This tells the program that no more digits are to be dialed. Thus the telephone number can contain from one to seven digits. When the program detects the "end of number" digit, it branches to "Read Input Port."

If the digit to be dialed is zero, it must be converted to ten before it is dialed. Notice that "0" on a telephone represents ten instead of zero. After this test, the dialing sequence begins.

The dialing technique used in this

Fig. 2. Flowchart for the telephone dialer.





program is referred to as "pulsed dialing" because each digit is dialed by a series of pulses over the phone line. If the digit is "4," the relay will be pulsed four times to dial the digit. Each pulse "breaks" the telephone circuit for 38 milliseconds with a 62-millisecond pause between pulses and a 300-millisecond pause between digits. This is illustrated in Fig. 4. The digit to be dialed is first stored in one of the registers. Then Q is set to break the telephone circuit. Following this block is the 38-millisecond delay. Then Q must be reset and followed by the 62-millisecond delay. This completes one pulse for the digit being dialed. The register containing the digit is decremented by one and then tested for zero. If the result is not zero, the program will branch to "Dial Digit" and send another pulse. This process will continue until the digit has been decremented to zero. After a 300-millisecond interdigit delay, the program will branch to "Test Digit" and the next digit in the number will be dialed or the "End of Number Digit" will be detected which will stop the dialing and return the program to "Read Input Port."

**Organizing the Program.** After completion of the flowchart, work can begin on the machine language program. The format used to lay out a program was discussed in the first article of this series. A register and Memory Utilization Table, such as shown in Fig. 5, will be helpful in keeping track of register use and memory addresses. It is not always known before a program is written how many registers will be used nor how much memory will be required. As the program is written, register and memory assignments can be made and added to the table as needed. This technique can prevent conflicting use of the registers and memory.

The first register entry in the table will be the program counter (PC) which is register "0" (R0). A stack pointer will be used, so we can make it the next entry. The stack pointer can be any of the remaining 15 registers. Register 1 would be as good as any and should be entered in the table next.

Next come some memory assignments. First, the program will begin at address 0000, so this should be entered in the table. Since the length of the program is not yet known, we should allow plenty of memory.

Now we should specify the location of the stack. If the stack is located at 00FF, there will be 255 locations for the program and input table. This should be adequate. Once we know where the program ends, we will locate the input table somewhere above it.

(continued overleaf)

## telephone dialer

Assigning memory space for the 32 telephone numbers is the next operation. Each number will be allocated eight bytes of memory—seven for the number and one for the end of number digit. To

store 32 numbers, 256 bytes will be needed. Fig. 5 shows that no memory above 00FF has been used, so the numbers can be stored from 0100 to 01FF.

(to be continued.)

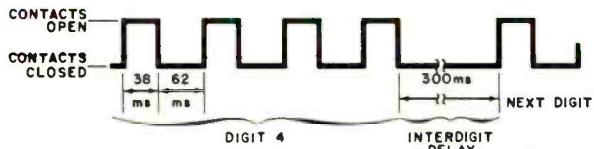


Fig. 4. Specifications for telephone dialing pulses.

Register	Use	Memory	Use
R0	Program counter	0000-00FE	Program area
R1	Stack pointer	0060-007F	Input table
R2	Delay timer	00FF	Stack
R3	Input table pointer	0100-01FF	Number storage
R4	Counter and pointer		
R5	Temporary storage of digit being dialed		

Fig. 5. Register and  
Memory Utilization Table.

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Fig. 3. Valid input combinations.  
X indicates a closed switch.

8	7	6	5	4	3	2	1	Binary Code	Hex
					X	00000001	01		
					X	00000010	02		
					X	00000100	04		
					X	00001000	08		
					X	00010000	10		
					X	00100000	20		
					X	01000000	40		
					X	10000000	80		
					X X	00000011	03		
					X X	00000101	05		
					X X	00001001	09		
					X X	00010001	11		
					X X	00100001	21		
					X X	01000001	41		
					X X	10000001	81		
					X X	00000110	06		
					X X	00001010	0A		
					X X	00010010	12		
					X X	00100010	22		
					X X	01000010	42		
					X X	10000010	82		
					X X	00001100	0C		
					X X	00010100	14		
					X X	00100100	24		
					X X	01000100	44		
					X X	10000100	84		
					X X	00011000	18		
					X X	00101000	28		
					X X	01001000	48		
					X X	10001000	88		
					X X	00110000	30		
					X X	01010000	50		
					X X	10010000	90		
					X X	01100000	60		
					X X	10100000	A0		
					X X	11000000	C0		

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BY JERRY AND ERIC EMBINDER

## Part 4: Video cartridge games

**O**ur discussion of electronic games concludes with a rundown of the latest video cartridge games.

**Video Cartridge Games.** The four major contenders in the video cartridge game business are Atari, Magnavox, Mattel and APF Electronics. Their cartridges are not interchangeable. The only source for compatible cartridges is Activision, a company started a year ago by four ex-Atari programmers. Activision makes four cartridges that can be played on Atari systems and will introduce two more, "Skiing" and "Bridge," this month.

The average family will probably be able to afford only one of them and that's unfortunate. Each has cartridges of incredible appeal and individuality. In selecting the cartridges of greatest entertainment value, we evaluated 38 Atari cartridges, 15 Magnavox cartridges and 8 Mattel Intellivision cartridges and selected six Atari, five Magnavox and four Mattel cartridges for listing in the top 15. Eleven cartridges made by APF Electronics were received too late for judging by a control group. The best three cartridges in the APF line, in the opinion of the authors, are "Hangman," "Catena," and "Boxing."

APF Electronics puts a lot of emphasis on playing against the computer. In "Catena," a computer game version of Gabriel's "Othello," one of the options pits the computer against itself (the player sits back and watches).

APF's "Hangman," which also includes "Tic-Tac-Toe" and "Doodle," is well done. "Hangman" can accommodate words up to 10 letters. A message center which comments on a player's moves and a nine-color display enhance the cartridge's appeal.

In "Boxing" a player can be matched against another player or the computer. As in the actual sport, the object is to knock out your opponent or win the most rounds. A knockout is accomplished by landing five consecutive blows to the head without receiving a return punch from the opponent.

Six new Magnavox cartridges were released too late for judging by the control; but one, "Blockout/Breakdown," particularly impressed the authors. "Blockout/Breakdown" is a second-generation "Breakout." While one player tries to break out, the other attempts to rebuild the wall (more fun for the second player who merely watches the action in Atari's "Breakout").

The final standings for the cartridges that were judged are:

2. Space Invaders (Atari)
  3. Space Battle (Mattel)
  4. Baseball (Mattel)
  5. Football (Mattel)
  6. Superman (Atari)
  7. Football (Magnavox)
  8. Basketball (Atari)
  9. Baseball (Magnavox)
  10. Circus Atari (Atari)
  11. Alpine Skiing (Magnavox)
  12. Sky Diver (Atari)
  13. Thunderball (Magnavox)
  14. War of Nerves (Maganovax)
  15. Math Fun (Mattel)

15. *Math Fun* (Mattel) "Adventure" (Atari) does not involve combat or racing against the clock. The royal golden goblet has been stolen from the golden castle and you set out to retrieve it. As you travel the kingdom, you seek out objects that can help you in your quest such as keys to open up cas-



*Atari Video Computer System*

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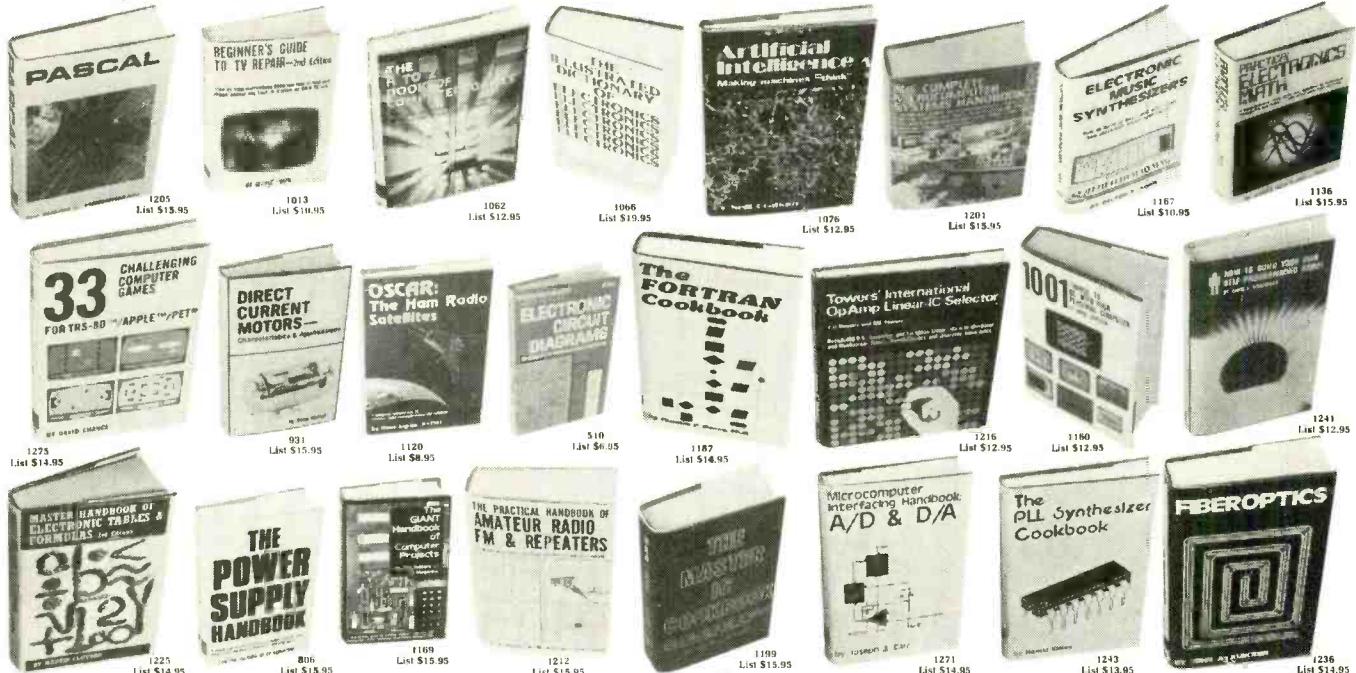


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### electronic games

ties, a sword to help protect you, a magic bridge for crossing through walls and a magnet to help attract objects. Since you can only carry one object at a time you may want to pass up or drop

let an invading spaceship slip through his defense and reach earth. The player loses when he is hit three times by enemy missiles or when one of the invaders lands on earth.



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objects until you locate the sword. You'll need it to battle three deadly dragons: Yorgle, Rhindle and Grundle. Especially watch out for Rhindle, the fastest of the dragons and the most difficult to outmaneuver. If you don't have the sword, you may be able to outrun him through the mazes. If he catches you, he'll eat you; but you can reincarnate. There's also a troublesome black bat who'll try to steal the object you're carrying and replace it with something else (this could be helpful).

Eventually you'll find the golden key and unlock the golden castle. Then all you have to do is find the golden goblet and place it in the golden castle.

"Space Invaders" (Atari) has 36 invading spaceships moving downward toward the earth, launching missiles as they approach. The player returns their fire as he tries to prevent them from landing while simultaneously maneuvering to avoid their missiles. Although "Space Invaders" offers 111 variations, some players won't get past the basic game which is well thought-out and extremely habit-forming. Many of the variations are slight, such as moving shields (instead of fixed ones) for earth's protection or zig-zagging enemy missiles which really keep the defender on his toes.

Nice touches in "Space Invaders" include the increasing speed at which enemy ships attack as their numbers grow fewer, and emphasis on precision firing. (Rapid, poorly directed firing is actually detrimental since the player cannot fire again until an errant shot leaves the screen.) The player can increase his score considerably by knocking out the invader's mothership, but going after the mother ship can be a risky tactical decision. If the player spends too much time tracking and firing at the mothership, he may

eventually you'll find the golden key and unlock the golden castle. Then all you have to do is find the golden goblet and place it in the golden castle.

"Space Invaders" is a truly remarkable achievement and a good indication of Atari's ability to transfer a popular arcade game concept to a cartridge. "Space Battle" (Mattel) sends five alien squadrons, each possessing attack ships, against your mothership. You have three squadrons of three fighters each to counter the invaders. As the game begins, you see a radar screen revealing the positions of the enemy squadrons. You decide to engage one of the alien squadrons with one of your fighter wings. Your ships go out to intercept the enemy. As you close with the aliens, you turn off the radar display and take command of one of your fighters. You now view the alien ships through your starship window. You can set your sights on the enemy ships and fire your lasers. When hit, the enemy fighters explode. Sometimes a chain reaction can destroy a nearby enemy ship as well as the one that was hit. But be careful, the enemy ships fight back. Three hits from them will wipe out your squadron.

If the enemy penetrates your defenses and threatens the mothership, the red alert sounds; at this point, you'll have to recall some of your fighters to protect the mothership. When the situation really becomes serious, a three-stage warning siren is activated. At this time, rescue must be immediate or the mothership will be lost. Should you annihilate all of the enemy squadrons, the battle will be over.

Fairchild, Coleco, RCA and others have dropped out of the video cartridge business. But Atari (Video Computer System), Magnavox (Odyssey 2), Mattel (Intellivision), and APF Electronics (MP1000) are pioneering new ground. All plan stepped-up cartridge development activity during 1981. To the public this means: "You win turkey."

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# THEY'RE WOOING YOU IN ELECTRONIC LAND!

BY THE PE EDITORIAL STAFF

**C**HANCES are that you are an electronics engineer, computer professional, electronic technician or planning to hold one of these titles soon. You should know, then, that you're in a seller's market with bright prospects for at least the next decade. In fact, the demand for people with such skills has never been higher.

A 1979 salary survey by the IEEE revealed that the mean income for respondents was \$31,680, with an average of 18.1 years of experience. With salaries rising in leaps and bounds, 1981 income is expected to be substantially higher. Naturally, a variety of factors influence income, such as level of responsibility, product area, and region of the country. For example, if your area of technical competence is in electronic devices, you are likely earning more than someone working in, say, instrumentation (\$35.2M vs. \$32.1M in 1979). If you work in Philadelphia, you're probably earning much more money than a counterpart in Florida (\$37.2M vs. \$29M in 1979).

Today, you don't even require experience to land a job in electronics. It's not unusual for freshly minted electronic engineers or computer science majors to start their first job in the low-\$20,000 bracket. Add a few thousand dollars per year for a master's degree. And you could look at a median starting salary of more than \$30,000 for Ph.Ds.

Not everything always comes up roses for electronic engineers, however. This past summer saw a dip in the demand for high-technology top engineering jobs, though it was still a seller's market. A stronger demand was evident in the fall, however. As seasoned engineers know, supply and demand is cyclical. For instance, it wasn't too many years ago when there were not enough jobs to go around in the engineering field. The picture has changed, though, making recruiters' jobs tougher.

Engineering and computer sci people enjoy one of the highest starting salaries among degree holders. But ten years down the line, they fall behind as compared to incomes of the sales-marketing and accounting grads, you should know.

Furthermore, there's career-maintenance time—keeping up with new technology—that is tougher to pursue owing to its complexities than in nontechnical fields. Nonetheless, career satisfaction is a large part of a person's drive to enter technical fields. For example, Frank Coss of Deutsch, Shea & Evans, Inc., NY, human resources consultants, concluded from a survey of programmers and systems analysts that they show more job satisfaction than any other group of workers they researched.

**Job Classifications.** In hardware, jobs may be broadly broken down into technicians, engineering technicians, engineering technologists, and engineers.

Engineers (BSEE) are generally involved in circuit and systems design, and research and development. Training generally requires graduation from an engineering course with the BSEE degree. One can specialize in a variety of areas, of course, such as computers, integrated circuits, communications, and so on. Moreover, some colleges or universities, such as MIT, emphasize underlying principles in electronics, while others lean more toward applications.

Following EEs are the BETs or engineering technologists. This training prepares students for circuit design, modifications and applications work, and a few become involved in research. There are proposals out at the IEEE to eliminate calling BET graduates "engineers," but they do indeed perform as engineers at work. A BET graduate pursues a four-year undergraduate course, while getting a BSEE is really a five-year regimen, often squeezed into four years.

An engineering technician does troubleshooting, circuit modifications and, in some instances, even circuit design. Formal training can be had at a two-year community college, a resident technical school, home-study school, or military. The highest certification would be an Associate Degree.

A technician is generally confined to troubleshooting, maintenance and repair. Work might be on consumer electronic equipment—TV receivers, marine radio, etc.—or in commercial areas

such as two-way radios, medical electronic equipment, and so on. Training is most often through a resident technical school, home study school or military. Being lowest on the technical totem pole isn't too bad, though, since many such techs start their own businesses and can earn more than higher-level people in the electronics field.

People in the computer software area are a breed apart. One might be a graduate EE as a software engineer, another a two-year college grad as a computer programmer or systems analyst. More and more, though, are four-year college grads, either specializing in computer science or in information science. The latter leans to business computer applications, with more limited mathematics. Then, of course, one can be a major in math with some computer courses behind them, or a major in business with same, and break into the field without much trouble.

The computer field is the hotter-than-hot field now and in the foreseeable future. There are more than one-million computer systems operating today, a seven-fold increase in six years. And there's no end in sight. The Bureau of Labor Statistics indicates that there are 534,000 programmers and systems analysts today, which is an increase of 25% in only the past two years. *Business Week* notes that the need for programmers could reach 1.5 million by 1990!

With more than 1,000 computer languages around, one might ask which one should be studied. It's probably best to be proficient in two or three major languages, such as FORTRAN, COBOL, or APL, plus Assembly. Most important is a demonstrated ability to learn languages quickly and be able to program well. For example, RPG (Report Program Generator) is an important language for business computers, though few colleges teach it.

If you're planning to enter college in the pursuit of a computer or engineering career, you may be interested in seeking out a computer for counselling. If so, don't overlook "Siggy." This is an acronym for the System of Interactive Guidance and Information developed by the

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There are many different avenues you can travel in developing varied electronics experience and a career. Perhaps you are interested in the military electronics area, which is very dependent on how much money the government allocates. This is a traditionally good field for electronics and is expected to continue to be so. However, overall U.S. defense budgets for the coming year will not come close to keeping up with inflation. Electronics and communications research and development fare much better (+2.5%), though there will still be some slippage since inflation is expected to be 7% to 10%.

The federal government has computer jobs, too. And why not, since here's where some 20% of the computers are. Just check the Civil Service Commission hiring lists. One, Computer Specialists announcement #420, is a non-test exam that requires at least a substantial training background. Another is announcement #424 for computer specialists with engineering or math backgrounds.

**Making Your Move.** As electronics is applied to more and more areas of business, commerce, industry and the consumer marketplace, the demand for engineers and technicians will undoubtedly grow. You can cash in on the present and near-future opportunities by simply getting an education in electronics, upgrading your electronics knowledge through home study courses, seminars, industry training programs, or, if you're ready, changing jobs.

For the latter—changing jobs—look for very substantial real increases in income, at least 20 per cent. If a position in another part of the country interests you, do check out living costs in that area compared to your present location. Check the fringe benefits package before accepting the job to weigh what you will truly gain in added money. Find out about employee turnover in your area, too. Note, though, that in the computer field, job hopping is commonplace, and thus turnover is typically high. If you're investigating joining a company that depends on defense contracts, find out about the contracts in house. Long-term ones are better than short-term ones, of course.

So do peer outside to see if there's a much better world waiting for you. But don't simply jump into a new job without learning as much as you can about your future in the company.

# SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

## Wire-and-Glass Holdovers from the Pre-Solid-State Age

FOR THE PAST twenty years, solid-state devices have dominated the electronics scene. Yet there are still many *non-solid-state* components around. The two biggest categories of these components are electron tubes and various kinds of lamps. Let's examine some of the most important components in each category and find out how many of them might eventually be replaced by solid-state devices.

**Electron Tubes.** Contrary to the claims of advertisements, press releases, books, articles and TV programs about modern technology, the electron tube is in many applications alive and well. Your television receiver, for example, might be advertised as "100% solid-state." Actually, the visual images it produces appear on one end of a giant vacuum tube, the venerable *cathode-ray tube* (CRT). The camera in the TV studio also employs a vacuum tube, usually an *image orthicon*.

There are many other applications in which cathode-ray and other types of vacuum tubes play key roles. For example, if you own a home computer, chances are its principal means of presenting information to you is a CRT. If you use a microwave oven, your meals are cooked by the radiation emanating from a vacuum tube called a *magnetron*. And, no doubt, more than once in your life you've been exposed for medical purposes to the penetrating radiation emitted by an *x-ray tube*.

Although solid-state components are now almost universally used in low-to-medium-power electronic equipment, there are still plenty of applications for electron tubes. In high-power switches, radar pulse generators, and the output stages of high-power transmitters, the use of electron tubes is the rule rather than the exception. Interestingly, in one specialized low-to-medium power application, there is a move back to vacuum tubes. Purists and traditionalists alike wax poetic over what they perceive to be the superior sound quality of vacuum-tube, as compared to totally solid-state, audio components.



Fig. 1. RCA TV camera uses solid-state and electron-tube technology.

**Illumination.** Today, solid-state light-emitting diodes (LEDs) are widely used in numeric-readout and low-power indicator-lamp applications. However, despite a 1967 RCA advertisement which predicted that someday LEDs "may light your home," non-solid-state light sources still dominate both special- and general-purpose lighting.

Closed-cycle gas lasers, neon glow lamps and xenon flash tubes are good examples of special-purpose lamps that have no solid-state counterparts. Although there are many different solid-state lasers, none emit light with the spectral purity or narrow beam divergence of such electron-tube lasers as the helium-neon (HeNe) gas laser. No LED can produce a flash as brilliant as that generated by a xenon strobe lamp. And even the versatile LED cannot outperform the lowly neon glow lamp as a super-simple high-voltage indicator.

**The Future.** Will any of these non-solid-state components ever be replaced by solid-state devices? The process is already taking place in some cases. For example, some of the latest television cameras employ arrays of light sensitive *charge-coupled devices* (CCDs), instead of image orthicons or similar electron tubes. Other new cameras combine semiconductor and electron-tube technology in a light-sensing tube called the *silicon vidicon*. Figure 1 shows a high-resolution, closed-circuit TV camera with a zoom lens and an automatic-

light-control system. Thanks to its silicon vidicon, the camera can operate over an ambient light range of 400,000:1 and can produce usable images of scenes illuminated by as little as 0.05 foot-candle of ambient light.

Thus far, the CRT, which has survived a 20-year effort to develop a suitable solid-state alternative, is still by far the best video-display device available. Nevertheless, ongoing research in high-resolution, liquid-crystal and LED displays might result in an acceptable, limited-resolution substitute.

The helium-neon gas laser is beginning to receive competition from a new generation of sophisticated semiconductor lasers. These tiny new lasers are much smaller, use less power and are far more efficient than HeNe lasers.

Geiger tubes might one day be replaced by a new generation of efficient solid-state detectors. Several suitable devices have already been developed, but they still are far more expensive than most Geiger tubes.

In the areas of general-purpose lighting, heavy-duty switching, high-power

Fig. 2. The largest (320 lb) water-cooled tube of its kind ever made. (RCA)



radar and radio transmitters, electron tubes are unlikely to be replaced by solid-state devices of similar capabilities, at least in the foreseeable future.

One convincing example of the importance of non-solid-state components is the huge vacuum switching tube shown in Fig. 2. Developed by RCA at a cost of \$600,000, this 320-pound tube can switch 200,000 volts at up to 125 amperes. That's a total power of 25,000,000 watts, roughly equivalent to turning on 300,000 TV sets simultaneously! While operating, this tube dissipates 2,016,000 watts. That's enough power to heat 100 all-electric homes. Excess heat is removed from the tube by a self-contained cooling jacket through which 250 gallons of water are pumped each minute.

It's unlikely that solid-state components will ever be used for *all* applications in electronics. However, newly developed components will continue to take over functions which traditionally have been performed by non-solid-state components. I'll report on any important developments in future columns.

**An Intelligent Instrument Panel.** A solid-state odometer for automobiles has been developed by National Semiconductor Corporation as part of its Intelligent Instrument Panel program. The odometer consists of a fusible-link bipolar PROM, a 4-bit COP420L microcontroller and a speed sensor.

In operation, the microcontroller counts pulses generated by the speed sensor. When the number of incoming pulses coincides with a permanently stored mileage increment, one bit is programmed into the PROM. Because this mileage information is permanently programmed into the PROM, it is virtually unalterable and therefore tamper-proof. This feature satisfies the requirement of the proposed Federal Motor Vehicle Safety Standard which, if implemented, will require that new cars be equipped with tamper-proof odometers.

The COP420L microcontroller does

double duty by converting the pulses from the speed sensor into the vehicle's road speed. This information and the mileage data are sent to speedometer and odometer displays in the Intelligent Instrument Panel. Both readouts can display information in either English or metric units.

**Component News.** The Honeywell Corp. Electro-Optics Center has announced an important new development in the field of thermal imagery. Present thermal-imaging systems utilize a mechanical scanning system to divide a scene into bars which are then swept past a single infrared detector. The mechanical scanning components in such a system are bulky and inherently fragile.

Honeywell's development is an integrated array of 1,024 Mercury Cadmium Telluride (HCT) detectors on a single substrate. The substrate is actually a silicon charge-coupled device. HCT detectors respond to infrared radiation at wavelengths of 3 to 5 microns. Potential applications for Honeywell's array include remote sensing from satellites and aircraft, military reconnaissance and portable night-vision equipment.

Thermal printers are used in some data loggers, calculators and microcomputers to provide hard-copy printout on heat-sensitive paper. R-Ohm Corporation (P.O. Box 19515, Irvine, CA 92713) has announced the development of a new thermal printhead that can produce both alphanumeric and graphic information readouts.

Designated the KH101, the new printhead has a single 5-inch wide, one-piece heating element which can produce both lines and solid shapes in addition to numerals and characters. Its printing resolution is 102 dots per inch.

Figure 3 shows a complete KH101 printhead together with an interface connector. Also shown is a KH101 partially disassembled to reveal the sixteen 40-pin chips that contain the printhead's 32-bit  $I^2L$  drive circuits, shift registers and diode arrays. Specified life of the KH101 is  $30 \times 10^6$  printing pulses or 18.6 miles (30 km) of paper length, whichever occurs first.

Another National Semiconductor development is the MM57499, a 28-pin chip that contains all the encoding logic necessary to interface a remote keyboard to a CRT terminal. Up to 96 keys can be handled, and only five wire connections are required. Adding a 4-to-12-line decoder (74S154) will expand the number of keys to a maximum of 144.

Do-it-yourself computer hobbyists will be particularly interested in the many features of the MM57499. It includes, for example, phrase storage ca-

pability which allows up to 14 key-strokes to be recalled by pressing a single key. Both upper- and lower-case ASCII and a separate digit pad capability are available.

Other features include two-key lock-out to prevent erroneous double entries, manual hold-down repeat and fast automatic repeat. A self-contained baud-rate generator is also included.

The MM57499 is a 5-volt, TTL-compatible chip. National Semiconductor will sell the MM57499 for \$6.15 each in lots of 100. You will have to ask local distributors about single-quantity availability and price.

Incidentally, National Semiconductor has also announced publication of the new editions of its Linear, Voltage Regulator and Audio Handbooks. In recent years these books were available through Radio Shack, but I have heard from a reliable source that Radio Shack will not handle the new editions. These books contain hundreds of pages of invaluable material. Ask your National Semiconductor distributor or mail-order electronic parts companies about availability and cost.

This magazine has published several columns describing construction projects employing LED dot/bar display drivers made by Texas Instruments and National Semiconductor. Chips of this type are also manufactured by several foreign companies. One of the most recent entries is a family of six display drivers made by AEG-Telefunken. Each of these chips is housed in an 8-pin mini-DIP and is able to drive a 5-element LED bargraph display. The family is divided into three pairs, each of which can be combined into a two-chip, 10-element readout driver.

The U237B and U247B are linear response drivers with minimum thresholds of 0.2 volts and, respectively, 100-millivolt and 200-millivolt increments between LEDs. The U257B and U267B have logarithmic rather than linear responses. The U244B and U254B are similar to the U247B and U257B, respectively, but are characterized by gradual rather than sharp transitions between output states. This has the effect of nearly doubling the resolution of the display because an intermediate level is indicated by two simultaneously glowing LEDs.

All six chips in this new family are available for approximately a few dollars each in 1,000-lot quantities. Unit prices will therefore be several dollars each. AEG-Telefunken's address is Route 22, Orr Drive, Sommerville, NJ 08876. Literature describing the new chips can be obtained by writing directly to the company.

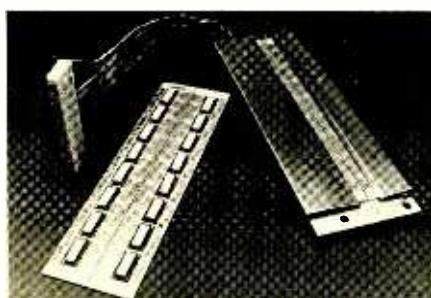


Fig. 3. New thermal printhead from R-Ohm Corp. prints all types of symbols.

# EXPERIMENTER'S CORNER

By Forrest M. Mims

## Experimenting with a Light Pen—II

**I**N part one of this two-part series, we discussed the chief differences between light wands and pens. We then designed a basic phototransistor light pen and experimented with a 16-position, light-pen-controlled data-input terminal.

**Adding a Bus Register.** The data terminal which was described in Part I can be made more compatible with external circuits by adding a register to its 4-bit bus. The register will ignore any logic signals on the bus until a WRITE switch issues a command to load the register with whatever is on the bus.

Figure 1 shows one simple way to add such a register. The register, a 74175 quad D flip-flop, follows the bus data when

its LOAD input is brought to logic one by means of the WRITE switch. The data remains in the register until the WRITE switch is again toggled from HOLD. The contents of the register can be cleared to 0000 by toggling the RESET switch from HOLD to CLEAR.

You'll need to insert three-state transmission gates between the register outputs and the bus. Alternatively, you can use a 74173 4-bit D register with self-contained three-state outputs. This approach is shown schematically in Fig. 2. Note that the 74173 has more control inputs than the 74175. The system clock loads into the 74173 the data present at its inputs when both DATA ENABLE inputs (pins 9 and 10) are grounded by

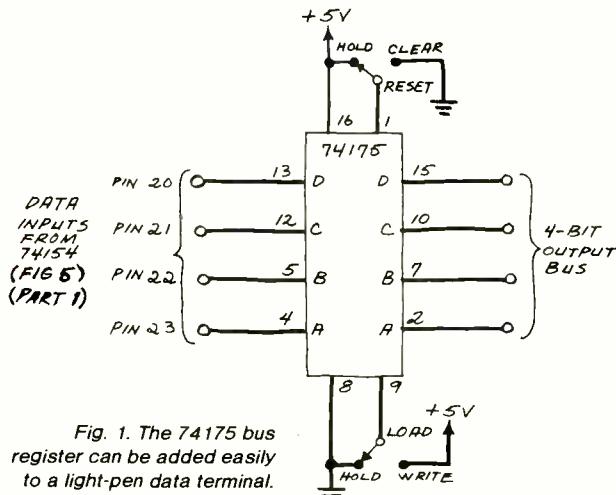


Fig. 1. The 74175 bus register can be added easily to a light-pen data terminal.

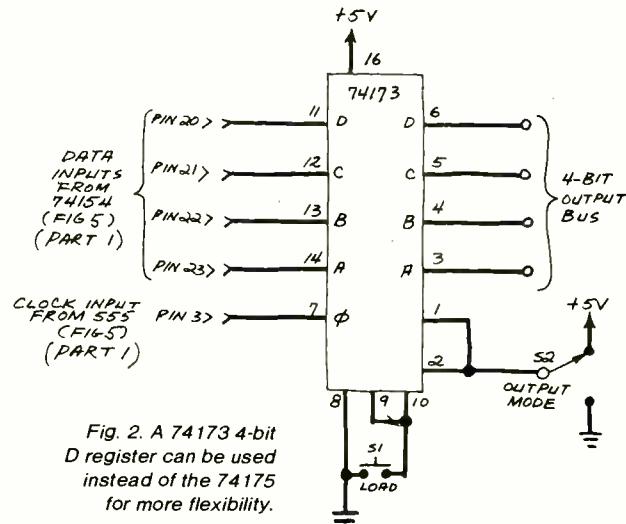


Fig. 2. A 74173 4-bit D register can be used instead of the 74175 for more flexibility.

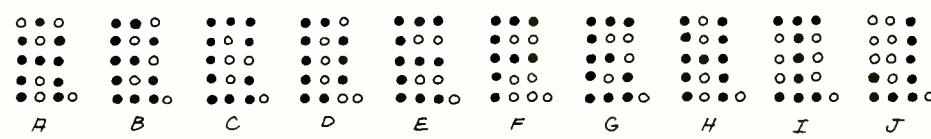
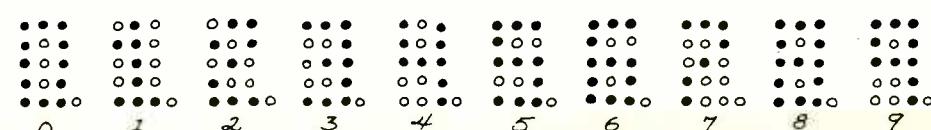
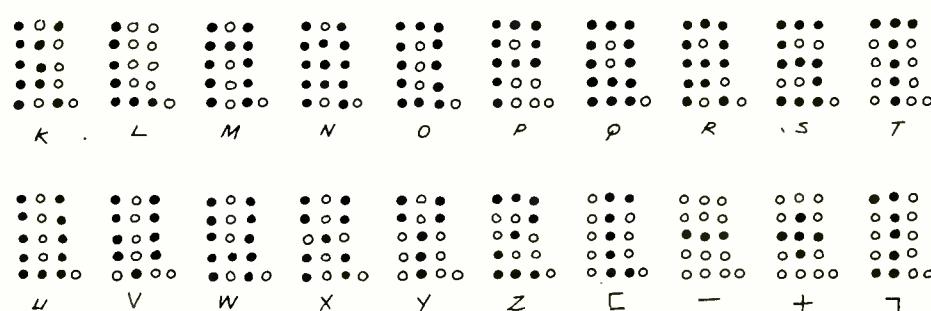


Fig. 3. Letters, symbols, and digits created by 5-by-3 dot matrix.



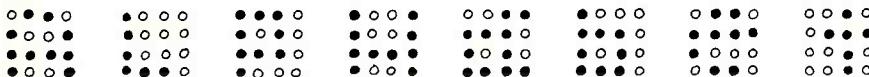


Fig. 4. Upper- and lower-case letters of the alphabet on a 4-by-4 array.

means of *S1*. This means that you must be sure to depress *S1* for at least one clock cycle—which can be a significant interval when the clock rate is very slow.

The outputs of the 74173 and therefore the output bus reflect the data stored in the chip when both OUTPUT CONTROL inputs (pins 1 and 2) are grounded. Should either OUTPUT CONTROL input go to +V<sub>cc</sub>, the outputs enter the high-impedance state and, for practical purposes, the 74173 disconnects itself from the output bus.

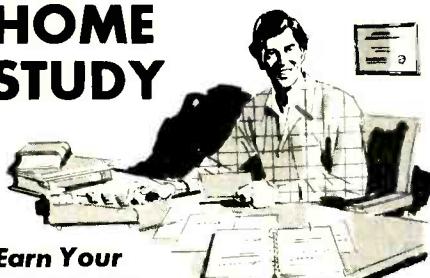
**A Light-Pen-Controlled LED Display.** The basic light-pen data-entry terminal forms the nucleus of a 16-element LED display that can be illuminated in a pattern selected by the light pen.

If, for example, the LEDs are arranged in five rows, four having three LEDs and one having four, then each of the ten decimal numerals plus a decimal point can be formed. Figure 3 shows one possible way to form each decimal numeral or any of the letters of the alphabet on such a display. As you can see, in spite of the limited number of display elements, the legibility and appearance of the characters generated are surprisingly good. Arranging the LEDs in a 4 x 4 array makes possible the display of many graphic symbols and some upper- and some lower-case letters. Figure 4 shows some examples.

Hopefully, you are by now as interested as I've long been in experimenting with a circuit having such capabilities. Assuming that you are already familiar with the basic light-pen data-entry terminal described in Part I, we can now begin modifying that circuit for video-graphics applications.

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The solution to the first problem is simply to add a RAM. The second requirement is trickier. Ideally, only the selected LEDs should glow. That's impossible, however, because all of the LEDs must be sequentially strobed to make them eligible for future selection by the light pen. There are several solutions to this apparent contradiction. You can better understand the one that I chose by referring to the block diagram of the complete light-pen-controlled display in Fig. 5.

If you compare Fig. 5 of this part with the block diagram of the light-pen data-entry terminal (Fig. 5 of Part I), you'll immediately notice several important similarities. For example, the configurations of the clock, counter, decoder, bus and light pen are identical in both circuits.

You will also notice some important additions to the circuit. One major addition is a 1 x 16-bit RAM whose address lines are connected to the 4-bit output bus. Also, a LOAD switch connected to the RAM has been incorporated into the light pen.

When a particular LED has been selected by the light pen, closing the LOAD switch records its new status in the RAM. The RAM is able to keep track of the selected LED because the count supplied to the decoder is equivalent to the address furnished to the RAM.

Notice the AND gate that has been connected to the OR array between the decoder and the LEDs. This gate network permits the LED array to be strobed and therefore to display

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## experimenter's corner

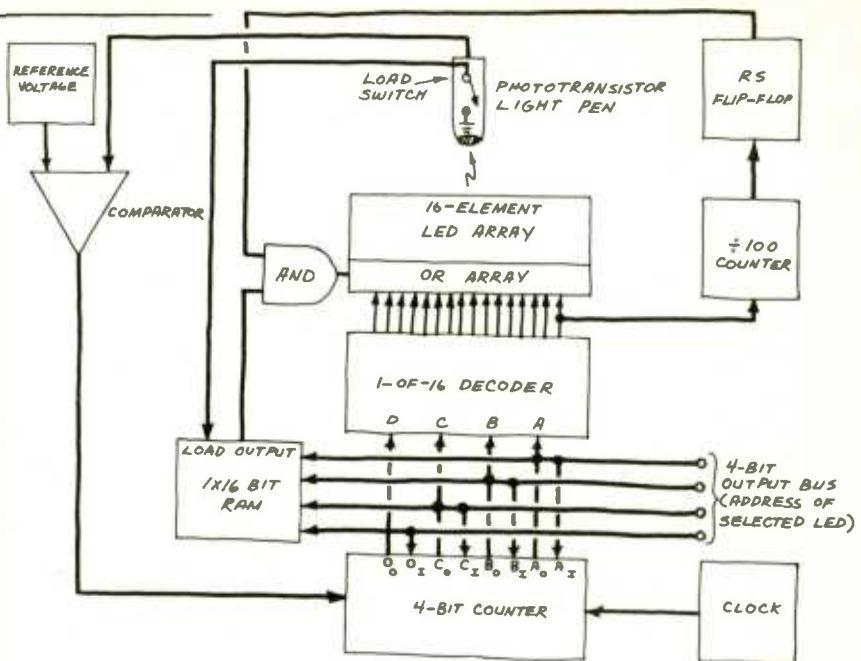


Fig. 5. Block diagram of a light pen controlling a 16-bit LED display.

selected LEDs. Without the assistance of the additional logic, the multiplexing action would be divided equally between the LEDs being sequentially strobed by the scanning circuit and the LEDs selected by the light pen. This means that both the scanned and the selected LEDs would appear equally bright.

This problem is solved by means of a divide-by-100 counter and a set-reset flip-flop. Connecting the flip-flop to the counter results in a combined circuit that is a modified divide-by-10 counter. The output of the modified counter is at logic 0 for ten

clock pulses. It then goes to logic 1 for 90 clock pulses. The cycle then repeats.

The outputs of the RAM and the counter are ANDed and the result ORed with the decoder outputs. This is done so that the LEDs selected by the light pen are strobed 90 times during an interval of 100 clock pulses. All of the LEDs are then strobed 10 times during the remainder of the 100-pulse clock interval. The net effect is that the LEDs selected by the light pen are substantially brighter than the remaining LEDs.

(continued on page 92)

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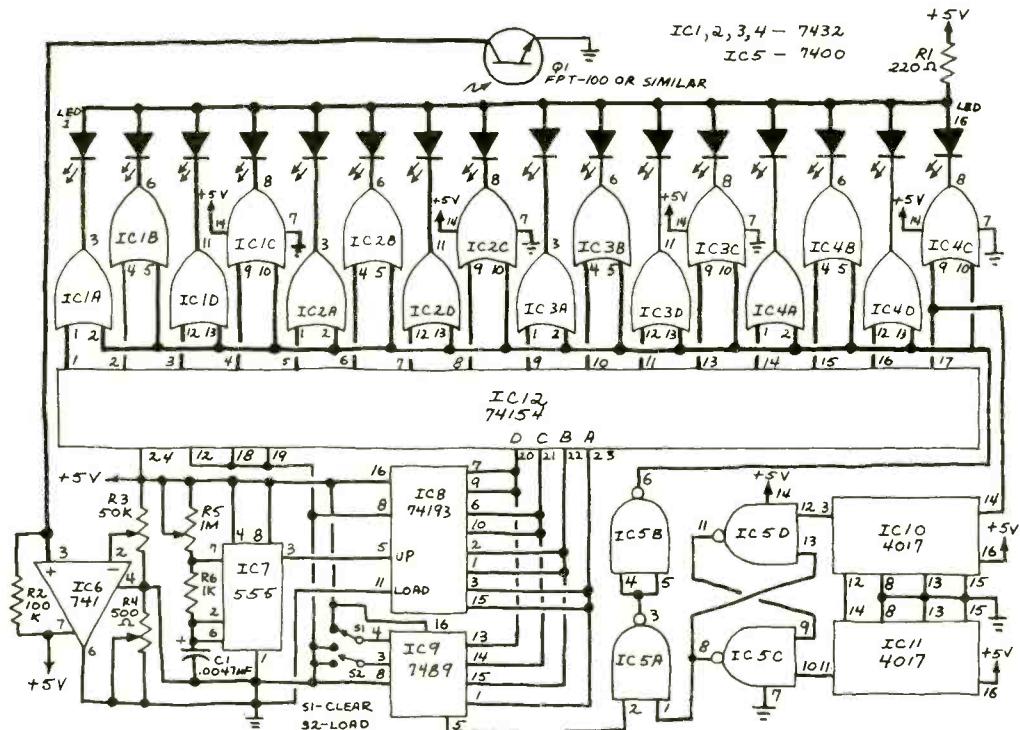


Fig. 6. Complete circuit of a 4-by-4 LED display controlled by a light pen.

It's even possible to extinguish the unselected LEDs for intervals of one second or more by slowing down the clock. The selected LEDs will appear to glow continuously and the other LEDs will blink on every second or so during the scan period.

Figure 6 is the schematic of a practical circuit that corresponds to the block diagram of Fig. 5. Although the circuit appears much more complex than the relatively simple light-pen data-input terminal described in Part I, that circuit forms



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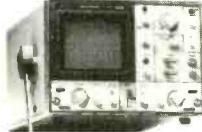
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the core of this one. You can verify this for yourself by noting the almost identical connections of the 555 timer, 74193 counter, 74154 decoder and the light pen comprising *Q1* and operational amplifier *IC6*.

The lowest-order bits in each nibble of a 7489 4-by-16-bit RAM (*IC9*) provide a 1-by-16-bit RAM for the circuit. Although three-fourths of this RAM is not utilized, it's always available should you wish to expand the display.

Two series-connected 4017 CMOS decade counters (*IC10* and *IC11*) and an RS flip-flop made from two gates in a 7400 (*IC5C* and *IC5D*) comprise the circuit's modified divide-by-10 counter. The remaining two gates are configured as a gate that ANDs the outputs of the RAM and the divide-by-10 counter. The AND output is ORed with each of the 16 outputs of the 74154. The LEDs are illuminated sequentially.

**Modifying the Circuit.** There are several modifications that can be made to the circuit that was just presented. You can eliminate counter *IC11* by connecting pin 10 of *IC5* to pin 11 of *IC10*. This will provide divide-by-10 operation, but the unselected LEDs will be strobed once for every nine times that the selected LEDs are strobed.

There are several ways to substitute other memories in place of the 7489 (*IC9*). You can, for instance, use a MOS or CMOS 256-by-1-bit RAM if you prefer. While only the first 16 bits will be used, the remaining 240 will be available for future expansion of the circuit. You can eliminate RAMs entirely by using an array of flip-flops. The resulting circuit, however, will employ more ICs than the RAM version.

**A Long-Range Light Pen.** During my experiments with the light-pen circuits that have been described in this two-part series, it often occurred to me how convenient it would be to have a long-range light pen. This would not be possible with red LEDs, however, because the optical power typically radiated by red emitters is measured in tens of microwatts. Also, their spectral emission peaks at approximately 670 nm, halfway down the response curve of most phototransistors.

An infrared LED made from gallium arsenide is much more powerful than a red LED. When, for example, a forward current of 20 mA is flowing, an infrared LED might emit more than one milliwatt of optical power. Also, its near-infrared emission corresponds closely to the wavelengths at which a silicon phototransistor exhibits peak response.

On the assumption that an infrared LED should increase the detection range of the light pen, I connected a General Electric 1N6266 near-infrared emitter in series with one of the red LEDs in the display in Fig. 6. The detection range increased from a fraction of an inch to several inches. I then removed the red LED and connected the infrared emitter in its place. This increased the current through the infrared emitter and resulted in a further increase in the detection range.

Of course, visible emitters must be used in light-pen-controlled displays. Therefore, I tried a GE SSL-3 LED which emits both near-infrared and visible green light. This LED, which is no longer manufactured, consists of a gallium arsenide chip coated with an infrared-sensitive phosphor. When forward biased, the chip emits infrared light. This stimulates the phosphor into emitting green light. The result is a visible green beam superimposed upon an invisible infrared beam.

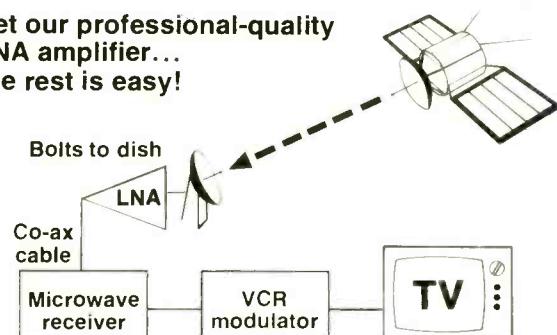
Using the SSL-3 resulted in a light-pen detection range of several inches. But it proved impractical to use an array of such LEDs in the display because the low duty cycle resulted in a barely visible green glow.

My final attempt to extend the light pen's detection range used a simple pnp driver delivering several hundred milliamperes to the LED during each strobe pulse. This resulted in the radiation of enough infrared power to trigger the light pen at a distance of up to ten inches.

The range resulting from the use of infrared LEDs can be further extended by adding a collection lens to the light pen. Theoretically, the detection range will be doubled each time the collection area is doubled. Adding lenses to the infrared emitters is not advisable. This would restrict the detection region of the light pen to sixteen narrow cones of invisible light. The use of only the self-contained lenses of typical infrared LEDs results in a much broader detection region. ◇

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# DX LISTENING

By Glenn Hauser

## Trends in International Broadcasting

**Israel Radio** became the first international broadcaster to transmit slow-scan television (SSTV) pictures, in an historic experiment Nov. 2, 1980. Three scenes of Jerusalem were each transmitted three times on five different broadcasts that day, despite the fact that the station was unable to transmit on AM at that time free of distortion. This is an experiment we encouraged in the July "DX Listening," and *Israel Radio* indicated there would be more such tests. It appears unlikely that *Radio Australia* will try it, since their DX program was cancelled.

**BBC World Service** installed a new studio-based audio processing and compression system as of Sept. 14. While it gives speech more "punch" under difficult reception conditions, it brings up the background noise to a more annoying level for the many listeners who already have clear reception. And despite its worldwide prestige, *BBC WS* has never gotten rid of the sound of clunking microphone switches, something which U.S. broadcast operators avoid without trouble.

Within Great Britain, *BBC* is using digital techniques to feed audio from studios to transmitters, and it has been suggested that the next step forward for international broadcasting should be digital rather than analog transmission direct to the listener. Studio-quality audio akin to that enjoyed by National Public Radio listeners, networked by satellite, would be possible on shortwave! Unfortunately, it could be transmitted, but no one has receivers for it. Moreover, there's another problem—bandwidth. Several contributors to the *Review of International Broadcasting* estimate it would take up to 1.5 MHz for a single digital transmission, much wider than any single ISWBC band. However, a somewhat degraded digital transmission using a quarter of that bandwidth, could fit into the 11-meter band with a minimum of disruption to other stations and still be an improvement over analog audio. And what station has programming more worthy of higher fidelity than the *BBC*?

Stereo on shortwave is another area of experimentation. Since any two fre-

quencies, no matter how close (even independent sidebands with the same center frequency), fade independently, stereo shortwave has never been seriously considered, although one pirate operator reportedly tried it. Some listeners enjoy a stereo effect by employing frequency or antenna diversity. However, once stereo AM broadcasting is underway, there is no reason the same system could not be tried on shortwave, where AM is also the standard transmission mode. Single-hop paths, where signals are strong and fading is minimal, should be the best bet.

There are a lot of unanswered questions about a *Radio Afghanistan* program carried on 19637.15 kHz SSB, most of the time between 0130 and 1930 GMT, and surprisingly heard well in North America. It's presumably to, or from, Afghanistan's "Great Northern Neighbor." One listener, David Crawford, hypothesizes that this and a nearby frequency are actually transmitting stereo; one of them L+R, the other L-R. But such experimentation would seem to be a very low-priority item in relations between Afghanistan and the U.S.S.R.

Most stations on shortwave have a characteristic identification tune, which serves the dual purpose of enabling listeners to tune in the best frequency before programming begins and giving the engineers expendable audio while they switch transmitters and antennas. We are pleased to note that several stations, including *Austrian Radio* and *Radio RSA* have cut the amount of time spent playing their pleasant but repetitive tunes in favor of more programming. All those minutes gained certainly add up, and we hope other stations will follow their example.

Another group of stations is in the vanguard of putting higher priority on programming for the airwaves than on correspondence, as a result of increasingly scarce funding. Instead of sending out QSL (verification) cards on request, as many stations still do, these stations have recently introduced restrictions. *Radio Australia* verifies reports only one month per year (in 1980 it was November). *BBC* does not verify except under special circumstances such as *World*

*Radio Club* competitions (but that program goes off the air in 1981). *Deutsche Welle* also declines to verify. *Radio Finland* requires comments on programs, rather than technical details, and then sends an "Audience Card." *Radio Nederland*, which frequently introduced new QSL designs, has reduced them to two a year starting in May and November, hoping this will reduce demand. (This will not likely deter the breed of DXer who tries to verify every frequency a station uses, which is certainly an abuse of station courtesy). *Radio Canada International* sends blank QSLs to everyone (but only those) on their mailing list. Those who want them verified must fill them out themselves and send them back to *RCI* for checking, verification and return. *RCI* says only a small fraction of recipients bother to do so. *Radio Sweden* has a system similar to *RCI*, but combines it with audience research by asking some questions on the card.

In October, *Radio Baghdad* reportedly offered a special QSL for the duration of Iraq's war with Iran! Meanwhile, both Iraq and Iran have announced plans to expand their international broadcasting capabilities.

We are happy to report that, as of this writing, the USAF Over-the-Horizon Backscatter radar threat to shortwave listening (detailed in September "DX Listening") had not materialized. The OTHB managers have been made aware that there is a concerned shortwave listening constituency.

**Propagation Predictions.** Though far from an exact science, shortwave propagation can be foreseen. These sources all approach it in different ways. You can get it by phone any time from Goddard Spaceflight Center, (301) 344-8129. *WWV* has capsule summaries every hour at 18 past, on 2.5, 5, 10, 15 and 20 MHz; *WWVH* at 45 past on 2.5, 5, 10 and 15. Weekly outlooks are included on my *RCI* DX reports, Saturdays in the 2130 broadcast, and Mondays at GMT 0100 and 0400. George Jacobs issues *Mail-a-Prop* every two weeks, at \$25 a year, and sells his new *Shortwave Propagation Handbook* for \$7.95 ppd. in U.S.A., both from Box 1714, Silver Spring, MD 20902. And at least one broadcast DX program gives recommended frequency ranges for the following month—*Radio Sofia*, the last Friday in the 2130 broadcast, repeated Saturday 0430, Monday 0000.

**Special-Purpose Broadcast Stations.** There is a growing number of limited-range, low-power stations which are for the public, but do not broadcast programming in the usual sense. They

also make challenging DX targets for those outside their intended coverage areas. Operating on 530 and 1610 kHz are *Highway Advisory Radio* (HAR) and *Traveller's Information Service* (TIS) stations, normally running tape-loop messages that repeat every few minutes. They are found near national parks, resorts, airports and highway construction areas, with powers of about 10 watts and deliberately inefficient antennas. A cluster of several HAR stations are synchronized on 530 kHz from Knoxville, TN, in preparation for the 1982 World's

Fair. A TIS station on 530 in Gatlinburg, TN, was picked up as far away as Maryland by Hank Holbrook. *NOAA Weather Radio* now has more than 300 stations across the country broadcasting continuously on one of three frequencies: 162.4, 162.475 and 162.55 MHz. Their potential range expands greatly during intense sporadic E openings. If your FM band is "wide open" for skip, check these frequencies too.

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## dx listening

of lessons are broadcast on local and national stations. A few you might try for, per information from Australian DX News: 0000 GMT on Program I, 15590, 15510, GMT Mon/Wed/Thu/Fri/Sat; also at 0815. At 1000 on Nei Menggu, 4750 kHz; 1130 Wed/Fri on Wulumqi 4500; 1330 Sun-Fri on Lanzhou, 4865 and Fuzhou 4975, 2340; 1400 Mon-Fri on Lasa 4750, 5240, 4931, 7170.

**Cuba** is the heading, but Ethiopia is the more likely location for a station on 7218 kHz, heard last July at 1657-1745 GMT by Rikard Johansson as he circumnavigated Africa. "Radio Olanda" (perhaps the name of the female DJ) carried entertainment in Spanish for Cuban military personnel.

**Chile**. Two new shortwave stations in the far south have been heard in California. Ron Howard heard *Radio Patagonia Chilena*, Coyhaique, on 6080 from sign-on 1030 (currently 0930 due to DST in Chile); and *Radioemisora Manantiales*, Chile Chico was reported by Bob Hill, testing around 0100-0230 on 6225 (variable to 6260). In the mornings, you might hear instead *Radio One*, Philippines, which has been on 6225, too, instead of its nominal 6170.

**Guyana**. Those who listen only in the evening seldom hear *Action Radio*, 5950, but it's widely heard after sign-on 0755. Maxfield Greenwood "enjoys" their cockroach powder ads and death notices at 0830; Doug Jaffe recommends "Sunday Songtime" at 0900 for requests with an Indian flavor.

**Malta** is easy to hear thanks to *Deutsche Welle's* relay station (such as 15105 at 0120-0150), but hearing broadcasts in the Maltese language (a mixture of Italian and Arabic) is another matter. Only two shortwave stations have it on their schedule—barely. *BBC* has seven minutes Monday-Friday at 1635-1642 on 15345 and 11680. *RAI*, Italy, has it at 1430-1455 on 9710 and 7235, but has run this P.S. for the past year: "This transmission is temporarily in Italian because of the unavailability of Maltese-language announcers!" (If you speak Maltese, here's your chance.) And Malta has one other interesting connection. Tom Meijer frequently refers to his audience there, since tapes of *Radio Nederland's* "Happy Station" are carried on a cable radio network.

**Poland**. The name change that *Radio Warsaw* made last May to *Radio Polonia* has been explained by Richard E. Wood and Mike Tripka in *Review of International Broadcasting*, as emphasizing contact with the Polish "diaspora," which the word Polonia connotes.

**Portugal**. In November, we mentioned *Radio Renascencia's* plans for 100-kW shortwave broadcasts. From Andy Sennitt, of the *World Radio-TV*

*Handbook*, we learn that the frequency to be used is 6155. It happens to be one which has not been used for some time by any powerful station in our evenings.

**Surinam**. More updating to our November item on *Radio Apintie*. It jumped like a grasshopper around the 60-meter band to find out which frequency would serve it best—4794, 4751, 4950 and 5006 were among them. Power was raised to 4.5 kW, and a service to Surinamese in Holland was begun at 0430-0630 on Thu/Fri/Sat, per Andy Sennitt.

**Switzerland**. For a few days each month, the *Red Cross Broadcasting Service* carries out broadcasts in several languages, including English. Try 7210 kHz at 0600-0700 GMT on Dec. 29 and 31, Jan. 26 and 28, and Feb. 23 and 25. You might also hear *RCBS* at 0945-1015, Jan. 27 on 21695, 21520, 15305, 9560; Jan. 29 on 21630, 21520, 17830, 15430. Broadcasts at this hour are only in odd-numbered months.

**Tristan da Cunha**. At the top of the 'wanted' list for almost every North American DX listener is *Tristan Radio, ZOE*. On its present schedule of 1900-2200 GMT, Sun/Wed/Fri, however, only those on the East Coast during midwinter have a chance with a darkness path opening up near sign-off. Tom Haskett wrote the station anyway, and received an information sheet which said the station uses 40 watts on 3290 kHz, and has been on the air since 1968. Programs include kid shows, comedy, drama and/or serials, light and pop music, and news; much of it from the BBC and South Africa. They use two Garrard GT-35P record decks, a Sony TC-158D stereo cassette, an FRG-7 receiver fed into a Millbank Electronics MCC MK-111 stereo mixer. We tell you this so you can visualize the studio during your DX catch of a lifetime; it's a bit easier if you visit South Africa. *ZOE* requires items from their own local newscast at 2009 to be quoted by those trying for a QSL.

**Updating Listings.** The following changes and additions should be made in the "English Broadcasts" listings that appeared in the December issue. To make the corrections as concise as possible, only the GMT, station name, and frequency correction are given.

1230-1330, *Radio Korea*, 7550, 11830, ex-1300

1230-1551, *WYFR*, 17785, not 17845 Sun.

1235-1245, *V. of Greece*, 17830, ex-17835

1300-1351, *WYFR*, 11830, ex-9535

1400-1800, *WYFR*, 15215, ex-11830 and 9535

1535-1545, *V. of Greece*, 17830, ex-17835

1600-1630, *R. Portugal*, 21530, ex-21475



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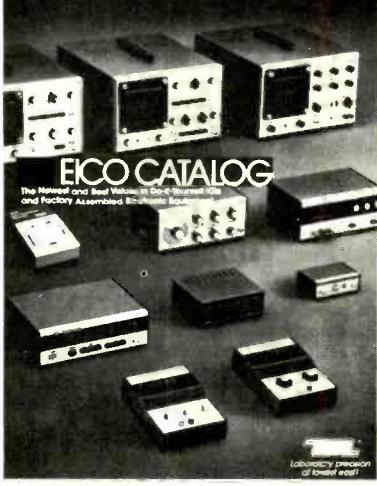
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# PROJECT OF THE MONTH

BY FORREST M. MIMS

**M**any high-brilliance light-flasher circuits have been published over the years in this and other electronics magazines. Almost every one of these flashers has employed power transistors or SCRs, components which require heat sinking and careful circuit design.

Figure 1 shows an ultra-simple flasher circuit that I recently built around an FRL-4403 flashing LED, with only a few additional components. It will flash at a typical rate of 3 Hz any lamp whose current and voltage requirements fall within the ratings of the relay's contacts. The particular relay specified in Fig. 1 has contacts that can handle up to 1 ampere at 125 volts. The lamp shown is rated at 150 mA at 6.3 volts.

Incidentally, *FRL* stands for *Flashing Red LED*. The FRL-4403 is a Litronix product (19000 Homestead Road, Vallco Park, Cupertino, CA 95014). This novel LED, which incorporates a flasher integrated circuit, is also available from Radio Shack (stock No. 276-036).

The FRL-4403 LED in the circuit shown in Fig. 1 does *not* produce a visible flash. You can modify the circuit as shown in Fig. 2 if you want the red LED in the FRL-4403 to flash each time the relay coil is energized. Potentiometer  $R_2$  must be adjusted until the relay starts to oscillate. Although the LED will flash, it will not be as bright as if it were powered directly from a 5-volt supply. The circuit shown in Fig. 2 might occasionally cease to oscillate. When this occurs, it is necessary to readjust potentiometer  $R_2$ . For this reason, use the circuit shown in Fig. 1 for such applications as emergency beacons in which high reliability is essential.

Both versions of the circuit might operate erratically or even fail to operate if both the oscillator circuit and the flashing lamp are powered by the same battery. These difficulties are due to the large current demand placed on the battery when the lamp is switched on. In some cases, the circuit will oscillate at much higher than its normal rate.

The oscillator portion of each circuit consumes only 20 to 35 milliamperes. Therefore, it's feasible to power it with a

## Ultra-Simple Power Flasher

small 6-volt battery if a silicon diode is connected in series with the positive terminal of the battery to drop the voltage to approximately 5 V. A much larger 6-volt lantern battery can be used to power the flashing lamp.

Of course, *both* the oscillator and flashing lamp can be powered from a common supply if it can source a suffi-

ciently large current. You can experiment with different supplies and lamps to determine if you will need more than one supply.

Finally, the circuits presented in Figs. 1 and 2 can both be used to apply power pulses to devices other than lamps. Typical applications include gating power to warning horns, alarm sirens, etc. ◇

Fig. 1. Ultra-simple high-brightness lamp flasher.

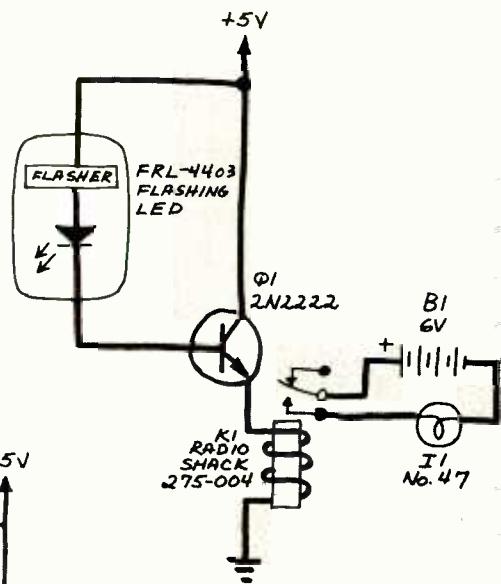
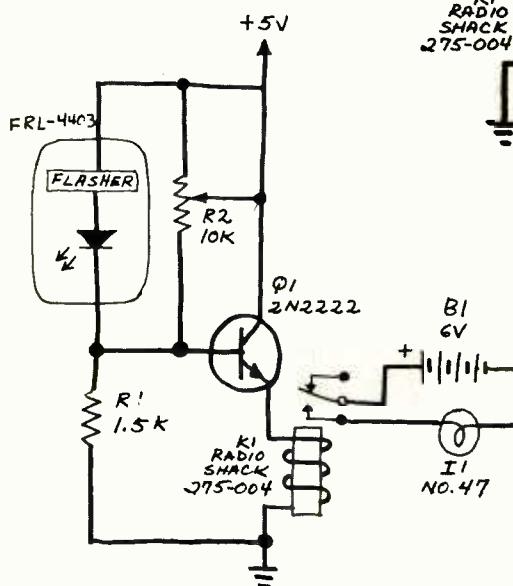


Fig. 2. Relay driver circuit with a flashing LED.







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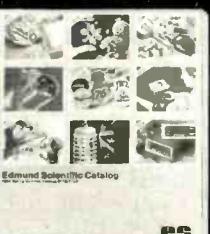
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MAN 2	5x7 D.M.-red	.300	.45	DL745	C.A.-red ±	.630	.49
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MAN 4	C.A.-green	.300	.45	DL750	C.O.-red	.600	.49
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MC556G	200° green	4/51	XCL20R	.125° red	5/51	XCL11G	.190° green
MC556Y	200° yellow	4/51	XCO99	.125° green	4/51	XCL11Y	.190° yellow
MC556C	200° clear	4/51	XCO99Y	.125° yellow	4/51	XCL11C	.190° clear
XCC2R	200° red	5/51	XCS5R	.185° red	5/51		
XCC2G	200° green	4/51	XCS5G	.185° green	4/51		
XCC2Y	200° yellow	4/51	XCS5Y	.185° yellow	4/51		
MV10B	.170° red	4/51	XCS5C	.185° clear	4/51		

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**74L621**

**74L622**

**74L623**

**74L624**

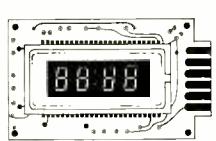
**74L625**

**74L626**

**74L627**

**74L628</**

## National Semiconductor Clock Modules



12VDC  
AUTOMOTIVE/  
INSTRUMENT

### CLOCK

- Ind.-mark auto/locks
- After-market auto/
- RV clocks
- Aircraft/marine clks
- 12VDC oper. instru.
- Portable/battery-powered instruments

Features: Bright 0.3" green display. Internal crystal timer-base, +0.5 sec./day accur. Auto-display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

**MA1003 Module . . . . . \$16.95**

**MA1023 .7" Low Cost Digital LED Clock Module . . . . . 8.95**  
**MA1026 .7" Dig. LED Alarm Clock/Termometer . . . . . 18.95**  
**MA5036 .3" Low Cost Digital LED Clock/Timer . . . . . 6.95**  
**MA1002 .5" LED Display Dig. Clock & Xformer . . . . . 9.95**



## National Semiconductor RAM SALE

**MM5290N-4 (MK4116/UPD416) . . . . . \$4.95 each**

16K DYNAMIC RAM (250NS)  
(8 EACH \$39.95) (100 EACH \$450.00/lot)

**MM5290J-2 (MK4116/UPD416) . . . . . \$6.95 each**

16K DYNAMIC RAM (150NS)  
(8 EACH \$49.95) (100 EACH \$550.00/lot)

**MM5298J-3A . . . . . \$3.25 each**

8K DYNAMIC RAM (LOW HALF OF MM5290J) 200NS  
(8 EACH \$23.95) (100 EACH \$250.00/lot)

**MM2114-3 . . . . . \$5.95 each**

4K STATIC RAM (300NS)  
(8 EACH \$43.95) (100 EACH \$450.00/lot)

**MM2114L-3 . . . . . \$6.25 each**

4K STATIC RAM (LOW POWER 300NS)  
(8 EACH \$44.95) (100 EACH \$475.00/lot)

## EPROM Erasing Lamp



- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact — only 7-5/8" x 2-7/8" x 2".
- Complete with holding tray for 4 chips.

**UVS-11E . . . . . \$79.50**

## Jumbo 6-Digit Clock Kit

- Four, 630" ht. and two, 300" ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6" x 3-1/8" x 1"

**JET47 . . . . . \$29.95**

## 6-Digit Clock Kit

- Bright 300 ht. comm. cath. display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- SI: 3-1/4" x 3-1/8" x 1"

**JE701 . . . . . \$19.95**

## Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to +5V, -9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3-1/4" x 5" x 2" H

**JE200 . . . . . \$14.95**



**ADAPTER BOARD**  
—Adapts to JE200—  
±5V, ±9V and ±12V

DC/DC converter with +5V input. Toroidal hi-speed switching XFRMP. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3-1/4" x 2" x 9/16" H

**JE205 . . . . . \$12.95**

## MICROPROCESSOR COMPONENTS

### 8080A/3080A SUPPORT DEVICES

	DATA ACQUISITION (CONTINUED)
IN5420A CPU	8-Bit A/D Converter (8-Ch. Multi.) . . . . . 3.25
DP8212 8-Bit Input/Output . . . . . 3.25	8-Bit A/D Converter (8-Ch. Multi.) . . . . . 10.95
DP8214 Priority Interrupt Control . . . . . 5.95	10-Bit D/A Conv. Micro. Comp. (0.02%) . . . . . 13.95
DP8224 Bi-Directional Bus Driver . . . . . 1.49	10-Bit D/A Conv. Micro. Comp. (0.02%) . . . . . 8.95
DP8225 Close Loop Operator/Driver . . . . . 1.96	10-Bit D/A Conv. Micro. Comp. (0.02%) . . . . . 8.49
DP8226 Bus Driver . . . . . 2.49	10-Bit D/A Conv. Micro. Comp. (0.02%) . . . . . 8.49
DP8228 System Controller/Bus Driver . . . . . 4.95	12-Bit D/A Converter (0.20% Lin.) . . . . . 9.95
DP8230 System Controller . . . . . 5.95	8-Channel Multiplexer . . . . . 1.19
IN5424 I/O Expander for 48 Series . . . . . 9.95	30K BAUD UART . . . . . 5.95
IN5425 Asynchronous Parallel I/O . . . . . 10.95	RAMS . . . . . 5.95
DP8231 I/O Expander (I/O SART) . . . . . 1.01	24x1 Static . . . . . 1.49
DP8243 Prog. Interval Timer . . . . . 14.99	1024x1 Dynamic . . . . . 99
DP8255 Prog. Peripheral I/O (PPI) . . . . . 9.95	256x4 Static . . . . . 1.75
DP8257 Prog. DMA Controller . . . . . 19.95	1024x1 Static . . . . . 1.95
DP8258 Prog. Memory Controller . . . . . 14.99	256x4 Static . . . . . 1.95
DP8259 Prog. CRT Controller . . . . . 40.95	256x4x1 Dynamic 50nsec threesholded . . . . . 4.95
DP8275 Prog. Keyboard/Display Interface . . . . . 15.95	16.384x1 Dynamic 50nsec threesholded . . . . . 4.95
DP8300 Octal Bus Receiver . . . . . 6.95	164 Dynamic 50nsec . . . . . 4.95
DP8303 System Timing Element . . . . . 6.95	4096x1 Fast 70nsec . . . . . 19.95
DP8307 8-Bit Bi-Directional Receiver . . . . . 3.95	256x4 Static . . . . . 2.49
DP8308 8-Bit Bi-Directional Receiver . . . . . 3.95	1024x1 Dynamic Fully Decoded . . . . . 2.49
DP8308 8-Bit Bi-Directional Receiver . . . . . 2.25	2kx1 Dynamic . . . . . 2.49

### 6800/6800 SUPPORT DEVICES

MC6800 CPU	240 (80C) CPU (20MHz) . . . . . 12.95
MC6801CPU	MCPU with Clock and RAM . . . . . 18.95
MC6810API	128x4 Static RAM . . . . . 4.95
MC6821	Peripheral Inter. Adapt (MC6820) . . . . . 7.49
MC6840	MCPU . . . . . 10.95
MC6840-1	MCPU with ROM (MC6840-1) . . . . . 10.95
MC6850	Asynchronous Comm. Adapter . . . . . 5.95
MC6850-1	Synchronous Serial Data Adapter . . . . . 6.95
MC6860	0-600nsec Digital MODEM . . . . . 12.95
MC6862	2400bps Modulator . . . . . 12.95
DP8308	16-Bit Parallel Trans. (MC6826) . . . . . 2.25

### MICROPROCESSOR CHIPS

28C1000 CPU	240 (80C) CPU (20MHz) . . . . . 12.95
MM5290 (7M-1)	MCPU (MM5290-1) (4MHz) . . . . . 15.95
CP01802	CPU . . . . . 15.95
2654	MPU . . . . . 15.95
MM5290 ADC (7M-1)	4-Bit Slice (Comp., Temp., Grade) . . . . . 12.95
MM5290-1	8-Bit (MM5290-1) . . . . . 12.95
IN5823H CPU	8-Bit (MM5290-1A) . . . . . 12.95
IN5823H-1	8-Bit (MM5290-1B) . . . . . 12.95
IN5823H-2	8-Bit (MM5290-1C) . . . . . 12.95
IN5823H-3	8-Bit (MM5290-1D) . . . . . 12.95
IN5823H-4	8-Bit (MM5290-1E) . . . . . 12.95
IN5823H-5	8-Bit (MM5290-1F) . . . . . 12.95
IN5823H-6	8-Bit (MM5290-1G) . . . . . 12.95
IN5823H-7	8-Bit (MM5290-1H) . . . . . 12.95
IN5823H-8	8-Bit (MM5290-1I) . . . . . 12.95
IN5823H-9	8-Bit (MM5290-1J) . . . . . 12.95
IN5823H-10	8-Bit (MM5290-1K) . . . . . 12.95
IN5823H-11	8-Bit (MM5290-1L) . . . . . 12.95
IN5823H-12	8-Bit (MM5290-1M) . . . . . 12.95
IN5823H-13	8-Bit (MM5290-1N) . . . . . 12.95
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IN5823H-15	8-Bit (MM5290-1P) . . . . . 12.95
IN5823H-16	8-Bit (MM5290-1Q) . . . . . 12.95
IN5823H-17	8-Bit (MM5290-1R) . . . . . 12.95
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Electronically senses magnetic field. 750 gauss "on" threshold. 5-16VDC supply. Similar to type 3006ULN. 276-1646 ..... 3.98

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**A** Gate-protected transistors for digital, analog, or RF circuits.

**A** VNG7AF. 15W dissipation. TO-202 case. 276-2071 ..... 2.49

**B** VN10KM. 1W dissipation. TO-92 + case. 276-2070 ..... 1.59

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Produces 12 Touch-Tone™ Frequencies

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Enclosed in protective plastic. Designed to fit printed circuit boards. Contacts rated 1/2 amp at 125VAC. 275-229 ..... 99c

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Pkg.  
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Highly-reflective chrome holders.

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### Cadmium Sulfide Photoresistor

**1<sup>19</sup>**

Wide resistance range — 5 megohms (darkness) to 100 ohms (bright light). Max. power dissipation: 200 mW (@ 170V). 276-116 ..... 1.19

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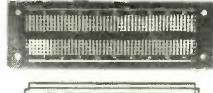
Linear/I<sup>2</sup>L Device

**Save  
20%** **3<sup>59</sup>**  
Reg. 4.49

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Non-Corrosive Contacts for Reliable Connections—Time After Time!



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**D** Mini-Socket. 22 rows of 5 tie-points each plus 2 bus strips with 10 connections each. Interlocks with above. 2 1/8" x 1 1/8" 276-176 ..... 4.49

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**B** Straight mount. Contacts rated 6A (@ 125VAC. 275-668 ..... (Reg. 2.19) Sale 1.19

### 12V, 5A Power Transformer

**10<sup>95</sup>**



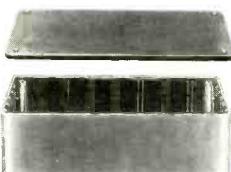
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Or Replacement

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Low As

**159**



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4 3/8x2 1/2x1 5/16" 270-222 ..... 1.99  
6x3 3/8x2 1/2x1 5/16" 270-223 ..... 2.59  
7 1/2x4 1/2x2 1/8" 270-224 ..... 2.99

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of 100



Ideal for audio and RF circuits. Assortment includes PC chokes, inductors, tuned RF coils. 273-1570 ..... 100/1.98

### Assorted Ferrites

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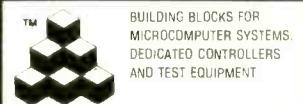
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74145	50	74LS32	0.75	74LS32	0.75	74LS270	0.86	74S280	2.75
74146	50	74LS33	0.75	74LS33	0.75	74LS271	0.86	74S280	2.75
74147	50	74LS34	0.75	74LS34	0.75	74LS272	0.86	74S280	2.75
74148	50	74LS35	0.75	74LS35	0.75	74LS273	0.86	74S280	2.75
74149	50	74LS36	0.75	74LS36	0.75	74LS274	0.86	74S280	2.75
74150	50	74LS37	0.75	74LS37	0.75	74LS275	0.86	74S280	2.75
74151	50	74LS38	0.75	74LS38	0.75	74LS276	0.86	74S280	2.75
74152	50	74LS39	0.75	74LS39	0.75	74LS277	0.86	74S280	2.75
74153	50	74LS40	0.75	74LS40	0.75	74LS278	0.86	74S280	2.75
74154	50	74LS41	0.75	74LS41	0.75	74LS279	0.86	74S280	2.75
74155	50	74LS42	0.75	74LS42	0.75	74LS280	0.86	74S280	2.75
74156	50	74LS43	0.75	74LS43	0.75	74LS281	0.86	74S280	2.75
74157	50	74LS44	0.75	74LS44	0.75	74LS282	0.86	74S280	2.75
74158	50	74LS45	0.75	74LS45	0.75	74LS283	0.86	74S280	2.75
74159	50	74LS46	0.75	74LS46	0.75	74LS284	0.86	74S280	2.75
74160	50	74LS47	0.75	74LS47	0.75	74LS285	0.86	74S280	2.75
74161	50	74LS48	0.75	74LS48	0.75	74LS286	0.86	74S280	2.75
74162	50	74LS49	0.75	74LS49	0.75	74LS287	0.86	74S280	2.75
74163	50	74LS50	0.75	74LS50	0.75	74LS288	0.86	74S280	2.75
74164	50	74LS51	0.75	74LS51	0.75	74LS289	0.86	74S280	2.75
74165	50	74LS52	0.75	74LS52	0.75	74LS290	0.86	74S280	2.75
74166	50	74LS53	0.75	74LS53	0.75	74LS291	0.86	74S280	2.75
74167	50	74LS54	0.75	74LS54	0.75	74LS292	0.86	74S280	2.75
74168	50	74LS55	0.75	74LS55	0.75	74LS293	0.86	74S280	2.75
74169	50	74LS56	0.75	74LS56	0.75	74LS294	0.86	74S280	2.75
74170	50	74LS57	0.75	74LS57	0.75	74LS295	0.86	74S280	2.75
74171	50	74LS58	0.75	74LS58	0.75	74LS296	0.86	74S280	2.75
74172	50	74LS59	0.75	74LS59	0.75	74LS297	0.86	74S280	2.75
74173	50	74LS60	0.75	74LS60	0.75	74LS298	0.86	74S280	2.75
74174	50	74LS61	0.75	74LS61	0.75	74LS299	0.86	74S280	2.75
74175	50	74LS62	0.75	74LS62	0.75	74LS300	0.86	74S280	2.75
74176	50	74LS63	0.75	74LS63	0.75	74LS301	0.86	74S280	2.75
74177	50	74LS64	0.75	74LS64	0.75	74LS302	0.86	74S280	2.75
74178	50	74LS65	0.75	74LS65	0.75	74LS303	0.86	74S280	2.75
74179	50	74LS66	0.75	74LS66	0.75	74LS304	0.86	74S280	2.75
74180	50	74LS67	0.75	74LS67	0.75	74LS305	0.86	74S280	2.75
74181	50	74LS68	0.75	74LS68	0.75	74LS306	0.86	74S280	2.75
74182	50	74LS69	0.75	74LS69	0.75	74LS307	0.86	74S280	2.75
74183	50	74LS70	0.75	74LS70	0.75	74LS308	0.86	74S280	2.75
74184	50	74LS71	0.75	74LS71	0.75	74LS309	0.86	74S280	2.75
74185	50	74LS72	0.75	74LS72	0.75	74LS310	0.86	74S280	2.75
74186	50	74LS73	0.75	74LS73	0.75	74LS311	0.86	74S280	2.75
74187	50	74LS74	0.75	74LS74	0.75	74LS312	0.86	74S280	2.75
74188	50	74LS75	0.75	74LS75	0.75	74LS313	0.86	74S280	2.75
74189	50	74LS76	0.75	74LS76	0.75	74LS314	0.86	74S280	2.75
74190	50	74LS77	0.75	74LS77	0.75	74LS315	0.86	74S280	2.75
74191	50	74LS78	0.75	74LS78	0.75	74LS316	0.86	74S280	2.75
74192	50	74LS79	0.75	74LS79	0.75	74LS317	0.86	74S280	2.75
74193	50	74LS80	0.75	74LS80	0.75	74LS318	0.86	74S280	2.75
74194	50	74LS81	0.75	74LS81	0.75	74LS319	0.86	74S280	2.75
74195	50	74LS82	0.75	74LS82	0.75	74LS320	0.86	74S280	2.75
74196	50	74LS83	0.75	74LS83	0.75	74LS321	0.86	74S280	2.75
74197	50	74LS84	0.75	74LS84	0.75	74LS322	0.86	74S280	2.75
74198	50	74LS85	0.75	74LS85	0.75	74LS323	0.86	74S280	2.75
74199	50	74LS86	0.75	74LS86	0.75	74LS324	0.86	74S280	2.75
74200	50	74LS87	0.75	74LS87	0.75	74LS325	0.86	74S280	2.75
74201	50	74LS88	0.75	74LS88	0.75	74LS326	0.86	74S280	2.75
74202	50	74LS89	0.75	74LS89	0.75	74LS327	0.86	74S280	2.75
74203	50	74LS90	0.75	74LS90	0.75	74LS328	0.86	74S280	2.75
74204	50	74LS91	0.75	74LS91	0.75	74LS329	0.86	74S280	2.75
74205	50	74LS92	0.75	74LS92	0.75	74LS330	0.86	74S280	2.75
74206	50	74LS93	0.75	74LS93	0.75	74LS331	0.86	74S280	2.75
74207	50	74LS94	0.75	74LS94	0.75	74LS332	0.86	74S280	2.75
74208	50	74LS95	0.75	74LS95	0.75	74LS333	0.86	74S280	2.75
74209	50	74LS96	0.75	74LS96	0.75	74LS334	0.86	74S280	2.75
74210	50	74LS97	0.75	74LS97	0.75	74LS335	0.86	74S280	2.75
74211	50	74LS98	0.75	74LS98	0.75	74LS336	0.86	74S280	2.75
74212	50	74LS99	0.75	74LS99	0.75	74LS337	0.86	74S280	2.75
74213	50	74LS100	0.75	74LS100	0.75	74LS338	0.86	74S280	2.75
74214	50	74LS101	0.75	74LS101	0.75	74LS339	0.86	74S280	2.75
74215	50	74LS102	0.75	74LS102	0.75	74LS340	0.86	74S280	2.75
74216	50	74LS103	0.75	74LS103	0.75	74LS341	0.86	74S280	2.75
74217	50	74LS1							

# ELECTRONICS WORLD®

## Personal Electronics News

**FIVEFOLD GROWTH IN TELECOMMUNICATIONS** is expected by the end of the century, according to NASA studies conducted by IT&T and Western Union. Demand for conventional voice services (message-toll and private-line traffic) will predominate, and as much as 25% of all long-distance voice traffic may be carried by satellite, as well as half of all data and video traffic. To meet the demand, satellites with higher capacities and capable of operating in the 20/30-GHz band will be required. This Ka band would provide a frequency range five times that allocated to communications satellites now in use.

**MOVIES ARE #1 FOR PRERECORDED** video programming, according to a "Home Video Recording and Playback Equipment" report from Venture Development Corp. New and classic movies received the highest ratings in a recent study, drawing 66.5% and 50.2% interest, respectively. Between one-fifth and one-third of those polled expressed interest in PBS series and specials (31.6%), educational courses (24.2%), plays and dramatic specials (23.4%), sports events (23%), and old TV series (22.4%). Do-it-yourself programs that would make the most of the video disk's special freeze-frame, reverse, and random-access features ranked modestly (15.9%). At the bottom of the list were children's programs (9.9%), sports lessons (8.3%), and foreign-language movies (8.1%).



**MICROPROCESSOR CONTROL OF POWER TOOLS** has come to the consumer market with Black & Decker's new \$180 Model 9413 "electronic" drill press. Supplementing the microprocessor are a touch-sensitive keyboard and LED numeric display. The microprocessor performs a number of functions: maintains the selected (via the keyboard) speed under varying drilling loads; keeps track of drilling depth, updating the display in 0.020" increments; gradually changes speed electronically to prevent the work piece from being jolted; remembers and displays the last speed used when drilling is done; flashes "LOAD" on the display when incorrect drilling speed and pressure are used for prolonged drilling periods; and shuts off the drill when excessive loads are suddenly encountered.

**POLICE OFFICER SAFETY** can be increased with a device developed by Antenna Specialists. Rescu™ Emergency Location Alerting System enables a mobile-radio-equipped officer to call for help when he's not in his vehicle. In an emergency, the officer presses a button on his compact belt-worn actuator to send an emergency alert and a repeat of his last exact-location voice message via the vehicle's radio to the despatcher. The system also automatically triggers if the officer wearing the actuator falls or lies prone. The system is currently being evaluated by a number of law-enforcement agencies across the country.

**BRITAIN PLANS TO LEGALIZE CB RADIO**, perhaps within a year. The "open-channel" CB system proposed by the British Home Office calls for an operating frequency of about 900 MHz and range of 10 miles in open country to minimize interference with TV and other radio services. Supporters of a national CB service, however, criticize selection of 900 MHz on the grounds that transceivers designed for this range would have to cost about \$800 each, thus restricting the market. The National Committee for the Legalization of CB Radio is lobbying for the 41-to-47-MHz band, estimating that a transceiver designed to operate in this band would sell for \$350 to \$425 and make it possible for more enthusiasts to use the new CB service.

**FCC MAY UPGRADE LOW-POWER TV TRANSMITTERS** known as "translators" to "ministation" status. The proposal, made in September, would give the new service the authority to originate programming. Under the proposal, ministations would be allowed to operate on any vhf or uhf channel that will not interfere with full-service stations. To give the new service a competitive edge, power would be increased from 1 watt to 10 watts on vhf and from 100 watts to 1 kW on uhf. There would be no minimum number of operating hours set, and program origination would be optional. Only one ministation would be permitted per market. Major TV networks would be barred from ownership, while cable-TV operators would have to restrict ownership of ministations to locations outside their franchise areas.

# We've just lowered the price of admission.

Your ticket to a live performance just became even more affordable. Because the Koss K/4DS Digital Delay System with built-in amplifier and matching ambience speakers now has a suggested retail price of just \$459. Now that should really be music to your ears! Not since the introduction of stereo has a product so dramatically increased the listening enjoyment of recorded music. With four computerized ideal environment selections—club,

theater, concert hall, and auditorium—the Koss K/4DS Digital Delay System offers the most life-like and realistic portrayal of a live performance you've ever heard. Ask your audio dealer for a live demonstration, or write c/o Virginia Lamm, for more information on the K/4DS or other famous Koss stereophone and loudspeaker products. Now that the price of admission is so low, you won't want to miss the missing link in stereo.

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UL Listed

## Someone's always home when the Night Sentry Timer is on duty.

**Night Sentry puts electronic timed lighting control where it belongs: on the wall...**

Most home security experts agree that one of the most effective deterrents to intruders and burglars is lighting that creates the "lived-in" look while you're away. Now the new Dynascan Night Sentry enables you to easily achieve that lived-in look. Using a micro-computer that does the work of more than 10,000 transistors, it provides automatic control of indoor or outdoor light fixtures, including porch, post, kitchen, bathroom, and bedroom lights.

The amazing micro-computer's "memory" permits automatic self-programming (just use the Night Sentry as a conventional light-switch—after 24 hours, your pattern of light use will be repeated daily thereafter.) You also can program it manually in a matter of seconds! Up to 48 ON-OFF settings per 24-hour period are possible. Installs in minutes with only a screwdriver.

Comparison Chart

FEATURE	NIGHT SENTRY	OTHER TIMERS
1. Automatic programming	YES	NO
2. Manual programming	YES	YES
3. Built-in microprocessor/memory	YES	NO
4. Solid-state reliability	YES	NO
5. Silent operation (no motor)	YES	NO
6. 48 "ON-OFF" selections	YES	SOME MODELS
7. Variable "ON-OFF" times	YES	SOME MODELS
8. Easy pushbutton override	YES	NO
9. Easy 2-wire installation	YES	NO
10. Fits any single or multiple switch box	YES	NO
11. Usable with most standard or decorator switch plates	YES	NO
12. Attractive "low-profile" decorator styling	YES	NO
13. "Soft-start" triples bulb life	YES	NO
14. Available in 3-way model	YES	NO
15. Available in table model with dimmer	YES	NO

Check these "never-before-available" features: No clock motor or gears to become noisy; easy override of program to use as conventional ON-OFF switch (no fumbling behind or under furniture to locate an override button); built-in variability of ON-OFF times to confuse intruders or burglars "casing" your home; usable in single or gang switch boxes; uses existing standard or decorator switch plates; available in 3-way version. Also available: table top model for controlling lamps plugged into wall outlets.

Visit your local hardware, home center, or department store and see the new Night Sentry. Suggested retail price under \$25.

### NIGHT SENTRY Timed Light Control

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*Write for color brochure.*

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