Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE FEBRUARY 1981/95¢

Get Multi-Trace Displays on Oscilloscopes

PE Tests Hitachi's New 13" Portable Color TV

Power Supplies from Discarded AC Adapters

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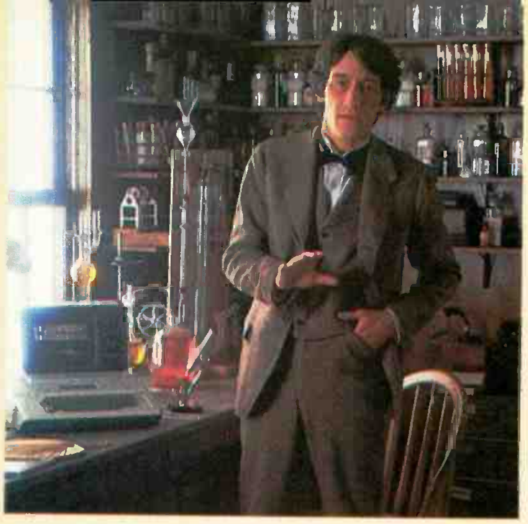


Edison had over 1,800 patents in his name, but you can be just as inventive with an Apple.

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 5¼", 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.

a $5 LCD digital

NOW WITH STOP WATCH

WATCH

Try only 10 DAK high energy 90 minute cassettes <u>risk free</u> for just $2.19 each and get a beautiful $69 value LCD digital watch for only $5!

YOU CAN'T LOSE!!! IF YOU'RE NOT 100% SATISFIED, KEEP AN ML90 FREE AS A GIFT FOR TRYING OUR CASSETTES!!!

Are the very high frequencies disappearing from your cassettes as you play them? Friction within your cassettes may be erasing your crystal clear highs even as you read this ad.

DAK developed a jam proof cassette for professional high speed duplicators and in the process discovered why recordings that sound great when you make them, may sound less than great in just a few months.

Here's a chance to try DAK ML90s risk free and pick up a great LCD watch complete with stop watch for only $5!

YOUR TIME IS PRECIOUS

Imagine yourself just finishing recording the second side of a 90 minute cassette and horrors, the cassette jams. Tape is wound around the capstan, your recorder may be damaged and you've just wasted 90 minutes of your time and perhaps lost a great recording off FM.

MOLYSULFIDE

DAK manufactures enough tape for over one million cassettes per month, mostly for professional duplicators and loaders. We developed polyester slip sheets which are inside the cassette with raised spring loaded ridges to guide each layer of tape as it winds so it won't jam.

We coat the liners with a unique formulation of graphite and a new chemical called molysulfide. It reduces friction several times better than graphite and allows the tape to move more freely within the the cassette.

HIGH FREQUENCY PROTECTION

Tape is basically plastic, and as it moves within the cassette friction causes the build up of static electricity, much as scuffing your shoes on a carpet in dry weather.

Static electricity within the cassette is drastically reduced by the low friction of the molysulfide so that it won't erase crystal clear highs. A very important consideration for often played tapes.

MAXELL 'TAPE' IS BETTER

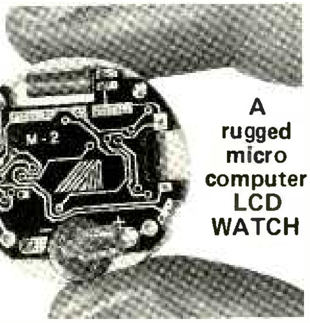
Yes, honestly, if you own a $1000 cassette deck like a Nakamichi, the frequency responses of Maxell UDXL or TDK SA are superior and you just might be able to hear a difference.

DAK ML has a frequency response that is flat from 40hz to 14,500hz ±3db. Virtually all cassette recorders priced under $600 are flat ±3db only from 40hz to about 12,500hz, so we have over 2000hz to spare, and you'll probably never notice the difference, and we feel that we have equaled or exceeded the mechanical reliability of virtually all cassettes.

NOT MAGICAL OR CHEAP

DAK manufactures the tape we sell. Our tape really doesn't cost less to make. You only avoid paying the wholesaler and retailer costs and profits. When a cassette leaves other factories, it must be marked up each step of the fine way; even duty on some of the fine imported cassettes must be added, so with DAK tape you really only save the middlemen profits.

While Maxell UDXL 90s may sell for $3.50 to $4.50 each at retail, DAK ML90s sell factory direct to you for only $2.19 each complete with deluxe all clear hard plastic boxes and index insert cards.



A rugged micro computer LCD WATCH

A $5 LCD WATCH++STOP WATCH?

This beautifully styled slim silvertone watch is loaded with features. LCD means that the time in hours and minutes always shows without having to push buttons.

Push the button once, and you'll see the date in months and days, and push the button again and see seconds. Push the second button and the entire time section lights up for convenient night viewing.

Stop watch feature. This fine watch has a third button which starts and stops an accurate stop watch. The stop watch displays up to 15 minutes and then continues running displaying up to 15 minutes at a time. It's great for timing cassettes.

Quartz crystal accuracy means constant time within 1 minute per month. Crystals use little electricity, so the battery should last up to a year, and is easily changed.

Stainless steel band for long life and comfort. No imitation, a first rate locking adjustable band.

It's guaranteed. This fine watch comes with a manufacturer's limited warranty, good for one full year.

DAK TAKES A RISK

Obviously giving away quality watches is not going to make DAK rich. We are betting that once you get our new 40 page catalog with over 6000 words about how to make better recordings, you will want to buy our cassettes again, and we are putting our money where our mouth is!

Customers like you are very valuable in the form of future business. We anticipate receiving over 6000 orders and over 4500 repeat customers from this advertisement to add to our list of over 80,000.

TRY DAK ML90 CASSETTES RISK FREE

Try these high energy cassettes on your own recorder without obligation for 30 days. If you aren't 100% satisfied for any reason, return only 9 of them and the watch for a refund. The cassette you test recorded is yours as a gift.

To order your 10 DAK ML 90 minute high energy cassettes at $2.19 each and get the LCD digital watch for only $5 with your credit card, simply call the toll free number below, or send your check for only **$21.90** plus **$5** for the watch and **$3** for postage and handling for each group to DAK. (CA residents add 6% sales tax).

DAK unconditionally guarantees all DAK cassettes for one year against any defects in material or workmanship.

Why not order an extra group of 10 DAK ML90 cassettes for yourself or a friend? We will add one free ML90 cassette to each additional group you buy and of course you can still get an LCD watch for only $5 with each additional group you order.

DAK INDUSTRIES INCORPORATED

Call TOLL-FREE .... (800) 423-2636
In California Call .... (213) 984-1559
10845 Vanowen St., North Hollywood, CA 91605

CIRCLE NO. 67 ON FREE INFORMATION CARD

FEBRUARY 1981 VOLUME 19, NUMBER 2

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

Feature Articles

Construction Articles

Equipment Reviews

Columns

Departments

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Space Scape

A new painting by Mark Rickerson offers opportunity for JS&A customers in this exclusive print offering.

The painting above is by one of America's fastest rising American artists, Mark Rickerson. Rickerson's works represent some of the most popular space paintings ever created and they have been displayed at some of America's leading galleries and purchased by many space-age companies.

About one year ago, JS&A's president was traveling through Honolulu on a trip back from the Far East when he stopped by an art gallery to examine some paintings.

PRESIDENT'S IDEA

While in the gallery he saw one of Rickerson's works. Since JS&A markets space-age products, our president thought it would be a great idea to feature one of Rickerson's paintings on the next cover of JS&A's space-age catalog.

So he bought the painting and traveled to the Hawaiian Island of Maui, where he met with Rickerson in his studio to discuss reproduction rights. Rickerson refused. His paintings were growing in value and he did not want to commercialize his efforts at that stage of his career.

PROGRAM UNACCEPTABLE

Several months later however, our president received a call from Rickerson. The artist wanted to know if JS&A would be interested in offering limited edition prints exclusively to its customers, many of whom would appreciate the subject matter because of their interest in space-age electronics.

This time we refused. Rickerson wanted JS&A to offer 300 signed and numbered proofs for $200 each. A typical JS&A response, however, would far exceed the available prints and we would have to return too many orders. In addition, Rickerson had been getting $350 for his prints and we didn't understand why he would lower his price.

RICKERSON'S PLAN

But Rickerson had a plan. Those who would respond to our offer would have their name placed in a computer and at the end of our promotion, the computer would randomly select 300 people eligible to purchase the prints. All respondents however, would make up his personal mailing list.

In the future, whenever a new Rickerson print would be announced for $350 or more, those on his personal list would be eligible to purchase that print during the next three years at only $200 regardless of Rickerson's status, fame or the value of his paintings.

Rickerson looked to this promotion as a way of establishing himself and his art firmly as a major factor on the American art scene and at the same time establish a strong following. JS&A in turn has not only agreed to assist Rickerson in that goal, but will be actively promoting his art and his products during the next three years. This offer to participate in his print program will end on February 28, 1981 and only those who respond will be allowed to participate during the next three years.

26 SEPARATE PLATES

Rickerson's painting shown above is called 'Space Scape,' and is one of a series of four that will be offered in this program. Space Scape is a spectacular view of outer space and expresses mankind's relationship to space in a dazzling display of colors, planets and shapes.

The serigraph prints are as spectacular as the original. Limited to only 300 hand-signed and numbered proofs, there are 26 separate overlaid colors from 26 separate silk screens to reproduce every exact detail on 100% museum-quality PH-balanced paper. And they are large—a 30" x 40" image size delivered in a well-constructed and protected carton.

PAINTING OFFERED

Later the original painting will be offered to the general public for $10,000, or for $5,000 to anyone on Rickerson's list on a first-come first-served basis.

There is no obligation to enter and no money is required. Simply fill in the information requested on the coupon and mail it to: One JS&A Plaza, Northbrook, Illinois 60062.

Each participant will be sent an acknowledgment letter with a number. The program will officially close on February 28, 1981 and those selected to receive the print will be notified directly by a public accounting firm by March 15, 1981. There is a strict limit of one entry per person and our computer will automatically reject duplicate applications. If for any reason you are dissatisfied with your purchase, you may return your print anytime during the next three years for a full refund.

Participate and join with us in a great opportunity to own a print from one of America's fastest rising American artists and become part of a select group. Send in your free reservation today.

FREE PARTICIPATION COUPON

Please accept this coupon as my eligibility for participation in the random selection drawing for the print shown above. I understand that I am under absolutely no obligation and that I will be eligible in future programs whether I obtain the print or not.

Name

Address

City State

Zip

JS&A

One JS&A Plaza
Northbrook, Ill. 60062 (312) 564-7000

PE

EDITORIAL

Computer User Discovery

I don't yet have the satisfaction of everyone's adopting my views about who purchases microcomputers, but I was pleased to read an article in *Business Week* (December 1,1980) that supports what I've expounded for years: A high percentage of micros bought as personal computers find their way into work situations either in a company or for company work at home.

The article observed that microcomputer and peripheral makers have ignored the real way in which their equipment is used and by whom it is purchased. It notes that in an industry with an annual sales of nearly $1billion, a driving force in its growth is the middle manager or technical professional who wants his own computer for work, but rationalizes its purchase as a home or hobby computer. Once in the home, the buyer finds ways to apply it to his job. Interestingly, Vantage Research, a Mountain View, CA market research company, estimates that one-third of the 750,000 personal computer systems reported to be shipped to date have landed in private offices.

The potential market for personal computers among professionals and managers is much larger than the number of very small businesses (less than 10 employees) in this country (17.5 million vs 2.3 million), says Personal Software's chairman, Dan Fylstra. Yet, the smaller-potential group has been the target of computer makers for the past few years, virtually ignoring the so-called hobbyist who more often than not uses it for work purposes. Indeed, the word "hobbyist" has been anathema to computer makers for some time now, though there are indicators that this is changing.

POPULAR ELECTRONICS' latest microcomputer study underscores the importance of the technical/professional market. For example, about 89% of our readers expressed an interest in microcomputers, while 52.6% own or have access to a micro. Of this group, 37.5% indicate they use the micro for both business and personal purposes, while 29.7% use it only for business purposes, for a total of 67.2%

The areas in which PE subscribers use computers are revealing: 38.3% for storing and analyzing research data, 34.7% for math, 34.2% for graphics, 27.3% for business/accounting, 22% for word processing, 9.8% for testing/control, and 4.3% for medical. Also extremely interesting is that 49.7% buy software programs, while an astoundingly high 81.4% write their own programs.

What is judged to have the greatest influence on buying a particular microcomputer? Not surprisingly, our survey indicates that initial cost is number one (57.8%), followed by software support (52.6%), manufacturer's reputation (52.3%), range of peripherals available (48.3%), availability of local servicing (34.3%), and bus support by other manufacturers (27.7%). The last two were also deemed to be least important among the categories cited: local servicing, 34%; bus support, 31.9%.

Among other survey results, peripheral buying plans for the next 12 months show that floppy disk machines lead the pack with 55.9%; followed by printers, 50.8%; modems, 26.3%, and video terminals, 24.5%.

These market research figures will give you some idea of the interest in computers shared by PE readers, among other electronics activities they enjoy. Furthermore, with a whopping 64.4% of respondents noting their job titles as professional/technical/electronics related and 19.3% as management, and 60.7% noting they get involved with computers on the job, there's good reason for computer makers to look to our readers as a very significant part of their market. We made this discovery a long time ago.

Art Salsberg

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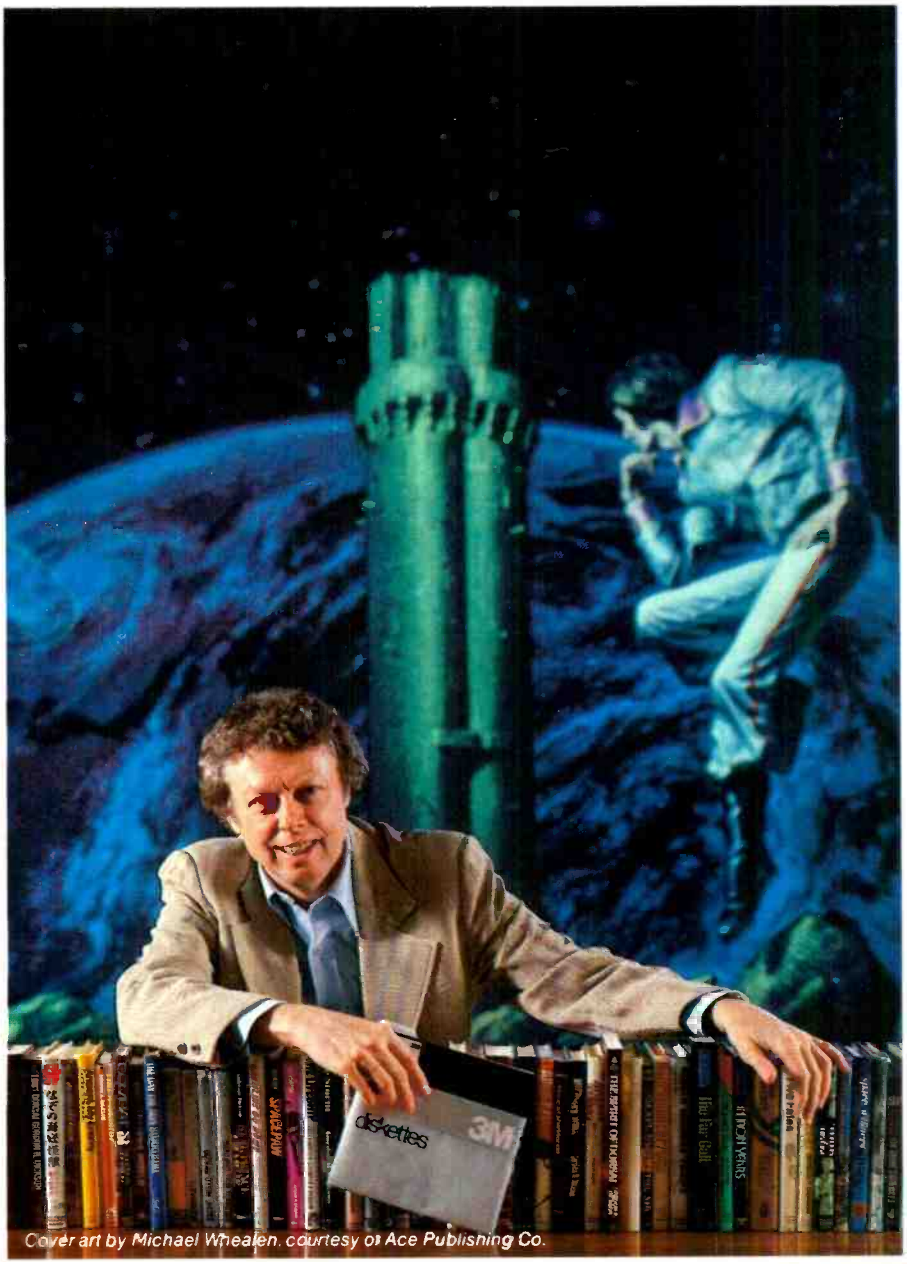
"My computer helped me write <u>The Final Encyclopedia.</u> I wouldn't trust anything less than Scotch® Brand Diskettes to make a long story short."



Cover art by Michael Whealen, courtesy of Ace Publishing Co.

Gordon R. Dickson,
Science Fiction Author,
Minneapolis, Minnesota

Gordon Dickson: a small businessman whose product is his own imagination. He's written more than 40 novels and 150 short stories; his newest work is *The Final Encyclopedia*. He uses his personal computer and word processing software to maximize his production. All his words—his product—are stored on diskettes. He calls up sentences and paragraphs on demand, and gets more rewrite out of the time available. So he depends on Scotch diskettes to save himself production time.

Dependable Scotch media can work just as hard for you. Each Scotch diskette is tested before it leaves our factory, and certified error-free. So you can expect it to perform exactly right.

Scotch 8" and 5¼" diskettes are compatible with computer/diskette systems like TRS-80, Apple, PET, Wang and many others. Get them from your local 3M distributor. For the one nearest you, call toll-free: 800/328-1300. (In Minnesota, call collect: 612/736-9625.) Ask for the Data Recording Products Division. In Canada, contact 3M Canada, Inc., Ontario.

If it's worth remembering, it's worth Scotch Data Recording Products.

3M Hears You...

3M

CIRCLE NO. 58 ON FREE INFORMATION CARD

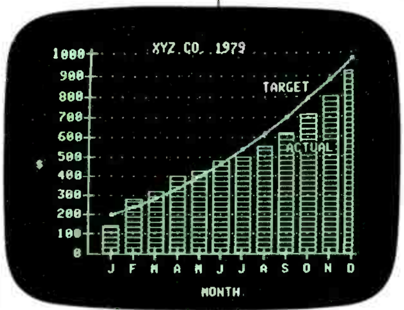
Three good reasons why professionals pick Apples.

1 In research

Apple personal computer systems help you collect, store and analyze data as fast as you can load a disk and execute a program. Because more than 100 companies offer software for Apple, you have the largest program library for manipulating your data in the personal computing world. Need special programs? Use any of Apple's development languages — BASIC, FORTRAN, Pascal.

2 In engineering

Apple personal computer systems let you define models, make trade-offs and refine prototypes. Want to study cause and effect of several variables? Apple computes new results instantly and displays them in colorful, easy-to-read graphs, charts or plots on a video monitor.



3 In production management

Apple personal computer systems make it easy to gather data, analyze productivity, measure yields and facilitate all phases of production control. Want to speed up repetitive tasks? Rely on Apple's word processing capabilities to write, edit and print your reports.

Apples grow with you.

Whichever system you pick, Apple never locks you into a single configuration. You can use up to four or eight I/O accessory expansion slots to add an IEEE bus, Apple's Silentype™ printer, a modem or a graphics tablet. Add memory up to 64K bytes or 128K bytes. Add up to four or six 5¼″ disk drives without adding any overhead.

For support, service and the best extended warranty in the industry — Apple is the answer.

If you have any other questions about why Apple is the pick for professionals in engineering, see your nearest Apple computer dealer or

	Apple II	Apple III
Maximum Memory Size	64K bytes	128K bytes
Screen Display	40 column (80 column with peripheral card) 24 Lines Upper Case	80 column 24 Lines Upper Case/Lower Case
Screen Resolution (B&W)	280 x 192	560 x 192
Screen Resolution (Color)	140 x 192 (6 colors)	280 x 192 (16 colors)
Keyboard	Fixed	Programmable
Numeric Key Pad	Accessory	Built-in
Input/Output	8 expansion slots	4 expansion slots plus built-in: disk interface RS-232 interface Silentype™ printer interface clock/calendar
Disk Drives	Add-on one to six drives	One drive built-in, plus interface to support three more drives
Languages	BASIC Fortran 77 Pascal Assembly Pilot	Enhanced BASIC Fortran 77 Pascal Assembly
Typical Configuration Pricing	CPU, 48K RAM, single disk drive, B&W Monitor (9″), Silentype™ printer, and BASIC. **$2875.00***	CPU, 96K RAM, integrated disk drive, B&W Monitor (12″), Silentype™ printer, SOS, Enhanced BASIC. **$4865.00***
*Suggested retail price.		

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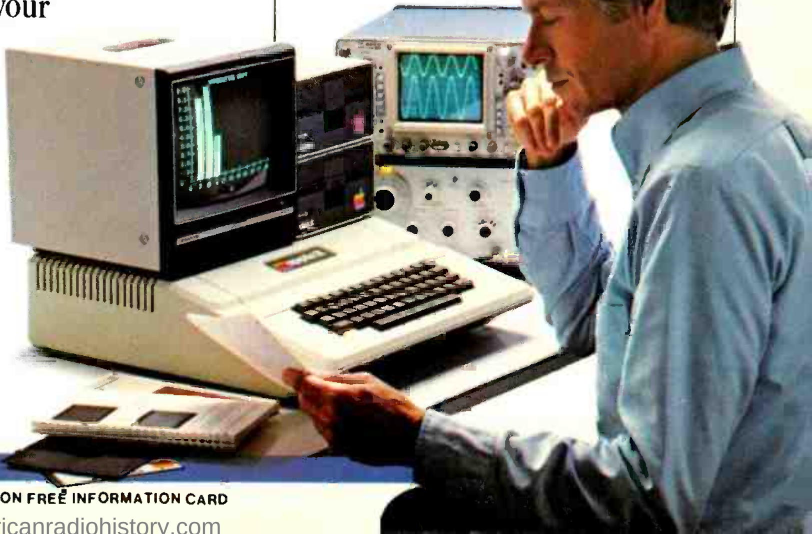


LETTERS

It's Better Than You Think

I was moved to write by a misleading statement in "Phonograph Playback: It's Better Than You Think" (Nov. 1980). The authors cite the 19th harmonic of a 900-Hz violin tone, which was given as a 17.1-kHz tone at −70 dB and point out that at a 50-kHz sampling rate, the harmonic would be represented by slightly less than three points per period and would be encoded by only 3 bits. They further state that quantizing noise has a far more annoying spectrum than ordinary white noise.

The fact that high-frequency sinusoids are represented by a very small number of points should not be taken to imply that this introduces distortion. The sampling theorem assures us that if the anti-aliasing filter is perfect, and in the absence of quantizing distortion, sinusoids with frequencies up to half the sampling rate are perfectly recoverable without distortion. In the presence of real-world filters and finite word lengths, the theorem is still true, except that the noise floor is determined by the word length (given as 16 bits in the example) and the stop-band rejection of the anti-aliasing filter, which is 85 dB or more in modern digital systems.

A sinusoid represented by 3 bits sounds awful alone, but if there is any other simultaneous signal, such as the lower 18 harmonics of the violin tone, the noise is white. For any complex signal, quantization distortion is very difficult to distinguish, either analytically or perceptually, from white noise. At low levels, the quantization distortion produces a noticeably nonwhite sound that is often described as "graininess." The only time this graininess is heard in real situations is in the quiet portions between movements. Residual room noise (air conditioning, coughing, etc.) is then quiet enough to exhibit nonwhite noise distortion.—*James Moorer, San Anselmo, CA.*

Time-Sharing Nets

Thanks to Carl Warren for introducing us ("Computer Bits," June 1980) to the two time-sharing services, Micronet and Tymnet.—*G. L. Wilson, Cambria Heights, NY.*

TRS-80 Alarm Adjustment

In the article "Use Your TRS-80 as a Timer or Alarm Clock" (October 1980), if the alarm is set to go off on the hour, the alarm will not sound because of line 720. If Y=60, the program will GOTO 850, skipping line 730 where the clock time and alarm time are compared. The next time line 730 is run, the time will have advanced one minute so the time and alarm will not compare. Lines 730 and 890 should be changed to read GOTO 910. Line 910 should have the instruction previously on 730 and line 911 should be added reading GOTO 630.—*B. E. McBee, San Antonio, TX.*

Transistor Should Be PNP

In my article "How Many Hours on Your Phono Stylus?" (December 1980), transistor Q6 should be shown as a pnp device as given in the Parts List.—*Dennis Bohn, Kingston WA.*

Keep SWL Coming

Glenn Hauser's SWL columns are great and his "English Broadcasts Audible In North America" listings are excellent! Many of my friends, who are also shortwave listeners, feel as I do. Please keep Glenn Hauser coming.—*Thomas Harrington, Columbus, OH*

POPULAR ELECTRONICS welcomes comments from its readers. However, queries can be individually answered only if they are accompanied by stamped self-addressed envelopes.—Ed.

NEW PRODUCTS

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

Onkyo Programmable Record Player

Onkyo's Model CP-1150F direct-drive turntable uses a microprocessor to control its straight carbon-fiber tonearm. Its 12¼" platter is directly driven by a brushless dc motor and controlled by a crystal-locked PLL system, while the tonearm is positioned by its own separate stepping motor. Operation of the two-speed (33⅓- and 45-rpm) player is fully automatic. Microprocessor control permits automatic fast repeat of any given preprogrammed part of the record being played. Wow and flutter are rated at 0.025% wrms, S/N at 75 dB (DIN-B). The player measures 16½"W × 15"D × 5⅛"H and weighs 13.6 lb. $350 for player alone; $50 for optional RC-5T remote-control unit.

CIRCLE NO. 92 ON FREE INFORMATION CARD

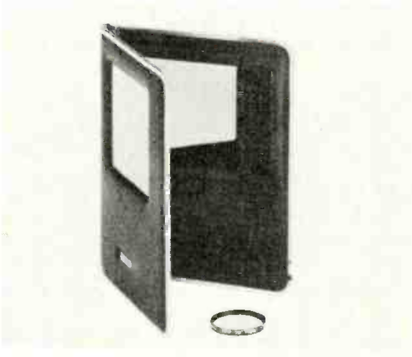
Single-Board Computer

The Model SBC-02 computer from Star-Kits is a minimal 4-chip system on a 6" × 6" pc board. It features a 6802 CPU, with 128 bytes of RAM, 2K of EPROM, and parallel or serial I/O. A wire-wrap area for expansion is provided. A machine-level monitor called HUMBUG that provides program entry and control, single stepping, breakpoints, and other front-panel functions is within a 2716 EPROM. $25 for the bare board, $75 for the parallel I/O kit, or $150 wired and tested. Additional support includes 4K floating point BASIC (in ROM), a cross-assembler for the 6802, and HUMBUG ROMs for other 6800 systems.

CIRCLE NO. 88 ON FREE INFORMATION CARD

Akai Slide/Film VCR Adaptor

Photographic film and slide images can be transferred simply and inexpensively to video tape with a videocassette recorder and Akai America's Model VLC-V9 "Tele-Cine Adaptor." Material being shown by a film or slide projector is directed through a vertical fresnel lens and reflected by a mirror into a video

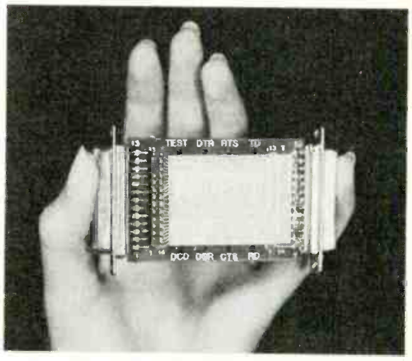


camera. It is then immediately recorded on tape. Using the video transfer adaptor, home movies can be edited, segments can be placed in chronological order, and films and slides can be interspersed on tape to give a multimedia effect. $89.95.

CIRCLE NO. 91 ON FREE INFORMATION CARD

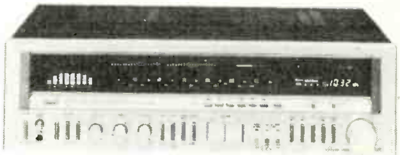
RS-232 Test Set

The SYZYGY Model 232 Test Set can be inserted into any standard EIA RS-232 serial interface without loading the circuit. An array of LED indicators monitors



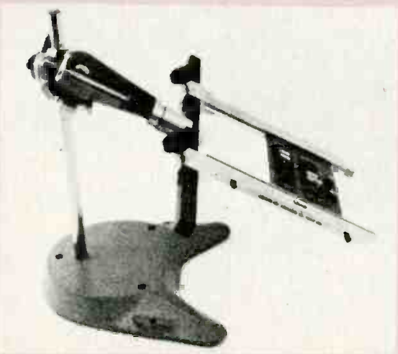
the seven most commonly used lines and one user-selected signal. All 25 pins are made available for use as test points. Double male, double female and null modem versions are offered. $75. Address: Syzygy, 252 San Lorenzo, Pomona, CA 91766.

Sansui High-Power Stereo Receiver



Crystal-controlled PLL digital synthesizer tuning accompanies dc amplification in Sansui's Model 9900Z 160-watt/channel AM/FM stereo receiver. The 9900Z includes both digital numeric and conventional "dial" frequency displays, the latter made up of a series of discrete LEDs. Instant recall of up to 12 preselected stations is offered, and an eight-band LED frequency-spectrum analysis display is built-in. LED "meters" display both peak output power and volume-level settings. Control of volume is via an up/down pushbutton Touch-Volume Control. FM specifications include: sensitivity 10.3 dBf (1.8 μV); signal required for 50-dB stereo quieting 37 dBf; stereo distortion 0.07%;

Panavise Circuit-Board Holder



The Model 333 Rapid Assembly Circuit Board Holder features an eight-position adjustment, indexes at 45-degree increments, has six positive lock positions in the vertical plane, and provides a 10-inch height adjustment. Having cross bars available in lengths to 30 inches, the device will hold circuit boards up to 28 inches in width. In addition, extra arms can be added for dual or multiple boards. The spring-loaded board holder allows for fast one-hand position changes. Its cast-iron base provides stability and is drilled for bench mounting.

CIRCLE NO. 89 ON FREE INFORMATION CARD

S/N 80 dB mono, 76 dB stereo. Amplifier specifications: frequency response 5 to 100,000 Hz +0/−3 dB; no more than 0.015% THD from 20 to 20,000 Hz at full power into 8 ohms: S/N 80 dB phono, 100 dB high-level. $1150.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Portable 4½-Digit DMM

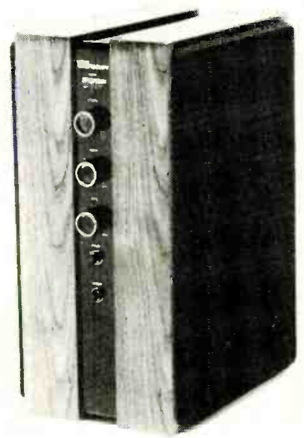
Data Precision's Model 255 4½-digit LCD portable/bench DMM is rated at 10-μV sensitivity on its lowest range and to 1-kV dc at 0.03% accuracy. Ac voltage range is from 10 μV to 5 kV; ac and dc current is measurable from 10 nA to 2 A and resistance can be measured from 0.1 ohm to 20 megohms. Both ac voltage and current are measured with an "average sensing" technique said to have full accuracy from 50 to 5000 Hz and an extended range to more than 2.5 kHz. Display digits are 0.4" high, black-on-silver LCD. All 25 ranges are selected via two front-panel rotary switches. Protection is 1 kV on all voltage ranges and 250 volts for resistance. A 2-A fuse handles the current ranges. Size is 5½" × 1½" × 3½" and weight is 1.3 lb. Power is provided by internal nickel-cadmium batteries. $279 including battery pack, carrying case, and recharger.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Microprocessor-Based Morse Trainer

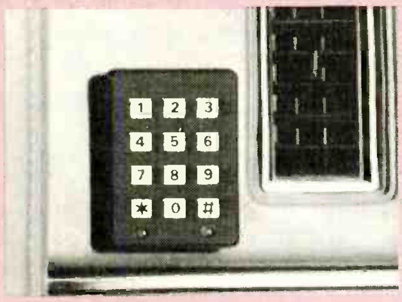
The Model MT-1 by Advanced Electronic Applications, Inc. generates essentially random Morse code at a rate of 1 to 99 wpm in selectable 1-wpm increments and in any of several modes. Practice messages are sent at either standard character lengths or with faster character lengths and extended spacing. The user can select either five-character code groups or random word lengths and one of two levels of difficulty—normal characters or all characters. Dash-to-dot-to-element space ratio is initially a standard 3:1:1, but this can be varied by the user. Automatic increase of speed can be programmed. The Model MT-1 requires +12 V (±3 V) at 200 mA. $99.95. Address: Advanced Electronic Applications, Inc., Box 2160, Bldg. O&P, 2006-196th SW, Lynnwood, WA 98036.

Hi-Fi Converter for TV



Petrous Electronics Corp.'s "Telefidelity" is a high-fidelity audio converter for television. Two models are available. Model TF-100 has a 15-watt rms amplifier that drives an 8" woofer and 3" tweeter. Deluxe Model TF-200 contains two 15-watt amplifiers, an 8" woofer, 4½" midrange driver, and 3" tweeter; it adds a pseudo-stereo effect. Both models offer a "Dynamic Compliance Fidelity Enhancement System" (FES) that automatically equalizes frequency response. Instead of a direct connection, an etched coil "antenna" is placed under the TV set to pick up the TV's sound carrier and pass it to the converter. (The Telefidelity may not operate with some TV receivers, especially those whose chassis are shielded.) Multiple inputs permit connection of tape decks, radios, and other high-level signal sources. $99.95 for Model TF-100; $129.95 for Model TF-200. Address: Petrous Electronics Corp., 415 W. Walnut St., Compton, CA 90220.

Computerized Antitheft Device



"Steal Stopper" from A.C. Custom Electronics Inc. is a computerized antitheft device for cars and RVs. A complete system consists of a keyboard controller, control module, motion detector, siren, and pin switches for trunk and hood. With a system installed, the protected vehicle cannot start until a secret four-digit code is properly keyed in, even if the ignition key is used or the ignition system is "hot-wired." Available in four models: Model 1043 has keyboard ignition lockout and disengage feature but no audible alarm. Model 1036 is the same but uses the vehicle's horn as an audible alarm; Model 1048 offers keyboard ignition lockout, siren alarm, motion detector (senses when the vehicle is jacked up), and pin switches; Model 1024 uses the ignition key to control the alarm and includes motion detector and siren. The dash-mounted unit measures 2"W × 2¾"H × ½"D. Address: A. C. Custom Electronics, 868 Alpha Dr., Cleveland, OH 44143.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Ac Magnetic Flux Probe

The Model 1846 axial-type ac magnetic flux probe converts flux to a voltage that can be measured on a meter or an oscilloscope with a BNC connector. Sensitivity is to 100 millivolts per gauss at 60 Hz. The probe allows a user to draw a flux map and locate sources, paths, and influenced areas so that steps can be taken to reduce the noise-producing flux by shielding or other means. $69. Address: Magnetek Corp., 7315 Red Deer Dr., Boulder, CO 80301.

Computer-Operated Typewriter

The Dynatyper from Rochester Data Inc., is an electro-mechanical computer interface that can be used with electric typewriters to generate hard copy in both upper and lower case. Weighing 3 pounds, the plastic-covered device fits over the typewriter keyboard and is held in place by its own weight and a pair of sticky "buttons." Inside are 52 solenoids and a pc board. No modifications are required to the typewriter. With the Dynatyper off, the typewriter can be used in the normal fashion. Operation is as fast as the typewriter can go. Interfaces are available for the Apple, TRS-80, and GPIB. A 6-bit parallel interface is available for general operation.

CIRCLE NO. 96 ON FREE INFORMATION CARD

Astatic Moving-Flux Phono Cartridge

Astatic Corporation is offering its new MF 200 Moving Flux® phono cartridge. This cartridge, employing a Shibata-type stylus and a small magnet attached to opposite ends of an aluminum cantilever, is said to offer the performance characteristics of a moving-coil cartridge and the high output levels of a moving-magnet or moving-iron type. Rated frequency response is 10 to 20,000 Hz ± 2.2 dB; output channel balance within 1.5 dB at 1 kHz; channel separation 23 dB at 1 kHz; output voltage 4.2 mV at 1 kHz and 5 cm/s; and source inductance 90 mH. Recommended tracking force is 1¾ grams ± gram. The cartridge is also available premounted in a universal plug-in type headshell. $160 unmounted, $182.50 premounted.

CIRCLE NO. 97 ON FREE INFORMATION CARD

General Sound Three-Piece Speaker System

The Micron III Concert Series Speaker Ensemble from General Sound consists of a pair of Model GS-5 satellite speakers and one Model GS-10 subwoofer. Each two-way acoustic-supension GS-5 features a 5¼" high-compliance woofer that crosses over at approximately 2.5 kHz to a 1" soft-dome tweeter. The vented, tuned-port GS-10 features a 10" dual-voice-coil driver and a built-in dual-channel (100-Hz) crossover system. Overall ensemble specifications: frequency response 30 to 22,000 Hz ± 3 dB; 87 dB SPL output with 1-watt input at 1 meter; minimum power 25 watts/channel; maximum power 150 watts/channel. Sizes: GS-5—10"H × 7"W × 7"D; GS-10—21"W × 19"H × 18"D. $475.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Digital Storage Scope

The Epic Instruments Inc., WAVE-SAVER connects between the circuit under test and an oscilloscope and can accept analog signals for later display and study. The digitized input data is stored within a 1K × 8 memory. Recording rates are from 2 μs to 100 ms per point and with an external clock go from 2 μs to dc. Input sensitivity is ± 50 mV to ± 10 volts at an input impedance of 1 megohm/15 pF. The post-trigger mode starts recording after detecting a trigger, while the pre-trigger mode stops recording after detecting the trigger. The device can also drive a plotter. Scope image resolution is 1024 bits horizontally and 8 bits vertically. $295.

CIRCLE NO. 99 ON FREE INFORMATION CARD

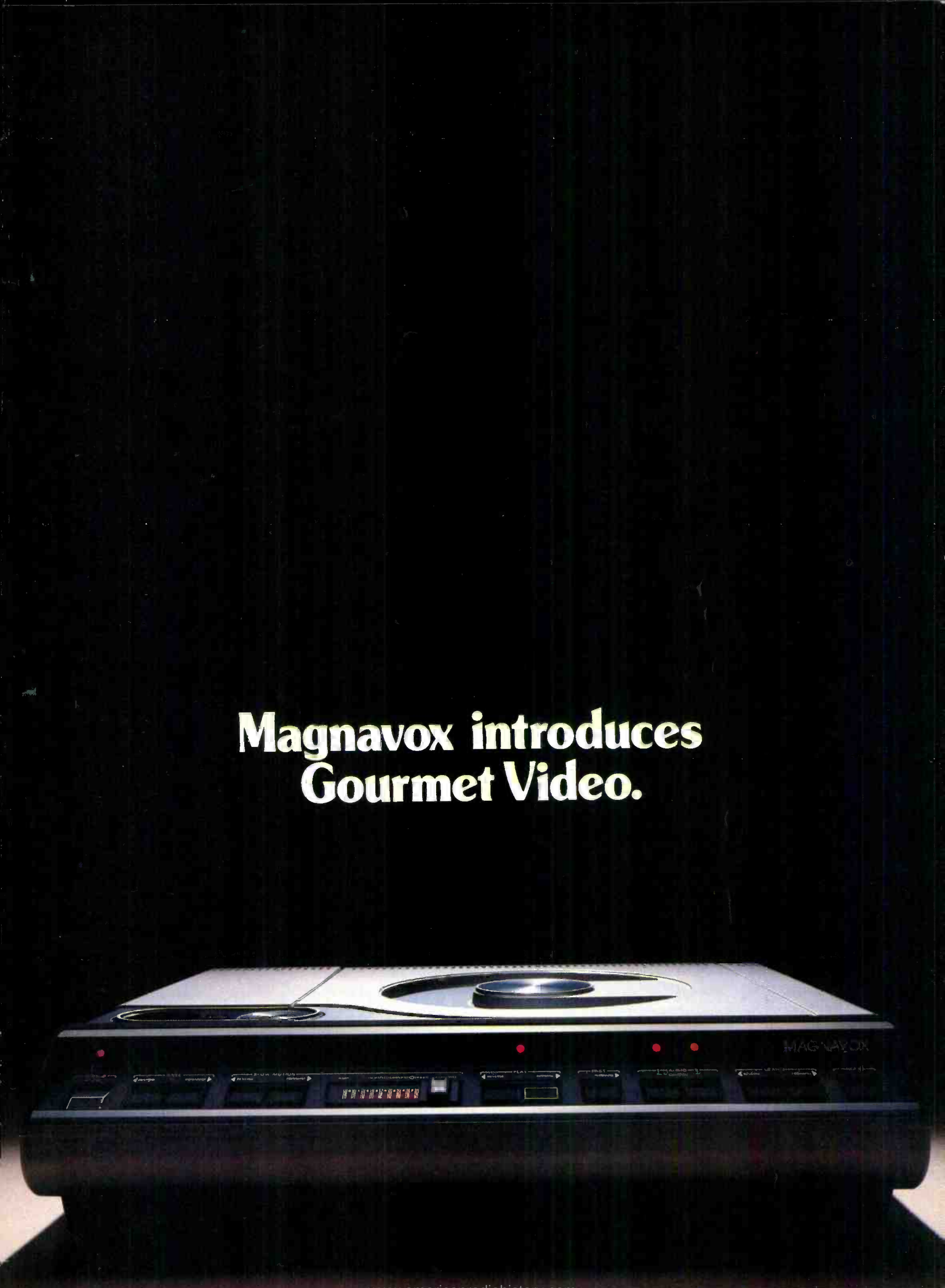
Maxell Premium Cassettes

Maxell Corp. of America has announced the availability of two new premium cassettes with a new epitaxial magnetic formulation and improved housings. The XL I-S and XL II-S cassettes are said to offer increased dynamic range, better S/N ratios, wider bias latitude, lower IM distortion and less print-through. The XL II-S is designed for decks whose bias and equalization can be switched to HIGH (CrO_2) and 70 μS, respectively. XL I-S is for use with NORMAL bias and 120-μS equalization. Tighter tolerances on the cassette shell halves, super-smooth rollers, and improved slip sheets are claimed to minimize deterioration of wow and flutter performance after repeated use. Suggested list prices are $5.10 for C-60 and $6.99 for C-90.

CIRCLE NO. 100 ON FREE INFORMATION CARD

Rechargeable Hearing-Aid Batteries

The Battery Store has introduced a rechargeable hearing-aid power system. Able to run up to 95% of the aids currently made, the system consists of a recharger and a pair of nickel-cadmium cells. The cells are said to maintain a constant voltage during discharge and to be rechargeable up to 500 times, for an operating lifetime of 10,000 hours. $19.95 plus $1.50 shipping/handling. Address: The Battery Store, P.O. Box 141, Ridgefield, CT 06877.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STILL lets you see a museum full of art (up to 54,000 pictures on each side of a disc) one piece at a time. You can advance frame by frame like you would with slides. Or hold a single picture for as long as you like with no damage to the disc or the player.

FAST FORWARD moves the picture at three times normal speed for hilarious effects. While SEARCH lets you scan an entire side of a videodisc in just 26 seconds. INDEX displays the number of each disc frame (54,000 per side) on your TV screen to help you locate specific scenes.

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CIRCLE NO. 38 ON FREE INFORMATION CARD

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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GX-379

ENTERTAINMENT ELECTRONICS

By Harold A. Rodgers
Executive Editor

Can We Hear Phase Distortion?

ACCORDING to the results of an investigation made by Hideo Suzuki, Shigeru Morita and Takeo Shindo of Mitsubishi Electric's Consumer Products Research Laboratory, phase distortion can be heard sometimes. Writing in the September 1980 issue of the *Journal of the Audio Engineering Society*, the three researchers report on the outcome of listening tests using special signals and musical program material that had been processed to simulate the phase response of a conventional two-way loudspeaker system.

Once it was determined that a good match could be obtained between the phase response of a two-way speaker and that of two single-pole, active all-pass filters, subjects were asked to compare the sounds of test signals presented via headphones and loudspeakers. The latter were at times located in an anechoic chamber and sometimes in normal listening environments, with no significant effect on the outcome.

As it turned out, the most revealing test signal was a tone burst, on which the listeners were able to detect the presence of the all-pass network reliably, especially when listening via headphones. The authors speculate that the delay to which the dominant low-frequency component of the signal is subjected by the network allows the hearing sense to fix on a high-frequency component and retain it, even after the low-frequency component arrives. When the phase response is linear, the high-frequency component is masked.

Perhaps the most significant result of the investigation is contained in the following quote: ". . . no one found *even the slightest change* [italics added] in sound quality by the phase shift when popular music from several commercial disks was used for a qualitative loudspeaker listening test." Another interesting discovery was that sensitivity to phase shift, even with artificial test signals, varies markedly from one individual to another.

The authors have indicated their intention to continue their research and establish a permissible limit for phase distortion. However, on the basis of their results so far, that produced by a two-way loudspeaker of conventional design appears to lie outside audibility.

Another examination of this topic was reported in a paper by S. P. Lipshitz, M. Pocock, and J. Vanderkooy, presented at the New York AES convention last November. These investigators, too, establish that phase distortion is audible with specially constructed test tones, noting that the signals they employed could easily occur in electronically synthesized music. They further suggest that, just as levels of nonlinear distortion that are inaudible on musical program material but audible on sine waves are not considered tolerable in a reproduction chain, phase distortions of similar audibility ought not to be tolerated either.

Another interesting conclusion reached as a result of this work is that polarity of an asymmetrical signal created by summing a sine wave and its second harmonic is practically *always* audible, even when heard via loudspeakers in a normally echoic space. Experimental results also suggest that the effect of phase distortion on transient material depends on the degree to which the signal is oscillatory. In general, nonoscillatory transients are affected in a more audible way.

When it comes to musical program material, the picture is less clear. Subtle effects of phase distortion are detectable via headphones when listening to male and female voices. But, to quote from the paper: "It is . . . clear that no blatant effects are caused by simple midrange first- and second-order all-pass filters, on musical and speech signals reproduced over headphones, let alone . . . loudspeakers."

Like the Mitsubishi group, Lipshitz and his colleagues caution that the results so far are to be considered preliminary. Nonetheless, it seems reasonable to conclude that, while some improve-

Mura Model VH-300
High-Velocity
Stereo Headphone

ments in sound quality may be eventually realized from better phase linearity through the audio reproduction chain, these are not likely to be earthshaking.

Two Interesting Audio Products. Recently, I had a chance to try out the Mura Model HV-300 stereo headphone. As it seems doubtful exactly how measured data on headphones should be interpreted, and one of the more interesting features of this model can only be judged subjectively, it seemed entirely reasonable to give them an informal trial rather than a lab test.

The sound of the HV-300 is clear and well-balanced without seeming extraordinary in any particular way. That is to say, they do not draw attention to themselves and away from the music. An especially endearing characteristic is that they do not emphasize noise that may be present in the program material. They are reasonably comfortable to wear, though not paragons of virtue in that respect, and come with a 10-ft cord that is coiled so tightly as to deprive the user of some of its length. Levels of the two drivers are independently adjustable, and a switch for stereo/mono choice is provided.

What is unusual about this headset, however, is the stereo separation control, apparently some sort of network that alters the relative phase of the signals reaching the listener's ears. When engaged, this system reduces the in-head localization often associated with headphone listening. The aural perspective thus created is not the same as that received from a pair of loudspeakers (that would be miraculous indeed!). However, on the basis of what I could hear, it gives a more credible vantage point than that produced by most headsets. Suggested retail price of the Mura HV-300 is $50.

The Dynamic Noise Reduction System from Advanced Audio Systems International is a "bandwidth follower," in this case, a lowpass filter whose breakpoint varies with the level of the musical signal. It is characteristic of music that as it gets louder, it becomes richer in high frequencies. When such highs are present in abundance, noise in the upper part of the audio band is masked and, therefore, inaudible. As the level drops and the highs start to disappear, a controller in the DNR squeezes off some of the filter bandwidth, thus attenuating the noise. To minimize losses of soft signals with high-frequency content—for example, a lightly struck triangle—the controller weights the input signal by frequency as well as amplitude. Depending on the signal, then, the filter cutoff point varies from 800 to 30,000 Hz.

Advanced Audio System International Dynamic Noise Reduction System

The DNR, realized from an IC developed by National Semiconductor, is equipped with a series of LEDs that indicate the approximate bandpass allowed at any instant. In addition to a POWER ON/OFF switch, it has a BYPASS switch and a rotary control for SENSITIVITY. In contrast to the effect one would normally expect, the device allows progressively more high frequencies to pass as the control is turned to the right. The chip on which the unit is based is, incidentally, expected to be used in several upcoming consumer audio products.

When connected into an audio system, the DNR does give a clearly noticeable reduction in high-frequency hiss that may contaminate program material. If carefully adjusted, the device has virtually no effect on legitimate high-frequency content. What I have always considered the acid test for a single-ended noise reducer such as this (pre-encoded program material is *not* required) is a solo flute. If the device operates crudely, the sound that results when the flute tone widens the bandwidth seems breathy, as the ear interprets the noise that leaks through as one of its components. The DNR passed this test with flying colors; no significant change was heard in the timbre of the flute. Suggested retail price is $150. ◊

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DON'T MISS: Highway HiFi Imagery With The 801-A Auto Unit Coming Soon!

Popular Electronics Tests Hitachi CT1306 13" Portable Color TV

AS IF TO celebrate its new 100,000 sq ft manufacturing plant in Compton, CA, Hitachi has announced the forerunner of next year's 1981 line by introducing its handsome 13-inch Color TV Model CT1306 with NP80SX chassis. This little set has a walnut-grained plastic cabinet with attractive silver-gray accents, and a tiny 9.5 × 10-inch planar (single board) chassis. Among its special features are an audio headphone jack and an infrared remote control for power on/off, channel up/down, volume, and mute. Cabinet dimensions are 18"W × 13.5"H × 15.1"D; power requirement is 65 watts (with signal input); suggested retail price is $459.95.

Chassis Layout. A rear-view wiring diagram (Fig. 1) showing how the various receiver sections interconnect may be of interest since many sets are adopting much the same layout. In the upper left and center are the tuner control and speaker with their connectors and wiring. Extending out at the left are uhf/vhf antenna terminals with r-f connections to the unitized (combined) shielded tuner, which is snugged to an open tuner control board. At bottom left is the remote control power transformer, and immediately above, a simplified view of the full remote control assembly made up of a pair of large printed-wiring boards.

Though the main power board at the bottom is quite small, it is, nonetheless, the operational center of the receiver, containing all sync, luminance/chroma processing, sound detection and amplification, as well as picture (P), brightness (B), tint (T), and color (C) potentiometer controls at the front right. Video i-f amplifiers and detector in a shielded container occupy the left center of the board, along with the power assembly. In addition, there are the power regulator, horizontal output and ceramic voltage divider, all on large aluminum heat sinks, and vertical outputs with their heat sinks as well (not shown). At bottom right is the small, encapsulated flyback transformer with integrally mounted focus and screen controls.

Above the main chassis is the pc board for the CRT, containing red, blue, and green output transistors, drive and background controls, and some passive components. Except for a few solder connections, the chassis unplugs for extensive servicing, and partially slides out for routine maintenance. And with only five ICs and 11 transistors, not counting the tuner, there are not many active elements to go bad.

Circuitry. Figure 2's block diagrams of the remote-control transmitter and the control sensor section that feeds the receiver's remote control board belie the complexity of what goes into a remote system—and why it adds between $60 and $100 to the price of the set! This is an all-electronic system that's highly sophisticated.

Each of the 12 available u or v (high/low) channels is tuned by a voltage derived from a ZD0201 zener-regulated 33 V applied to the collector of a voltage-tuning driver transistor. Potentiometers divide this voltage for varactor-diode tuning so that diodes are coupled, as each channel is selected, through the base-emitter of the aforementioned transistor and on to tuner control inputs. At the same time, switch elements, being manually tuned to select low vhf, or high vhf, or uhf, are energized.

When such voltage reaches any of the

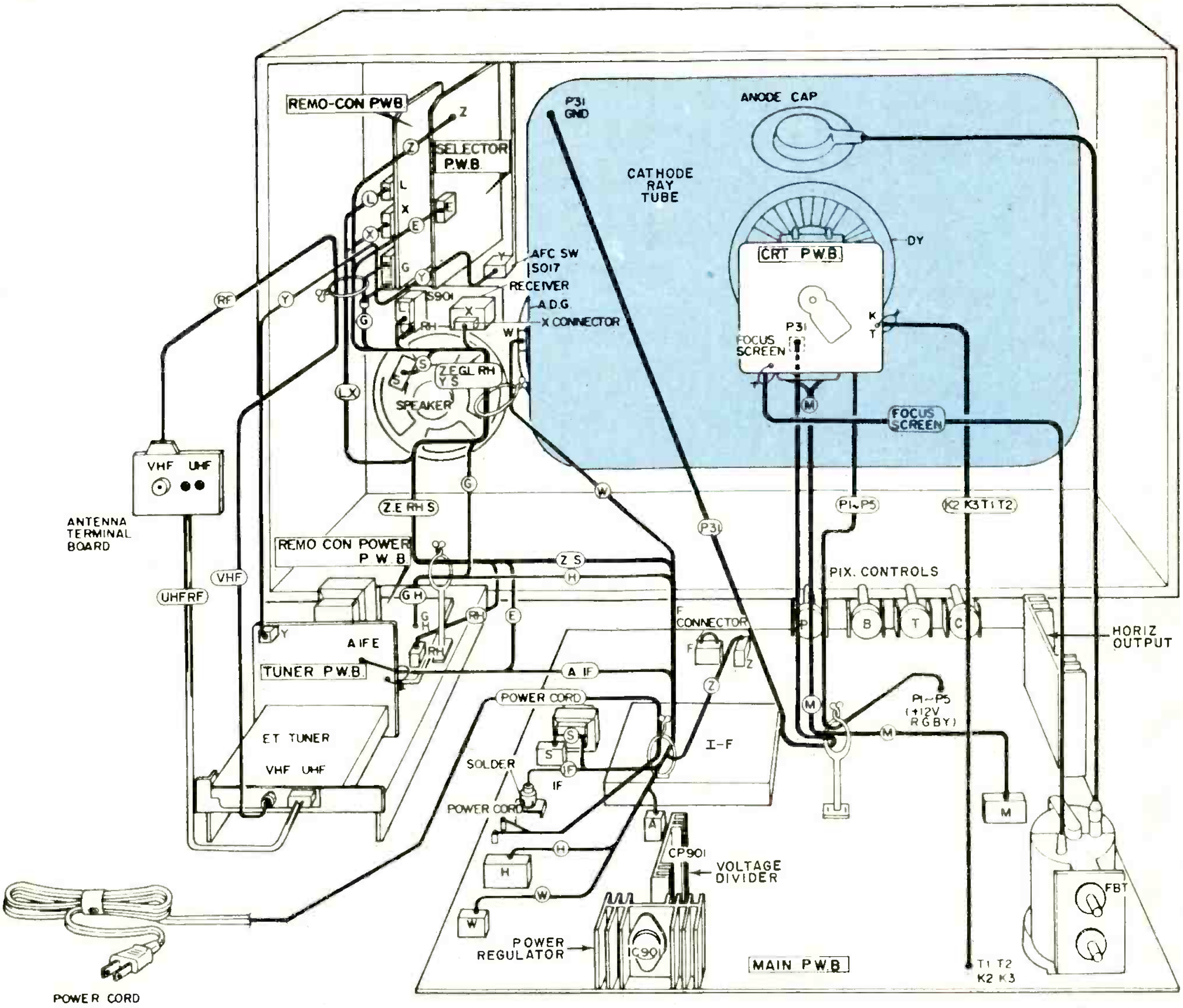


Fig. 1. Rear view of the CI1306 showing approximate location and wiring of major components and chassis.

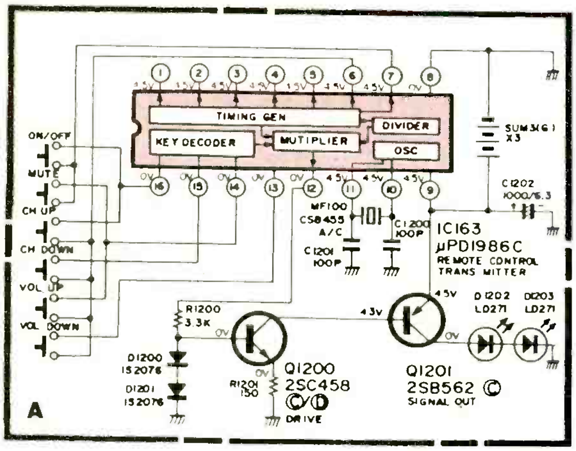
engaged 12 switch-band positions, it is transferred to the appropriate transistor inverter, energizing the portion of the tuner required to receive signals from the appropriate part of the regulator 82-channel spectrum. Now, with each of the 12 available positions set to some uhf or vhf channel, either the remote or manual scan system can operate the channel selection system.

At the bottom of the selector SW board, there are the channel up/down and volume up/down buttons that turn on one of the transistors on the remote control board. These connect to four inputs into a remote-decoder microprocessor. The remote-control transmitter, with its local oscillator, timing generator, key decoder, divider and discrete transistor output, translates the commands from its six control buttons into logic outputs so that LEDs can modulate them onto the infrared carrier. This is picked up by the infrared remote control sensor in Fig. 2. Its output is ac coupled into the base of a preamplifier and delivered to the primary of a coupling transformer and then to a Schmitt trigger. Output of the Schmitt is a series of pulses applied to the input portion of a microprocessor, *IC0101*, on the main remote-control board, not shown. Timing for this chip is provided by an oscillator, whose frequency matches that of the hand-held remote control transmitter. Thus, all commands will become synchronous. The Schmitt pulses are routed to the command and channel counter and key decoder. Out of *IC0101* comes a volume-control signal from its 5-bit D/A converter, a relay drive signal from the power flip-flop, and memory information for a program controller microprocessor, *IC0201*, located on a third pc board, which is a selector board.

Three other stages of interest are the relay driver, error amplifier, and power-initial transistors. Briefly, when the power-off section of *IC0101* receives the proper command, it passes a positive signal to the base of a normally cutoff driver transistor, which conducts, energizing a relay. This turns on power to the receiver and permits a power-initial transistor to conduct and initiate (reset or clear) the key-in decoder in *IC0101*.

In microprocessor *IC0201*, an RC oscillator produces a clock signal that also syncs the counter and memory functions. Another 16 pins access inverting buffers for the channel-tuning pots.

The Main Chassis. There's little novel about the rest of the receiver except that maximum use is made of minimum parts, especially in the power supply and chroma/luminance processor. Audio develops from the traditional 14-pin quadrature detector sound IC, which amplifies it and drives a pair of stacked npn output transistors designed to accept a total 130-V swing. The final load is an 8-ohm, transformer-coupled speaker with auxiliary earphone and recording jack for private recording or listening. Complete transformer isolation makes this output perfectly safe to connect to other chassis. Of course, the speaker



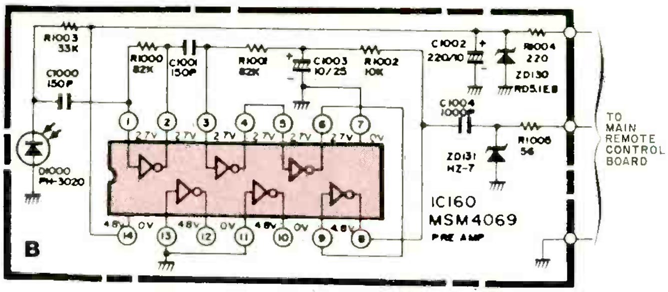


Fig. 2. Schematics of the Remote Control Transmitter (A) and Infrared Remote Control Sensor (B).

voice-coil connection is opened whenever an external audio plug is inserted.

The surface-acoustic-wave filter (SAW) and its i-f, agc, afc, synchronous full-wave video detector, noise canceller, and video amplifier IC following are also noteworthy, but not really different from circuits we have seen and reported on before. So, too, is an 18-pin IC that strips and supplies vertical and horizontal timing sync from composite video to the sweep/oscillator circuits, and also provides protection from excessive high voltage. Therefore, let's continue with our prime topics: the power supply and video processor. What makes this power supply interesting is its simplicity and resurrection of an old technique that could be returning to popularity because of lower power drain and cost. Its basic drawback is that overall regulation

MODEL CT1306 HITACHI RECEIVER LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity (min. signal for snow-free picture):	vhf (Ch. 3): −8 dBmV (−56.8 dBm) uhf (Ch. 30): −7 dBmV (−55.8 dBm)
Voltage regulation (line varied from 105 to 130 V):	Low voltage: 130-V supply—93% 30-V supply—93.5% High voltage: 20-kV supply—91.2%
Luminance bandpass at CRT:	3 MHz
Luminance bandpass at video detector:	4 MHz
Dc restoration:	88%
Agc response before white/black level changes or sync clipping (−8 dBmV to +46 dBmV):	54 dB
S/N at CRT:	39.1 dB
Horizontal overscan:	15%
Audio bandpass (3 dB down):	45 Hz to 10.5 kHz
Aux. audio output impedance:	10 ohms
Chassis power requirements (signal applied):	65 W (incl. remote)

Note: Instruments used in these measurements are: Tektronix/Telequipment D66, D67A oscilloscopes; Sadelco FS-3D VU F/S meter; Winegard DX-300 amplifier; Sencore VA48 video analyzer (modified), CG169 color bar generator, PR57 power analyzer; B&K-Precision 1248 color bar and 1250 NTSC color generators; Data Precision 245, 1350, and 1750 digital multimeters; Tektronix and Polaroid cameras.

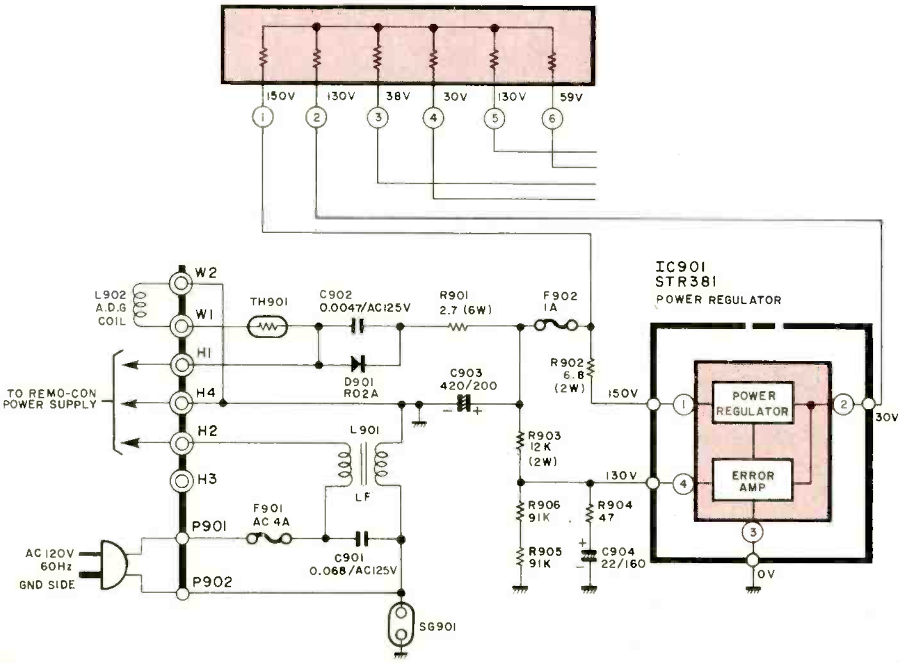


Fig. 3. Schematic of the primary power supply with new voltage divider circuit

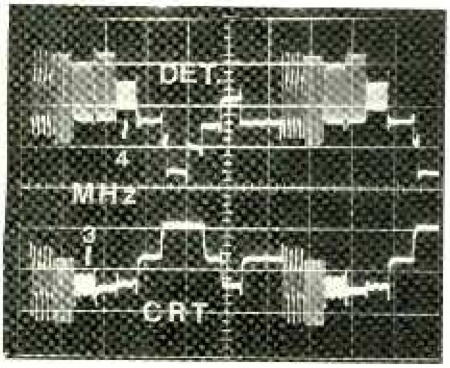


Fig. 4. Multiburst at video detector and cathode of picture tube.

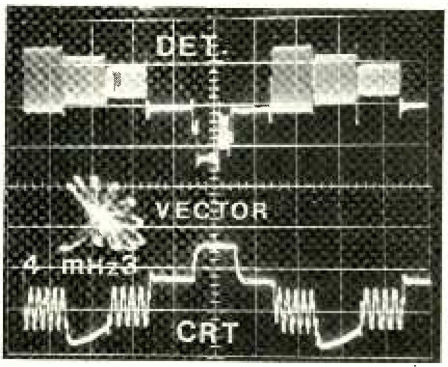


Fig. 5. Chroma and vector responses with gated rainbow vector.

is determined by the prime source; that is, individual regulation can be no better than the initial input from which all remaining voltages are derived.

As shown in Fig. 3, ac from the "mains" flows through radio frequency inductance filter *L901* (not a transformer), momentarily turns on the degaussing via thermistor *TH901* and is then half-wave rectified by *D901*, fuse protected by *F902*, and passed to both power regulator *IC901* and power resistor array *CP901*, a thick film deposition on ceramic substrate that's heat sunk to the chassis. Voltage dividers within *CP901* drop the 130-150 regulated/unregulated arrangement to 30, 38, and 59 volts for use by various portions of the system.

The power regulator receives half-wave rectified and filtered voltage through pin 1, producing a regulated output of 130 V through pin 2, and also reacts to any voltage error indications through discrete divider resistors at pin 4. This is a classic feedback arrangement in which a sample of the output voltage is returned to the regulator, driving its main output of 130 V higher or lower, depending on current drain. Since there is a 1-A fuse (*F902*), the power should be something less than either 150 or 130 watts. With total receiver drain specified as 78 watts with no signal applied, the fuse is conservatively rated. As you will note in the Laboratory Data, the best dc regulation for this system is 93.5% which is just about adequate under most circumstances.

The luminance/chroma processor, on the other hand, is exceptional. The 28-pin LSI chip eliminates all but a few of the additional discrete transistors usually required before the picture tube. All that remain are one luminance and three RGB cathode ray tube drivers. These are necessities because they're all power outputs needed to mix chroma and luminance adequately and drive the CRT. This large-scale integration chip also obviates chroma alignment, addition of extensive voltage dividers and excess ac filtering. Furthermore, it permits a surprising amount of ac coupling, followed by very good black-level clamping. The chip includes a video (luminance) driver, but not the three RGB outputs. The latter are standard stages used by virtually every color receiver on the market.

Delayed luminance information enters the sharpness portion of the LSI—apparently an entirely self-correcting circuit (no manual controls)—and proceeds directly to the contrast control (which does have a potentiometer adjustment) and also to the second bandpass amplifier. Ac coupling takes this amplified luminance to the black-level pedestal clamper, where it is gated into black-level restoration during horizontal sync times. After clamping, the final IC video amplifier processes this 7.5 IRE-corrected information and directly couples it to the *Q304* luminance (video) driver, and from there to the RGB final matrix chroma and luminance amplifiers before all combined signals enter the three cathodes of the picture tube.

Comments. For a 13-incher, this is a responsive little set, whose remote control you'll like. It has a stylish appearance, LED channel readouts, and separate power-on button with lighted indicator. Brightness, tint, color, and picture controls—all chassis mounted—are available, but not readily visible (they're positioned to the left and under the picture tube mask). Volume and channel up/down electronic controls are both positive and effective, and the "color lock" preset tint, color, brightness feature does just about what most similar circuits do—offers a fixed picture setting with some distortion to broaden the general area of fleshtones, trying to correct the usual broadcasting phase and amplitude errors.

Luminance bandpass is a bare 3 MHz (Fig. 4) at the picture tube and there is some amplitude modulation riding on the signal. This does not produce maximum picture resolution, and indeed causes some visible distortion. A few preshoot and overshoot blips are present among the higher frequencies at both the video detector and cathode ray tube, probably to "sharpen" black/white transitions.

The chroma reproductions in Fig. 5 are actually very good, even though some preshoot/overshoot conditions appear again, especially at the video detector. Even the vector shows good chroma alignment, although the yellow-orange-red petals are not 30° apart, as they should be, at the beginning of the pattern. This, indicative of abnormal fleshtone squeeze, forces yellows and reds to become somewhat orange. The third and sixth bars also show an angle of demodulation slightly in excess of 90 degrees (quadrature), possibly to compensate slightly for the tube phosphors. So color quality is good. Moreover, convergence and linearity are excellent, as can be seen in Fig. 6.

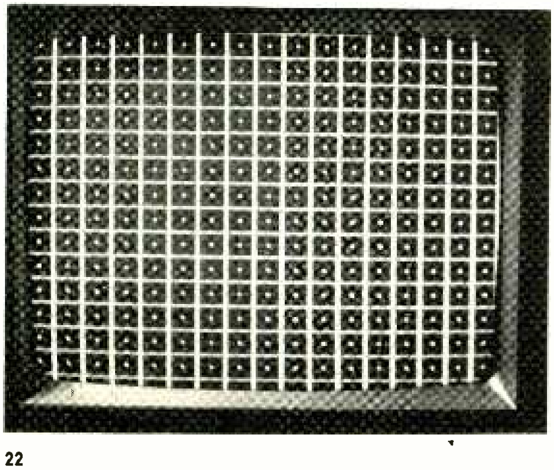


Fig. 6. Test photo shows precise convergence and linearity.

We found that the up/down volume response is somewhat quick on the trigger, and takes some getting used to. Furthermore, the combination of no CATV channels and only 12 vhf/uhf stations may bother some people who live in the large metropolitan centers having 15 or 20 stations. So might the slight CB interference we noted on channel 2 (60 ft away test).

Remember, however, this is a little 13-inch receiver that is considerably less expensive than its 19-inch counterparts. Yet, we have applied the same exhaustive tests and standards in evaluating it. Does it stack up in its class? Yes it does, and in every way! A little better power-supply regulation, less AM ripple, and a slight cleanup of the i-f and luma/chroma sections could improve performance, but this little set is a good value just as it stands.—*Stan Prentiss*

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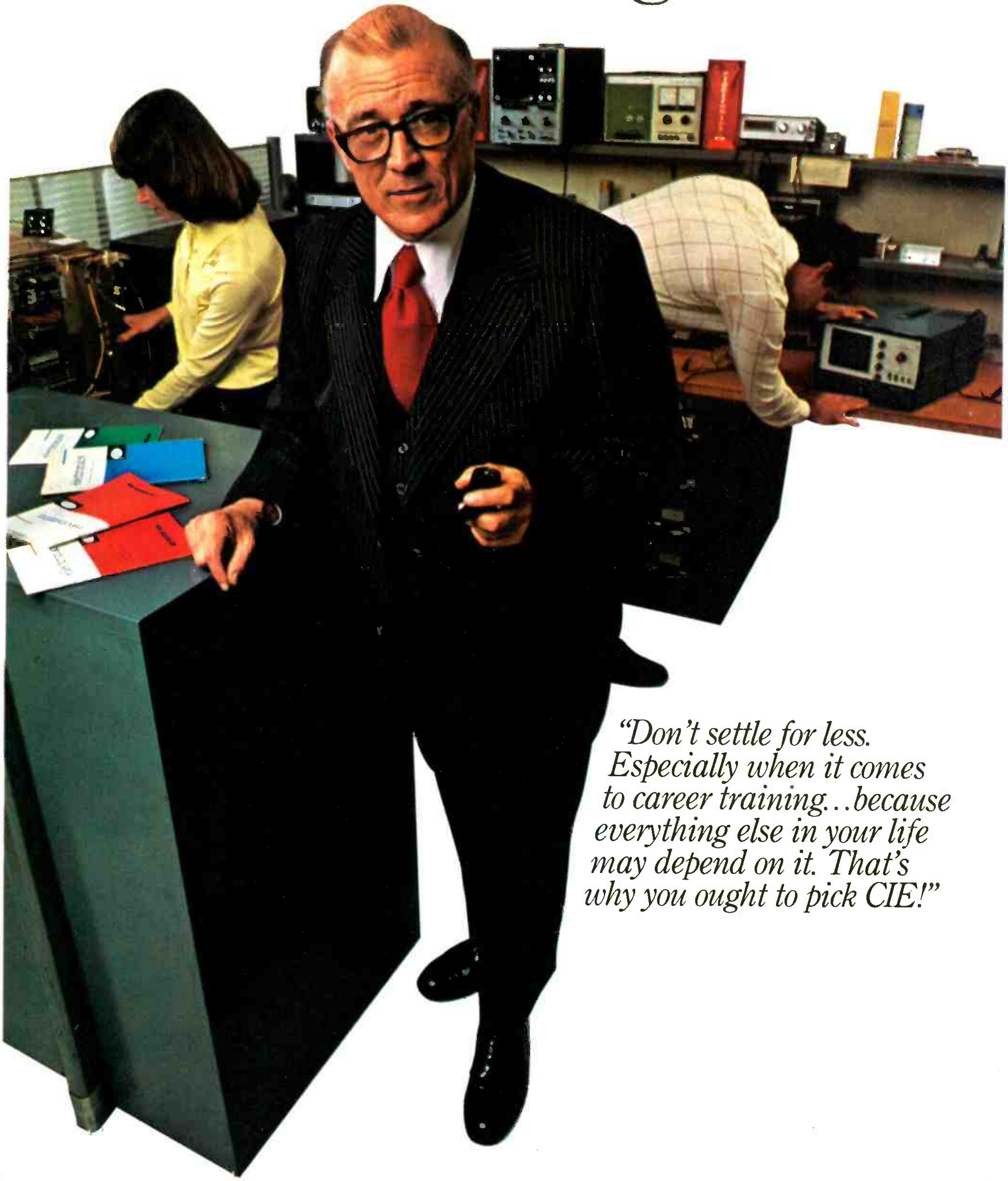

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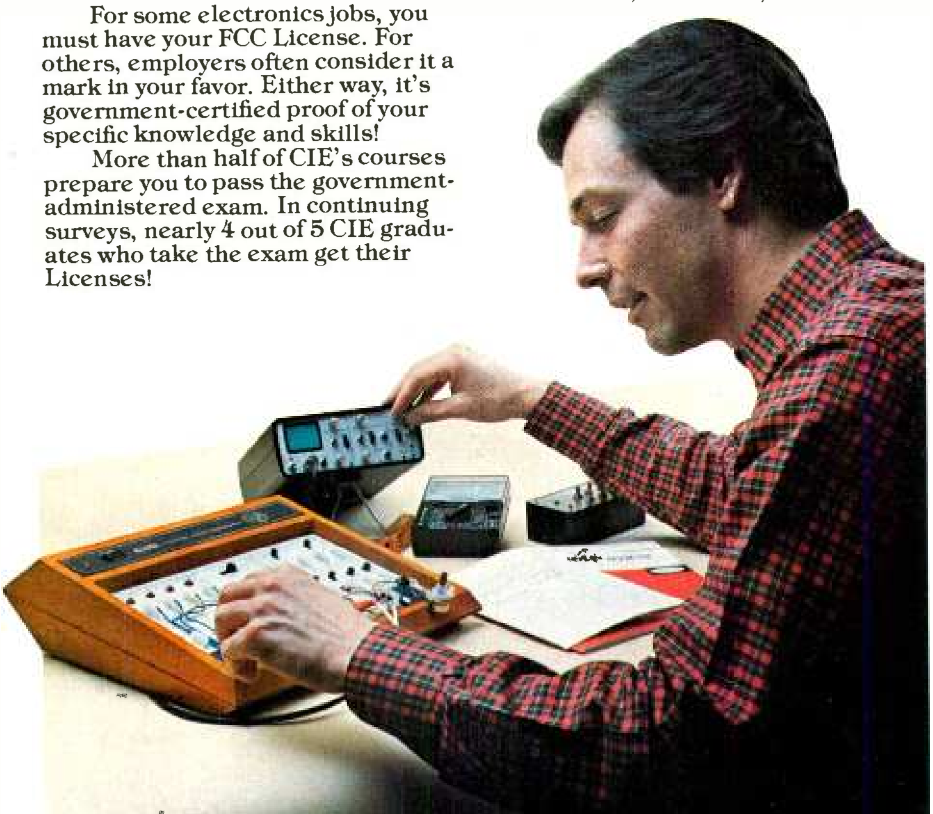

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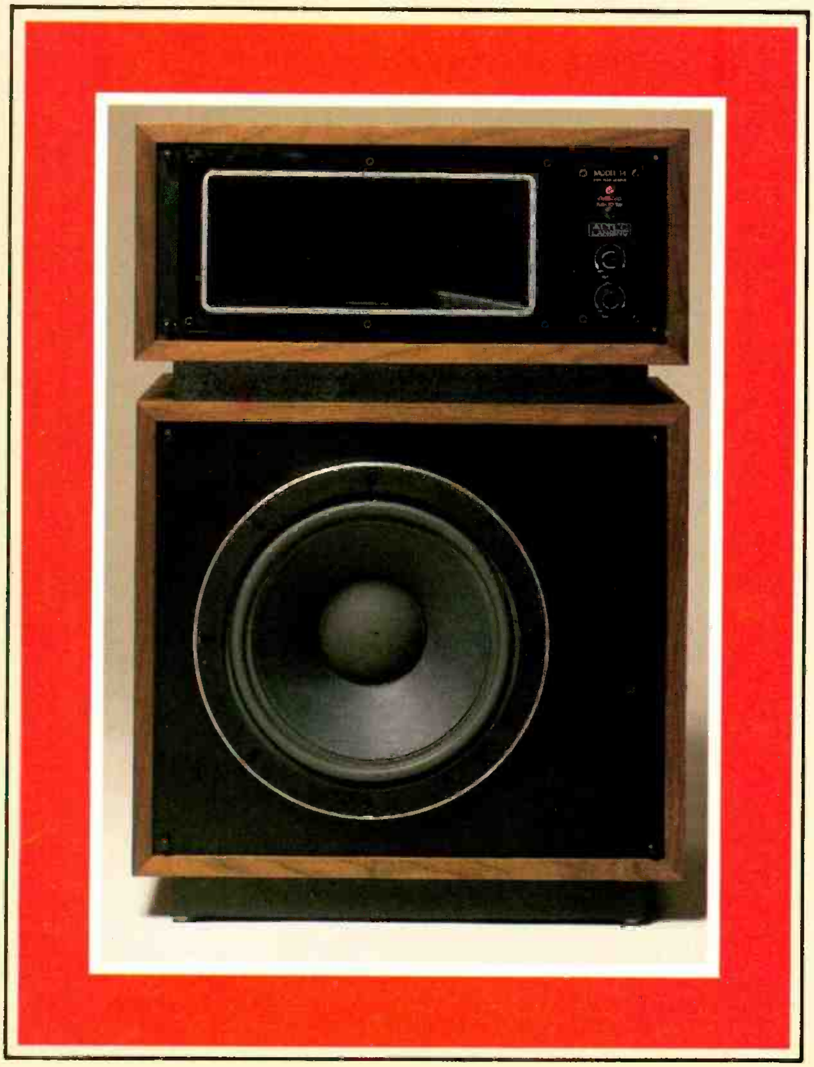
Altec Lansing Model 14 Two-Way Speaker System

Features the Mantaray high-frequency horn and passive Automatic Power Control protection system



THE Altec Lansing Model 14 is a two-way speaker system whose compression-type tweeter features the Altec Tangerine radial phase plug and drives a Mantaray constant-directivity horn. The drivers are protected against damage from excessive input power by a passive Automatic Power Control system.

Designed as a floor-standing system and measuring 30″H × 21″W × 16$\frac{1}{2}$″D, it weighs 77 pounds. Suggested retail price is $530 per speaker.

General Description. The handsomely styled walnut-veneer wooden cabinet is finished on all six sides and covered in front by two removable black cloth grilles, retained by plastic fasteners. The lower grille covers the 12-inch cone woofer and the port of its vented enclosure. Crossover to a 1$\frac{3}{4}$″ compression driver is at 1,500 Hz. The diaphragm of the high-frequency driver is loaded by the proprietary Altec Tangerine phase plug.

The molded plastic Mantaray horn has a modified conical shape whose expansion taper changes at various points along its length. Enhanced control over dispersion is the goal of this unusual design geometry.

Altec has built an effective protective system into the Model 14. The Automatic Power Control (APC) system is powered from the input signal and requires at least 7 to 10 watts in order to function. Normally APC operates only when input power exceeds 75 watts, reducing the output sound level from the speaker during overload and turning on

a red LED behind the grille. Near the LED is a TEST button that lights it when pressed (if the speaker is being driven by at least 7 watts) to verify the operation of APC. At input levels of 10 watts or more, pressing the button also reduces the output level slightly, according to Altec.

The small control panel behind the tweeter grille also contains two continuous rotary controls that vary output in the middle- and high-frequency ranges. They are marked M.F. EQ and H.F. EQ. and each has an indicated optimum response setting range. To facilitate concealment of input leads, the spring-loaded input terminals of the Altec Model 14 are located underneath the cabinet.

Specifications of the Model 14 include a frequency response of 35 to 20,000 Hz ± 3 dB (measurement conditions unspecified) and a sensitivity of 95 dB (sound pressure level at 1 meter when driven by 1 watt). Rated system impedance is 8 ohms.

Laboratory Measurements. Frequency response was measured with the speakers about 2 feet from the wall in a normal stereo configuration. The microphone was on the axis of the left speaker and about 12 feet from it, placing it about 30 degrees off the axis of the right speaker. Frequency was swept slowly from 100 to 20,000 Hz, with a ±50-Hz "warble" to reduce the effects of standing wave patterns. Microphone output was plotted automatically, with the separate response curves for the two speakers appearing on the same chart.

An average of two curves was taken to obtain a single reverberant field response, which was then corrected (at high frequencies) for the known absorption characteristics of the room. The resulting curve is a fair representation of the frequency response of the speakers in a normally "live" room, and is reasonably valid from about 300 to 20,000 Hz.

Woofer response was measured separately with a close-spaced microphone to eliminate room standing wave effects from the measurement. Acoustic output was measured close to the woofer cone and again at the port opening. After the levels of the two curves were adjusted to allow for the relative radiating areas of the cone and the port, they were combined to form an equivalent anechoic bass response curve from 20 to 1,000 Hz (valid up to about 300 Hz) .

Since each curve (low and mid/high frequency) extends an octave or more beyond its valid range, the two can be overlaid and "spliced" in such a manner as to produce a composite overall frequency response curve that is indicative of what the speaker *can* deliver in a real listening environment (though not necessarily what it *will* deliver in some other room). The curve is inevitably influenced to some extent by the room, and the placement of speakers and microphone, escpecially in the midrange. Although the bass portion of the curve is a good approximation of an anechoic response, the audible bass in any real room will be a function of the room dimensions and the locations of the speakers and listeners.

The composite response curve had a very smooth bass section that was flat within ±1 dB from 50 to 350 Hz. Output dropped gradually at lower frequencies, reaching −10 dB at 20 Hz.

The response dipped into a broad "hole" (about −7 dB with respect to the bass level) centered at about 1,200 Hz. It then rose smoothly, reaching the original level at 3,000 to 4,000 Hz. Output varied less than ±2.5 dB from 2,500 to 20,000 Hz. Overall variation was ±4.5 dB from 27 to 20,000 Hz.

The M.F. EQ control affected the response between 1,000 and 6,000 Hz, with a maximum boost of about 5 dB in the middle of that range and a maximum reduction of about 2 dB relative to the "optimum" setting. The H.F. EQ control operated above 6,000 Hz, and gave a maximum boost of about 3 dB but virtually no reduction in output when rotated to its counterclockwise limit.

Impedance was a minimum of 8 ohms between 100 and 300 Hz, rising to maxima of about 30 ohms at 65 Hz and 3,000 Hz, as well as below 20 Hz. At middle and high frequencies, the impedance was generally between 15 and 30 ohms. The 8-ohm rating of this speaker is obviously well founded.

Woofer distortion was measured at the cone and in the port at frequencies from 100 down to 35 Hz, and at power inputs of 1 watt and 10 watts. Cone data were used at 60 Hz and above and port data at 50 Hz and below. At 1 watt, distortion was 0.2% down to about 70 Hz, and it rose smoothly at lower frequencies to just over 5% at 35 Hz. At 10 watts input, distortion was still only 0.3% down to 70 Hz, and reached 7% at 50 Hz. When comparing these figures to those for other systems, one must remember that the Altec Model 14 is about 10 dB more efficient than a typical acoustic suspension speaker. Viewed in practical terms, these distortion data are very good. Measured sensitivity was, in fact, exactly as rated. A sound pressure level of 95 dB was measured 1 meter from the center of the grille when the system was driven by an octave band of pink noise centered at 1,000 Hz.

User Comment. From the measured frequency response curve of the Model 14, we would expect it to have a deep, uncolored bass and an extended, well-dispersed high end. Both of these expectations were fully confirmed in our listening tests. The midrange "dip" is a fairly common characteristic of two-way speakers, since it is difficult to make the high-frequency response of a large woofer and the low-frequency response of a tweeter overlap with full energy output and similar dispersion characteristics. In some cases, the dip can be heard as a "distant" quality, but often it is not audible at all except by direct comparison with speakers having a flat response through the same frequency range.

Essentially, the Altec Model 14 heard by itself, is a smooth, full-range speaker with no obvious coloration. Further listening made a slightly "hard" quality in the upper midrange and treble evident at times, perhaps accentuated by the generally "dry" sound quality. While not a "warm" or "soft" sounding speaker, the Model 14 is not at all strident. The sound contains a minor coloration reminiscent of the "horn" sound of earlier days. Whether this is actually due to residual resonances in the horn, we cannot tell but the quality was not irritating, even when we compared the Model 14 to some very flat, highly regarded reference speakers.

There are properties of the speaker that are less subjective than its sound. Its sensitivity (efficiency) is very high, and it produces higher sound levels than one would ever wish to use when driven by only a few watts. Ironically, its price makes it an unlikely companion for a low-power receiver or amplifier that would otherwise drive it with ease.

To see how the APC system worked, we drove the speakers with the full output of a 200-watt-per-channel amplifier. It was interesting to find that the loudest levels we could apply with classical music were not able to flash the LEDs more than momentarily; to *really* overdrive the speakers we had to use rock music. With only occasional flashes from the light, we measured a sound pressure level of 112 dB in the rear of the listening room, 12 feet or more from the speakers. This was an *average* reading on our sound level meter—program peaks no doubt exceeded 120 dB! However, there were no obvious signs of distortion.

When the APC light did come on, we could not hear the level reduction the descriptive literature said would occur. Thinking that the ear-splitting sound level might be masking a small change, we used the TEST button with a more reasonable drive signal of pink noise. The test light came on, but again we heard no change in level. That both speakers behaved alike suggests that the APC system was operating properly. More to the point, however, these speakers took the full output of a powerful amplifier without distress or damage.

While, as we have noted, a pair of Model 14s can be driven to very high sound pressure levels by just a few watts, an amplifier with muscle makes truly awesome levels available without the dangers of waveform clipping or destruction of drivers. Moreover, the sound quality is as good at these lease-shattering levels as when the speakers are playing background music. It might be an overstatement to call this combination of qualities unique, but they are certainly sufficient to make the Altec Model 14 a rarity among loudspeakers.—*Julian D. Hirsch*

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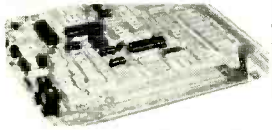

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LEVEL "A" SPECIFICATIONS

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an advanced 8155 RAM I/O . . . all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, plus generous prototyping space.

PC Board: Glass epoxy, plated through holes with solder mask. • **I/O:** Provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader . . . cassette tape recorder input and output . . . cassette tape control output . . . LED output indicator on SOD (serial output) line . . . printer interface (less drivers) . . . total of four 8-bit plus one 6-bit I/O ports. • **Crystal Frequency:** 6.144 MHz. • **Control Switches:** Reset and user (RST 7.5) interrupt . . . additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard. • **Counter/Timer:** Programmable, 14-bit binary. • **System RAM:** 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems . . . RAM expandable to 64K via S-100 bus or 4k on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F000, leaving 0000 free for user RAM/ROM. Features include tape load with labeling . . . examine/change contents of memory . . . insert data . . . warm start . . . examine and change all registers . . . single step with register display at each break point, a debugging/training feature . . . go to execution address . . . move blocks of memory from one location to another . . . fill blocks of memory with a constant . . . display blocks of memory . . . automatic baud rate selection to 9600 baud . . . variable display line length control (1-255 characters/line) . . . channelized I/O monitor routine with 8-bit parallel output for high-speed printer . . . serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Keypad/Display Version): Tape load with labeling . . . tape dump with labeling . . . examine/change contents of memory . . . insert data . . . warm start . . . examine and change all registers . . . single step with register display at each break point . . . go to execution address. Level "A" in this version makes a perfect controller for industrial applications, and is programmed using the Netronics Hex Keypad/Display. It is low cost, perfect for beginners.

HEX KEYPAD/DISPLAY SPECIFICATIONS

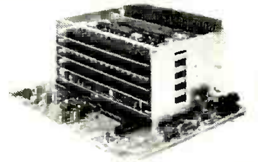
Calculator type keypad with 24 system-defined and 16 user-defined keys. Six digit calculator-type display, that displays full address plus data as well as register and status information.

LEVEL "B" SPECIFICATIONS

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards, and includes: address decoding for onboard 4k RAM expansion selectable in 4k blocks . . . address decoding for onboard 8k EPROM expansion selectable in 8k blocks . . . address and data bus drivers for onboard expansion . . . wait state generator (jumper selectable), to allow the use of slower memories . . . two separate 5 volt regulators.

LEVEL "C" SPECIFICATIONS

Level "C" expands Explorer/85's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and card are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card, gold plated S-100 extension PC board that plugs into the motherboard. Just add required number of S-100 connectors.



Explorer/85 With Level "C" Card Cage.

LEVEL "D" SPECIFICATIONS

Level "D" provides 4k of RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 0000 to EFFF in 4k blocks.

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Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for 2k x 8 RAM IC's (allowing for up to 12k of onboard RAM).

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COMPUTER BITS

By Carl Warren

Roll Your Own Computer Show

EVERYONE likes a computer show especially when it's a lot of fun. And fun is what we had a few months ago at the Heath Electronic Center located in Anaheim, CA. Bob Mathias, the president of the Anaheim Heath Users Group (ANAHUG), called and asked me if I would address that august group. After mulling it over for about 30 seconds, I told Bob I'd go him one better and put together a "mini computer show."

What I was able to do—and anyone can do it—was to get in touch with various notables in the industry and get their cooperation. Specifically, I called up Gary Kildahl, the creator of CP/M, and asked him to come and tell everyone about CP/M, MP/M and CP-Net. I also contacted the people at Remex and asked them to bring over their 8-in. intelligent floppy disk drives that are now being incorporated into the Heath/Zenith computer systems. Shugart Technology planned a special trip down to show off its ST-506 microWinchester drive and answer questions about interfacing equipment.

But that wasn't all. I contacted Dilithium Press, Reston Publishing, Sybex, and TAB books, explaining what we were doing. All the publishers responded by sending copies of their microcomputer books to be used as giveaways.

Heath came through with flying colors also. During the past year, Heath has provided me with several kits to be used for evaluation purposes in my columns. Consequently, I was able to use these kits as prizes. Intel provided an SDK-86 evaluation board for some lucky winner, and Osborne/McGraw Hill added its latest book.

Heath's Chief Design Engineer, Carl Goy, made sure that we had the 16K update for the H-89, and the 8-in. floppy disk controller for all to see. Magnolia Microsystems provided its version of the origin zero PROM via the good offices of Lifeboat Associates. Tony Gold, president of Lifeboat, went further and provided his latest software marvel, T/Maker®, for demonstration.

Although this mini exposition was put together on short notice, more than 60 people showed up to examine the wares and ask questions. Of immediate interest to the ANAHUG members were the Remex drives. These intelligent units are the heart of the H-47 floppy system that Heath began offering with its October catalog.

The Remex RFS4800 drive is a double-sided, double-density drive that accommodates up to 3M bytes of online storage when used in tandom with three 5.25-in. drives and an 8-in. slave drive. What makes this unit exciting is that it incorporates a 6809 microprocessor in the controller, thus permitting the building of a bus interface with less than six chips. You can't buy the drives directly from Remex, since they sell only on an OEM basis. But you will likely want to consider products that use them.

The Shugart Technology ST-506 microWinchester drive also caused quite a stir among attendees. This unit, which I have reported on in an earlier column, offers 6.38M bytes unformatted, 5M bytes formatted, and gives the small-business user a uniquely large storage capacity in a very small box.

Supporting the 5.25-in. microWinchester effort is American Computer and Telecommunications, which has developed an interface for the drive that can be used with the H-89, S-100 bus systems, and TRS-80. The interface is called the ACT 506, priced at $1,250. According to a company spokesman the interface supports CP/M 2.2 and HDOS. This appears to be worth looking into and will add an extra dimension to your system. My contacts at Heath say the ACT-506 interface is currently being carefully evaluated by the engineering staff and may be offered as part of the line.

Although we didn't get a chance to show T/Maker to the ANAHUG group in the manner that we wished to, all were very interested in its capabilities. Essentially, T/Maker is a powerful program, written in CBASIC, that permits development of management reports in tabular fashion. The T/Maker program is comparable to the popular Visicalc® system, but adds some other features. Among these are a full screen editor for setting up the tables. This editor permits both vertical and horizontal scrolling, arithmetic functions so totals can be generated, and the ability to create and include text material in a report. T/Maker is designed to run under the CP/M operating system either origin zero or the special implementations for a standard H-89 or TRS-80. However, since Heath/Zenith is offering a zero base and 8-in. drives, the standard distribution package fits right in. T/Maker is priced at $275. Should you want only the manual, it costs $25.

T/Maker requires 48K of memory. If you are planning to use it on a CP/M system that starts at 4200_{16}, some difficulties will arise. This is primarily due to the loss of 8K of memory space. You can solve this problem by adding the 16K update in the Heath system, but if you go to all that trouble, I suggest that you incorporate the zero-base PROM.

Speaking of computer shows, those of you who live in California or want an excuse for a trip there, can plan on attending the Sixth West Coast Computer Faire April 3-5 at the San Francisco Civic Auditorium. Should you have a project you are working on or have expertise in some field of microcomputing, you might consider chairing a conference.

Let Us Go FORTH. Just about everything you read talks about BASIC, how to program in it, and so on. There are alternative high-level languages, however, and one of these is called FORTH. This language was created by Charles H. Moore in 1969 at the National Radio Astronomy Observatory (Charlottesville, VA). Like many innovators, Moore felt he needed a language that met his special needs, particularly for observatory automation.

FORTH is what is termed a threaded language. This means that calls are inherent or threaded together. For example, if you want to jump to a subroutine, only the destination is required; the jump is implied. The language makes use of stack operations and, depending on the operation data, is either pushed or pulled on or off the stack(s). This design makes it possible to write compact code that can handle real-time operations.

Interest in FORTH is rapidly increasing, and the language is receiving a great deal of support from the FORTH interest group. This organization, located in San Carlos, CA., publishes a magazine called "Forth Dimensions," holds seminars, provides information on how to implement a FORTH package, how to program, and assists interested parties in becoming familiar with the language.

Those of you who find FORTH attractive can get on the bandwagon by contacting the FORTH interest group and obtaining copies of the magazine. When you are ready, they can supply a copy of the language for your machine.

Software Tidbits. I've tried out Business Micro's Filetrans product and found it most interesting. This package works in concert with the Omikron Mapper system I discussed last month, and permits transferring of TRSDOS files to CP/M and back again. This is an important utility, especially if you plan to use a TRS-80 for anything serious—in which case, you will need CP/M.

The Filetrans package comes in four flavors. Versions 1.01 and 1.02 are priced at $99 and permit file transfer in one direction to CP/M. Version 1.03 is for 4200 hex-based CP/M and 1.04 is for standard CP/M. Both allow file transfer in both directions.

(Continued on page 38)

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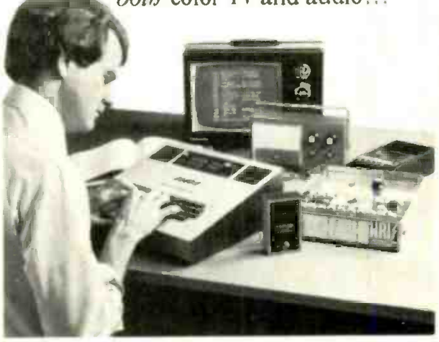

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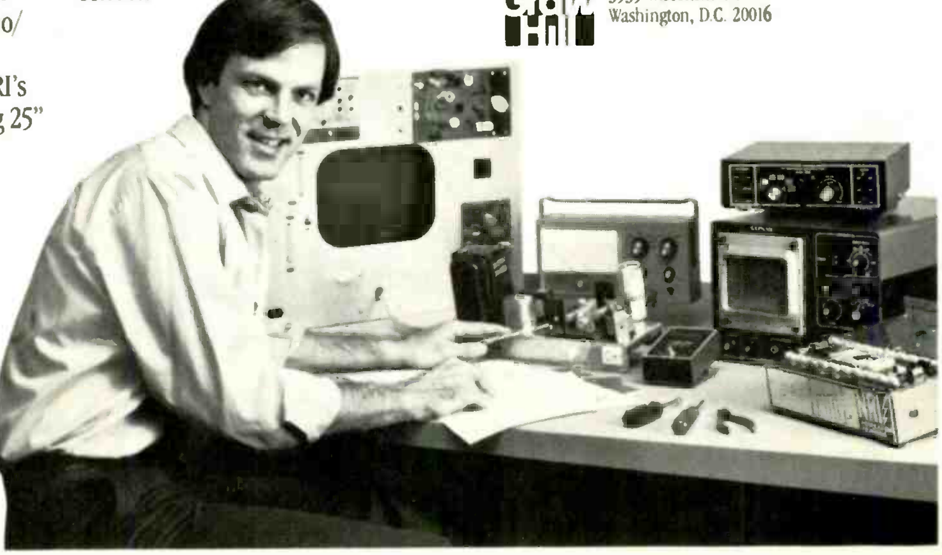

Learn at home at your convenience.

What makes this package important is that it establishes compatibility between a text editor designed to operate under TRSDOS and a CP/M text processor (such as Textwriter III from Organic Software). First you create your text under the editor package. Then transfer it to CP/M and let Textwriter process it. More important, you can take BASIC programs written under TRSDOS and transfer them to CP/M. In the case of the TRS-80, you will find that in most cases the program runs as originally written.

Let Us All Convert. In the past two columns, I discussed the conversion from one version of BASIC to another. As I indicated, various versions of this language exist; and with the differences between them, it can be difficult for an owner of a microcomputer to use all the software packages available.

In a discussion with Les Solomon, Senior Technical Editor of PE, the following simple idea to make all BASICs understandable was proposed. Let us use lots of REM's, even if it means one REM per BASIC line.

Obviously, on simple BASIC statements, no REM's are needed. However, in those lines that are specific to one machine, a REM should clear things up. For example, a TRS-80 owner would immediately recognize the BASIC statement CLR as the screen clear command for his machine. But, what does CHR$(27);CHR$(69) mean to him? This is the screen clear command used in Heath systems (quite meaningless to TRS-80 or Apple users). Therefore, we suggest:

```
10 CLS                    REM—screen clear
10 CHR$(27);CHR$(69) REM—screen clear
```

as the way out. This same approach should be used at each BASIC line that does something unique to the particular system for which the program is written. Some commands are not directly translatable—such as graphic commands. However, even these are not insurmountable since at least the person using the program will know what the author is trying to do. In many cases, the user can convert to commands his machine can perform even if it means writing small subroutines.

As an afterthought, another simple approach is for the microcomputer user to keep a notebook that contains all his BASIC statements, so that he can enter similar statements from other BASIC versions he encounters. This, of course, means a translator for a translator, which is not a very good thing, but one way to preserve sanity in the high-level language maze. ◇

MORE INFORMATION

For additional information about products or services mentioned in this column, contact the companies directly.

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A REMARKABLE MAGAZINE

David Ahl, Founder and Publisher of Creative Computing

creative computing

"The beat covered by Creative Computing is one of the most important, explosive and fast-changing."—Alvin Toffler

You might think the term "creative computing" is a contradiction. How can something as precise and logical as electronic computing possibly be creative? We think it can be. Consider the way computers are being used to create special effects in movies—image generation, coloring and computer-driven cameras and props. Or an electronic "sketchpad" for your home computer that adds animation, coloring and shading at your direction. How about a computer simulation of an invasion of killer bees with you trying to find a way of keeping them under control?

Beyond Our Dreams

Computers are not creative per se. But the way in which they are used can be highly creative and imaginative. Five years ago when *Creative Computing* magazine first billed itself as "The number 1 magazine of computer applications and software," we had no idea how far that idea would take us. Today, these applications are becoming so broad, so all-encompassing that the computer field will soon include virtually everything!

In light of this generality, we take "application" to mean whatever can be done with computers, *ought* to be done with computers or *might* be done with computers. That is the meat of *Creative Computing*.

Alvin Toffler, author of *Future Shock* and *The Third Wave* says, "I read *Creative Computing* not only for information about how to make the most of my own equipment but to keep an eye on how the whole field is emerging.

Creative Computing, the company as well as the magazine, is uniquely lighthearted but also seriously interested in all aspects of computing. Ours is the magazine of software, graphics, games and simulations for beginners and relaxing professionals. We try to present the new and important ideas of the field in a way that a 14-year old or a Cobol programmer can understand them. Things like text editing, social simulations, control of household devices, animation and graphics, and communications networks.

Understandable Yet Challenging

As the premier magazine for beginners, it is our solemn responsibility to make what we publish comprehensible to the newcomer. That does not mean easy; our readers like to be challenged. It means providing the reader who has no preparation with every possible means to seize the subject matter and make it his own.

However, we don't want the experts in our audience to be bored. So we try to publish articles of interest to beginners and experts at the same time. Ideally, we would like every piece to have instructional or informative content—and some depth—even when communicated humorously or playfully. Thus, our favorite kind of piece is acessible to the beginner, theoretically non-trivial, interesting on more than one level, and perhaps even humorous.

David Gerrold of *Star Trek* fame says, "*Creative Computing* with its unpretentious, down-to-earth lucidity encourages the computer user to have fun. *Creative Computing* makes it possible for me to learn basic programming skills and use the computer better than any other source.

Hard-hitting Evaluations

At *Creative Computing* we obtain new computer systems, peripherals, and software as soon as they are announced. We put them through their paces in our Software Development Center and also in the environment for which they are intended—home, business, laboratory, or school.

Our evaluations are unbiased and accurate. We compared word processing printers and found two losers among highly promoted makes. Conversely, we found one computer had far more than its advertised capability. Of 16 educational packages, only seven offered solid learning value.

When we say unbiased reviews we mean it. More than once, our honesty has cost us an advertiser—temporarily. But we feel that our first obligation is to our readers and that editorial excellence and integrity are our highest goals.

Karl Zinn at the University of Michigan feels we are meeting these goals when he writes. "*Creative Computing* consistently provides value in articles, product reviews and systems comparisons . . . in a magazine that is fun to read."

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COMPUTER SOURCES

By Leslie Solomon
Senior Technical Editor

Hardware

Miniature Computer. The SM-1, called The Small One, is 20 by 8 by 16 inches and contains a 9-inch, nonglare CRT, a 1920 character display, and a hinged keyboard. All 128 ASCII characters are available via the 77-key board. The hardware features 48K bytes

of RAM, expandable, in 16K byte increments, a floppy disk that provides 80-170K bytes of storage, and expansion for 5- to 8-inch drives. It uses the IEEE S-100 bus and has five card slots. Software includes GMOS operating system that is compatible with Cromemco CDOS and Digital Research CP/M. It provides print spooling, Copyfile for single disk back up, a line-oriented text editor, and English-language error messages. An optional switching power supply enables operation from 10 volts dc to 240 volts ac. Address: GM Research, Inc., 1048 East Burgrove St., Carson, CA 90746 (Tel: 213-639-4663).

TRS-80 Tape Digitizer. Claiming to eliminate bad tape loads while permitting copying of data and program tapes without the use of the TRS-80, the Tape Digitizer creates tapes that can be played back on any TRS-80 with compatability to Level I and Level II formats. It will also make copies of system tapes. It connects between the cassette recorder and the TRS-80 tape/earphone jack. $54.95. Address: Alphanetics, Box 597, Forestville, CA 95436 (Tel: 707-887-7237).

Two-Way Interface for the PET. SADI is a two-way RS-232 and parallel output interface for the PET that allows connection to parallel or serial printers, terminals, modems, etc. The independent ports allow simultaneous operation. Features include conversion to ASCII, cursor controls and function characters specially printed, selectable reversal of upper and lower case, PET IEEE connector for daisy chaining, and addressability for use with other devices. Baud rates are selectable from 75 to 9600, half or full duplex, 32 character buffer, X-on/X-off automatically sent, and selectable carriage return delay. The parallel port provides data strobe and device ready in either polarity, plus Centronics printer compatibility. $295. Address: Connecticut Microcomputer Inc., 34 Del Mar Drive, Brookfield, CT 06804 (Tel: 203-775-4595).

GPIB-488 to TRS-80. The Model 488-80B interface enables any TRS-80 Model 1 with a minimum of 16K RAM and Level 2 BASIC to be used as a GPIB-488 controller. A machine-language driver on tape or diskette interacts with Level 2, Level 3, or Disk BASIC. The interface connects to as many as 15 GPIB-488 peripherals. $225. Address: Scientific Engineering Labs., 11 Neil Drive, Old Bethpage, NY 11804 (Tel: 516-694-3205).

S-100 Prototype Board. The S100PWWB is a 9-inch deep, S-100, Wire-Wrap prototyping board for the IEEE-696 bus standard, compliance H. It will accommodate over 100 16-pin Wire-Wrap sockets and comes with on-board regulators for 5 volts at 3 amperes, and ± 12 volts at 1 amp. Twenty-six decoupling capacitors are distributed on the board. Silk-screened letters indicate the rows, and numbers identify the columns. The board is double-sided, plated-through with gold-over-nickel connector fingers. $98. Address: Inner Access Corp., Box 888, Belmont, CA 94002 (Tel: 415-591-8295).

Multibus Graphics. The Single Board Video (SBV) interface for 8-bit Multibus systems generates an EIA RS-170 composite video output. Resolution of the monochrome graphics is 256 by 240 pixels and up to 65K bits of data can be stored in the memory. Fields can be blanked or inverted and the entire screen can be cleared in 3.3 ms. Text is four times conventional size and can be read at 20 feet. Upper and lower case are generated on a 9 × 7 matrix in an 8 × 16 cell. This allows for descenders. Up to 480 characters can be displayed at one time. Characters can be inverted or blinked and vertically scrolled. A light pen can be used if desired.$750. Address: Artec Electronics, 605 Old Country Rd., San Carlos, CA 94070 (Tel: 415-592-2740).

Apple Video. The Full-View 80 provides an 80×24 alphanumeric display for the Apple II, yet retains the conventional Apple character and graphics operating mode. Upper and lower case is provided and a 7×9 dot character size as well as a 5×7 dot character size is available. Custom characters are available via an EPROM. Either a 2732 (255 characters) or a 2716 (127 characters) may be used. Characters can be defined as large as 8×16. On-board 2K firmware provides full keyboard editing, complete cursor control, and tabbing. Firmware includes PASCAL and BASIC protocols. A real-time clock, and a light-pen connector are additional features. $395. Address: Bit-3 Computer Corp., 1890 Huron St., St. Paul, MN 55113 (Tel: 612-926-6997).

Robot Base Unit. The RBU-II is a powerful, twin-tread, steerable mobile base platform that can carry up to 100 pounds as fast as two feet per second. Power is supplied through two gear reducers at 6 to 12 volts and 3 amperes. Weight is 45 pounds. $495 plus $15 shipping. Address: Hobby Robotics Co., Dept PE, Box 997, Lilburn, GA 30247.

STD Bus Card Rack. The CR24A is a card rack that will hold up to 24 STD Bus cards. It bolts into an EIA standard 19" rack and provides 16 card slots on one-half-inch centers and eight card slots on one-inch centers. The mother board reduces crosstalk between lines and can operate to +125°C with 95% humidity. It accepts STD cards of all manufacturers. Address: Pro-Log Corp., 2411 Garden Rd., Monterey, CA 93940 (Tel: 408-372-4593).

Software

COBOL Course. The Heathkit/Zenith EC-1105 COBOL Programming Course covers both ANS 74 and ANS 68 versions of COBOL. It teaches the fundamentals of encoding, input characteristics, program hierarchy, identification, environment, data and procedure divisions. Six practice programs are included. The text is reinforced with nine audio cassettes. $149.95. Address: Heathkit/Zenith Educational Systems, Dept. 350-490, Benton Harbor, MI 49022.

Ohio Scientific CP/M. CP/M2 for Ohio Scientific C3 computers, compatible with the original CP/M disk format, is now available. Disk read operations are four to five times faster and disk write operations can be 50 times as fast. The software also compensates for the 2- or 4-MHz CPU operation and can be configured for the older slow-stepping disk drives or the newer fast-steppers. The software includes a disk-to-disk copy routine, a memory test, and I/O drivers for all Ohio Scientific peripherals. $200. Address: Lifeboat Associates, 1651 Third Ave., New York, NY 10028 (Tel: 212-860-0300).

(Continued on page 42)

Write and run programs—the very first night—even if you've never used a computer before!

You're up and running with video graphics for just $99.95 — then use low cost add-ons to create your own personal system that rivals home computers sold for 5-times ELF II's low price!

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Master This Computer In A Flash!

Regardless of how minimal your computer background is now, you can learn to program an ELF II in almost no time at all. Our *Short Course On Microprocessor & Computer Programming*—written in non-technical language—guides you through each of the RCA COSMAC 1802's capabilities, so you'll understand *everything* ELF II can do...*and how to get ELF II to do it!* Don't worry if you've been stumped by computer books before. The *Short Course* represents a major advance in literary clarity in the computer field. You don't have to be a computer engineer in order to understand it. Keyed to ELF II, it's loaded with "hands on" illustrations. When you're finished with the *Short Course*, neither ELF II nor the RCA 1802 will hold any mysteries for you.

In fact, not only will you now be able to use a personal computer creatively, you'll also be able to read magazines such as BYTE...INTERFACE AGE...POPULAR ELECTRONICS and PERSONAL COMPUTING and fully *understand* the articles. And, you'll understand how to expand ELF II to give you the exact capabilities you need!

If you work with large computers, ELF II and the *Short Course* will help you understand what they're doing.

Get Started For Just $99.95, Complete!

$99.95 ELF II includes all the hardware and software you need to start writing and running programs at home, displaying video graphics on your TV screen and designing circuits using a microprocessor—the very first night—even if you've never used a computer before.

ELF II connects directly to the video input of your TV set, without any additional hardware. Or, with an $8.95 RF modulator (see coupon below), you can connect ELF II to your TV's antenna terminals instead.

ELF II has been designed to play all the video games you want, including a fascinating new target/missile gun game that was developed specifically for ELF II. But games are only the icing on the cake. The real value of ELF II is that it gives you a chance to write machine language programs—and machine language is the fundamental language of all computers. Of course, machine language is only a starting point. You can also program ELF II with assembly language and tiny BASIC. But ELF II's machine language capability gives you a chance to develop a working knowledge of computers that you can't get from running only pre-recorded tape cassettes.

ELF II Gives You The Power To Make Things Happen!

Expanded, ELF II can give you more power to make things happen in the real world than heavily advertised home computers that sell for a lot more money. Thanks to an ongoing committment to develop the RCA 1802 for home computer use, the ELF II products—being introduced by Netronics—keep you right on the outer fringe of today's small computer technology. It's a perfect computer for engineering, business, industrial, scientific and personal applications.

Plug in the **GIANT BOARD** to record and play back programs, edit and debug programs, communicate with remote devices and make things happen in the outside world. Add **Kluge** (prototyping) **Board** and you can use ELF II to solve special problems such as operating a complex alarm system or controlling a printing press. Add **4k RAM Boards** to write longer programs, store more information and solve more sophisticated problems.

ELF II add-ons already include the **ELF II Light Pen** and the amazing **ELF-BUG Monitor**—two extremely recent breakthroughs that have not yet been duplicated by any other manufacturer.

The ELF-BUG Monitor lets you debug programs with lightening speed because the key to debugging is to know what's inside the registers of the microprocessor. And, with the ELF-BUG Monitor, instead of single stepping through your programs, you can now display the entire contents of the registers on your TV screen. You find out immediately what's going on and can make any necessary changes.

The incredible ELF II Light Pen lets you write or draw anything you want on a TV screen with just a wave of the "magic wand." Netronics has also introduced the ELF II Color Graphics & Music System—more breakthroughs that ELF II owners were the first to enjoy!

ELF II Tiny BASIC

Ultimately, ELF II understands only machine language—the fundamental coding required by all computers. But, to simplify your relationship with ELF II, we've introduced an **ELF II Tiny BASIC** that makes communicating with ELF II a breeze.

Now Available! Text Editor, Assembler, Disassembler And A New Video Display Board!

The Text Editor gives you word processing ability and the ability to edit programs or text while it is displayed on your video monitor. Lines and characters may be quickly inserted, deleted or changed. Add a printer and ELF II can type letters for you—error free—plus print names and addresses from your mailing list!

ELF II's **Assembler** translates assembly language programs into hexidecimal machine code for ELF II use. The Assembler features mnemonic abbreviations rather than numerics so that the instructions on your programs are easier to read—this is a big help in catching errors.

ELF II's **Disassembler** takes machine code programs and produces assembly language source listings. This helps you understand the programs you are working with...and improve them when required.

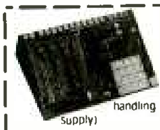
The new **ELF II Video Display Board** lets you generate a sharp, professional 32 or 64 character by 16 line upper and lower case display on your TV screen or video monitor—dramatically improving your unexpanded $99.95 ELF II. When you get into longer programs, the Video Display Board is a real blessing!

Now Available!

☐ **A-D/D-A Board Kit** includes 1 channel (expandable to 4) D-A, A-D converters, $39.95 plus $2 postage & handling.

☐ **PILOT Language**—A *new* **text-oriented** language that allows you to write educational programs on ELF II with speed and ease! Write programs for games...unscrambling sentences...spelling drills..."fill in the missing word" tests, etc.! PILOT is a must for any ELF II owner with children. *PILOT Language on cassette tape, only $19.95 postpaid!*

☐ **Game Package** on cassette tape (requires 4k RAM), $9.95 plus $2 postage & handling.



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☐ Power Supply (required) $4 95 postpaid

☐ RCA 1802 User s Manual $5 postpaid

☐ Tom Pittman s **Short Course On Microprocessor & Computer Programming** teaches you just about everything there is to know about ELF II or any RCA 1802 computer Written in non-technical language. it s a learning breakthrough for engineers and laymen alike $5 postpaid

☐ Deluxe Metal Cabinet with plexiglas dust cover for ELF II $29 95 plus $2 50 p&h

☐ I am also enclosing payment (including postage & handling) for the items checked below'

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ALSO AVAILABLE FOR ELF II

☐ **GIANT BOARD™** kit with cassette I/O RS 232 C/TTY I/O 8 bit P I/O decoders for 14 separate I/O instructions and a system monitor/editor **$39.95** plus $2 p&h

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☐ **Video Display Board** kit lets you generate a sharp. professional 32 or 64 character by 16 line upper and lower case display on your tv screen or video monitor—dramatically improving your unexpanded $99 95 ELF II (Fits inside ASCII Keyboard cabinet) **$89.95** plus $2 p&h

☐ **ELF II Tiny BASIC** on cassette tape Commands include SAVE LOAD ± × − () 26 variables A-Z LET. IF/THEN INPUT PRINT GO TO GO SUB RETURN END REM CLEAR LIST RUN PLOT PEEK POKE Comes fully documented and includes alphanumeric generator required to display alphanumeric characters directly on your tv screen without additional hardware Also plays tick tack-toe plus a drawing game that uses ELF II s hex keyboard as a joy stick 4k memory required **$14.95** postpaid

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☐ **ELF-BUG™ Deluxe System Monitor** on cassette tape Allows displaying the contents of all registers on your tv at any point in your program Also displays 24 bytes of memory with full addresses blinking cursor and auto scrolling A must for the serious programmer' **$14.95** postpaid

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By Netronics

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Computer Terminal

COMPLETE FOR ONLY... $149.95

The Netronics ASCII/BAUDOT Computer Terminal Kit is a microprocessor-controlled, stand alone keyboard/terminal requring no computer memory or software. It allows the use of either a 64 or 32 character by 16 line professional display format with selectable baud rate, RS232-C or 20 ma. output, full cursor control and 75 ohm composite video output.

The keyboard follows the standard typewriter configuration and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard regulators, selectable parity, shift lock key, alpha lock jumper, a drive capability of one TTY load, and the ability to mate directly with almost any computer, including the new Explorer/85 and ELF products by Netronics.

The Computer Terminal requires no I/O mapping and includes 1k of memory, character generator, 2 key rollover, processor controlled cursor control, parallel ASCII/BAUDOT to serial conversion and serial to video processing—fully crystal controlled for superb accuracy. PC boards are the highest quality glass epoxy for the ultimate in reliability and long life.

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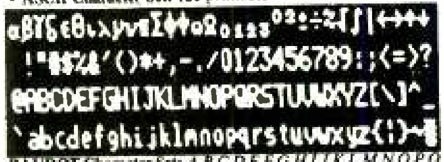
The heart of the Netronics Computer Terminal is the microprocessor-controlled Netronics Video Display Board (VID) which allows the terminal to utilize either a parallel ASCII or BAUDOT signal source. The VID converts the parallel data to serial data which is then formatted to either RS232-C or 20 ma. current loop output, which can be connected to the serial I/O on your computer or other interface, i.e., Modem.

When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

Video Output: *1.5 P/P into 75 ohm (EIA RS-170)* • **Baud Rate:** *110 and 300 ASCII* • **Outputs:** *RS232-C or 20 ma. current loop* • **ASCII Character Set:** *128 printable characters—*



BAUDOT Character Set: *A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? : • 3 $ # ( ) . , 9 0 1 4 ! 5 7 ; 2 / 6 8* • **Cursor Modes:** *Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing* • **Cursor Control:** *Erase, End of Line, Erase of Screen, Form Feed, Delete* • **Monitor Operation:** *50 or 60Hz (jumper selectable.*

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☐ **Netronics Stand Alone ASCII Keyboard/Computer Terminal Kit, $149.95** plus $3.00 postage & handling.

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☐ **12" Video Monitor** (10 MHz bandwidth) fully assembled and tested, **$139.95** plus $5 postage and handling.

☐ **RF Modulator Kit** (to use your TV set for a monitor), **$8.95** postpaid.

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Signature ________________ Exp. Date ________

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☐ **Send Me More Information**

Atari Directory. A free directory of software for Atari computers is available by sending a stamped, self-addressed envelope to Robert Purser, Box 466, El Dorado, CA 95623.

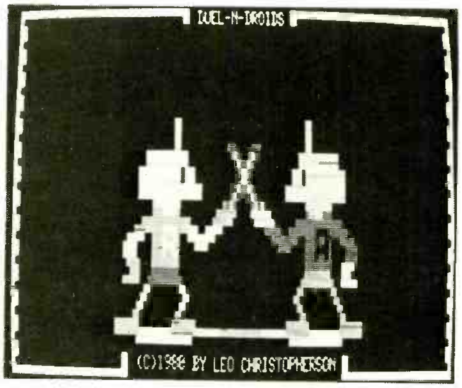
New DOS Commands. Providing eight new DOS commands, this utility package is an enhancement to the TRS-80 Model II. It includes the recovery of "blown" diskettes with the internal structure of diskettes, along with recovery techniques, fully documented; providing multi-file copies, wild-card mask select, I/O and directory error recovery modes, absolute sector mode, and others; examine/change diskette contents including track 0 and make an absolute disk backup/copy with I/O recovery provided; catalog diskette directories by name; and change disk names and create files. $150. Address: RACET Computes, 702 Palmdale, Orange, CA 92665 (Tel: 714-637-5016).

Handicapped Communicator. The Microcommunicator software enables an Apple computer to act as a communications device for severely handicapped people. No peripherals are required and only a single disk is needed. In operation, a single keystroke by finger or mouthstick will display any sentence selected from 60 or more programmed sentences that can be changed at any time. Messages of up to 100 words and phrases can be constructed for display or printout and selected from over 1600 sentence-building words, phrases, and suffixes, plus more than 250 words listed by categories. There is also a 50-word list for names, addresses, phone numbers, etc. Available at adult or children's level. $41.75. Address: Grover and Associates, Creekside Center, Suite D116, 7 Mt. Lassen Dr., San Rafael, CA 94903 (Tel: 415-479-5906).

Dynamic Simulation. ACES (Apple Continuous Equation Simulator) can be used by engineering/scientific students or professionals involved with large differential equations in control systems, electronics, aerodynamics, thermodynamic, and fluidic analyses. It is written in Applesoft and allows interactive run/rerun features. Solutions are provided via high-res graphics and a screen/printer tabular listing. Problem size can be in excess of 150 integrators on a 48K system. $149.95 Address: Modulo-2 Co., Box 3795, University Park, NM 88003 (Tel: 505-522-0592).

PET/CBM Disk Cataloger. The Disk Master for PET/CBM machines can be used to catalog 140 diskettes forming a master directory on a single diskette. The program automatically reads the directory blocks of any disk being cataloged so no typing is involved. The five major functions include: update of the master directory; delete a disk entry; display of directory with files in alphabetical order and including disk identification, number of blocks free, file size in blocks including name and type, and total number of files; find a specified file; and list disk ID's and names. $10 on cassette, $12 on diskette. Address: Baker Enterprises, 15 Windsor Drive, Atco, NJ 08004 (Tel:609-767-3085).

TRS-80 Androids. Duel-n-Droids is a sound and graphics game for the TRS-80 Level II. It features two androids



that square off against each other with swords. There are two modes—practice and tournament. Each droid can defend, back off, or attack. In the duel mode, the computer operates one droid. $14.95 on cassette, $20.95 on diskette. Address: Acorn Software Products, Inc., 634 North Carolina Ave., SE, Washington, DC 20003 (Tel: 202-544-4259).

Circuit Design. For the TRS-80, the following programs are available: plotting graphs on a line printer including cartesian, semi-log, and polar plots (No. 26000 at $16.95); 6 programs for active filter design covering low/high pass (Bessel, Butterworth, 1-, 2-, and 3-dB Chebyshev), state-variable, bandpass, stagger-tuned Butterworth bandpass, and notch filters (No. 26001 at $21.95); 3 programs for descriptive statistics (mean, standard deviation, variance, kurtosis, and z-scores), curvilinear regression (linear, inverse, polynomial, exponential, and log.), and multivariable linear regression, (No. 26002 at $21.95); 5 Electronics I programs including zener regulation, 555 timer, transistor bias parameters, single-stage transistor amplifier design, heat sinks, etc. (No. 26003 at $16.95); 7 Electronics II programs with 4-quadrant arctangent function, rectangular/polar conversion and complex number math, minimum and maximum values in an array, roots of polynomials with real coefficients, inverse Laplace transforms of a transfer function, and simultaneous equations with real and complex coefficients (No. 26004 at $16.95); and 8 programs for Electronics III with average and rms values of a periodic function, Fourier series expansion, Fourier transform and spectrum plot, analysis of damped oscillation, and pi-tee transforms (No. 26006 at $16.95). Address: Howard W. Sams and Co., 4300 West 62nd St. Indianapolis IN 46268 (Tel: 317-298-5400). ◇

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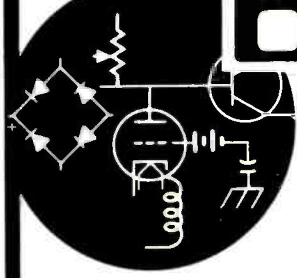

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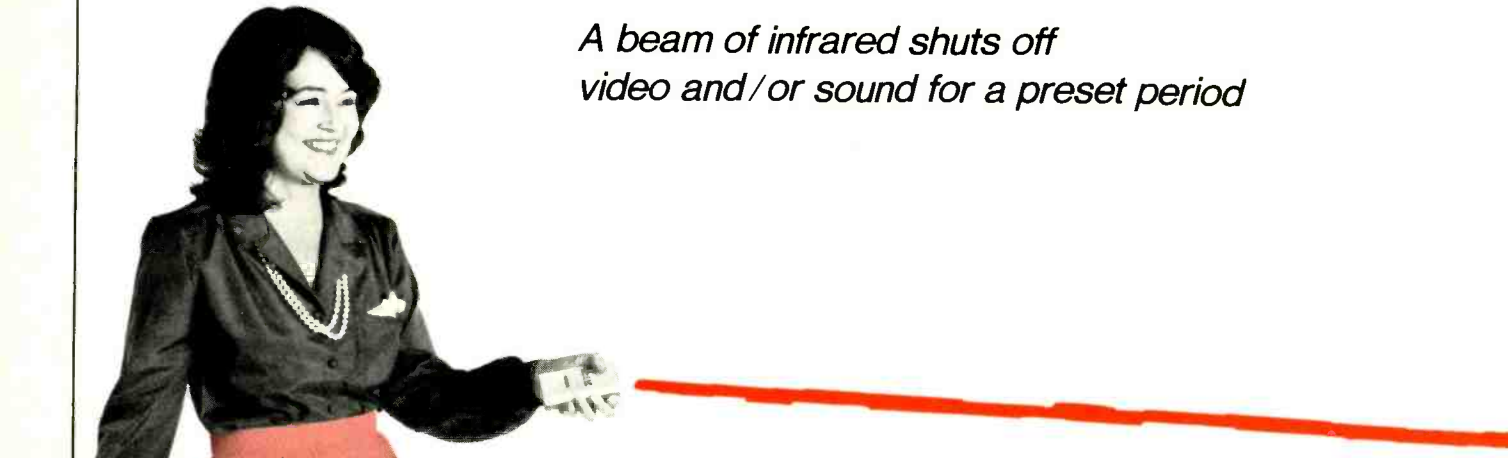



HAS a television commercial ever made you feel like shooting your receiver? Now you can "blow away" commercials without destroying the TV set. The AD*ZAP TV Commercial Killer presented here employs "bullets" of infrared light to kill the sound and/or picture during an annoying advertisement. The project is relatively simple and can be connected to virtually any television receiver with only minor work.

When assaulted by an undesirable commercial, the viewer points a remote transmitter (which can be assembled into a plastic toy pistol or a standard case) at a small photoelectric receiver attached to the TV set and momentarily closes a switch. The transmitter thereupon emits an infrared signal that silences the sound and causes the receiver to start its selectable timing interval (30 or 60 seconds). If a second infrared signal is received during the timing interval, the TV picture tube is darkened. At the end of the interval, normal television-receiver operation is automatically restored. Receipt of a third infrared pulse before the timing interval ends will restore normal TV operation. Since the TV receiver remains powered and in sync during the timing interval, the picture returns without rolling or tearing.

The transmitter is a small, self-contained, battery-powered wireless unit. Its companion receiver is housed in a small metallic enclosure that is generally positioned atop the TV set. The AD*ZAP receiver is powered by a small wall-mount transformer and is connected to the rear panel of the television receiver by means of a multi-conductor cable of convenient length. Disconnecting the AD*ZAP receiver from the TV set leaves the TV fully ready for normal operation.

About the Circuit. The schematic diagrams of two versions of the AD*ZAP transmitter are shown in Fig.1. At A is the transmitter circuit designed for installation in a plastic enclosure approximately the size of a pack of cigarettes.

BY DIETRICH SEAMAN

The circuit shown at B is almost identical and is designed to be mounted in a plastic-body six-shooter similar to the type used in some electronic target-practice games.

When switch *S1* is closed, battery power is applied to the astable multivibrator comprising 555 timer *IC1* and associated components. The multivibrator begins to oscillate and, when the output pulse causes pin 3 of *IC1* to be low (about 25% of the time), high-level current pulses flow through infrared emitter *LED1*. The LED radiates bursts of infrared at a rate of approximately 3.2 kHz. The exact pulse rate is determined by the setting of trimmer potentiometer *R2*. Capacitor *C3* ensures that enough current is available to the circuit during the time that *LED1* is conducting.

The schematic diagram of the AD•ZAP receiver is shown in Fig. 2. Pulsed infrared from the transmitter causes phototransistor *Q1* to turn on and off at around 3.2 kHz. Before infrared signals reach the phototransistor, they pass through an optical bandpass filter that attenuates much of the incident visible light that would otherwise affect the operation of *Q1*.

Voltage pulses developed across the phototransistor are amplified 60 dB by ac-coupled amplifiers *IC1F* and *IC1E*. These stages, as well as the high-Q, active state-variable filter that follows (*IC1A*, *IC1B*, *IC1C*), are part of a CD-4069 hex inverter. Although this CMOS chip is usually employed in a nonlinear operating mode, it is used here as linear amplifier inverter gates, much as low-gain op amps.

Also employed in this fashion is unity-gain buffer amplifier *IC1D*. This buffer supplies filtered pulses to the detector comprising *C6*, *C7*, *D1*, *D2*, and *IC3A*. Diode *D1* is a biased clamper that limits negative excursions of *IC1D*'s output to a level determined by the setting of THRESHOLD potentiometer *R16*. Half-wave rectifier *D2* passes pulsed positive dc to filter *R17C7*. After approximately 10 milliseconds, the voltage across *C7* increases to a level sufficient to trigger the Schmitt trigger—*IC3A*, *R19*, and *R20*. The output of *IC3A* thus goes to logic 1 when an infrared pulse reaches phototransistor *Q1*. Gate *IC3A*, together with *C8*, *R21* and *R23*, also acts as a debouncer that generates a clean logic pulse when manual control switch *S1* is closed.

The output of *IC3A* is applied to dual D flip-flop *IC2*. This chip is wired to function as a ÷3 counter. The first pulse applied to it causes pin 1 of *IC2A* (the Q output of the first flip-flop) to go to logic 1. As a result, relay driver *Q2* receives base drive from gate *IC3D* via *R29* and begins to conduct. Relay *K1* interrupts the circuit between the audio output stage of the TV set and the TV loudspeaker, and SOUND OFF indicator *LED1* begins to glow. Also, the logic-1 output of gate *IC3D* is inverted by *IC4A*, and the output of this NAND gate brings the RESET input of multistage counter *IC5* to logic 0. The counter then begins to tally the 60-Hz pulses that are derived from the ac power line, filtered by passive network *C2R34*, and squared up by Schmitt trigger *IC3B*.

If a second pulse appears at the output of *IC3A* due to either the receipt of another burst of infrared or a closure of switch *S1*, the Q output of *IC2A* (pin 1) returns to logic 0 and the Q output of *IC2B* (pin 13) goes to logic 1. The output of *IC3D* remains at logic 1, keeping *Q2* in saturation, but *Q3* begins to receive base drive from the Q output of *IC2B* via *R26*. As a result, relay *K2* becomes energized and PICTURE OFF indicator *LED2* begins to glow. The relay contacts are connected to the nodes of the television receiver's brightness-determining circuit. Closure of contacts D and F causes the screen to darken.

Both relays remain energized until either a third burst of infrared is received, switch *S1* is closed, or counter *IC5* has tallied 1800 pulses for a 30-second delay or 3600 pulses for a 60-second delay, depending on the setting of *S2*. If the counter runs through its cycle undisturbed, it will reset itself via *IC4B* and *IC4A* and will reset *IC2A* and *IC2B* via *IC4B*, *IC4A*, and *IC3C*. Both relays will then be deenergized and normal television reception will be reestablished. The counting cycle can be interrupted and the relay(s) deenergized at any time by a closure of *S1*. Passive components *C9* and *R24* generate a 100-millisecond pulse when power is first applied to the circuit. This pulse is routed to the RESET inputs of *IC2A* and *IC2B* via *IC3C* and ensures that both flip-flops are properly initialized and the relays deenergized in spite of any turn-on transients.

Power required by the AD•ZAP receiver is furnished by the simple supply shown in the lower right corner of Fig. 2. Unregulated dc provided by bridge rectifier *D3* through *D6* and filter capacitor *C11* powers the relay and LED indicator circuits. The CMOS logic ICs are powered by +5 volts regulated, which is furnished by integrated regulator *IC6*. This particular supply voltage was chosen for the CMOS ICs because such circuits when operated in the linear mode exhibit higher gains at lower supply voltages.

Construction. The use of printed-circuit construction techniques is recommended. Suitable full-size etching and drilling guides for the two versions of the AD•ZAP transmitter are shown in Figs. 3A and 3B. The receiver pattern is shown in Fig. 4. The full-size etching and drilling guide of the circuit board that accommodates relays *K1* and *K2* and protective diodes *D7* and *D8* appears in Fig. 5. This latter board should be mounted inside the TV receiver's cabinet. Corresponding component-placement guides for these boards appear in Figs. 6A, 6B, 7, and 8.

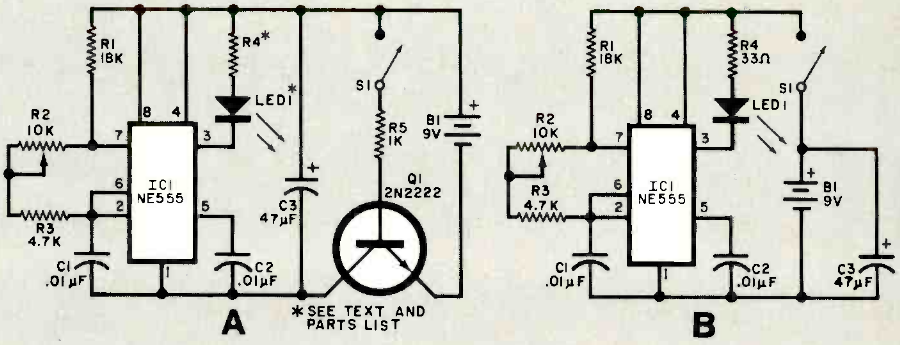


Fig. 1. Schematic diagrams of the box-style (A) and gun-style (B) infrared transmitters.

BOX-STYLE TRANSMITTER PARTS LIST

B1—9-volt transistor battery
C1—0.01µF, 10% tolerance Mylar capacitor
C2—0.01-µF disc ceramic capacitor
C3—47-µF, 10-volt radial-lead aluminum electrolytic or tantalum capacitor
IC1—NE555 timer
LED1—TIL32 unlensed infrared-emitting diode or TIL31 or LED55C lensed infrared-emitting diode
Q1—2N2222 npn silicon switching transistor
The following, unless otherwise specified, are ¼-watt, 10% tolerance, carbon-composition fixed resistors.
R1—18 kΩ
R2—10 kΩ, linear-taper horizontal pc-mount trimmer potentiometer
R3—4.7 kΩ
R4—33 Ω if *LED1* is a TIL32 unlensed diode, 15 Ω if *LED1* is a TIL31 or LED55C lensed diode
R5—1 kΩ
S1—Spst, normally open, momentary-contact pushbutton switch
Misc.—Mounting collar for *LED1*, lens for *LED1* if a TIL32 device is used, printed-circuit board, battery clip, suitable enclosure, solder, pc-board standoffs, suitable hardware, etc.

Note—Pushbutton switch S1 is a Panasonic No. EVQ-P1R component that is available from Digi-Key, Box 677, Highway 32 South, Thief River Falls, MN 56701.

GUN-STYLE TRANSMITTER PARTS LIST

B1—9-volt transistor battery
C1—0.01-µF, 10%-tolerance Mylar capacitor
C2—0.01-µF disc ceramic capacitor
C3—47-µF, 10-volt radial-lead aluminum electrolytic or tantalum capicitor
IC1—NE555 timer
LED1—TIL32 infrared-emitting diode
The following, unless otherwise specified, are ¼-watt, 5%-tolerance, carbon-composition fixed resistors.
R1—18 kΩ
R2—10 -kΩ, linear-taper vertical pc-mount trimmer potentiometer
R3—4.7 kΩ
R4—33 Ω
Misc.—Printed-circuit board, battery clip, plastic-body Coleco electronic-game gun with trigger-actuated switch (*S1*) and lens system, solder, etc.

Note—The Coleco gun is available from Meshna Electronics, Box 62, 19 Allerton Street, East Lynn, MA 01904.

Most components mount directly on the boards or via sockets. Exceptions include phototransistor *Q1*, resistor *R1*, and plug-in wall transformer *T1*. To suppress feedback-induced oscillations, one end of *R1* is connected directly to the base lead of *Q1*. The other end of *R1* and the collector and emitter leads of *Q1* are connected to the appropriate pc foil pads via short lengths of insulated hookup wire. Similarly, *LED1* and *LED2* are connected to the board with insulated hookup wire.

It is good practice to install lengths of spaghetti or heat-shrinkable tubing on the exposed leads of all components that are mounted off the board to prevent accidental short circuits. The AD•ZAP receiver circuit board *must* be housed in a metallic enclosure.

Substitutions should not lightly be made for phototransistor *Q1*. For the device specified and the parameters of the circuit shown in Fig. 2, the phototransistor should function in the linear portion of its response curve for ambient light levels of up to 50 foot-candles of incandescent light or 150 foot-candles of daylight. Sensitivity of the device specified can vary over a 7:1 range. Therefore, the circuit incorporates means to compensate for such sensitivity variations. For example, it may be necessary to change the value of resistor *R3* or to even substitute another phototransistor of the same type. (Note that photodarlingtons have too much gain and will, therefore, not

(Text continued on page 48)

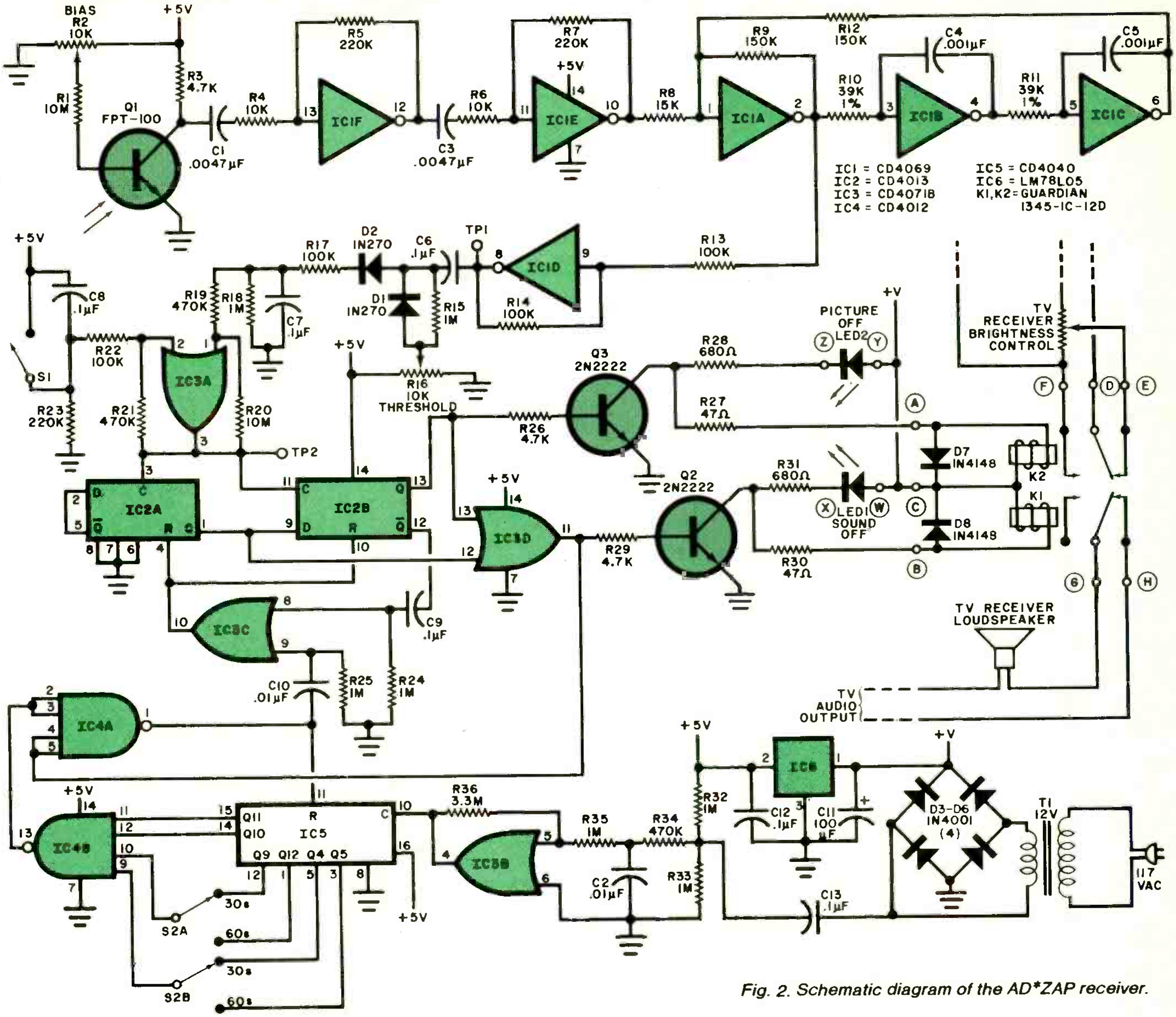


*Fig. 2. Schematic diagram of the AD*ZAP receiver.*

RECEIVER PARTS LIST

C1,C3—0.0047-μF disc ceramic capacitor
C2,C10—0.01-μF disc ceramic capacitor
C4,C5—0.001-μF, 5% tolerance Mylar or polystyrene capacitor
C6,C7,C8,C9,C12, C13—0.1-μF disc ceramic capacitor
C11—100-μF, 25-volt axial-lead aluminum electrolytic
D1,D2—1N270 or equivalent germanium diode
D3 through D6—1N4001 rectifier
D7,D8—1N914 or 1N4148 silicon switching diode
IC1—CD4069 hex inverter
IC2—CD4013 dual D flip-flop
IC3—CD4071B quad 2-input OR gate (device must have B suffix)
IC4—CD4012 dual four-input NAND gate
IC5—CD4040 12-stage binary counter
IC6—LM78L05 5-volt, 100-mA regulator
K1,K2—Spdt relay with 12-volt dc, 1400-ohm coil (Guardian No. 1345-1C-12D or equivalent)
LED1—Yellow light-emitting diode
LED2—Red light-emitting diode
Q1—FPT-100 phototransistor (Fairchild)
Q2, Q3—2N2222 npn silicon switching transistor
The following, unless otherwise specified, are ¼-watt, 5% tolerance, carbon-composition fixed resistors.
R1, R20—10 MΩ
R2, R16—10-kΩ linear-taper, horizontal pc-mount trimmer potentiometer
R3,R26,R29—4.7 kΩ
R4, R6—10 kΩ
R5, R7, R23—220 kΩ
R8—15 kΩ
R9, R12—150 kΩ
R10, R11—39 kΩ, 1%-tolerance, ¼-watt, metal-film
R13, R14, R17, R22—100 kΩ
R15, R18, R24, R25, R32, R33, R35—1 MΩ
R19, R21, R34—470 kΩ
R27, R30—47 Ω
R28, R31—680 Ω
R36—3.3 MΩ
S1—Spst, normally open, momentary-contact pushbutton switch
S2—Dpdt miniature slide switch
T1—12-volt ac, 100-mA wall-mount plug-in transformer
Misc.—Printed circuit board, suitable metallic enclosure, LED mounting collars, grommets, infrared bandpass filter (see note below), heat-shrinkable tubing, hookup wire, solder, pc standoffs, suitable hardware, etc.

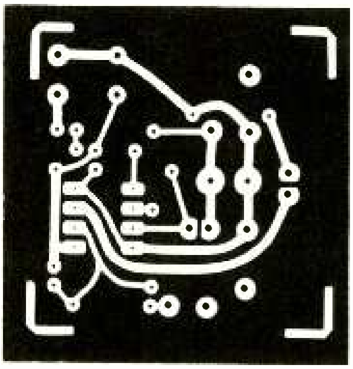
Note 1—Pushbutton switch S1 is a Panasonic No. EVQ-P1R component that is available from Digi-Key, Box 677, Highway 32 South, Thief River Falls, MN 56701.

Note 2—There are several possible items that can be used as an infrared bandpass filter. The author used a ¼-inch circular piece of Eastman Kodak Wratten No. 89B gelatin filter. Kodak advises that a piece of unexposed but processed Kodachrome slide film can also be used, as it blocks visible light almost completely but is transparent to infrared. Gelatin Wratten filters measuring 2 inches square are available from Eastman Kodak dealers for approximately $5.00 each.

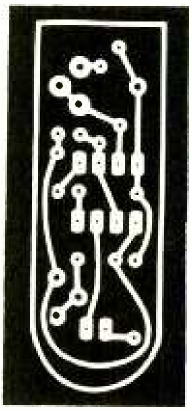
work.) The phototransistor should be mounted on the front panel of the AD*ZAP receiver's enclosure. The device specified just fits a standard 0.200-inch (Jumbo) LED mounting collar.

An infrared optical filter is mounted in front of the phototransistor's aperture. Use black silicone cement or some similar opaque material to ensure that no light can leak in behind the filter. The two indicator LEDs can also be mounted on the receiver enclosure's front panel. To facilitate interconnection of the receiver circuit and relay board, a multiconductor connector should be mounted on the enclosure.

For convenience, the author mounted his relay board inside the television receiver with which the AD*ZAP system was to be used. If you plan to use your system with more than one TV set, a separate relay board can be used in each. You can substitute the relays specified so long as their coils are rated at 12 volts dc and have resistances of 400 ohms or more. If a dpdt relay is employed for *K1*, the second set of contacts can be used to stop the transport of a video tape recorder during commercial messages.



A



B

Fig. 3. Full-size etching and drilling guides for the box-style (A) and gun-style (B) transmitter pc boards.

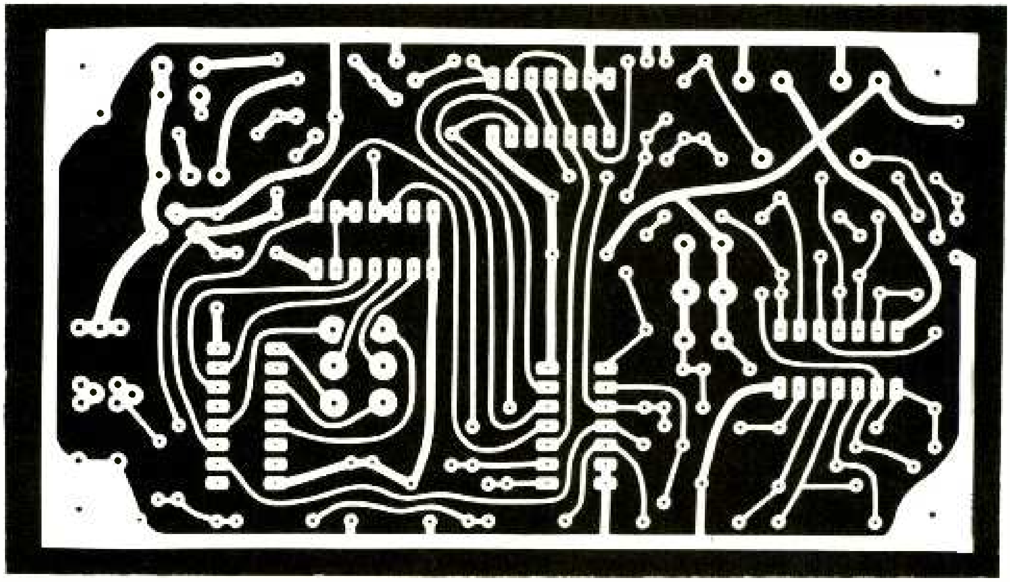


Fig. 4. Full-size etching and drilling guide for the receiver pc board.

The transmitter can be housed in a standard plastic enclosure or, for dramatic fun, a plastic six-shooter such as that used by the author. The "gun," manufactured by Coleco for use in a game, contains a trigger-actuated switch and a lens system. The pc board pattern of Fig. 3B was designed for use with this gun. Careful attention to dimensions will ensure proper alignment of the LED with the lenses, giving a narrow, correctly aimed beam.

To fit a nine-volt battery into the handle of the pistol, the internal plastic posts between the holes for the two handle screws must be cut away. This can be done with a heated knife or with a hobby power tool and its saw blade. Also, the terminals on the rear of the trigger-actuated switch must be cut off. The necessary electrical connections between the switch and the rest of the transmitter circuit should be made by soldering suitable lengths of hookup wire directly to the switch's leaf springs. Use a vise to hold the switch and then tin the leaf springs and the ends of the lengths of hookup wire. Place the tinned end of each wire next to the appropriate leaf spring and remelt the solder to form the connection. Work quickly to avoid losing the temper of the springs. Finally, make a 1/8-inch hole in the plastic body over the position occupied by trimmer potentiometer *R2* so that the circuit's frequency of oscillation can be conveniently adjusted.

If you prefer a more conventional transmitter enclosure, you will need a lens to focus the infrared beam. Focusing the invisible beam is difficult. Alter-

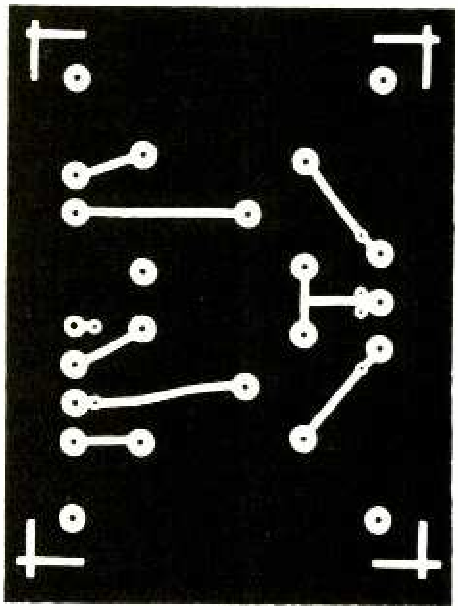


Fig. 5. Etching and drilling guide for relay pc board.

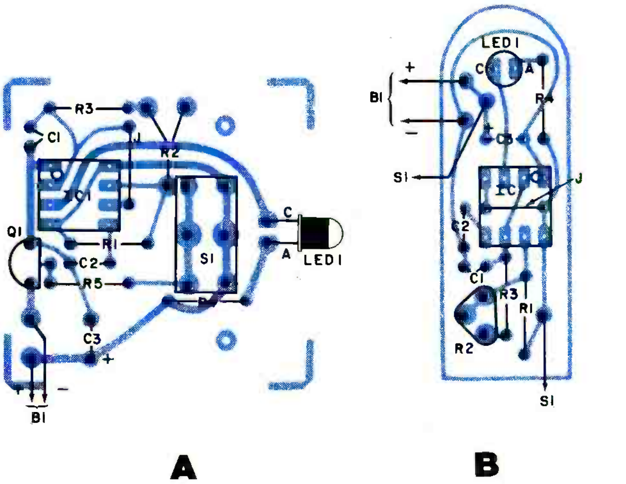


Fig. 6. Parts placement guides for the box-style (A) and gun-style (B) infrared transmitters.

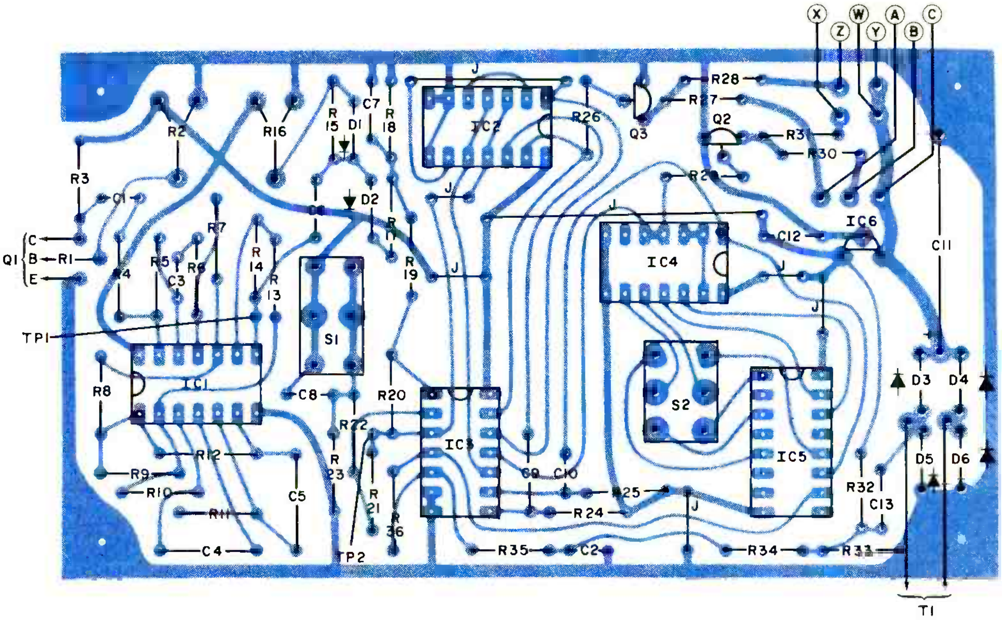


Fig. 7. Parts placement guide for the AD*ZAP infrared receiver printed circuit board.

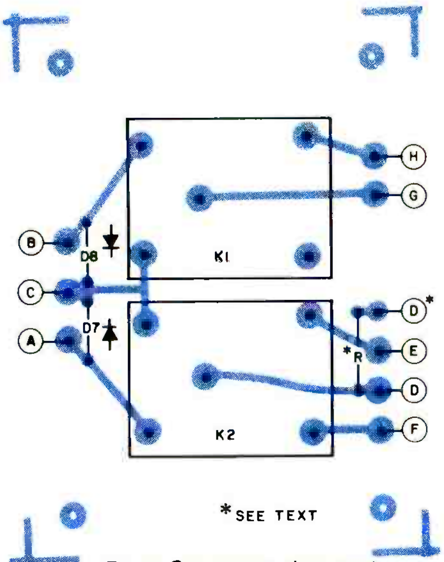


Fig. 8. Component placement guide for the relay pc board.

natively, you can use a Texas Instruments TIL31 or General Electric LED55C infrared-emitting diode. These include internal reflectors and glass lenses and mount in standard 0.200-inch LED mounting collars. They also tolerate larger forward currents, allowing reduction of the value of *R4* in the transmitter to 15 ohms. Pass transistor *Q1* and base resistor *R5* in the circuit of Fig. 1A allow switch *S1* to be a light-action, low-current keyboard switch.

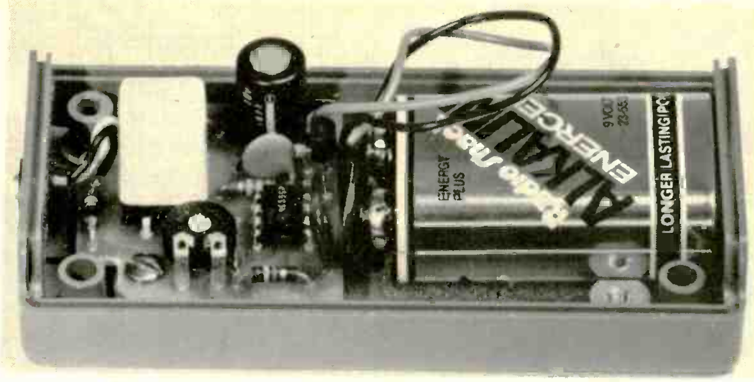
Adjustment. After the receiver and transmitter have been assembled, plug *T1* into a wall socket. With the top of the receiver enclosure removed, monitor the voltage across resistor *R3* with a high-impedance multimeter. Place an unshaded, lighted 60-watt light bulb two feet away from the filter that shields phototransistor *Q1*, and set the wiper of trimmer potentiometer *R2* fully counterclockwise. The voltage across *R3* should be 2.5 ±0.5 V. If necessary, change the value of *R3* to obtain this reading. Should this prove impossible, try another FPT-100 phototransistor.

When the voltage across *R3* is correct, cover the filter aperture with a totally opaque shield and adjust *R2* so that 0.25 volt appears across *R3*. Then remove the opaque shield.

Next, turn *R16* fully counterclockwise and check the voltage at *TP2*. This should be 0 volt. Slowly turn *R16* clockwise. At some point, *TP2* should suddenly go to +5 volts. When this happens, back *R16* off and stop just past the point at which *TP2* returns to 0 volt. Depress switch *S1* momentarily and verify that *TP1* goes to +5 volts with *S1* closed and returns to 0 volt when it is opened; if *TP2* fails to return to 0 volt when *S1* is released, turn *R16* a bit further counterclockwise.

Finally, to set the frequency of the transmitter's astable multivibrator to match the receiver's filter passband, connect an ac voltmeter or oscilloscope between *TP1* and ground. Have a friend monitor the voltage reading while you stand several feet away and "fire" the transmitter at the receiver's infrared filter. Hold the transmitter switch *S1* so that a continuous infrared output is generated. (With a pistol transmitter, pull the hammer back all the way and hold it.) Adjust transmitter trimmer potentiometer *R2* for a maximum voltage reading on the test instrument.

Place the top on the receiver enclosure and secure it in place. Connect the relay board to the rest of the receiver circuit and, if necessary, button up the transmitter enclosure. Making certain that the receiver is getting operating power, aim the transmitter at the receiver's infrared filter. When transmitter switch *S1* is closed momentarily, relay



Photograph of the author's prototype box-style transmitter.

INSTALLATION WHEN SCREEN CAN'T BE DARKENED.

Here are possible ways of darkening the screen even if it doesn't go fully to black when the BRIGHTNESS control is at minimum. First, you will need a schematic of the television receiver. (If one was not supplied with the receiver or is not available from the manufacturer, try the Sams Fotofact series of publications.) Next, you will have to determine how the brightness of the CRT is controlled, and how the range of the BRIGHTNESS potentiometer is affected by the "one-button" color preset, if any.

Several methods of brightness control are common; the simplest is found in many vintage color receivers and in many contemporary monochrome models. (Figure 9 is typical.) The video signal is capacitively coupled to the cathode of the picture tube, and the BRIGHTNESS potentiometer controls the dc bias voltage that sets the average beam current. The lower the bias voltage, the higher the beam current and the brighter the picture. Resistor *R34* limits the beam current to a maximum value.

Brightness-control circuits of this type almost always are able to send the CRT well past cutoff (screen completely dark). If you have a color receiver that employs a similar circuit (the partial schematic illustrated is of a General Electric HB color chassis), note that the red, green and blue SCREEN controls interact with the BRIGHTNESS control. While a video signal is being received, try adjusting the SCREEN controls for cutoff with the BRIGHTNESS control at its minimum setting. Then, if the CRT image is too dim when the BRIGHTNESS control is advanced to its maximum setting (this will rarely be the case), make the value of *R34* half as large. Check to see that the high voltage is at its specified value before making a substitution for *R34*.

The more usual approach to brightness control in today's solid-state receivers is to vary the dc bias at the input of one of the video amplifiers. Video is either dc- or ac-coupled (or a combination of the two) into the stage, and is sometimes clamped to the bias voltage during the blanking interval. The BRIGHTNESS potentiometer can be wired into the circuit either as a voltage divider (as a three-terminal device) or as a variable resistor (a two-terminal device). In the latter case, the potentiometer is only part of a voltage-dividing network. The Sharp Model XR-2194 typifies the first method, the Sony 9000U the second.

In the Sony, the bias voltage of the Y DRIVE amplifier is mixed with the video signal. The video signal is positive, that is, white is more positive than black. Blanking the screen can therefore be accomplished by bringing the base of the Y DRIVE stage to ground, either directly or by opening the path between the voltage divider that sets the bias and the low-voltage supply from which the bias is derived. In the Sharp receiver, the "one-button" color-preset switch selects between the BRIGHTNESS control and a screwdriver-adjustable trimmer potentiometer that is preset at the factory. Both the front-panel BRIGHTNESS control and the trimmer have range-limiting series resistors that prevent them from cutting off the CRT totally. Blanking can be achieved by having the relay disconnect the ends of the front-panel and trimmer potentiometers that are tied together from the source of low voltage which supplies them.

In some sets, the "one-button" color preset leaves the front-panel BRIGHTNESS control in the circuit, but restricts its effective range. One receiver that uses such a circuit is Toshiba's Model C345, chassis TAC-9310. The base of the fourth video amplifier is biased through a fixed resistor by a voltage divider composed of a fixed resistor and the BRIGHTNESS control, one end of which receives positive voltage via a SUB-BRIGHTNESS control. This latter control limits CRT brightness.

When the receiver's "one-button" color preset is engaged, a fixed resistor is placed in parallel with the front-panel BRIGHTNESS control. This restricts the effective range of the control to its upper half. To have AD*ZAP totally darken the screen, relay *K2* can be wired either to ground the wiper of the SUB-BRIGHTNESS control or connect a fixed resistance of approximately 5000 ohms between the base of the fourth video amplifier and ground. The use of such a resistor rather than a direct short to ground prevents the total loss of the demodulated video signal, which would also disable the sync circuits. This way, when *K2* is deenergized, the picture returns instantly—in sync and with no rolling or tearing. The relay pc board includes provisions for such a resistor (*R*) at point D*.

PARTS AND KIT AVAILABILITY

The following are available from Videomega, 2715 N. E. 14th Avenue, Portland, OR 97212. Prices do not include shipping and handling charges ($2 per order). Kits of all components for one transmitter, receiver, and relay board, enclosures, and a nine-volt battery for the transmitters: complete kit for AD*ZAP system employing gun-style transmitter (limited quantities available), No. KZ-S, for $69.00; complete kit for AD*ZAP system employing box-style transmitter, No. KZ-T, for $69.00; complete kit for AD*ZAP system capable of controlling VTR pause circuit, employing gun-style transmitter, and including VTR control cable (limited quantities available), No. KZ-SV, for $79.00; complete kit for AD*ZAP system capable of controlling VTR pause circuit, employing box-style transmitter, and including VTR control cable, No. KZ-TV, for $79.00. Individual kits for additional receivers, transmitters, and relay boards are also available. Write for prices.

Drilled, solder-plated, and silk-screened (component-placement legend) printed-circuit boards are also available separately: Set of boards for receiver, relay circuit, and gun-style transmitter, No. AZ-S, for $16.00; set of boards for receiver, relay circuit, and box-style transmitter, No. AZ-T, for $16.00; set of boards for receiver, relay and VTR pause-control circuits, and gun-style transmitter, No. AZ-SV, for $16.00; set of boards for receiver, relay and VTR pause-control circuits, and box-style transmitter, No. AZ-TV, for $16.00; receiver board only, No. AZ-A, for $7.50.

K1 should pull in and *LED1* glow. When transmitter switch *S1* is closed a second time, *K2* and *LED2* should do likewise. At the end of the interval determined by the setting of receiver switch *S2*, both relays should drop out and both LEDs darken. If *S1* is closed a third time before the receiver times out, this too should de-energize the relays and LEDs. Closure of receiver switch *S1* should initiate the timing sequence or, if it has already begun, interrupt it.

Modifying the TV Receiver. If control of only the audio output of the television is desired the AD*ZAP system can be used with any TV set and installation procedure is simple. However, achieving control of both sound and picture may be somewhat more difficult, depending on the TV set used. Two simple tests will tell you how much of a problem it will be to obtain picture control. If the CRT screen goes completely black when the BRIGHTNESS control is at minimum, installation will be easy. Alternatively, if the receiver has a "one-button" color preset, and the screen goes completely dark when the preset is engaged and the BRIGHTNESS control is at minimum, installation is again not complicated. However, if the screen cannot be wholly "blackened," installation will be more

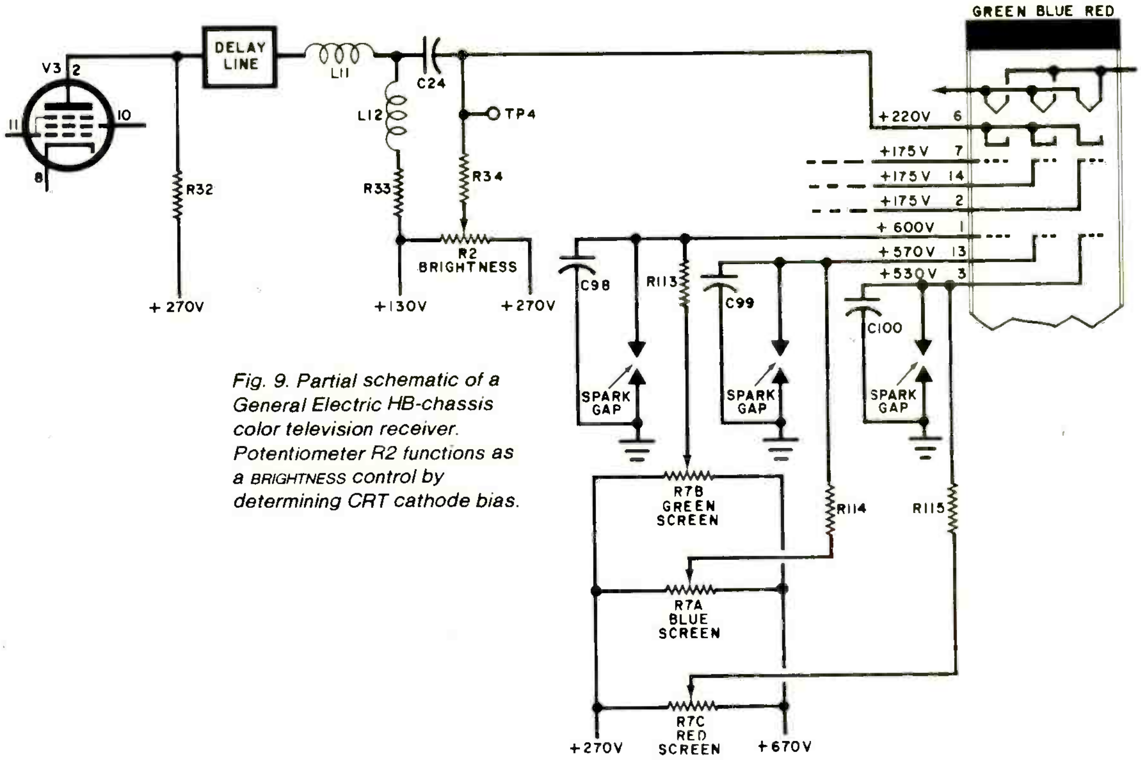
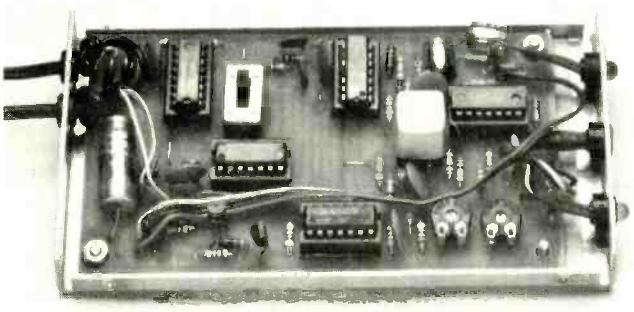


Fig. 9. Partial schematic of a General Electric HB-chassis color television receiver. Potentiometer R2 functions as a BRIGHTNESS control by determining CRT cathode bias.

troublesome, as detailed in a boxed section on the opposite page.

Here's the procedure that should be followed if test results are positive. Begin by removing the rear panel of the TV receiver (which should also remove ac power through the interlock) to gain access to the BRIGHTNESS control. Detach the wire connected to the center lug of the BRIGHTNESS control and connect it to point D on the relay printed circuit board. The free ends of the wires from points E and F on the relay board should be soldered to the center and left lugs, respectively, as seen from the *rear* of the BRIGHTNESS control. To control the audio, disconnect one of the two output leads from the loudspeaker and connect it to point H on the relay circuit board. If necessary, extend the length of this lead by splicing on a piece of hookup wire. Solder the splice and insulate it using PVC electrical tape or heat-shrinkable tubing. Then attach one end of suitable length of hookup wire to the free speaker lug, and the other end to point G on the relay circuit board. The relay board can be mounted inside the television cabinet using either screws and standoffs or two or three layers of double-sided adhesive foam tape.



*Photograph shows construction details of the prototype AD*ZAP infrared receiver.*

Photograph of the Coleco surplus plastic pistol modified by the author for use as a transmitter.

Using AD*ZAP. Although the receiver module includes an infrared filter, high levels of ambient light can affect phototransistor *Q1*. Therefore, avoid illuminating the sensor with bright sunlight, and keep incandescent lamps several feet away. The on-axis range of the six-shooter transmitter is more than 35 feet. That of the box-style transmitter is more than 20 feet. Because of its more diffuse radiation, the box-style transmitter need not be critically aimed.

Receiver switch *S1* should be set to provide the desired delay interval. The growing use of 30-second commercial messages on television prompted the inclusion of the switch. A few hour's attentive viewing of TV programs *and* commercials will enable you to judge which delay interval is more useful. To be certain not to miss any desired program material, you may want to avoid darkening the picture, at least at first. ◇

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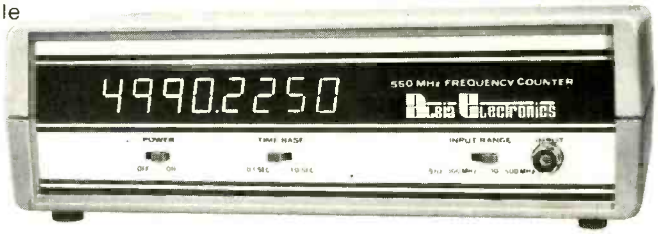

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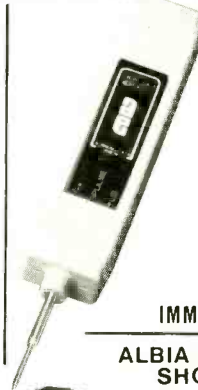

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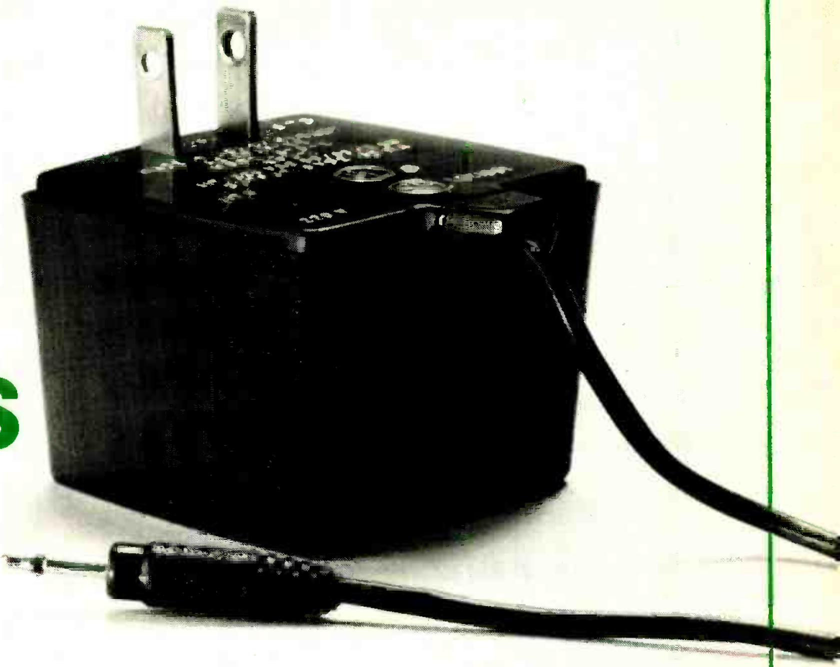


BY RALPH TENNY

How to check out and use modules that clutter your junk box

AC ADAPTERS for operating portable equipment such as radios, tape decks, calculators, or shavers from the power line instead of the usual batteries represent an often unrecognized resource for the electronics experimenter. The chassis for a project can often be made smaller and cheaper if one of these devices is used to supply operating power. And if small children are involved in any way with the project, the isolation from the power line provided by the adapter can be a safety factor. In addition, one adapter can power several projects if they are not all in use at once. Best of all, you probably have several of these devices left over from old, discarded appliances.

Types of Units. Since adapters are designed to reduce the nominal 117 volts at the wall socket to a lower voltage, all of them contain a small low-power transformer. There are two basic outputs from these devices; ac only or some form of dc. To identify the output, read the label on the case. If the label cannot be read, an oscilloscope across the output with a light resistive load (1 to 5 kΩ) will quickly identify it. An ac-only device will display a line-frequency sine wave, while a dc-output device that incorporates filtering will show a dc level with a small amount of ripple. If there is just a rectifier with no filtering, a line-frequency half sine indicates half-wave rectification while a series of half sines at twice the line frequency indicates full-wave rectification.

Testing. The setup used for testing ac and dc output adapters is shown in Fig. 1. The only practical difference between the two types is that a rectifier is used with the ac device.

With the load resistor disconnected, the supply will deliver its maximum dc voltage (1.41 times the rms value of the transformer output voltage). Construct a graph with voltage on the vertical axis and current on the horizontal axis. The upper end of the voltage axis is marked with the maximum (unloaded) voltage from the test circuit; from that point to the bottom (where this line joins the current axis) divide the voltage axis evenly into volts and parts of volts.

Ohm's Law ($R=E/I$) is used to determine the value of load resistor used. If, for example, the dc output is 15 volts, a 15,000-ohm resistor will draw 1 mA, a 1500-ohm resistor 10 mA, and a 150-ohm resistor 100 mA. If we wanted to start the current plot at, say, slightly under 10 mA, then a potentiometer (5-watt) having a value of 2000 to 2500 ohms will be required. To avoid burning out the module when the pot is set toward its low end, connect a 150-ohm, 2-watt resistor in series with the potentiometer to limit current flow to 100 mA. This latter resistor can be reduced if the supply proves capable of delivering more than 100 mA.

Adjust the potentiometer until the current meter indicates 10 mA. Observing both meters, plot the voltage and current on the graph. Reduce the potentiometer resistance until 15 mA is flowing. Plot the voltage and current again. Repeat these steps until you have sufficient data to construct a curve like that in Fig. 2. During these tests, make sure that the transformer does not overheat (though it may feel warm to the touch), indicating excessive current drain.

An oscilloscope connected across the output of a dc supply may show considerable ripple, particularly if the supply uses a half-wave rectifier or is heavily loaded. To reduce this ripple, add more filter capacitance. As a general rule of thumb, doubling the capacitance will halve the ripple.

The graph you have drawn will give a close estimate of output voltage at any given load current. In addition, it allows you to determine regulation (the degree to which the voltage varies with load). This is expressed as the percentage of the open-circuit voltage measured with maximum output current. Thus, the curve shown in Fig. 2 indicates regulation of 48%. The higher the regulation, the better the supply.

Before an adapter is used to power a project, it should be tested under load for an hour or more. If the exterior case gets too hot to touch comfortably, a hazard may exist, and a higher capacity adapter should be used.

AC Circuits. Four typical rectifier circuits for use with ac-only adapters are shown in Fig. 3. A full-wave rectifier like that in Fig. 3A can be had as an encapsulated module or synthesized from discrete silicon diodes. A filter capacitor is added to smooth the output and produce useful dc. For low-current applications where cost is a big factor, a half-wave rectifier circuit can be used. This is shown in Fig. 3B. The voltage doubler (Fig. 3C) and tripler (Fig. 3D) will deliver two and three times, respectively, the open-circuit voltage of a half-wave supply but with only small currents. In addition, they have very poor voltage regulation and excessive ripple unless very large valued filter capacitors are used.

DC Circuits. These types of adapters usually have some internal filtering, but for good results require about 1000-μF of external filtering. To improve voltage stability under load, an external regulator module can be added. The most convenient type of regulator to use is a

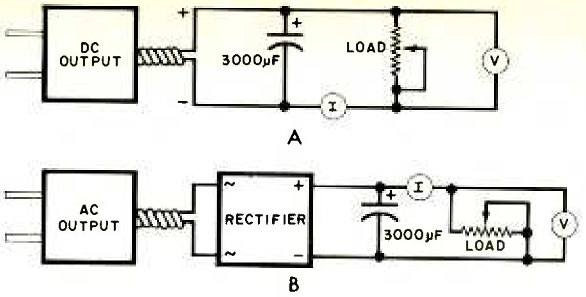
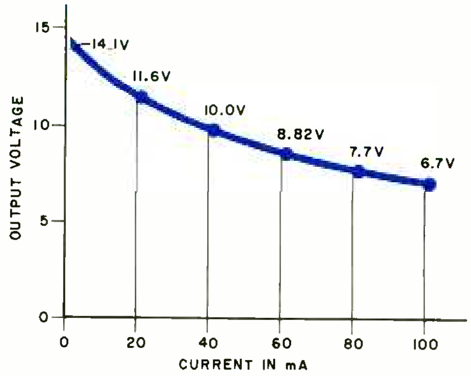
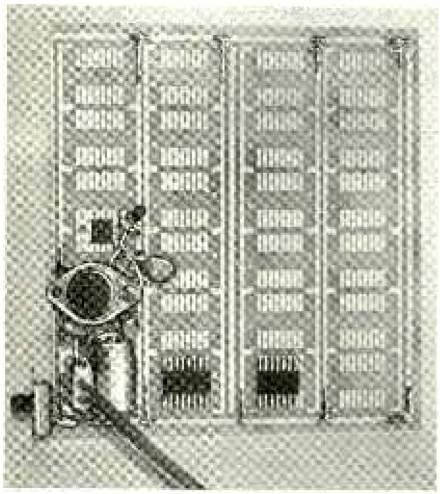


Fig. 1. The difference between the test circuit for an ac and dc adapter is the rectifier required by the ac version.

Fig. 2. A typical load regulation curve used to evaluate an ac adapter.





Rectifier and regulator on prototype board.

Ac adapter used as a trickle charger for automotive battery.

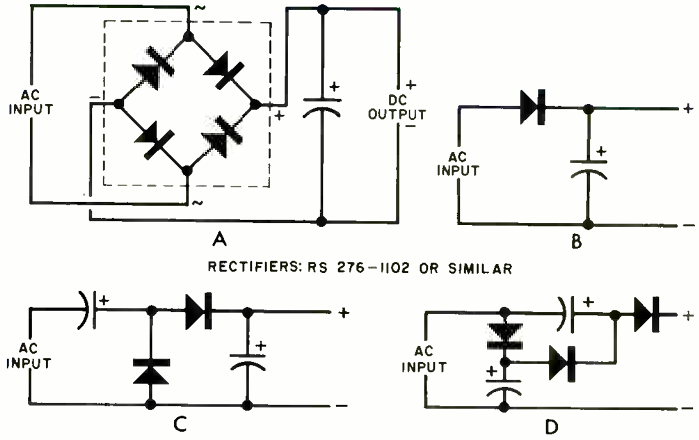
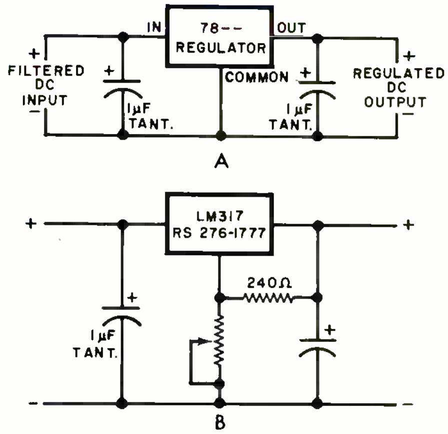


Fig. 3. Four circuits for an ac adapter. Full-wave rectifier (A), half-wave (B), half-wave voltage doubler (C), and voltage tripler (D).

Fig. 4. Three-terminal regulator at (A) delivers a fixed voltage while the circuit shown in (B) is adjustable and regulated.



three-terminal device such as the 7805, 7809, or 7812. These accept up to 35 volts input and deliver 5, 9, and 12 volts respectively. A typical circuit is shown in Fig. 4A. This circuit is ideal for non-critical, low-power applications, and is inexpensive. Three-terminal regulators are very rugged, and have internal circuits to protect them from overheating and overload. Keep in mind that the input voltage to the regulator must be at least 2.5 volts higher than the desired output voltage with maximum current drawn from the supply.

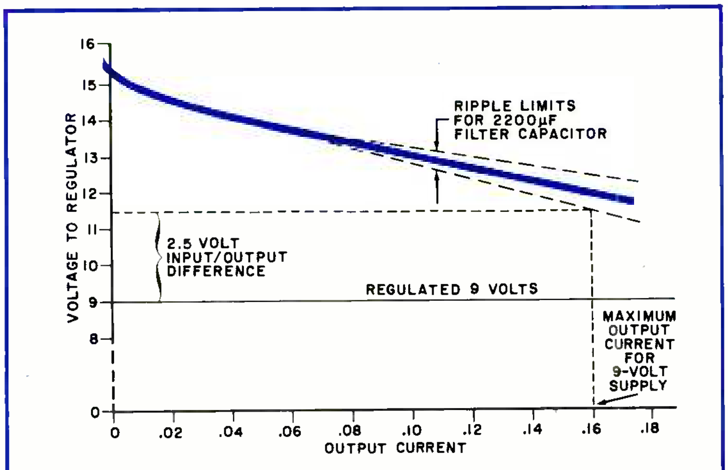


Fig. 5. Graphical operation of a 9-volt regulator showing how ripple affects delivered current.

The graph of Fig. 5 illustrates a dc source applied to a 9-volt regulator with the ripple voltage added. Note that as the output current increases, the output voltage comes closer to the desired regulated voltage. At some current, the regulator input voltage will intersect the lower edge of the ripple band. This then becomes the maximum allowable output current for this particular combination. This curve illustrates the need for load testing a finished supply.

By using a "third generation" three-terminal regulator such as that shown in Fig. 4B, a variable regulated voltage from about 1.2 volts to the input voltage minus 2.5 volts can be built.

Multi Voltages. Circuits requiring more than one dc voltage are shown in Fig. 6. For a dc adapter, the simplest approach is Fig. 6A. This circuit delivers 12 and 5 volts, both regulated. An ac adapter can use the circuit shown in Fig. 6B to deliver both a positive and negative voltage. If desired, a 7905 can be used in the *negative* line to deliver regulated −5 V, while a 7805 in the *positive* line delivers regulated +5 V. The circuit in Fig. 6C can deliver both positive and negative voltages if the output of the dc adapter is about two V higher than the sum of the two output voltages. The LM317 is set to the sum of the two voltages, while the 741 op amp forces the two transistors to sink current from both loads. This creates a common line that is treated as the circuit ground. This circuit can be used to create positive and negative voltages of equal or unequal magnitude, depending on the ratio of *R1* to *R2*. Both voltages will be as well regulated as the output from the regulator.

A negative voltage may be generated from a positive supply by a circuit called a "charge pump" as shown in Fig. 6D. This circuit uses alternate cycles of the transformer voltage to charge *C2* via *D1*. The other half cycle, selected by *D2*, turns on *Q1*. When *Q1* is turned on, the charge on *C2* is dumped via *D3* into *C3*, creating a negative voltage. With the values shown, this circuit has about 30% regulation.

A perusal of the many books covering power supplies will show a number of other circuits that can be adapted for use with ac and dc output power line adapters. With this information, it is possible to salvage most of those previously useless ac and dc adapters. ◇

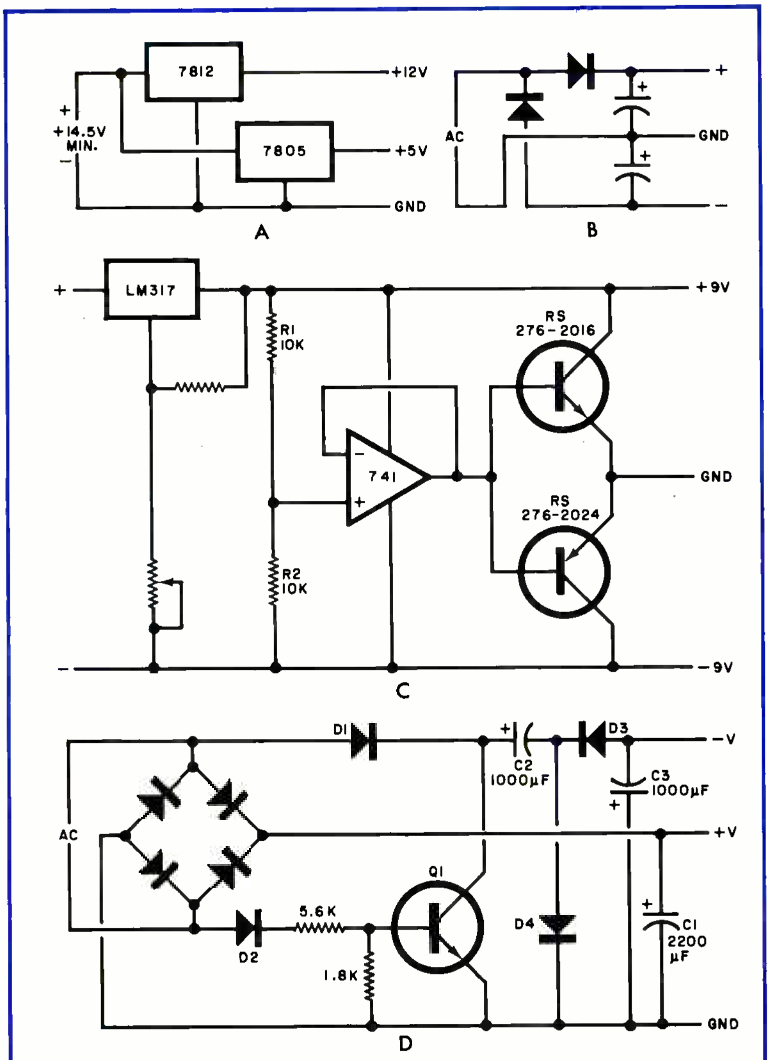


Fig. 6. Various methods of generating positive and negative voltages from a single power source.

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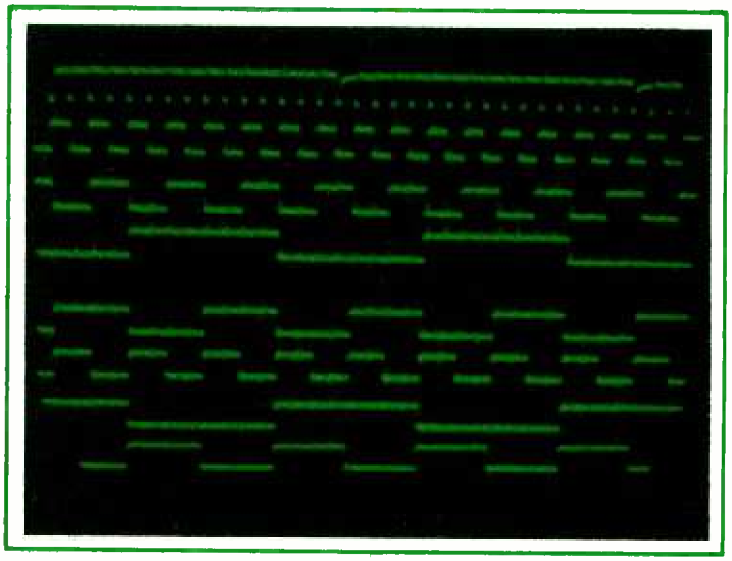


BY LES SOLOMON
Senior Technical Editor

DIGITAL logic circuits, whether they are in a simple counter or a complex computer, are formed from interlocking networks of gates and flip-flops. Observing such circuits as they operate is possible with a logic probe, a dc voltmeter, or a scope. But since a logic probe or voltmeter can monitor but one signal at a time and the operation of digital circuits depends on the time relationships between a large number of signals, these instruments are of little help. A dual-trace scope does little better as it can be used to monitor only two signals.

What is needed is a way to monitor many signals simultaneously. The obvious solution, a logic analyzer, is costly. However, by taking advantage of some low-cost, readily available ICs, it is possible to construct a very inexpensive logic state analyzer that can display eight vertically displaced discrete traces on a conventional single-trace scope. Each trace will display the signals present on a selected input line. Thus, the timing of up to eight different points within a circuit can be simultaneously observed. The basic circuit is shown in Fig. 1.

Circuit Operation. The "heart" of the circuit is a 1-of-8 data selector that can accept eight TTL inputs and, via an internal address decoder, place one of the eight at a time on the chip output line. The inputs are selected by applying a digital code from 000 to 111 to the three address inputs of the data selector. When the enable pin (7) is held low, the chip operates normally.

The three address lines are driven from a counter (a divide-by-sixteen 7493, a decade 7490, or almost any other counter). When the clock input is driven, the three address outputs cycle continuously through the digital code.

The eight traces are developed from the three address lines by a rudimentary D/A converter formed by *R1, R2,* and *R3* connected to the upper end of *R5*. When an address line goes high, current flows through the associated resistor and *R5* to ground, developing a voltage across *R5*. With the circuit shown, an 8-step waveform is present for application to the scope vertical input.

Note the relationship between the weighted outputs of the counter and the associated resistors. If the scope horizontal sweep is properly adjusted, eight discrete traces will appear on the display. As a point of interest, slightly reducing the value of *R1* will produce a small gap between the upper and lower four traces so that two "nybbles" can be displayed.

Resistor *R4* is connected between the output of the data selector and the D/A converter. The value of this resistor determines the amplitude of the data selector output signal. Scope sync can be taken from the system clock or from other points in the countdown chain. If the clock is very fast, a 7490/7493/or equivalent divider can be used ahead of the main counter.

Eight traces are usually the limit for observation on a 5" scope CRT. However, if your scope has sufficient writing speed and you wish to display 16 traces, substitute a 74150 (1-of-16 data selector) for the 74151. Add an 8000-ohm resistor to the new address line and the top of *R5*. Note that theoretical resistor values are specified in the circuit. Use nearest standard values.

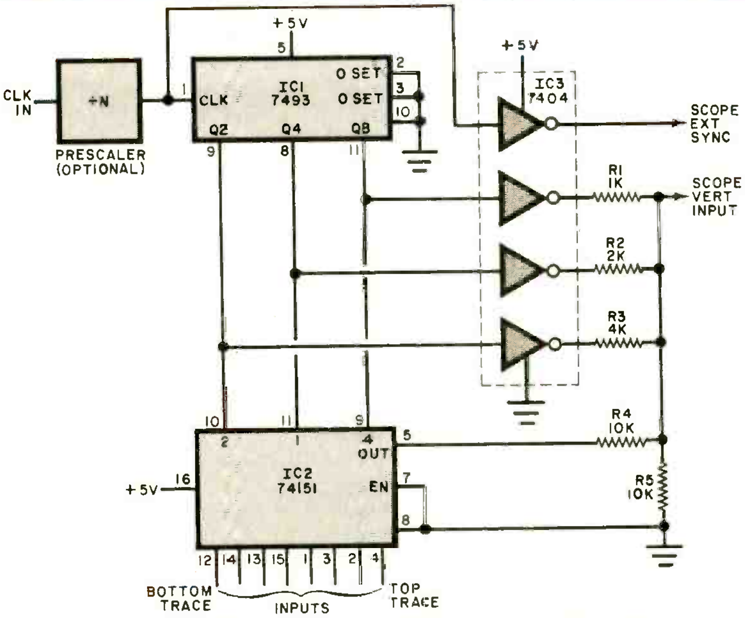
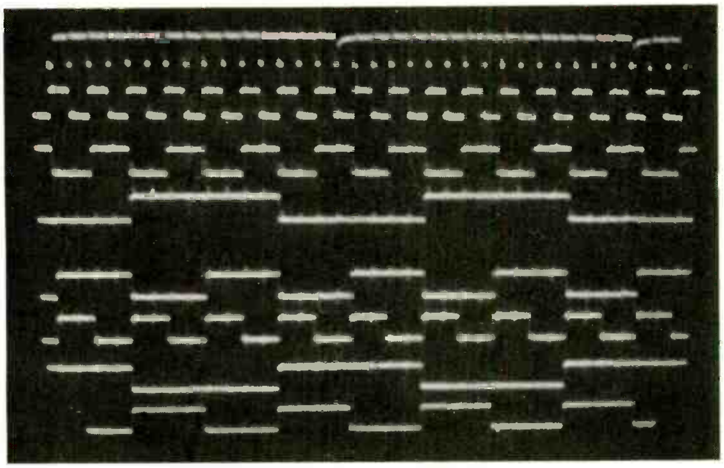


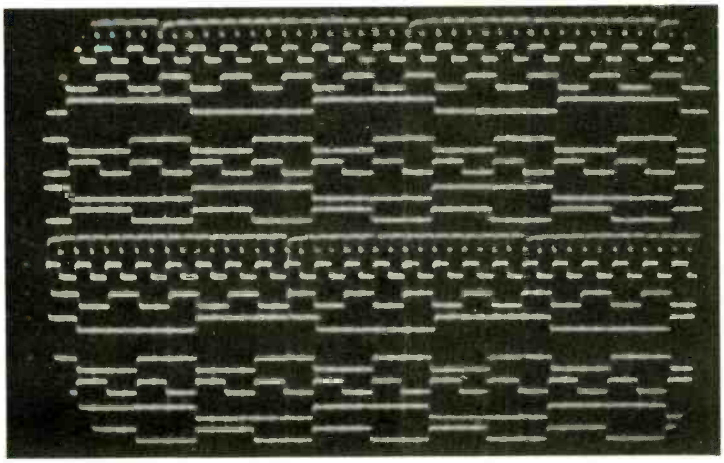
Fig. 1. Rudimentary D/A converter creates an eight-step wavefrom. Scope sweep adjustment produces eight traces.

PARTS LIST

IC1—7493 divide-by-16 counter
IC2—74151 1-of-8 data selector
IC3—7404 hex inverter
R1—1-kΩ, ½-W resistor
R2—2.2-KΩ, ½-W resistor (see text)
R3—4.7-KΩ, ½-W resistor (see text)
R4,R5—10-kΩ, ½-W resistor
Misc.—Optional prescalers, scope connectors, 8-lead ribbon cable (color coded), grommets, suitable enclosure, miniature test clips (Radio Shack 270-372, Calectro F2-916, or similar), 14- or 08 16-pin IC clamp on, mounting hardware, etc.



Display of eight traces from a typical counter.



Sixteen-trace synthethis using a dual trace scope.

Construction. The simple circuit can be assembled on a small perforated (or a home-made pc) board, leaving room for two or three optional ICs. The basic circuit consists of IC1, IC2, IC3 and the five resistors.

Once assembled, the board can be mounted in a small enclosure; and, if desired, a low-power 5-volt supply can be added. Since the basic circuit requires about 72 mA, the analyzer can be powered from the circuit under test.

The scope sync and vertical input connectors can be mounted anywhere on the enclosure, while the 8-lead ribbon cable (one lead for each data selector input) exits via a grommetted hole. The +5-volt, ground, and clock leads exit via their own protected hole.

The 11 leads can be terminated as desired. The prototype used miniature test clips (Radio Shack 270-372, Calectro F2-916, or similar) to make the closely spaced IC pin connections. To examine a single IC, a 14- or 16-pin IC clamp-on may be used. When using such a clamp-on, the +5 volts and ground can be taken from the IC. Some form of identification must be used on each of the eight data leads.

Use. Connect the status analyzer to the +5 volts, ground, and clock of the circuit under test. Connect the analyzer ground and output to the scope ground and vertical input, and the sync to the scope external sync input. With operating power applied, adjust the scope sweep for eight discrete traces.

Any or all of the eight analyzer inputs can be connected to the logic under test. Adjust the scope sweep and sync for a stable display. Once this is done, the value of *R4* can be selected for the desired signal height on the traces. To avoid confusion, make sure that the signals do not overlap. Resistor *R5* can be selected for a convenient signal level input for the scope.

Although this circuit is realized with TTL chips, a resourceful experimenter could build one using CMOS logic, following the same approach. ◇

Build a Diode Temperature Probe

Low-cost sensor gives temperature reading on a DMM

IF YOU own a digital multimeter (DMM), it can be made to give temperature readings for a small expenditure in parts and effort. When a small forward bias is applied to a conventional silicon diode, the voltage drop across the diode junction changes at a rate of about 1.25-mV/°F (2.24-mV/°C). Thus, a low-cost and readily available diode such as the 1N914 can be used as a temperature probe.

The bridge circuit shown in Fig.1 works in conjunction with the sensor diode and a DMM on the 200-mV (low temperature) or 2-volt (high-temperature dc voltage ranges. The displayed digits are the temperature. Note that in Fig. 1, two values are shown for *R2*, *R4*, *R6*, and *R7*. The values in parenthesis are for Celsius operation, while the others are for Fahrenheit. Capacitor *C1* is used to bypass stray signals that may be picked up on the leads.

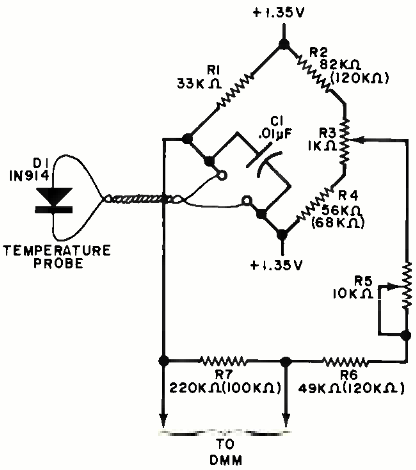


Fig. 1. Diode is one leg of a Wheatstone bridge connected to DMM.

PARTS LIST

- C1—0.01-µF disc capacitor
- D1—1N914 silicon diode
- R1—33 kΩ, ½-W resistor
- R2—82 kΩ (F) or 12 kΩ (C) ½-W resistor
- R3—1-kΩ pc-mount potentiometer
- R4—56 kΩ (F) or 68 kΩ (C) ½-W resistor
- R5—10 kΩ pc-mount potentiometer
- R6—49 kΩ (F) or 120 kΩ (C) ½-W resistor
- Misc.—1.35-volt battery and holder, vinyl or heat-shrink tubing, flexible two-conductor cable, epoxy, solder, etc.

Construction. The circuit can be assembled on a small printed-circuit or perforated board. The small circles at *C1* indicate the need for a pc pad, or WireWrap pin to make the connections to the remote diode.

To make the temperature probe safe for liquid immersion, the arrangement shown in Fig. 2 is used. Preform a short length of vinyl tubing, fill it with epoxy, and "thread" it up the diode leads to make contact with the diode body. Allow the epoxy to thoroughly cure. If desired, a length of heat-shrink tubing may be used. In either case, leave a short length of diode lead exposed for soldering to the flexible cable.

Slide a short length of heat-shrink tubing over the covered diode leads, solder each diode lead to the flexible cable, and then fit the tubing over the solder joint. Shrink the tubing to make a tight fit.

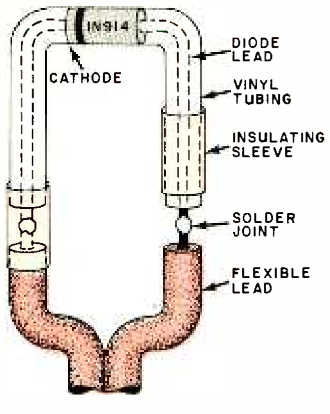


Fig. 2. To make probe immersible, vinyl tubing is added around leads.

Calibration. The resistance values for *R2-R4* and *R6-R7* are not critical, but their *ratios* are. Perform the following calibration tests before changing any resistance value.

Potentiometer *R3* balances the bridge to indicate 32°F (0°C) at this temperature. Potentiometer *R5* is used to reduce the 1.25 (2.24) mV/degree to exactly 1 mV/degree and is also used to set the upper range point.

With *R3* and *R5* at their center of rotation, immerse the diode probe in a container of finely shaved or crushed ice. Adjust *R3* to produce a DMM indication of 32 (°F) or 0 (°C). Place the DMM in the 2-volt dc range, immerse the probe in a container of boiling water, and adjust *R5* for a DMM indication of 212 (°F) or 100 (°C).

If you find that *R3* is at one end of its rotation, add a parallel resistor in the megohm range across either *R2* or *R4*, depending on the location of the wiper of *R3*. If *R5* is at one end of its rotation, add a parallel resistor (also in the megohm range) across *R6* or *R7*. If desired, a 10-turn trimmer potentiometer can be used for each of the fixed resistors and preset for the correct ratios.

Since the DMM will also indicate negative voltages, it will similarly indicate temperatures below those at which it is calibrated. Also, the diode can operate at temperatures above 212°F, which is about the limit for the plastic insulation used for the diode leads, so a plastic with a higher temperature rating can be used to liquid-proof the sensor. Or, without such protection, the sensor can be used for dry, or contact, temperature measurements. ◇

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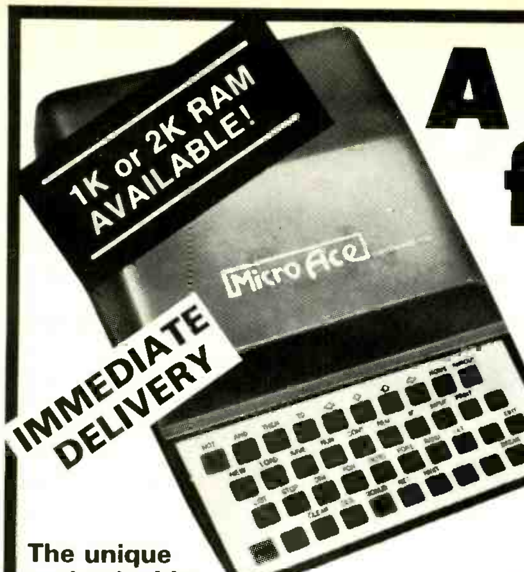

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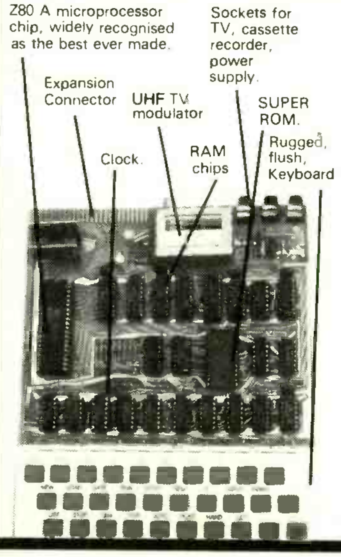

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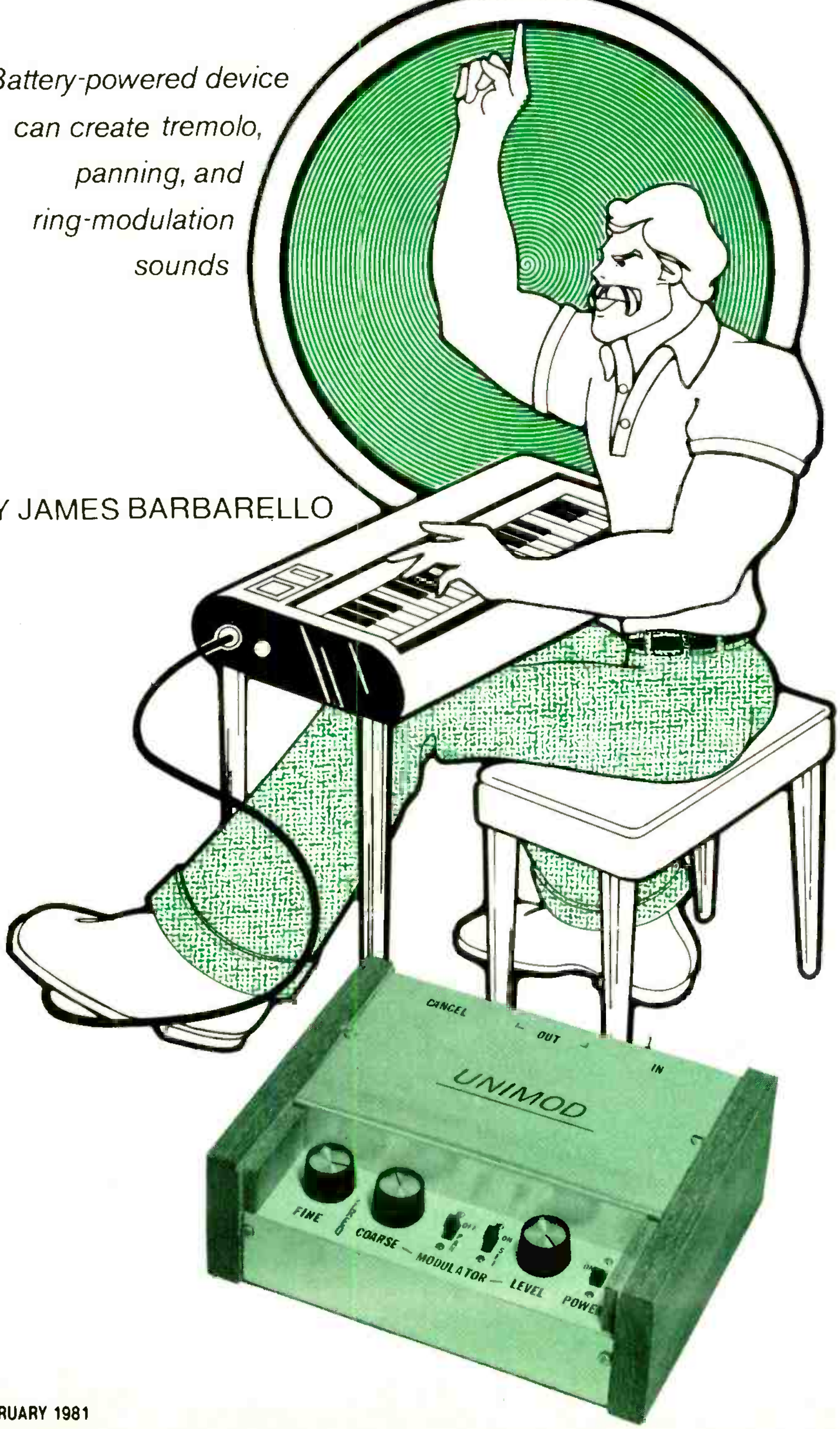
UNIMOD

A VERSATILE SOUND-EFFECTS GENERATOR

Battery-powered device can create tremolo, panning, and ring-modulation sounds

BY JAMES BARBARELLO



THE Universal Modulator (nicknamed "UniMod") is a versatile sound modifier for use with microphones and electric and electronic musical instruments. In essence, it is a preamplifier and amplitude modulator which can provide such effects as tremolo, automatic panning ("ping pong") and those unusual "ring modulator" sounds. Designed with the performing musician in mind, the project is battery-powered and controlled by a footswitch that cancels the sound effects when they are not wanted. Inexpensive, readily available components are used throughout, making it possible to construct the UniMod for about $30.

About the Circuit. The schematic diagram of the UniMod is shown in Fig. 1. This circuit can be considered the interconnection of four functional blocks: an input buffer (*IC1B*); two variable-gain amplifiers or amplitude modulators (*IC2* and *IC3*); a modulating-signal generator (*IC5A* and *IC5B*); and two output buffers (*IC1A* and *IC4B*).

The input buffer is a simple unity-gain inverting summer which provides a stable load for the signal source connected to input jack *J1*. Output signals from the buffer are capacitively coupled by *C1* and *C2* to the variable-gain amplifiers. Operational transconductance amplifiers (type CA3080E) are employed in this application. The gain of a CA3080E amplifier is proportional to the voltage difference between pin 4 (the chip's negative supply terminal) and the resistor connected to pin 5. Actually, the gain is determined by the *current* flowing into pin 5 of the IC, so the value of the resistor connected to it also influences the gain of a CA3080E.

The negative supply terminals of the CA3080E operational transconductance amplifiers employed in the UniMod are not connected to the full −9-volt negative supply voltage. Instead, they are connected to V_R −4.5 volts derived from the negative supply by a voltage divider (*R27* and *R28*). This is done so that the modulating-signal generator can fully turn off the operational transconductance amplifiers at the generator's most negative voltage swing, corresponding to 100% amplitude modulation. Potentiometers *R7* and *R13* and fixed resistors *R5* and *R11* source variable currents (remember, the CA3080E is a current-sensitive device) to pin 3 of each IC for nulling purposes.

Outputs of the variable-gain amplifiers are resistively loaded by *R9* and *R15* and buffered by *IC1A* and *IC4B*, which are unity-gain noninverting voltage followers. If the outputs of the operational transconductance amplifiers

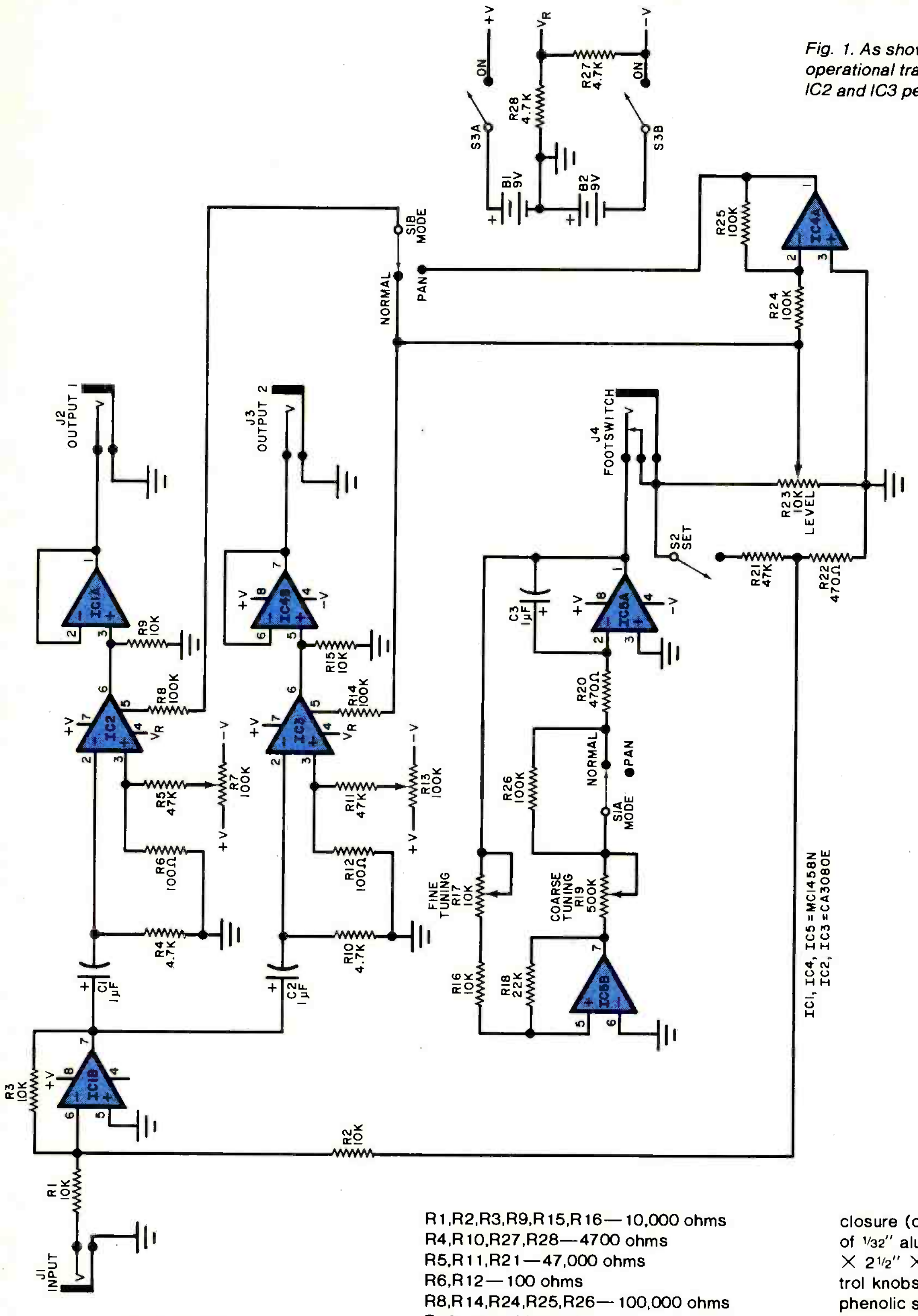


Fig. 1. As shown in schematic diagram, operational transconductance amplifiers IC2 and IC3 perform signal processing.

PARTS LIST

B1,B2—9-volt transistor battery
C1,C2,C3—1-μF, 25-volt electrolytic
IC1,IC4,IC5—MC1458N dual op amp
IC2,IC3—CA3080E operational transconductance amplifier
J1,J2,J3—phone jack
J4—closed-circuit, insulated phone jack
The following are ¼-watt, 10% tolerance fixed carbon-composition resistors unless otherwise specified.
R1,R2,R3,R9,R15,R16—10,000 ohms
R4,R10,R27,R28—4700 ohms
R5,R11,R21—47,000 ohms
R6,R12—100 ohms
R8,R14,R24,R25,R26—100,000 ohms
R18—22,000 ohms
R20,R22—470 ohms
R7,R13—100,000-ohm, pc-mount, linear-taper trimmer potentiometer
R17,R23—10,000-ohm, linear-taper potentiometer
R19—500,000-ohm, audio-taper potentiometer
S1—Dpdt switch
S2—Spst switch
S3—Dpst switch
Misc.—Printed circuit board, suitable enclosure (can be fabricated from a sheet of 1/32" aluminum and two pieces of 5½" × 2½" × ¾" mahogany or pine), control knobs, battery clips, battery holder, phenolic stock, machine and self-tapping hardware, hookup wire, solder, etc.

***Note**—The following are available from BNB Kits, R.D. No. 1, Box 241H, Tennent Road, Englishtown, NJ 07726: Kit of parts consisting of etched and drilled printed circuit board and all components except case, No. UNI-E, for $34.95; Etched and drilled pc board only, No. UNI-PC, for $10.95. Prices include postage and handling for USA and Canada orders. New Jersey residents, add 5% sales tax.*

were not buffered, the input impedances of the two channels of amplification which are driven by the UniMod could load down the outputs of the CA3080Es. If those input impedances were too low, there would be insufficient drive signal available. The buffers eliminate this problem by terminating the variable-gain amplifiers with fixed, relatively high-impedance loads. Also, they act as voltage sources with low output impedances, making it unlikely that *any* instrument amplifier will load them down.

The modulating-signal generator comprises both sections of IC5, an MC1458N dual operational amplifier. One half of *IC5* is used as an integrator (*IC5A*) and the other half as a comparator (*IC5B*). When the output of *IC5B* goes from −V to +V, the positive-going voltage step is integrated by *IC5A* into a ramp with a positive slope. The output of the integrator is fed back to the non-inverting input of the comparator via *R16* and *R17*. When the ramp attains an amplitude equal to the voltage between pin 7 of *IC5A* and ground times the quantity $-(R16 + R17)/R18$, the comparator output switches from +V to −V. Note that *R17* in the expression just given is the effective resistance of the potentiometer, which of course depends on the setting of its control shaft.

The negative-going voltage step generated when the comparator output changes states is integrated by *IC5A* into a ramp with a negative slope. This ramp voltage continues to become more negative until the signal fed back to the comparator reaches that stage's trigger level. At this point, the process begins all over again.

The resulting sequence of positive and negative ramp voltages is actually a triangle wave which is tapped at the output of *IC5A*. The slope of the ramps and hence the frequency of the triangle wave depend on the amount of current supplied to integrator capacitor *C3* via *R19*, *R20* and *R26*. Potentiometer *R19* functions as a coarse frequency control, allowing adjustment over the full range of the generator. Fine frequency adjustment (over slightly more than one octave) is performed by varying the setting of potentiometer *R17*.

Fixed resistors *R20* and *R26* set the upper frequency limits of the triangle-wave generator. When *S1* is in its PAN position, *R26* limits the maximum output frequency to approximately 30 Hz. This resistor is bypassed when the switch is in its NORMAL position, in which case the upper frequency limit (about 1000 Hz) is determined by *R20*.

The triangle wave which appears at the output of *IC5A* is passed through

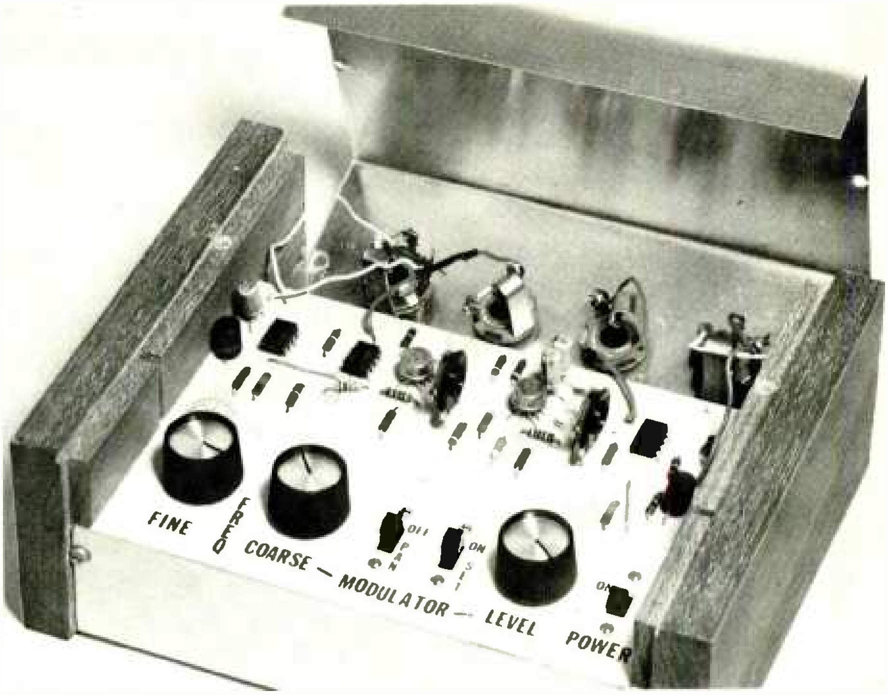


Photo of author's prototype shows how pc board extends under control panel to hold switches and potentiometers.

jack *J4* if either no footswitch is connected to the jack or a footswitch is connected to it and is closed. From the jack, the signal flows to LEVEL control *R23* and to SET switch *S2*. Closing that switch connects voltage divider *R21R22* to the output of the triangle generator. That fraction of the output voltage which appears across *R22* is applied to input summer *IC1B* via *R2*. The triangle waveform is then amplified and delivered to the output jacks for monitoring purposes.

Potentiometer R23 passes a portion of the triangle generator output to the control input of *IC3* through *R14*, to the NORMAL position of *S1B*, and to the input of inverting buffer *IC4A*. If MODE switch *S1* is in its NORMAL position, the same modulating signal is applied to the control inputs of both operational transconductance amplifiers via *R14* and *R8*. Note that *IC4A* is an inverting, unity-gain amplifier whose output waveform is 180° out of phase with respect to its input waveform. If MODE switch *S1* is placed in its PAN position, the modulating triangle wave applied to the control input of *IC2* is out of phase with respect to that applied to *IC3*. This results in an automatic panning effect—as the gain of *IC2* increases and reaches its maximum value, the gain of *IC3* decreases to its minimum value, and vice versa.

If a footswitch is connected to the circuit via *J4* and the switch is open, the modulation function is defeated. Triangle waves from *IC5B* cannot reach *S2* and *R23*. Resistor *R14* is grounded via *R23*, and *R8* is grounded in the same way if *S1* is in its NORMAL position. If the switch has selected the PAN mode, *R8* is grounded via the output of *IC4B*, which is at ground potential. Because the value of *R14* is 100,000 ohms, the resistance added by *R23* is negligible (regardless of its setting) and both operational transconductance amplifiers operate at essentially maximum gain.

The integrated circuits employed in this project require a bipolar (positive and negative voltage, referenced to ground) power supply. For simplicity and ease of set-up under live performance conditions, two 9-volt transistor batteries are used to power the project. They are connected to the rest of the circuit via dpst power switch *S3*. For longest battery life, alkaline cells should be used for *B1* and *B2*.

Construction. Any assembly technique is acceptable, but the author recommends the use of a printed circuit board. Shown in Figs. 2 and 3 are the etching and drilling and parts placement guides for the project's pc board. This board will not only accommodate the usual components installed on a pc board, but also the potentiometers and switches as well. At the builder's option, the latter components can be mounted

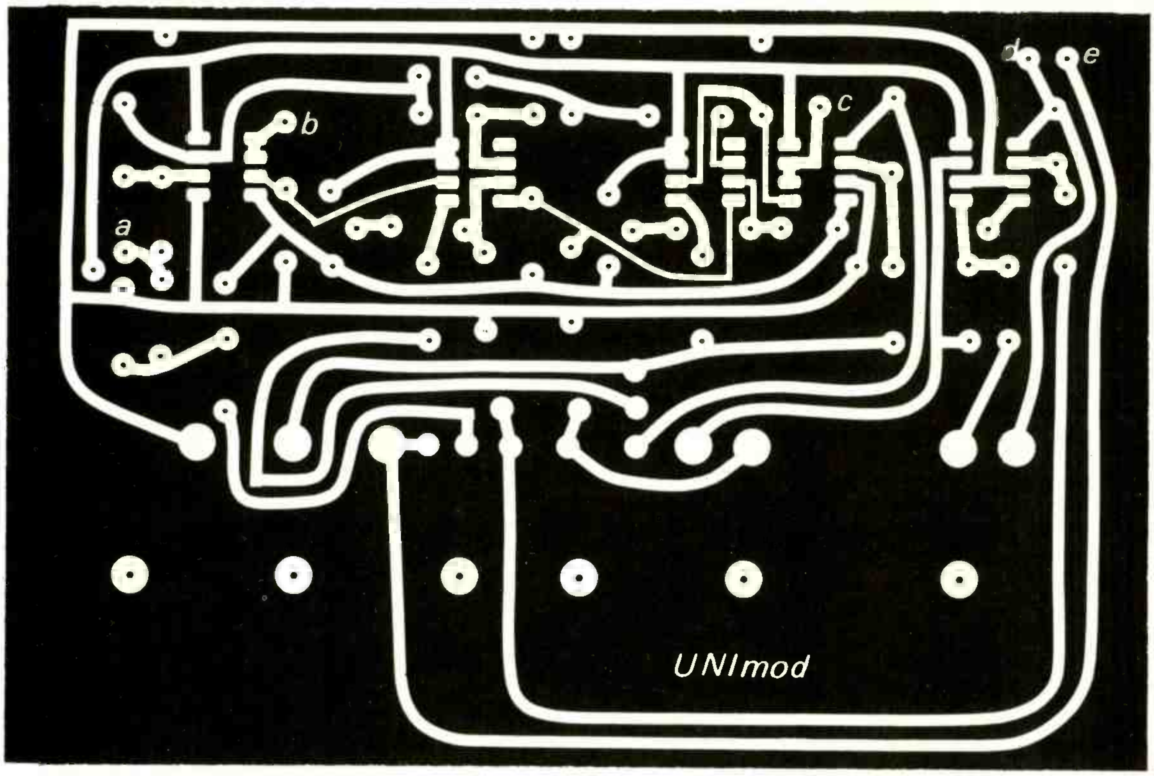


Fig. 2. Full-size etching and drilling guide for the printed circuit board for the UniMod.

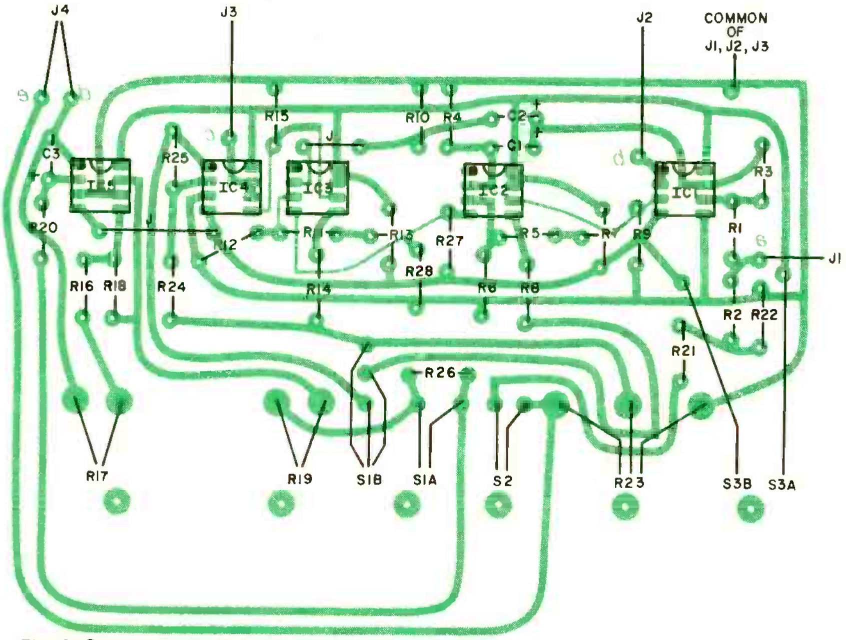


Fig. 3. Component layout for the Unimod. At bottom are markers for locations of various control switches and potentiometers.

on the project's enclosure instead.

When mounting semiconductors and electrolytic capacitors on the printed circuit board, pay close attention to pin basing and polarity. The use of IC sockets or Molex Soldercons is recommended. Don't apply too much heat or solder when making connections, and avoid cold solder joints and solder bridges across adjacent foils. Be sure to inspect the board carefully after all components have been mounted.

In line with the author's idea of mounting all switches and controls on the circuit board, the etching and drilling guide provides markers for locations of these components. Three large (3/8-inch or 9.5 mm) holes will accept standard-size potentiometers. Three rectangular holes to accommodate switches can be drilled and then squared off with a small file. Alternatively, miniature toggle switches which require 1/4-inch (6.4-mm) holes can be used, in which case filing is unnecessary. The author also suggests that all unlettered pads to which wires are to be attached (as well as those for *R26*, which he specifies as mounted on the foil side of the board) not be drilled. Component and wire leads to these undrilled pads should be "tack" soldered. However, if you are mounting switches and jacks off the board, all pc pads should be drilled.

Interconnect the printed circuit board and wires and jacks with suitable lengths of hookup wire. Then select an enclosure for the project and mount the printed circuit board in it using pc standoffs. Switches and jacks should be mounted on the enclosure, and a bracket to retain the batteries attached to it. Unlike the other three jacks, the shell of *J4* is not grounded. Therefore, if this jack is mounted on a metallic panel along with *J1* through *J3*, an insulated jack will have to be used. Alternatively, an uninsulated jack can be employed if insulating washers are used and the hole in which the jack is mounted is drilled oversize. The insulating washers can be fabricated by drilling 3/8-inch (9.5-mm) holes in two pieces of phenolic stock 1/2-inch (1.3-cm) square.

Alignment. Connect a patch cord between output jack *J2* and the input of your power amplifier. Set the various controls and switches as follows: *R17*, FINE TUNING fully counterclockwise (for maximum frequency); *R19*, COARSE TUNING fully counterclockwise (for maximum frequency); *R23*, LEVEL fully clockwise (for maximum modulation); *S1*, MODE in its NORMAL position; *S2*, SET so that it is open; *S3*, POWER to its ON position. Then apply power to the amplifier and set its gain control at some convenient level.

You should hear a high-pitched tone through the speaker connected to the output of the amplifier. Adjust trimmer potentiometer *R7* to null out the tone. It might not be possible to eliminate the tone completely, but the correct setting of *R7* is that which results in minimum feedthrough of the tone with no signal source connected to input jack *J1*. Repeat this procedure for the other output channel by connecting the patch cord running to the amplifier to output jack *J3* and adjusting trimmer *R13* for minimum tone feedthrough.

Next, close switch *S2*. You should hear the tone that was just nulled. Rotate COARSE TUNING *R19* clockwise, noting that the pitch of the output signal decreases. Similarly, rotate FINE TUNING control *R17* counterclockwise, noting a decrease in pitch. Rotate LEVEL control *R23*, increasing the volume of the tone from minimum to maximum as the control is rotated clockwise. Connect a normally open footswitch or pushbutton switch to jack *J4*. The tone will only be heard when the footswitch is depressed. This completes initial alignment and checkout. Return *S2* to its open position and you're ready to begin experimenting with the UniMod.

Use. The three principal sound effects that the UniMod can provide are automatic panning, tremolo, and amplitude modulation by an adjustable tone (similar to the effect produced by driving one input of a balanced modulator with the output of an oscillator). Let's examine each in turn.

Automatic panning requires two channels of amplification and two speaker cabinets. One amplifier's input should be patched to jack *J2*, the other amplifier's input to *J3*. For maximum effect, the speaker cabinets should be at least six feet (two meters) apart. Connect your musical instrument to input jack *J1* and place MODE switch *S1* in its PAN position. Depending on the settings of the TUNING and LEVEL controls, the sound will bounce back and forth between the two speakers at a given rate and to a certain degree. Increasing the frequency of the modulating triangle wave will cause the signal to "ping pong" faster. Adjusting the LEVEL control for more amplitude of the modulating signal will enhance the intensity of the "ping pong" effect, causing one operational transconductance amplifier to exhibit more gain at the same time that the other exhibits less gain.

Only one channel of amplification and one speaker cabinet are required for tremolo operation, but two can be used. For single-channel operation, follow the auto pan instructions just given but patch the input of a single amplifier to either output jack (*J2* or *J3*). Place *S1* in its PAN position and adjust the controls for the desired effect. If two channels are to be used, interconnect them and the UniMod as previously described but place *S1* in its NORMAL position, adjusting *R17* and *R19* for a modulating signal frequency of between 2 and 30 Hz. Again, the intensity of the effect is governed by the setting of *R23*.

"Balanced modulator" effects can be obtained with either one or two channels of amplification. For dual-channel operation, all controls are set as for dual-channel tremolo except that the COARSE and FINE TUNING controls should be adjusted to generate a modulating frequency in the audible range. When this is done, the input signal will be modulated by an audible signal, producing sum-and-difference modulation products. Many interesting effects such as gong and chime sounds can be generated in this manner. If only one amplifier is used, place *S1* in its NORMAL position, take output signals from either *J2* or *J3*, and adjust the LEVEL and TUNING controls for the desired effect.

Practice with the various modes of UniMod operation to get an appreciation of what this versatile little sound effects box can do. Experiment with the various controls, making notations of the various combinations of settings that particularly interest you. Finally, remember that the UniMod is battery powered. Use alkaline cells for maximum useful life and be sure to open power switch *S3* when UniMod is not being used. ◇

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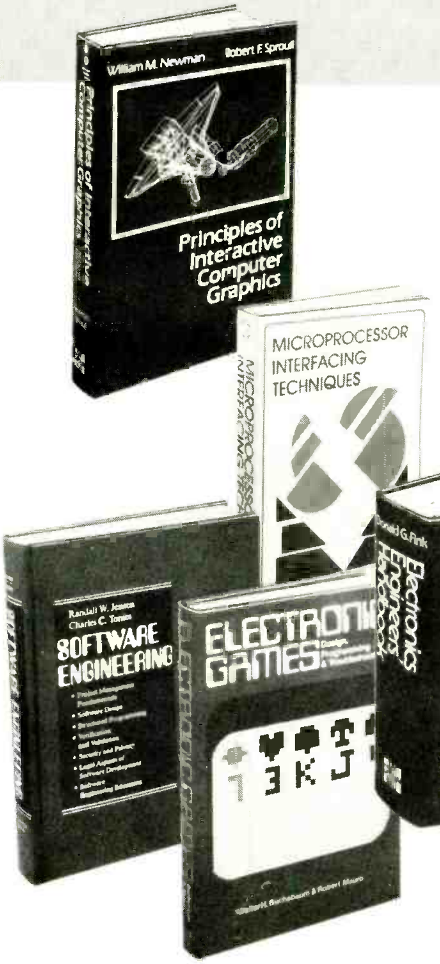

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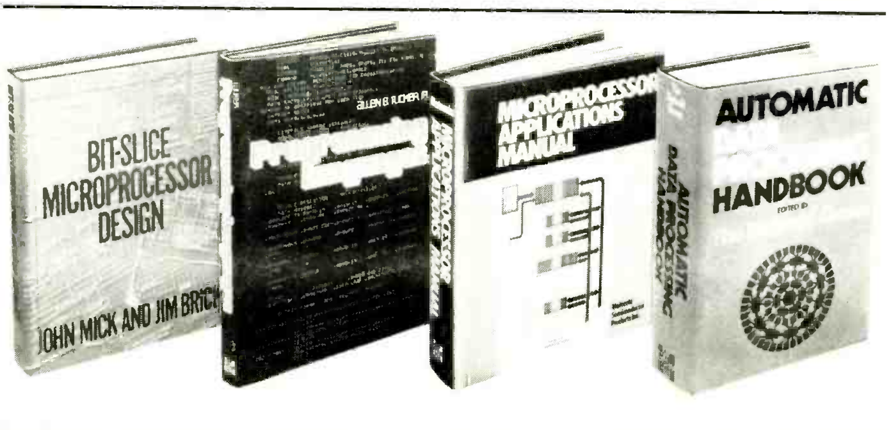

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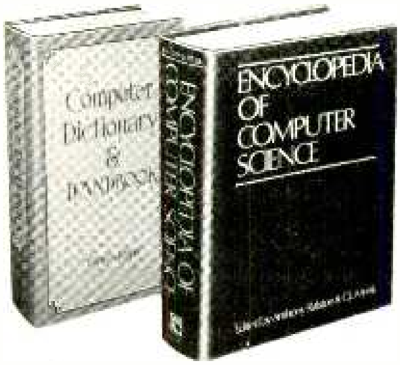

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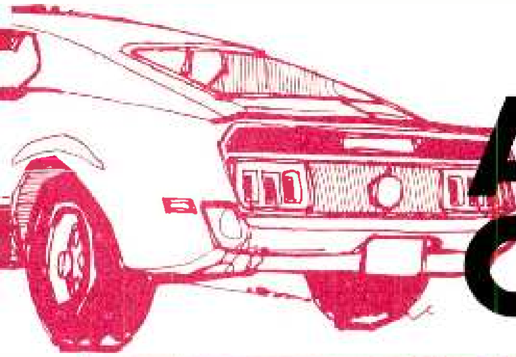


TRANSIENT PROTECTION FOR AUTOMOBILE CIRCUITS

BY ROBERT PEASE
National Semiconductor

Safeguards for solid-state circuits in your car

IT CAN be very frustrating to have a new circuit you built for your car malfunction when the engine is being started or even running smoothly—especially when it checked out fine with the car parked. What went wrong? Chances are the problem is at the power source.

A 12-volt battery by itself is a very well-behaved power supply. But when the engine runs and the alternator charges the battery, a variety of things can happen to upset electronic circuitry.

For example, transients measuring 1 to 10 volts P-P are commonly found in the 12-volt automotive power-supply. These will not usually harm semiconductor circuits, but they can cause severe noise and instability problems and false-triggering of sensitive logic circuits.

Larger transients that can cause damage also appear at various times, as when a battery is temporarily disconnected or when battery terminals become corroded. These transients, sometimes known as "load dump," can reach +60 to +80 volts for a few-hundred milliseconds. When the engine is running, and the alternator is delivering power to the battery, the voltage regulator holds the output to about 13.8 V. When the battery (load) is removed, the output overshoots until the voltage regulator can reduce the alternator field, which takes time to decay, and re-establish the correct output voltage. Another severe transient, which usually occurs when the ignition is turned off, can go to −50 volts for 100 milliseconds. This

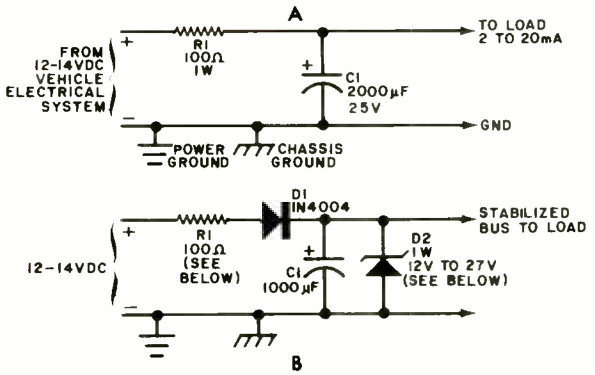


Fig. 1. The simple R-C filter at A will provide adequate protection against transients for low-power applications. For better protection, the circuit at B is recommended. Ratings for D2 and R1 are determined from the Table as described in the text.

VALUES FOR D2 AND R1

D2 Volts	D2 Watts	Type	R1 Ohms	Rated Output Current
12	1/2	1N759 or 1N963	300	8 mA
27	1/2	1N971A or 1N5254	150	15 mA
12	1	1N4742	150	15 mA
27	1	1N4750	75	30 mA
12	5	1N5349A	27	75 mA
27	5	1N5361A	15	150 mA
12 or 27	50	1N2810A or 1N3311A	1.5	1.5 A
27	75	Motorola MR2525	1	2 A

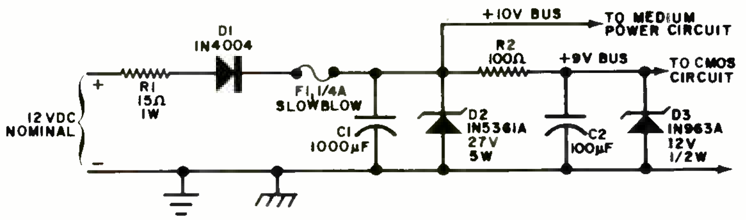


Fig.2. Sometimes, if your circuit contains parts requiring protection at different levels (such as CMOS components), it can be partitioned. Double protection is actually provided for the CMOS.

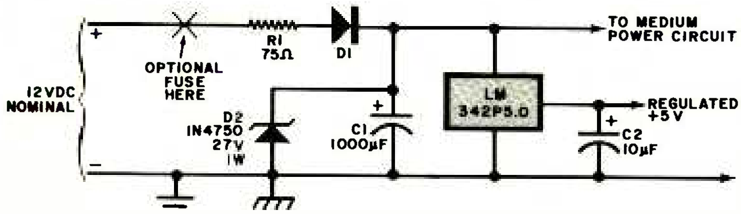


Fig. 3. CMOS components can be protected along with medium-power circuits by using a three-terminal regulator to provide separation.

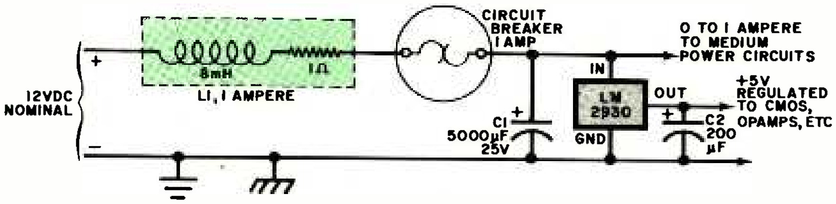


Fig. 4. The tops in decoupling and regulation provided by an inductor, circuit breaker, capacitors and regulator.

"field decay" results as the excitation in the alternator field dies away.

Other random transients can reach ± 200 to 400 volts for a few microseconds. Such peaks can be reached when inductive elements connected to the vehicle power bus are switched on or off, thus producing rather large back-emf spikes. No ordinary solid-state circuits can survive this kind of transient onslaught without protection. As a prime example, popular CMOS circuits, which are ideal for low-power designs, can be destroyed by supply voltages outside the range of +15 and −1 volt. Obviously, some form of protection is required to keep electronic equipment operating reliably in a car. But what kind? And how much?

Levels of Protection. One criterion for deciding how well protected a circuit should be is its importance to the system. The inconvenience caused by an inoperative car stereo system is of a different order from that caused by the untimely discovery—when you are miles from the nearest telephone—of a failure in a newly installed solid-state ignition system. It would make sense to protect the latter circuit more rigorously than the former.

Manufacturers, too, have reason to be concerned about intercepting transients before they cause trouble. How much immunity should be provided for a run of 10,000 radar detectors? What will warranty repairs cost if they are needed? And what about microprocessor-controlled systems to be installed in 3 million cars? An epidemic of malfunctions here could be calamitous. Clearly, protective systems in which you can place a high degree of confidence are called for in these situations.

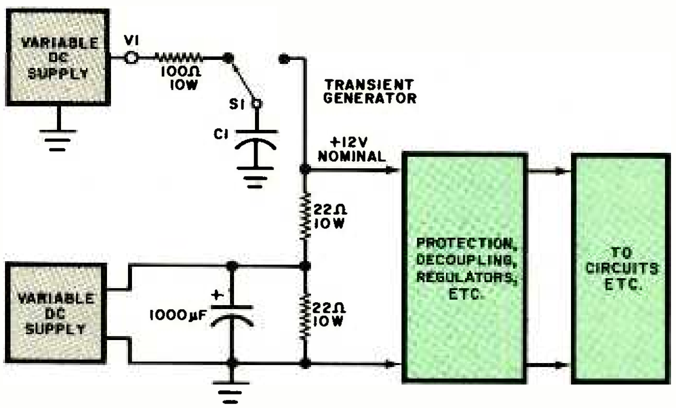
Trapping the Spikes. Now, let's discuss several circuit approaches for protecting a hobbyist's circuits and/or store-bought hardware. The first technique is simple decoupling and bypassing. There are many low-power circuits which will run reliably and well in a car if you simply add a large R-C filter in the supply line. As the cost of a 2000-μF capacitor is very reasonable, circuit A of Fig. 1 is a good basic scheme. All the positive and negative transients mentioned above will be heavily attenuated by the simple *R1C1* filter. For low-power applications, Fig. 1A provides adequate protection. But the circuit in Fig. 1B is better and costs little more.

In Fig. 1B, diode *D1* will provide full tolerance of negative transients on the 12-volt bus; and positive transients will cause less ripple, too. Also, this diode will guard against inadvertently reversed supply connections. Zener diode *D2* prevents the stabilized bus from rising too high. If you use a 27-volt zener, this circuit will be highly resistant to any short-term 60-volt transients on the input. It will also withstand connection of a 24-volt battery, which some mechanics use for emergency starting. (Obviously, placing 24 volts on a 12-volt system can damage any electrical or electronic elements connected to the bus. For safety sake, *all* circuit elements other than those necessary to start the vehicle should be switched off during the application of the 24 volts.)

If you use a 12-volt zener to limit output voltage, use a larger-valued resistance for *R1*. This is recommended because during fault conditions, most of the current will be diverted to *D2* rather than *C1*. If a lower value of *R1* is needed to permit a larger output current to be drawn, the dissipation rating of the zener diode should be increased accordingly. (See Table.) In normal operation, a low-power zener will never get warm, but it can be destroyed by a load-dump transient if the value of *R1* is too low. For good reliability, therefore, the resistor values in the Table should be treated as the lower limits.

The use of a 27-volt zener presumes your circuit can tolerate a +30-volt supply. What if your circuit includes CMOS components that are rated for +16 volts absolute maximum? You might be able to partition your circuit. If the high-current portion can tolerate +27 volts briefly, and the CMOS is, of course, drawing only a small current, then the circuit of Fig. 2 will do nicely. The path to the CMOS circuitry is now doubly protected.

Note that a fuse has been added to



V1	C1
+60 to +80V	2,000 to 10,000μF, 100V
−50V	1,000 to 5,000μF, 60V
+200V	1μF, 400V
−200V	1μF, 400V
+400V	0.1μF, 600V
−400V	0.1μF, 600V

Fig. 5. Circuit to be used in testing your transient protection system. Throwing the switch provides transients on the regular supply. Be sure the polarity and rating of the capacitor agree with those of the transient voltage.

this circuit. Resistor *R1* will normally prevent the fuse from blowing, but the fuse is intended to open up in case of severe overload, such as repetitive 60-volt pulses, or a short on the 10-volt bus. Should you use a fast-blow or a slow-blow fuse? The latter will be more suitable for critical systems where you really don't want the fuse to blow. An instrument-type fuse can open up quickly and provide better protection to delicate circuits. The choice of fuse type depends on the "level of confidence" you want.

Another good way to run CMOS along with medium-power circuits is shown in Fig. 3. A three-terminal regulator that can put out 0.2 or 0.5 ampere costs less than a dollar—and often less than a 1-watt zener. The 5-volt bus in this circuit will be much less noisy than the protected but unregulated voltages shown in Figs. 1 and 2. Most 5-volt regulators are rated to 25 or 30 volts input, and voltage transients will be rejected by 60 dB or more.

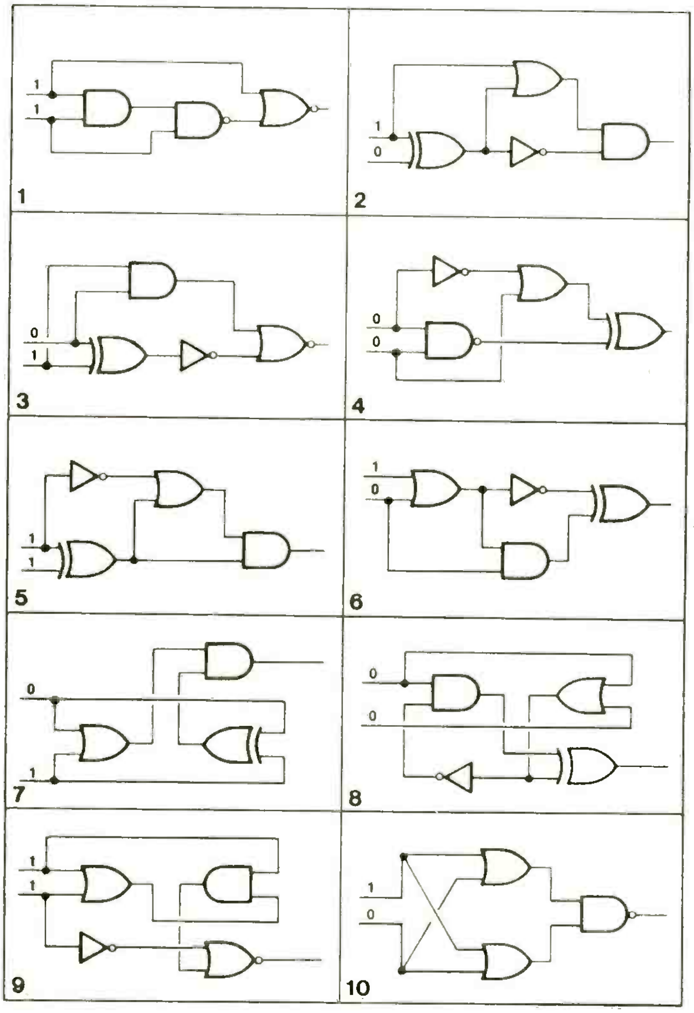
The circuit of Fig. 4 represents an ultimate in protection and reliability. It incorporates several moderately priced features, and while you may not want to use all of them, you can pick the ones you consider advantageous. In case of a 60-volt load-dump, the output voltage will not rise above 40 volts because inductor *L1* will prevent the current from rising for 10 to 20 milliseconds. Capacitor *C1* prevents the brief pulse through *L1* from pulling the output line to an excessive level. A circuit breaker provides instant reset—no searching for spare fuses—and the LM2930 provides a 5.0-volt regulated output for critical circuits while withstanding transients as large as +40 volts. As the LM2930 was especially designed for automotive uses, it will not be damaged by −12 volts on its input bus. Thus in this case, a diode is not needed in the power path (presuming that the medium-power circuits can tolerate supply reversal). Other National 3-terminal regulators such as LM317HV will tolerate as high as +66-volt inputs with a well-regulated 6-volt output.

Final Testing. How do we ensure that a circuit is adequately protected against automotive transients? When your breadboard or prototype is running properly, connect it as shown in the test circuit of Fig. 5, and throw *S1*, for several "transients" at each voltage. If the circuit keeps on running during and after these tests, you'll know that the protection circuit is really doing its job! That way, circuits you add to your vehicle will operate at least as reliably as those installed at the factory. ◇

GATING CIRCUIT QUIZ

BY ROBERT P. BALIN

To test your ability to trace out gate circuits, see if you can follow the logic level 1 and 0 signals applied simultaneously to the two input terminals of each of the circuits (1-10) shown below and determine what signal (1 or 0) appears at the output. To keep from getting mixed up as you go through each circuit, it may be helpful to write in the inputs at each gate. Answers are below.



ANSWERS

1. 1
2. 0
3. 1
4. 0
5. 0
6. 0
7. 1
8. 0
9. 0
10. 0

BY RON REESE

A COMPUTERIZED AUTOMATIC TELEPHONE DIALER

(Conclusion)

Last month, we defined the purpose of the project—developing an automatic telephone dialer based on the RCA 1802 microprocessor and using either the Product Board introduced here in November or the Elf II Computer. We described instructions and elements in the computer that had not been used previously and then developed a flowchart for the project. The next step is to write the program.

Writing the Program. The program should begin at address 0000 with REQ to de-energize the output relay, followed by the initialization of the stack pointer. Referring to Fig. 5, we see R1 was selected to be the stack pointer and must be loaded with the stack address, 00FF, as indicated by addresses 0001-0006. The instruction LDI at address 0001 is a two-byte instruction and will require two memory addresses—0001 for the op code, F8, and 0002 for the operand, 00. Therefore, the next instruction, PHI, will be at address 0003. The instruction at 0004 also requires two addresses.

At this point the program will load the stack address, 00FF, into R1; but nothing has told the processor to use R1 as the stack pointer. In fact, on each Reset, it will automatically select R0 as program counter and stack pointer. The SEX (Set X) instruction—op code E1—selects R1 as stack pointer. When executed, it will load 1 (0001) into the four-bit X register. This completes initialization of the processor.

Next, the input switches are read by selecting and reading the input port that interfaces them. Since this program is designed to run on an Elf II computer or a Product Board, the INP instruction must be selected accordingly. Use INP 7 (6F) for the Elf II and INP 2 (6A) for a Product Board. This program line, address 0008, should be labelled "Read Input Switches." The INP instruction loads the byte from the input port into the D register and onto the stack.

The next instruction BZ, opcode 32, tests the D register to see if it is zero. If so, no switches are closed, and the program branches back to Read Input Switches. The branch instruction, 32 (BZ), is a two-byte instruction—the first byte is the opcode and the second an address. In this case the branch goes to 0008; only the two least significant digits, 08, are needed, since this is a short branch.

If the D register is not zero, the program will advance to a one-second delay, beginning at address 000B. This is a software delay that depends on the time required to execute instructions. The delay loop operates by loading a register with some value and then decrementing the register until it reaches zero. (The May 1980 article in this series explains this type of delay in greater detail). The loop begins at 000B by loading 92 (1001 0010) into the D register. The instructions at addresses 000D and 000E transfer the 92 from the D register to the lower and upper halves of R2. Since R2 is being used as a delay timer, it should be entered as such in the memory and register utilization table. The instruction 22 at address 000F decrements R1 by 1. Instruction 92 at address 0010 loads the upper half of R2 into the D register, and 3A at 0011 tests D for zero. If D is not zero, the program will branch back to address 0F for another loop. The looping will continue until D is zero, approximately one second later.

Then the input port is read again by the INP instruction at address 0013. This loads any change of the switches into the D register and stores it on the stack. Next, the pattern generated by the input switches is compared to the input table to determine if a valid code was entered. To execute the search of the input table, a register must be loaded with its starting address. Referring to the register and memory utilization table, we find that R3 has not been used, so R3 is chosen as the Input Table Pointer. Program address 0014 uses F8 to load 00 (0000 0000) into the D register and B3 at 0016 copies the 00 in the D register into the upper half of R3. The purpose of loading 00 into the lower half of R4, address 0017, will be explained later. F8, address 0018, will load the lower address byte of the input table into the D register. Since we do not yet know the low order address of the input table, we will leave the second byte of the F8 instruction temporarily blank.

The program now tests the switch pattern against the input table. The instruction 43 (LDA) at 001B loads the D register with the byte stored at the address contained in R3 and increments R3 by 1. Since R3 contains the address of the input table, 43 loads one of the 32 valid input patterns into the D register. SM (F7), address 0010, subtracts the byte stored on the stack from the D register. Remember the INP instruction at 0013 stored the switch pattern on the stack. Therefore, F7 compares the switch pattern on the stack to the input code in the D register by subtraction. If they match, D will contain zero and the next instruction, BZ (32) at 001D, will branch the program to Calculate Address. Again, we leave the second byte of the instruction blank until we know the address of Calculate Address.

If D is not zero after the subtraction, the program flows to a decision block labelled End of Input Table. The program will either continue searching the input table or return to Read Input Switches. At program address 0017, the instruction A4 loaded 00 (0000 0000) into the low-order half of register-4. Register-4 will serve as a counter to show when all 32 entries of the table

Entry	Name	Number	Switch	Code	Mem. address
1	Fred Friend	123-4567	1	01	0100
2	Shop extension	1234	1 & 2	03	0108
3					0110
4					0118
5					0120
•					•
•					•
•					•
31					01F0
32					01F8

Fig. 6. Sample Directory Listing.

have been tested. Register-4 should be added to the register and memory table as a counter. After address 001F uses instruction 14 to increment register-4, the subsequent instruction, 84, loads the low-order of register-4 into the D register. SMI (FF) is used to subtract the byte, 20 HEX (32 decimal) from the D register. If the result is not zero, the branch instruction 3A, address 0023, takes the program back to address 001B from whence it will continue looping until register-4 has been incremented to 32. When register-4 reaches 32, the program will move on to the unconditional branch, 30, at address 0025, going back to Read Input Switches.

When the program finds a match between the input switches and the input table, it must calculate the memory address of the corresponding telephone number. These numbers are stored sequentially and must appear in the same order as the corresponding switch patterns in the input table. Since all number addresses contain the high-order byte 01, only the low-order byte has to be calculated. Register-4 keeps count of the patterns tested and can be used to calculate the number address. Since each number is allotted eight bytes of memory, the value in register-4 can be multiplied by eight to produce the lower byte of the address.

The processor does not have a MULTIPLY instruction, but a number in the D register can be multiplied by 2 by shifting it one bit to the left. This is analogous to shifting decimal 50 one place left to get 500. Three one-bit shifts to the left multiply a binary number by eight. This technique is used to perform multiplication on an 1802 processor. Calculate Address begins at program address 0027 with 84, which loads the low-order half of register-4 into the D register. Next, three left shifts perform the necessary multiplication by eight. The instruction A4, at address 002B, loads the product into the lower half of register-4. The next instruction, F801 followed by B4 loads 01 into the high-order half of register-4. Program address 002F begins the dialing sequence, by using 04 to load the first digit of the telephone number into the D register from the memory location addressed by register-4. The LDN instruction used here is similar to the LDA instruction but does not increment the register afterward. The digit in the D register must be tested to see if it is an end of number digit. The test is implemented by subtracting 0A (0000 1010), or 10 decimal, from the D register using FF0A at program address 0030. If the BPZ, 33, instruction at 0032 detects zero or a positive number, indicating an end-of-number digit, the program will branch to Read Input

PROGRAM

Label	*Program Address*	*Op Code*	*Mnemonic*	*Comments*
Start Initialize Stack PTR	0000	7A	REQ	Make Q output low
	0001	F8 00	LDI	Load 00 (0000 0000) into the D register
	0003	B1	PHI	Loads D register into high-order half of register 1
	0004	F8 FF	LDI	Load FF (1111 1111) into D register
	0006	A1	PLO	Loads D register into low-order half of register 1
	0007	E1	SEX	Load X register with 1 (0001)
Read Input Switches	0008	6F*	INP	Load input port data (switch status) into D register and into stack
	0009	3208	BZ	If no input switches depressed, branch to Read Input Switches else next instruction
1-Sec Delay	000B	F8 92	LDI	Load 92 (1001 0010) into D register
	000D	A2	PLO	Loads D register into low-order half of register-2
	000E	B2	PHI	Loads D register into high-order half of register-2
Delay	000F	22	DEC	Decrement the contents of register-2 by 1
	0010	92	GHI	Load high-order byte of register-2 into D register
	0011	3A 0F	BNZ	If the content of the D register is not zero, branch to Delay and continue decrementing register-2 and testing D register. When D register contains zero, go to next instruction
Read	0013	6F*	INP	Load input port data (switch status) into D register and into stack
Load Code	0014	F800	LDI	Loads 00 (0000 0000) into D register
Table Address	0016	B3	PHI	Loads D register into high-order half of register-3
	0017	A4	PLO	Loads D register into low-order half of register-4
	0018	F8 60	LDI	Loads 60 (0110 0000) into D register (starting address of input table)
	001A	A3	PLO	Loads D register into low-order half of register-3 (register-3 now contains the Input Code Table starting address
Compare	001B	43	LDA	Loads D register with the byte from the memory address contained in register-3 and then increments register-3 by 1
	001C	F7	SM	Subtract content of stack from D register
	001D	32 27	BZ	If content of D register is zero, branch to Calculate Address, else next instruction
	001F	14	INC	Increment contents of register-4 by 1 (register-4 contained 00 from address 0017)
	0020	84	GLO	Load low-order byte of register-4 into D register
	0021	FF 20	SMI	Subtract 20 from D register (20 Hex = 32 decimal)
	0023	3A 1B	BNZ	If content of D register is not zero, then branch to compare and continue searching Input Code Table for a match, else next instruction
	0025	30 08	BR	No match found in Input Code Table, branch to Read Input Switches. The program will not accept a switch combination unless the combination is in the Input Code Table

**Use 62 for Product Board*

Calculate Address	0027	84	GLO	Load low-order byte of register-4 into D register
	0028	FE FE FE	SHL	Shift contents of D register left 3 times. (This multiplies contents of D register by 8)
	002B	A4	PLO	Loads D register into low-order half of register-4
	002C	F8 01	LDI	Load D register with 01 (0000 0001)
	002E	B4	PHI	Load 01 from D register into high-order half of register-4 (register-4 now contains starting address of the number to be dialed)
Test Digit	002F	04	LDN	Load D register with byte from memory address contained in register-4
	0030	FF 0A	SMI	Subtract 0A from D register
	0032	33 08	BPZ	If content of D register is positive or zero, the dialing is finished, branch to Read Input Switches, else next instruction
Load Digit	0034	44	LDA	Loads D register with byte from the memory address contained in register-4 and then increments register-4 by 1
	0035	3A 39	BNZ	If content of D register is not zero, then branch to Store Digit, else next instruction
	0037	F8 0A	LDI	Load D register with 0A (If digit loaded into D by 0034 is 00, it must be converted to 10 decimal)
Store Digit	0039	A5	PLO	Load the digit to be dialed from the D register into the low-order byte of register 5
Dial Digit	003A	7B	SEQ	Set Q output high (energize output relay)
38-millisecond Delay	003B	F8 89	LDI	Load D register with 89 (1000 1001)
	003D	A2	PLO	Load 89 from D register into low-order half of register-2
	003E	F8 06	LDI	Load D register with 06 (0000 0011)
	0040	B2	PHI	Load 06 from D register into high-order half of register-2
Loop 1	0041	22	DEC	Decrement contents of register-2 by 1
	0042	92	GHI	Load high-order byte of register-2 into D register
	0043	3A 41	BNZ	If content of D register is not zero, branch to Loop 1. Continue decrementing, then testing the D register. When D register contains zero, next instruction
	0045	7A	REQ	Make Q output low (de-energize output relay)
62-millisecond Delay	0046	F8 0F	LDI	Load D register with 0F (0000 1111)
	0048	A2	PLO	Load 0F from D register into low-order half of register-2
	0049	F8 0A	LDI	Load D register with 0A (0000 1010)
	004B	B2	PHI	Load 09 from D register into high-order half of register-2
Loop 2	004C	22	DEC	Decrement contents of register-2 by 1
	004D	92	GHI	Load high-order byte of register-2 into D register
	004E	3A 4C	BNZ	If content of D register is not zero, branch to Loop 2. Continue decrementing and testing D register when D register contains zero, next instruction
	0050	25	DEC	Decrement contents of register-5 by 1. (Register-5 contains digit being dialed—see address 0039)

(Continued overleaf)

Switches and dialing ceases. Otherwise, the dialing sequence continues.

The End of Number Test altered the digit in the D register, so program address 0034 uses the 44, LDA instruction to reload the digit and advance the pointer, register-4, to the next digit of the number. If the digit is zero, it must be converted to ten (10) before it is dialed. BNZ at address 0035 forces a branch to Store Digit if D is not zero. If D is zero, the LDI instruction F80A converts the zero to ten. The digit is then stored in the low-order half of register-5 by the A5 instruction located at 0039. (Don't forget to add register-5 and its use to the register and memory utilization table.)

Pulse dialing begins with 7B (SEQ) at address 003A, followed by a 38-millisecond delay loop very similar to the one-second delay discussed earlier. At the end of the 38-millisecond delay, Q is reset by 7A at address 0045 and followed by a 62-millisecond delay. The same delay loop is used here. At the end of the 62-millisecond delay, register-5 is decremented by 25 to indicate one pulse of the digit has been dialed. Next, the low-order half of register-5 is loaded into the D register using the 85, GL0, instruction at address 0051. If the digit has not been completely dialed, the D register will not be zero and the BNZ (3A) instruction will make the program branch back to Dial Digit. When the digit is complete, the program enters the 300-millisecond interdigit delay beginning at address 0054. This delay is just like the others. When the delay is over, the last instruction in the program at address 005E is an unconditional branch, 30, which sends the program back to Test Digit to dial the next digit or end the dialing sequence.

We can now decide where we want to locate the input table; and, since the program ends at address 005F, we can place this table from address 0060 to 007F. The blank we left at address 0019 in the program can now be filled in with 60, the low-order address of the input table. We should also add this memory assignment to the register and memory utilization table. The entries for the input table can be derived by making a table of all the possible switch combinations that use no more than two switches at a time. There are actually 36 combinations, so we may choose any 32 of the 36 possibilities shown in Fig. 3. The Hex equivalent of the 32 selected codes will be entered in memory starting at address 0060.

We can now fill in the other blank we left in the program at address 001E. The Calculate Address routine starts at 0027, therefore, we will enter 27 at address 001E.

PROGRAM *(Continued)*

Label	Program Address	Op Code	Mnemonic	Comments
	0051	85	GLO	Load low-order byte of register-5 into D register
	0052	3A 3A	BNZ	If content of D register is not zero, branch to Dial Digit. Continue dialing digit, decrementing the digit and testing D register. When D register is zero, next instruction
300-millisecond Delay	0054	F8 B1	LDI	Load D register with B1 (1011 0001)
	0056	A2	PLO	Load B1 from D register into low-order half of register-2
	0057	F8 2C	LDI	Load D register with 2C (0010 1100)
	0059	B2	PHI	Load 2C from D register into high-order half of register-2
Loop 3	005A	22	DEC	Decrement contents of register-2 by 1
	005B	92	GHI	Load high-order byte of register-2 into D register
	005C	3A 5A	BNZ	If content of D register is not zero, branch to Loop 3. Continue decrementing and testing D register. When D register contains zero, next instruction
	005E	30 2F	Br	The digit has been dialed, branch to Test Digit. This gets next digit in number and tests it to see if all the digits have been dialed

Entering Numbers. Earlier, we decided to store the telephone numbers in memory locations 0100-01FF. The digits of the number are entered in the same order you would dial them. For example, let's suppose we want to enter the following two numbers:

1. *Name*: Fred Friend
   Number: 123-4567
   Switch Combination: 1
2. *Name*: Shop Extension
   Number: 1234
   Switch Combination: 1 & 2

The first step is to make up a simple directory, as shown in Fig. 6, to keep track of entries made. To enter the first number, fill in Fred Friend, his number (123-4567), and the selected switch combination. Next, we want to store the number in memory as follows:

Address	*Digit*	*Binary*
0100	01	0000 0001
0101	02	0000 0010
0102	03	0000 0011
0103	04	0000 0100
0104	05	0000 0101
0105	06	0000 0110
0106	07	0000 0111
0107	0F	0000 1111

Only one digit is stored per address, and the number is ended with 0F as End of Number Digit. The last step is to load the Hex code for the switch combination into the input table. The Hex code must occur in the same order in the input table that the number occurs in memory. From Fig. 6 we see that this number is the first entry in memory, therefore, the Hex code must be the first entry in the input table. We would enter the Hex code 01 at memory location 0060 of the input table.

The next number, 1234, is added to the directory as before; but, since the number is only four digits long, it will be entered in memory slightly differently:

Address	*Digit*	*Binary*
0108	01	0000 0001
0109	02	0000 0010
010A	03	0000 0011
010B	04	0000 0100
010C	0F	0000 1111
010D	XX	
010E	XX	do not care
010F	XX	

In this case, there are three unused memory locations, 010D-010F. This number is the second entry in memory, so the Hex code, 03, for the switch combination must be the second entry of the input table at address 0061. Subsequent numbers would be added in the same manner. When it is necessary to dial more than seven digits, say, to accommodate an area code, the number can be broken up and stored in two locations. To store 201-123-4567, for example, we could assign 201 (followed by an end-of-number digit) to switch 1 and 123-4567 (also followed by an end-of-number digit) to switch 1 plus switch 2. Pressing switch 1 dials the area code; then switches 1 and 2 together dial the rest of the number.

If the program is running and switch one or the combination of switches one and two is pressed, the program will begin dialing the selected telephone number. However, if any other valid switch combinations are entered, the program may attempt to dial an incorrect or nonexistent telephone number. The byte at address 0022, which tells the program when to stop testing entries in the input table, can prevent this. Since only two entries in the table represent real telephone numbers thus far, we can place 02 at address 0022; now the program will only check the first two entries. As more numbers are added, this byte can be altered.

Hardware. The computer system should be interfaced to the telephone line by a good 5-12-volt relay with contacts rated at 60 volts dc at 50 mA. The normally closed relay contacts are wired in series with the telephone; therefore, if the computer is powered down or not being used for dialing, it will not interfere with normal telephone operation. This program is designed for an Elf II or a Product Board, but some minor hardware changes are required. Referring to Fig. 1, the eight 22,000-ohm resistors must be added to the Product Board, and the 1000-ohm resistor and 2N2222A transistor must be added to the Elf II. The strobe input of the input port on both the Product Board and the Elf II must be tied to +5 volts to enable the processor to read the switches.

The project also requires some means of storing data in a ROM. This means either a fuse burner for a fuse-type ROM, or an EPROM programmer for the type of EPROM used. In the latter case, an erase device can be used if incorrect data is entered. Errors burned into a fuse-type ROM are permanent and uncorrectable.

Other Uses. The dialer program could be used in an automatic fire/burglar alarm system by paralleling a switch from the alarm system to one of the switches of the dialer. Whether the task is to dial a telephone number, flash lights, generate sound, control alarm systems, or control robots, the microcomputer can become a powerful tool to anyone who will learn to use it. ◇

BUILD A
MORSE-A-KEYER

Conclusion

BY GEORGE R. STEBER

THE first part of this article, in the January issue, described the circuit and purpose of the "Morse-A-Keyer" project. In this issue are details of construction and operation.

Construction. The use of printed-circuit assembly techniques is recommended. To keep the prototype's printed-circuit board compact, a double-sided pc board was used. Full-size etching and drilling guides for the board appear in Fig. 2. If you decide to make your own board from these guides and do not have facilities for making plated-through holes, leads *must* be soldered to foil pads on both sides (where applicable) to create the proper circuit connections. If you use a double-sided board with plated-through holes, component leads must be soldered only on the bottom side of the pc board. Employ a fine-tipped, low-wattage soldering iron, small-diameter 60/40 rosin-core solder, and IC sockets or Molex Soldercons when assembling the pc board.

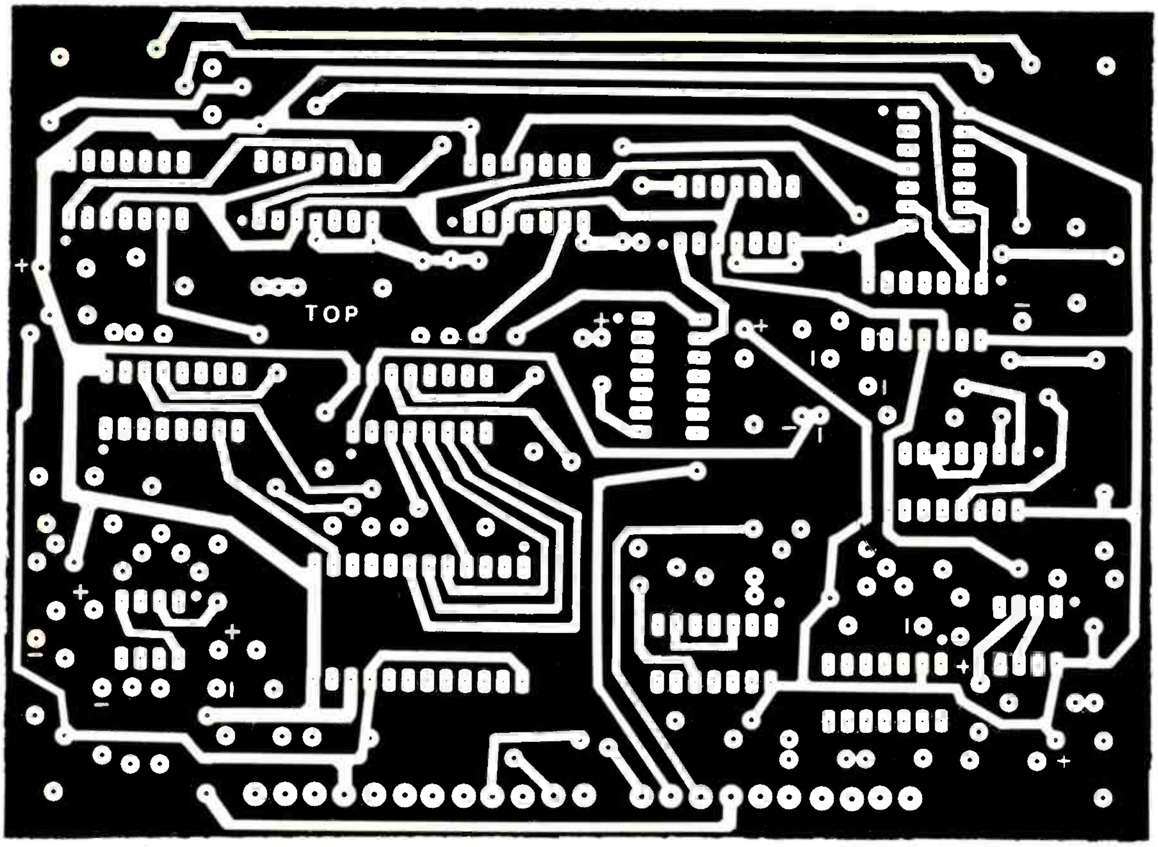
The component-placement guide appears in Fig. 3. Install the IC sockets or Molex Soldercons first, the smallest components next, and then the largest. Remember to install the jumpers at *J1* to select the desired strobing-pulse polarity, at *J2* if it is desired that one of the relay contacts be grounded, and at *J3* so that +5 volts from the supply can reach the Morse-A-Keyer circuit. Observe the polarities and pin basings of all electrolytic capacitors and semiconductors. Note that the +5-volt power supply, the sidetone speaker, SPEED control *R30*, relay-protective components *R24* and *C17*, and BUFFER FULL *LED1* are not mounted on the pc board. These items, various switches, input and output connectors, and an ASCII keyboard if desired, should be mounted on a suitable metal enclosure. The pc board can be secured to the keyboard by standoffs.

The 1702A PROM, *IC12*, must be properly programmed. Its truth table appears in Table I. If you want to program your own PROM but don't know how to do so, consult the PROM programmer construction article that appeared in the February 1978 issue of this magazine. Some semiconductor dealers will program the device for you if you include the truth table with your order for the device.

TABLE I—CODING FOR 1702A ASCII/MORSE EPROM

	ASCII								Morse								Octal	
Character	A7	A6	A5	A4	A3	A2	A1	A0	D8	D7	D6	D5	D4	D3	D2	D1	ASCII	Morse
A	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0	0	101	014
B	0	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	102	042
C	0	1	0	0	0	0	1	1	0	0	1	0	1	0	1	0	103	052
D	0	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	104	022
E	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0	105	004
F	0	1	0	0	0	1	1	0	0	0	1	0	1	0	0	0	106	050
G	0	1	0	0	0	1	1	1	0	0	0	1	0	1	1	0	107	026
H	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	110	040
I	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	111	010
J	0	1	0	0	1	0	1	0	0	0	1	1	1	1	0	0	112	074
K	0	1	0	0	1	0	1	1	0	0	0	1	1	0	1	0	113	032
L	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	114	044
M	0	1	0	0	1	1	0	1	0	0	0	0	1	1	1	0	115	016
N	0	1	0	0	1	1	1	0	0	0	0	0	1	0	1	0	116	012
O	0	1	0	0	1	1	1	1	0	0	0	1	1	1	1	0	117	036
P	0	1	0	1	0	0	0	0	0	0	1	0	1	1	0	0	120	054
Q	0	1	0	1	0	0	0	1	0	0	1	1	0	1	1	0	121	066
R	0	1	0	1	0	0	1	0	0	0	0	1	0	1	0	0	122	024
S	0	1	0	1	0	0	1	1	0	0	0	1	0	0	0	0	123	020
T	0	1	0	1	0	1	0	0	0	0	0	0	0	1	1	0	124	006
U	0	1	0	1	0	1	0	1	0	0	0	1	1	0	0	0	125	030
V	0	1	0	1	0	1	1	0	0	0	1	1	0	0	0	0	126	060
W	0	1	0	1	0	1	1	1	0	0	0	1	1	1	0	0	127	034
X	0	1	0	1	1	0	0	0	0	0	1	1	0	0	1	0	130	062
Y	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	131	072
Z	0	1	0	1	1	0	1	0	0	0	1	0	0	1	1	0	132	046
1	0	0	1	1	0	0	0	1	0	1	1	1	1	1	0	0	061	174
2	0	0	1	1	0	0	1	0	0	1	1	1	1	0	0	0	062	170
3	0	0	1	1	0	0	1	1	0	1	1	1	0	0	0	0	063	160
4	0	0	1	1	0	1	0	0	0	1	1	0	0	0	0	0	064	140
5	0	0	1	1	0	1	0	1	0	1	0	0	0	0	0	0	065	100
6	0	0	1	1	0	1	1	0	0	1	0	0	0	0	1	0	066	102
7	0	0	1	1	0	1	1	1	0	1	0	0	0	1	1	0	067	106
8	0	0	1	1	1	0	0	0	0	1	0	0	1	1	1	0	070	116
9	0	0	1	1	1	0	0	1	0	1	0	1	1	1	1	0	071	136
0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	1	0	060	176
.	0	0	1	0	1	1	1	0	1	1	0	1	0	1	0	0	056	324
,	0	0	1	0	1	1	0	0	1	1	1	0	0	1	1	0	054	346
?	0	0	1	1	1	1	1	1	1	0	0	1	1	0	0	0	077	230
/	0	0	1	0	1	1	1	1	0	1	0	1	0	0	1	0	057	122
_	0	0	1	0	1	1	0	1	0	1	1	0	0	0	1	0	055	142
=	0	0	1	1	1	1	0	1	0	1	1	0	0	0	1	0	075	142
AR (;)	0	0	1	1	1	0	1	1	0	1	0	1	0	1	0	0	073	124
SK (ESC)	0	0	0	1	1	0	1	1	1	1	0	1	0	0	0	0	033	320
AS (:)	0	0	1	1	1	0	1	0	0	1	0	0	0	1	0	0	072	104
SP (SPACE)	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	040	011
KN (DEL)	0	1	1	1	1	1	1	1	0	1	0	1	1	0	1	0	177	132

Operation. The Morse-A-Keyer is very easy to use. Preparing the project for Morse generation involves connecting an ASCII source to its data input lines, applying power to its supply, connecting its keyed output to the keying line of the transmitter or transceiver with which it is to be used (if any), and applying an ASCII character to its input to generate a (silent) space. This ini-



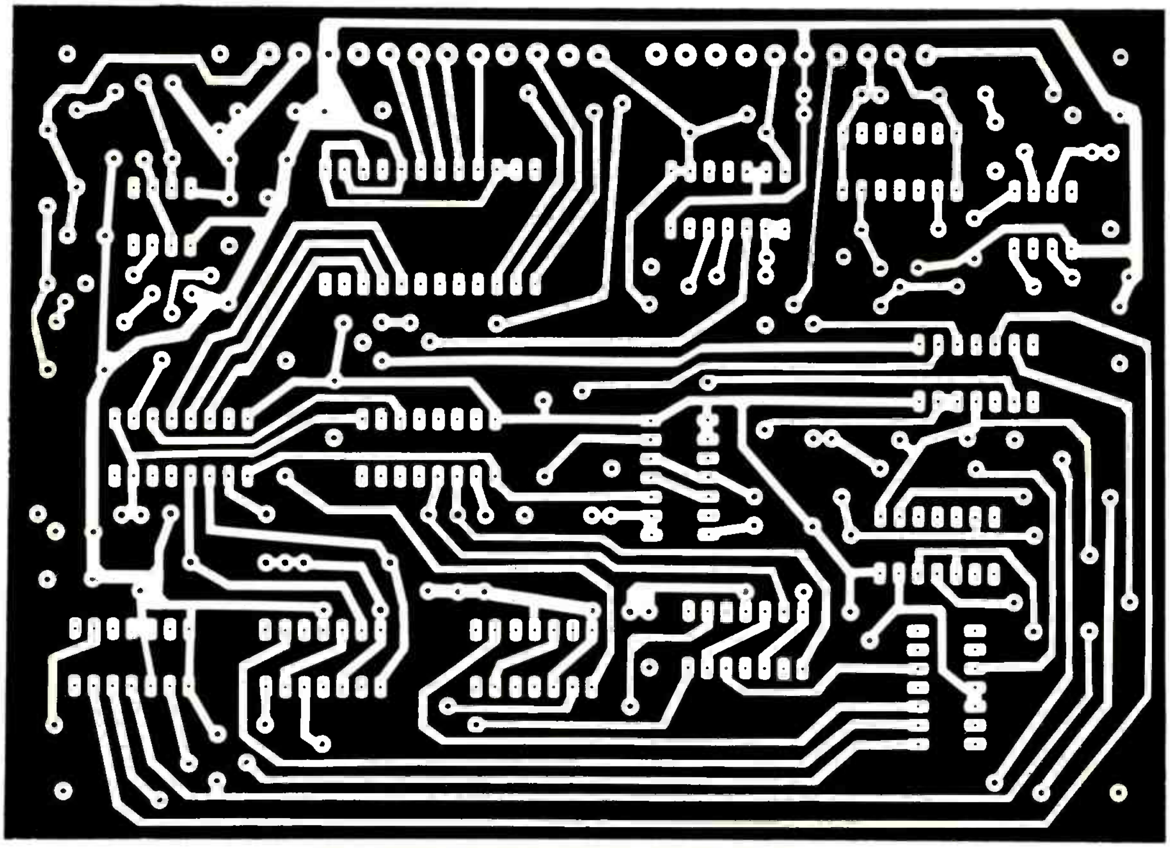


Fig. 2. Full-size etching and drilling guides for the top (above) and bottom (below) of the Morse-A-Keyer's pc board.

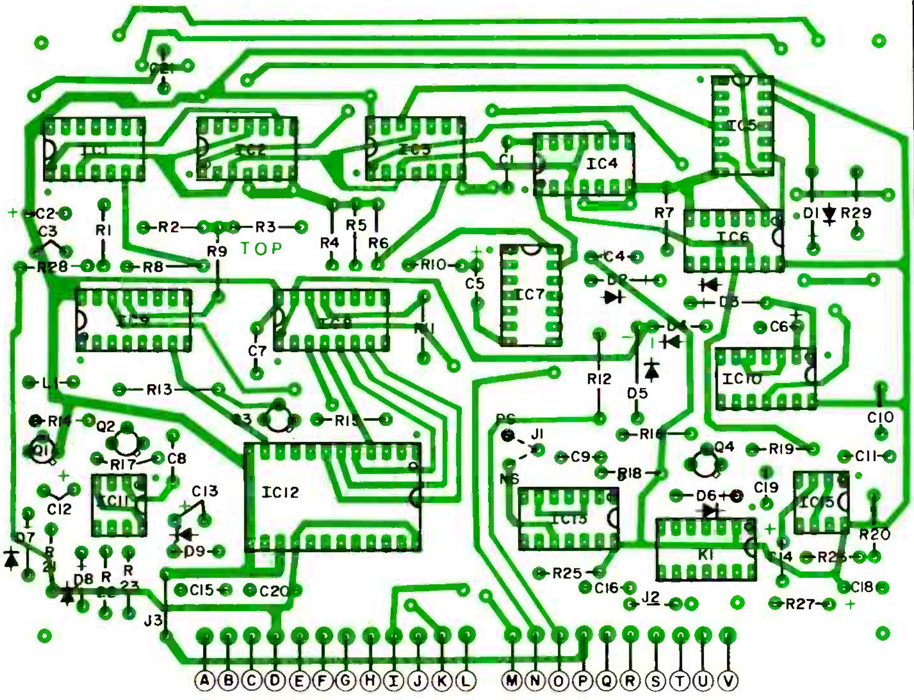


Fig. 3. The component placement guide for the project's pc board. Circuit points corresponding to those that appear in the schematic diagram are called out by letter designations.

tialization is necessary because when the project is first powered, its flip-flops' outputs can assume random logic states. This can be accomplished by tapping the space bar of an ASCII keyboard if such a keyboard is used. Actually, any character will work, but the space bar is the most convenient. The settings of the SPEED and sidetone VOLUME controls are matters of user preference.

The Morse-A-Keyer as designed can transmit code at a rate from 5 to 35 wpm. This range can easily be modified by changing the value of *R12*. For example, if a component with a resistance that is less than the specified 82 kilohms is used as *R12*, the project's top speed will be greater than 35 wpm.

When feeding ASCII data into the project by means of a keyboard or some other source, do so at approximately the same rate that is selected by the setting of the SPEED control. The Morse-A-Keyer's 16-character elastic buffer will compensate to some extent for variations in the rate at which data is presented to its input lines so that the generated code that appears at its output will have constant speed and spacing. However, if the SPEED control is set for 5 wpm and ASCII data is applied to the input lines at a rate of 20 wpm, the buffer will quickly overflow (this condition is indicated by the BUFFER FULL LED glowing) and characters will be lost.

One final point—if you transmit a CQ at 35 wpm, be prepared to receive a reply at the same speed. If you can copy code that fast, or have a Morse decoding device such as the Morse-A-Word (see POPULAR ELECTRONICS for March and April 1979), you're all set for a brisk, breezy QSO! ◇

In the first part of this article, the value of C6 on the schematic should have been 0.47 μF not 47 μF and capacitor C10 should have been connected between + 5 volts and ground, with the coil of relay K1 connected directly to the supply.—Ed.

KIT ORDERING INFORMATION

The following is available from Microcraft Corp., Box 513, Thiensville, 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.

HOBBY SCENE

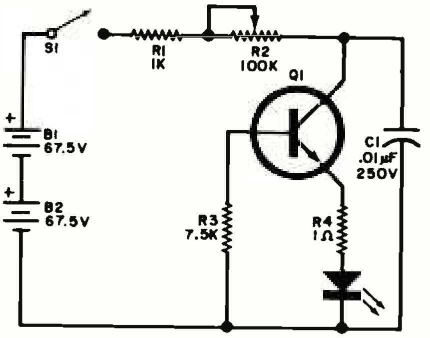
By John McVeigh, Technical Editor

Using Laser Diodes

Q. *I am interested in using an infrared laser diode in a target game. I would like to know what kind of power supply and detector I should use. Also, must I use a lens to focus the infrared output, or does the diode produce a narrow beam like a visible, gas-tube laser?—Peter Dix, Milwaukee, WI*

A. Single-heterostructure (SH) laser diodes, the type that are supplied at bargain prices by some of the merchants who advertise in this magazine, must be driven by narrow current pulses of at least 5 or 10 amperes. These diodes will not lase until the forward current exceeds a threshold known as J_{th}. As the forward current increases above J_{th}, the optical power increases linearly. The J_{th} of SH diodes is typically 5 to 10 amperes, but this much current can only be applied in pulses of no greater duration than 200 nanoseconds. Otherwise, the diode will literally explode.

The avalanche-transistor circuit shown in the figure will provide high-current pulses only 50 to 75 nanoseconds in duration. Different transistors avalanche at different voltages, so you'll have to select a specific transistor for your particular laser. Don't incorporate the diode into the circuit until you have selected a transistor that will provide an acceptable level of current and have verified the operation of the circuit.



Select *Q1* by connecting a short copper wire in place of the diode and monitoring the voltage developed across *R4* by means of a fast (15-MHz) scope. Keeping leads as short as possible, temporarily connect a transistor as *Q1* and monitor the scope trace. If the circuit is oscillating (and it will with most npn switching transistors), the vertical amplitude of the pulses across *R4* in volts will equal their peak current in amperes. Select a transistor that delivers two and a half to three times your diode's J_{th}, which rating is usually supplied with the device.

In the circuit shown, *S1* can be a trigger-actuated momentary switch, and the entire circuit can be mounted in the body of a fake rifle.

The beam generated by an SH laser diode is invisible and occupies a fairly broad field—about 20 x 40 degrees. To see the beam, you'll need an infrared-to-visible-light converter. The most inexpensive converter is a plastic, phosphor-coated infrared viewing card that is available for about $30 from Kodak Special Products Sales, Rochester, NY 14650. With the help of an image converter, you can compress the wide beam

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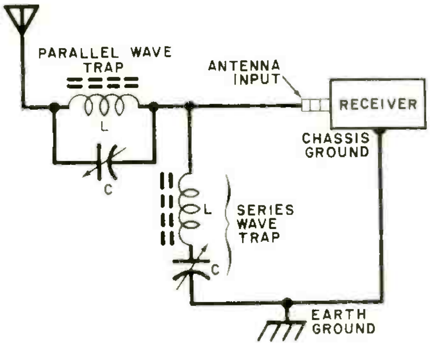
of infrared light into a pencil-thin beam as narrow as that emitted by a helium-neon tube laser. All you need is a convex f1 lens, which is available from Edmund Scientific Co., or one of the other optics dealers.

Any sensor that is to be used must be sensitive to the laser's 900-nanometer infrared radiation. Silicon photodiodes driving fast amplifiers are best. A phase-locked receiving loop can be used as a detector if the pulse rate of the transmitter (determined by the setting of *R2*) is within the lock range of the loop. The amplified error-voltage output of the loop can be used to drive digital scoring circuits. Ideas for the infrared link can be gleaned from Forrest Mims' "Experimenter's Corner," especially the September 1977, March 1979, July 1980 and August 1980 installments, and the January 1979, February 1979, and July 1979 "Projects of the Month," all of which helped me formulate a response to your question.

Front-End Overload

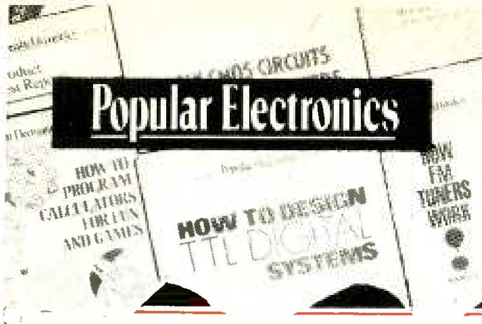
Q. ***I have a general-coverage shortwave receiver that picks up signals from local AM broadcast stations on the shortwave bands. What can I do to remedy this situation?—Marvin Rosen, Baltimore, MD***

A. Assuming that the AM broadcast-station transmitters are not radiating harmonics of their fundamental frequencies, the spurious signals that you are noting on the shortwave bands are the result of nonlinearities in your receiver. This not-uncommon situation arises when the "offending" signal is very strong or when the receiver lacks sufficient ability to reject out-of-band signals. One possible solution is to attenuate the AM broadcast signals by means of a *wave trap*. If a series LC circuit tuned to the frequency of the offending signal is connected between the receiver's antenna input and ground, the tuned circuit will offer a low-impedance shunt path to ground. The frequencies of the shortwave stations that you want to receive will be so far removed from the resonant frequency of the trap that the trap will not adversely affect them. A suitable trap can be fashioned from a 10-to-365-pF variable capacitor and a ferrite loopstick inductor. Both components can be salvaged from a discarded AM radio.



To use the trap, simply adjust the variable capacitor for minimum spurious response in the receiver. If one section of trapping is insufficient, it can be augmented by means of a parallel wave trap (see figure) constructed from similar components and placed between the antenna input of the receiver and the antenna.

Another solution is to use an active or passive r-f preselector with a band-pass response. Some antenna tuners provide this as a bonus in addition to their impedance-matching function. If you decide to try an active preselector, be sure to choose a design that employs devices known for their ability to resist strong-signal overload. The excellent ability of MOSFETs to cope with high-level input signals makes them ideal candidates for this application. ◇



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SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

A New Super LED

A NEW-PRODUCT announcement in a recent issue of an electronics trade magazine described a recently developed family of "super-high-output" infrared light-emitting diodes. My initial reaction to this item was one of skepticism, because over the past several years *a number* of companies have announced new high-power LEDs. In fact, all of these "new" LEDs deliver approximately the same amount of optical power—6 milliwatts at a forward current of 100 milliamperes. Nevertheless, I wrote to the manufacturer, Xciton Corporation, and requested more information.

Xciton sent a package of data sheets which revealed the new "super" LEDs are made from (AlGa)As, a compound which emits at a wavelength of 880 nm in the near infrared. The data sheets claimed that the new diodes have twice the power-conversion efficiency of comparable GaAs:Si LEDs, whose radiation is at the longer wavelength of 940 nm. Xciton's data seemed in order, so I sent for sample LEDs for evaluation.

When the new LEDs arrived, I measured their power output using a calibrated Centralab Model CS-12 silicon detector. In all cases, the new (AlGa)As diodes were indeed twice as efficient as similar GaAs:Si emitters. Incredibly, at forward currents of less than 30 milliamperes, one of the new diodes exhibited a power-conversion efficiency fully 2½ times greater than that of a comparable GaAs:Si unit!

Figure 1 compares the power output of one of the new (AlGa)As emitters, the Model XC-880-C, with that of a high-quality GaAs:Si emitter, Optron's Model OP-195. I made the graph with the help of the Centralab calibrated detector. Note that, at a forward current of 30 milliamperes, the power output of the Model XC-880-C diode is three times that of the Model OP-195. The power-conversion efficiencies of the two emitters are 6.5 percent and 2.6 percent, respectively.

The results given in Fig. 1 are somewhat conservative, because both diodes are encapsulated in T-1¾ standard-diameter epoxy packages. Diodes housed in these packages emit off-axis radiation which is not intercepted by the calibrated detector and is therefore not measured. Nevertheless, because both diodes are installed in identical packages, Fig. 1 provides a fair comparison of the outputs of the two diodes.

Now that Xciton's claim about the efficiency of its new emitters has been vindicated, let's look at the specified output powers for the most powerful members of this new family of LEDs. There are three series of epoxy-encapsulated diodes and two series of metal-package diodes, each series being divided into four power-output categories designated, in ascending order, A,B,C and D.

The most powerful epoxy-encapsulated diodes include a miniature, wide-emission-angle, T-1-packaged version (XC-1288-D), and both narrow- and wide-emission-angle, T-1¾-packaged versions (XC-880-D and XC-881-D, respectively). All three of these diodes

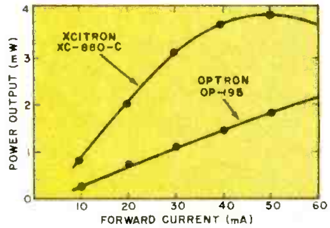


Fig. 1. Comparing power outputs of two types of light-emitting diodes.

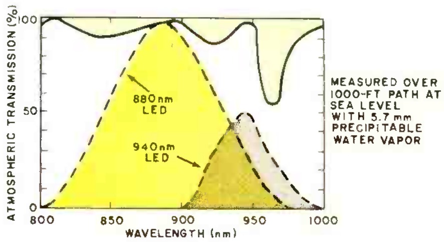


Fig. 2. Response of silicon phototransistor compared to emission wavelengths of LEDs.

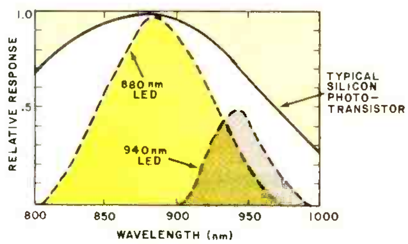


Fig. 3. How LED emissions are reduced by atmospheric absorption.

emit 5.0 milliwatts at only 20 milliamperes of forward current!

The most powerful metal-package versions include both flat-window (XC-88-FD) and lens (XC-88-PD) configurations in TO-46 packages. Both emit 12.0 milliwatts at 100 milliamperes!

There are at least sixteen individual diodes in this new family of 880-nm emitters, so it's not possible to include all their specifications here. For data sheets, write to Xciton Corporation (Shaker Park, 5 Hemlock Street, Latham, NY 12110).

Applications for Super LEDs. The new 880-nm super LEDs offer several important advantages over conventional infrared emitters. Their very high output-power levels, for example, mean that optical communication, ranging, and detection systems can be designed using less-sensitive receivers. Alternatively, if the new super LEDs are substituted for older, less powerful emitters in existing circuits, transmitter drive currents can be reduced substantially. This can be particularly beneficial in battery-powered applications.

The 880-nm emission wavelength of the new LEDs offers important advantages, also. As Fig. 2 shows, the peak-emission wavelength of the new emitters is much closer to the peak-sensitivity region of silicon phototransistors. Another advantage is that, although the radiation from a 940-nm emitter is totally invisible, that from an 880-nm LED is visible as a dim, red glow. The beam is too faint to be obvious, so the new LEDs can be used in applications where an essentially invisible beam is desired (as in an intrusion alarm). However, its slight visibility solves a problem that has always beset users of infrared LEDs—the desire to know quickly whether or not the LED is actually radiating.

A less obvious advantage of the 880-nm wavelength radiated by the new LEDs is substantially reduced atmospheric absorption. Figure 3, which is extracted from a small portion of a wall chart published by the Santa Barbara Research Center of the Hughes Aircraft Company, shows that some wavelengths are heavily attenuated due to absorption by atmospheric water vapor. Note that 940 nm is within one of these absorption regions. On the other hand, the more powerful emissions from 880-nm LEDs fall within a very high transmission region known as a *window*.

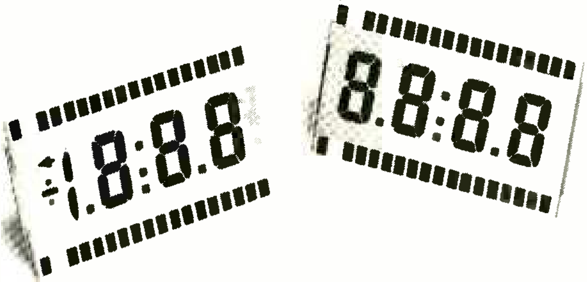
We can therefore conclude that, for long-range, free-space light-wave communications and detection, the 880-nm emitter is superior to the 940-nm emitter. Its output power can be twice as high for a given forward current through the LED and it will be subject to only approximately one-half the atmospheric attenuation.

Unfortunately, the excellent atmospheric transmission at 880 nm poses a possible problem if a super-LED light-wave communication or detection system is to be used during daylight hours. Sunlight can cause substantial interference in such systems. At sea level, solar radiation at 880 nm is 0.07 watts/meter^2, nearly twice that at 940 nm—0.04 watts/meter^2. Therefore, potential receiver noise at the shorter wavelength is almost double that at the longer wavelength. This problem can be alleviated by using a narrow-bandpass optical filter at the detector of a light-wave receiver and by reducing its field of view.

Incidentally, another drawback of the new super LEDs is their relatively slow rise and fall times—approximately one microsecond. This limits their information-carrying capacity to about 400 kHz, which is more than adequate for carrying as many as 100 voice channels, but which is at best marginal for video and high-data-rate applications. GaAs:Si LEDs are about as slow as the new super LEDs.

Based upon previous reader response to infrared construction projects in this magazine, many of you will want to know how you can purchase these new super LEDs. You can't buy small quantities of the new diodes from Xciton, because the company has a minimum billing of $100. Many electronic-parts dealers, however, will sell the diodes in small quantities. Ask Xciton to send you a list of dealers who sell its products.

Incidentally, it's possible that some mail-order dealers will include the new 880-nm super LEDs in their product lines. If so, pay close attention to the part numbers because Xciton super LEDs are graded according to power output. Remember than an "A" suffix



Beckman Instruments' Model 739 liquid crystal displays consume 20 microwatts and can be read at distances up to 5 feet.

denotes the lowest output-power category while a "D" suffix denotes the highest category. Be wary of buying diodes from dealers who fail to give the suffix!

Xciton isn't the only company that makes (AlGa)As LEDs. Laser Diode Laboratories, RCA and other companies make LEDs and injection lasers from this compound, but their products are usually communications-grade, fast-risetime devices. None is as efficient as the Xciton diodes. Hopefully, other companies will see the light and follow Xciton's lead by introducing other versions of the new, super-powerful 880-nm LEDs. These devices are just what many experimenters have been waiting for, and I can hardly wait to build some working systems using the ones with which I've been tinkering.

Solid-State Detective Story Update. In the September 1980 column, I described a mysterious problem which has plagued some large-capacity memory chips. The problem is the occasional, seemingly random loss of stored bits. You will recall, if you read that column, that the source of this problem had been traced to alpha particles emitted by radioactive contaminants in the ceramic and plastic compounds used to make packages for memory chips.

That column has generated some interesting feedback from readers. Dr. Stephen R. Coover, a research assistant professor at the University of North Carolina, wrote "I found your attempt to induce soft errors in an Intel 2101 RAM by alpha irradiation from a lamp mantle to be intriguing. Although it was not indicated, I assume the irradiation was performed on an intact, encapsulated chip. Alpha irradiation of an encapsulated chip would be ineffective in inducing soft errors, as the alpha particles could not penetrate the chip deeply enough to reach the active silicon layers. Possibly this explains why you could not detect any errors."

Dr. Coover is correct. I conducted the experiment with an intact chip. I would like to try it with an exposed chip, but haven't determined a way to remove the top of the package without damaging the chip or the bonding wires.

Gary E. Hower, a radiation physicist in Wichita, KS and Phil Spray, an engineer in Amarillo, TX wrote letters very similar to Dr. Coover's. They also discussed the fact that alpha particles are not generally detectable with conventional Geiger counters because such particles are blocked by the tube wall. I had mentioned in the column a miniature radiation detector with which I can detect the radiation emitted by a lamp mantle. Perhaps my counter is detecting gamma emissions from the thorium in the lamp mantle. Phil Spray, however, observed that the gamma emission from natural thorium possesses very low energy (55 keV) while the alpha emission is more energetic (3.98 MeV).

J. F. Ziegler of IBM's Thomas J. Watson Research Center has sent a fascinating paper he wrote with W. A. Lanford. It's entitled, "Effect of Cosmic Rays on Computer Memories," and it appeared in the November 16, 1979 issue of *Science* (pp. 776-788). Be sure to read this paper if you're interested in this topic. You can find back issues of *Science* at most libraries.

New Components. Beckman Instruments, Inc. (2500 Harbor Blvd., Box 3100, Fullerton, CA 92634) has introduced a new series of liquid-crystal displays, designated the 739 series.

These displays consume only 20 microwatts of power, and their 0.4- or 0.5-inch digits can be read at distances up to 5 feet. High-temperature-range versions which operate from −10° to 85°C are also available (739A series).

For those who want to experiment with LC displays, Beckman offers the 750-2 LCD Designer's Kit, which includes polarizers, display, connector/bezel assembly, elastomeric contacts, etched circuit board and hardware. Also included is an instruction folder. The kit is available for $11.95 from Beckman distributors, *not* directly from the manufacturer. You can consult the manufacturer, however, or a standard reference like *Electronic Design's Gold Book*, for the nearest Beckman distributor.

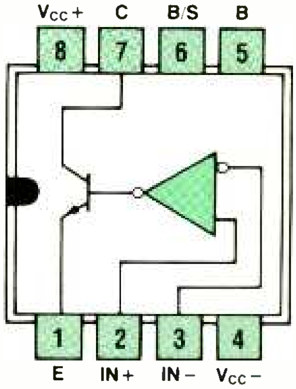


Fig. 4. Pinout of Texas Instruments' TL311 NMOS comparator.

Texas Instruments has announced a unique NFET comparator designed for single-ended supply operation. The new chip, whose pinout is shown in Fig. 4, will accept input signals at V_{cc} or ground. The chip is designated the TL311. Its n-channel JFET input provides an input impedance of 10^{12} ohms. Response time is a very fast 165 nanoseconds and current consumption is only 2.5 milliamperes. Because the chip can be powered by a single +5-volt supply (or by a ±15-volt supply), it's sure to become very popular among analog-circuit designers. It is ideally suited for TTL-interface applications. ◇

EXPERIMENTER'S CORNER

By Forrest M. Mims

CMOS Basics: The 4011 Quad NAND Gate

IT'S common knowledge that CMOS integrated circuits lacking internal zener protection are vulnerable to electrostatic damage. That's why many experimenters are reluctant to use them. This month we're going to try to convince those of you who shy away from CMOS to get your feet wet by experimenting with one of the most basic CMOS chips, the 4011 quad 2-input NAND gate. In doing this, we hope to make clear the advantages of CMOS to those of you who still use TTL exclusively in your projects.

As you'll see by building the circuits that follow, CMOS is in many respects much more versatile and easier to use than TTL. Its principal advantages are its wide operating voltage range, low current consumption, and high input impedance. CMOS chips also provide very good noise immunity and large fan-out (that is, the number of gate inputs that can be driven by a single output). The only major advantage TTL has over CMOS is considerably greater switching speed. Typical maximum speeds for CMOS logic range from 1 to 5 MHz.

Using CMOS Chips. The circuits described here will enable you to learn firsthand about the operating characteristics and requirements which distinguish CMOS from TTL. Probably the most important requirement is that *every* input pin of a CMOS chip *must* go somewhere. If the pin is unused, it must be connected to V_{DD} (the positive supply voltage) or V_{SS} (the negative supply voltage, which is usually ground). Otherwise, stray signals can enter the device via the unused pin, turn on a gate, and cause a very large current to flow. This can cause the chip to overheat or exhibit erratic, unpredictable operation.

Another important difference is power-supply voltage. TTL must be operated within half a volt of +5 volts. Most CMOS chips can be operated with a potential difference between the V_{DD} and V_{SS} terminals of from +3 to +15 volts. Although the wide operating voltage range of CMOS is very desirable, its ultra-low current consumption is even more important. At a switching speed of 1 MHz, for example, a typical CMOS gate draws only 0.1 milliampere when the supply voltage is +5 volts and only 0.2 milliampere when it is +10 volts.

Today's CMOS chips are less vulnerable to electrostatic-discharge damage than those of older vintage, thanks to protective zener diodes diffused across their inputs. These diodes shunt high voltages (generated as static electricity by simple physical handling) away from the delicate gate structures of CMOS devices. Nevertheless, always play it safe and follow standard CMOS handling precautions.

- Never store CMOS chips in *nonconductive* plastic trays, bags or foam.
- Always place CMOS chips *pins down* on a conductive aluminum foil sheet or tray when the chips are not being stored in conductive foam.
- Avoid touching the pins of CMOS chips.
- Use a grounded or battery-powered soldering iron to solder the pins of CMOS chips. Better yet, employ IC sockets or Molex Soldercons.

Recently, there have been reports that some so-called conductive plastic bags and foams intended for the storage of

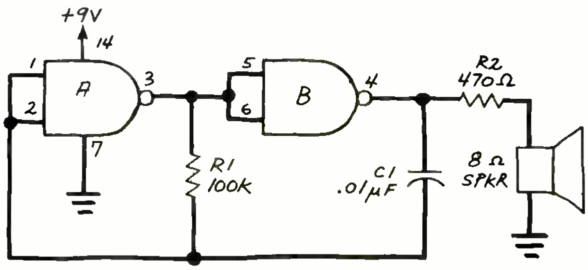


Fig. 2. Circuit for an ultra-simple CMOS tone generator.

CMOS chips are not nearly as effective as they are supposed to be at protecting the chips from static discharge damage. You can avoid this potential problem by plugging CMOS chips you want to store into a flat piece of foam plastic wrapped with aluminum foil.

Figure 1 is the pinout of one of the simplest CMOS gate packages, the 4011 quad 2-input NAND gate. If you're a veteran TTL user, you will immediately notice that the gates connected to pins 4, 5 and 6 and pins 8, 9 and 10 are oriented in the opposite direction as compared to the corresponding gates in the 7400, the TTL counterpart to the 4011. Be sure to keep that in mind when you use the 4011 in the circuits here.

Audio Oscillator. Figure 2 shows a simple tone generator

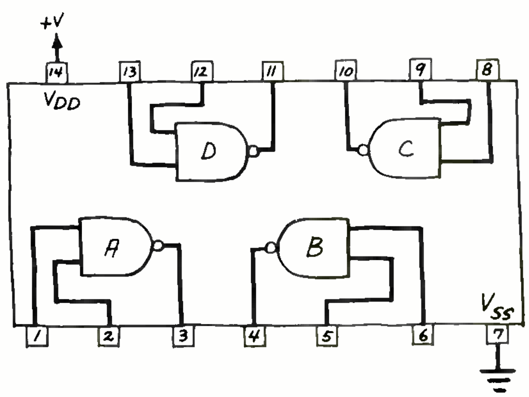


Fig. 1. Pin outline for a 4011 quad 2-input NAND gate.

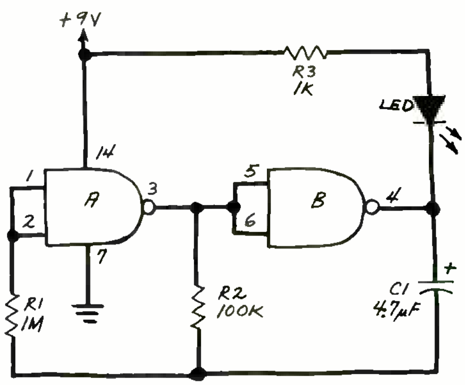


Fig. 3. Schematic of a CMOS LED flasher.

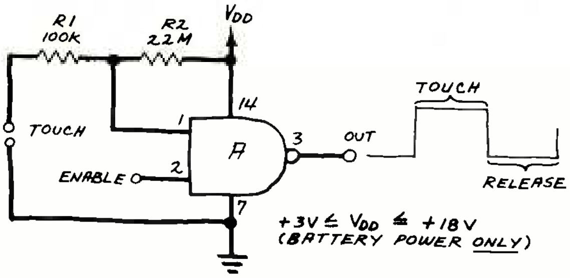


Fig. 4. Simple touch switch includes ENABLE input.

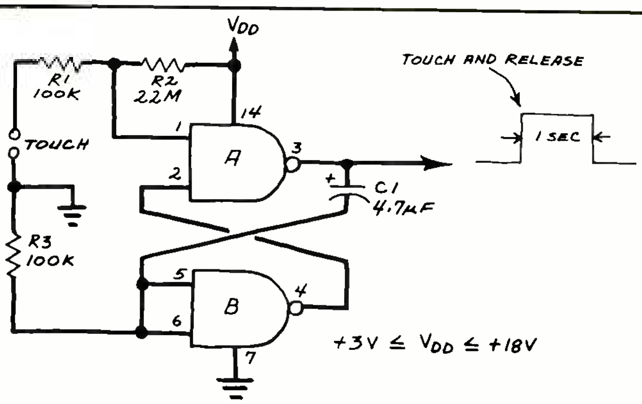


Fig. 5. One-shot touch switch provides 1-second output.

made from half of a 4011. The circuit delivers a 1-kHz square wave to a miniature 8-ohm speaker. The frequency of the output signal can be increased by decreasing the value of *C1*.

The square-wave output can be made more symmetrical by inserting a 1-megohm resistor between pins 1 and 2 of the 4011 and the common connection of *R1* and *C1*. For increased drive capability, connect together all four inputs and both outputs of the two unused gates (*C* and *D*) to form a buffer which is then inserted between pin 4 and the speaker.

You can turn the tone generator on and off with an external logic signal by disconnecting one of the inputs of the first gate and using it as an enable input. The circuit will oscillate when the enable input is at logic 1.

LED Flasher. Figure 3 schematically shows an LED flasher patterned after the basic oscillator circuit of Fig. 2. The LED will flash once or twice each second. The flash rate can be reduced by increasing the value of *C1*. To use the circuit as a 1-kHz LED tone transmitter, use 0.01-μF for *C1*.

Simple Touch Switch. A single 4011 provides the nuclei oı up to four momentary touch switches. The switch shown in Fig. 4 includes an ENABLE input. Touch switches make ideal replacements for pushbutton switches in many circuits. The touch wires can be any pair of closely spaced contacts, terminals or exposed wires.

One-Shot Touch Switch. Figure 5 shows a one-shot touch switch which provides a one-second output pulse when actuated. The circuit consists of two cross-coupled gates which, together with *C1* and resistors *R1*, *R2* and *R3*, form a monostable multivibrator. For an output pulse of greater duration, increase the value of *C1*.

A one-shot touch switch has many applications. One possibility is to connect its output to the ENABLE input of a CMOS tone generator such as the one shown in Fig. 2. The tone generator will then issue a one-second burst of sound when the TOUCH terminals are bridged by a finger.

Bounceless Switch. The bounceless switch is essential to digital experimentation. A single 4011, two spdt switches and four 100-kilohm resistors can form *two* independent bounceless-switch circuits.

Figure 6 is the circuit for one bounceless switch. Resistors

R1 and *R2* reduce the current spikes that occur when the circuit changes states. Actuating the switch forces the latch formed by the two gates to assume the appropriate logic state irrespective of any contact bounces which the switch produces. Without the latch, the bounces of the switch mechanism would be interpreted as individual input pulses by the logic circuits that the switch is intended to control.

X10 Linear Amplifier. A unique application for CMOS gates which has no TTL counterpart is *linear amplification*. Figure 7, for example, shows an ultra-simple ×10 voltage amplifier made from a single gate in a 4011. The voltage gain of the circuit is determined by the ratio of the value of *R2* to that of *R1*. In this circuit, therefore, the gain is 10.

The chief advantages of CMOS gate amplifiers are convenience, simplicity, and high input impedance. They can easily replace op amps in such applications as gain blocks for frequency counters and other circuits that require input buffering and amplification. High-frequency response is about 1 MHz. The voltage gain can be set as high as 50 by increasing the value of the feedback resistor (*R2* in Fig. 7).

Dual-LED Flasher. The dual-LED flasher in Figure 8 illustrates several important CMOS applications. The first is the use of cross-coupled gates to form an astable multivibrator. This configuration is very similar to the latch shown in Fig. 5. The capacitors have been added to provide astable operation. The second application is the use of very large capacitances to give a time constant or flash rate of about 1 Hz. The rate can be slowed even more by further increasing the values of *C1* and *C2*.

The third application that is illustrated by this circuit is the use of output buffers to interface LEDs to the circuit. Without the buffers, the LEDs might disrupt the operation of the oscillator. The buffers, of course, are formed from the two unused gates in the 4011.

Miscellaneous Logic Functions. Figure 9 sums up several of the fundamental logic functions which can be achieved by interconnecting the gates in a single 4011. Perhaps these functions can save a chip or two in a CMOS design you have

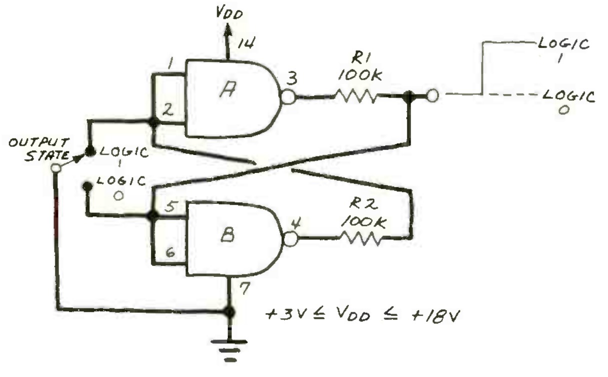


Fig. 6. Bounceless switch necessary for digital experiments.

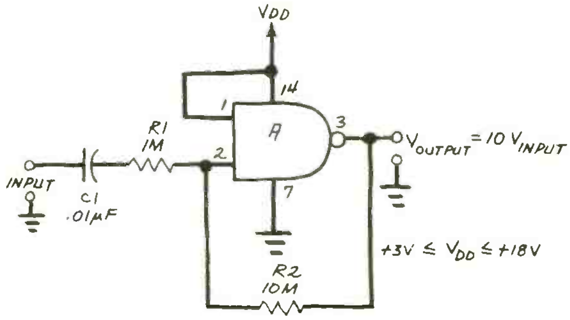


Fig. 7. A X10 linear amplifier using one gate in a 4011.

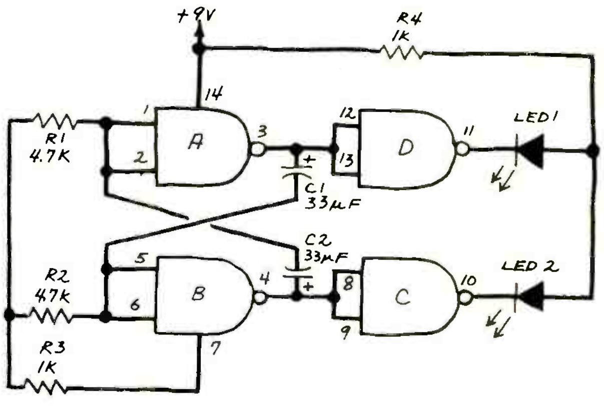


Fig. 8. Dual-LED flasher uses cross-coupled gates.

in mind if you have some unused 4011 gates on your breadboard. Or, they might come in handy when you need a specific logic function but don't have the chip that incorporates the gate to perform it. Indeed, with the exception of three-state logic and transmission gates, one or more 4011's can be used to form virtually *any* conceivable logic function, including that of a flip-flop, a latch, a counter, a decoder or even a memory circuit.

If you want to learn more about the basics of CMOS, there are many books on the subject. The classic, of course, is Don Lancaster's *CMOS Cookbook* (Sams, 1977). Don describes many CMOS circuits and applications.

A good short book is *Understanding CMOS Integrated Circuits* by Roger Melen and Harry Garland (Sams, 1979). A good do-it-yourself "short course" is Howard Berlin's *Guide to CMOS Basics, Circuits & Experiments* (Sams, 1979). An excellent, somewhat more formal book is *CMOS Designers' Primer and Handbook* by Robert Glorioso and Jack Streater (E & L Instruments, 1978). This book also covers some microprocessor basics.

I've included more than 100 CMOS application circuits in *Engineer's Notebook* (Radio Shack, 1980). The circuits are designed around twenty of the CMOS chips most popular among experimenters and hobbyists.

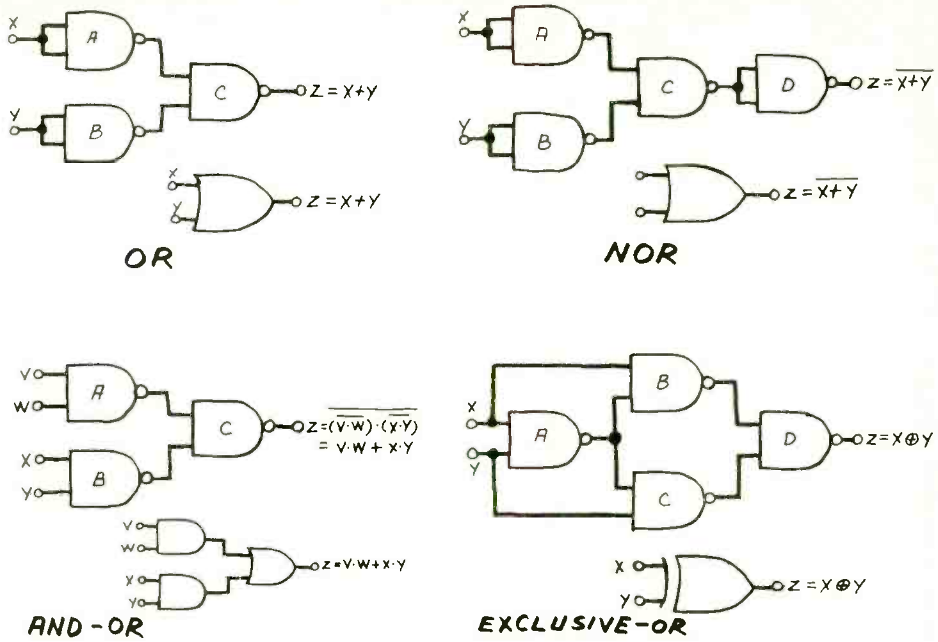
Reader Letters. E. D. Trellue, Jr. of Metairie, LA has written to suggest a possible energy-conservation method. He points out that if the fan of an air conditioner could be caused to run for several minutes after the compressor is turned off by the thermostat, ". . . it would take advantage of the evaporator-coil temperature and the temperature effect of the evaporation of the condensate water on the coil, rather than losing it all when the fan stops with the compressor." It's a good idea, and if no reader can point to a commercial system that does the same thing, perhaps we can include a suggested circuit in this column.

Benjamin Poehlan of Walkersville, MD writes to ask why the S2688/MM5837 noise-generator chip previously described in this column (August 1980) produces a distinct ". . . low-frequency 'bumpety-bump-bump' whose pattern is about as random as a disco beat; i.e. *not* random noise! I used one MM5837 and two S2688's in the circuit; although the pattern changed, it was always present, always low-frequency (100-200 Hz?) and always very *regular*."

Ben's right. This chip is not a *random* noise source. It's a pseudo-random source because the noise is produced by a rapidly clocked string of shift registers. The clearly audible beat heard over the noise level merely indicates the completion of each cycle. In many applications, the background beat poses no problem. Should the background beat be undesirable, I recommend using a diode noise generator. Alternatively, use a reverse-biased emitter-base junction of an npn transistor as shown in Fig. 3 of the August 1980 column (p. 81).

Richard Dornhoffer of Arkansas, KS is a model-

Fig. 9 Logic diagrams of some of the fundamental functions that can be achieved by interconnecting gates of a single 4011.



railroading buff. He writes to ask if an LED and detector could be teamed up to trigger a flip-flop as a model train passes by. After the train passes, the flip-flop should be reset. This is easily accomplished by a minimum of parts. Because there are other applications for such a circuit, I'll describe how it's done in an upcoming Project of the Month.

Finally, many readers continue to request data sheets, custom-designed circuits and other specialized information. Your letters are always appreciated, but it's simply not possible to respond to such requests. Try the parts distributors and sales representatives in your area for data books and data sheets. Search through back issues of this and other magazines for specific circuits you need. Often you can find exactly what you're seeking. As in Richard Dornhoffer's case, requested circuits which appear to have general appeal will be considered for inclusion in this or other columns. ◇

DX LISTENING

By Glenn Hauser

Sports on Shortwave

IF SPORTS fans knew how much there is for them on shortwave, the popularity of shortwave listening would undoubtedly expand. Here's a rundown of what can be heard. (Refer to the December and January POPULAR ELECTRONICS for frequencies not mentioned here. All times and days are GMT.)

U.S.A. There is no shortwave station in the world with a greater commitment to sports than our own *American Forces Radio & TV Service* (*AFRTS*). Although the service has a carefully constructed 24-hour program schedule, when play-by-play sports coverage is available, it always takes priority, pre-empting the regular schedule. Major league baseball, football, hockey, and basketball (in season) are carried several nights per week and on weekend afternoons. There are also special events such as horse races, car races, etc. Naturally, the times vary. The schedule is announced more than a week in advance on "Program Notes," Monday-Friday 1835 and Tuesday-Saturday 0635. *AFRTS* produces its own "Expanded Sports" seven days a week at 0245 and 0745 (14 minutes). Sports reports appear in NPR's Morning Edition, at 1135 and 1235 Monday-Friday. Sports reports from the commercial networks ABC, AP, CBS, MBS, NBC, SBN, and UPI are scheduled as follows: Mon.-Fri.: 1317-1335, 1417-1430, 1545-1559, 2030-2035, 2130-2135, 2345-2359; Tue.-Sat.: 0023-0028, 0123-0129, 0224-0229, 0324-0329, 0424-0429, 0624-0629. Sat.: 1327-1335, 1623-1629, 1826-1829, 1923-1929, 2123-2129, 2327-2329, Sun.-Mon: 0017-0028, 0054-0059, 0123-0129, 0224-0229, 0327-0329, 0424-0429, 0624-0629. Sun.: 1623-1629, 1823-1829, 1923-1929, 2023-2029, 2123-2129, 2327-2329. And, Howard Cosell's "Speaking of Everything" interview frequently features sports figures, Sundays 1435 and 1935. All times are one hour earlier by GMT during DST; however, the schedule may also be revised at that time.

UK. *BBC* World Service sometimes "breaks away" a few of its frequencies (25650, 9740) to carry play-by-play coverage of cricket test matches, usually during the local afternoon hours. It's beamed to such areas as the Caribbean, South Asia and Australia/New Zealand, but is often audible here. Occasionally during test match series and other important sporting events, such as Wimbledon Tennis, regular programs are pre-empted or re-timed to accommodate day-to-day summaries of the action. A popular time for this seems to be 2115 GMT.

The major sports program on "mainstream" World Service is "Saturday Special," between 1315 and 1800 (the starting and ending times vary seasonally), interrupted only for news. Though it sounds "live," much of the coverage is somewhat delayed to avoid timing conflicts. A wide variety of sports are covered—for instance, football, golf, racing, athletics, squash, tennis, and rugby union. If you are lucky enough to pull in BBC-1 television sound on 41.5 MHz during the same time period, you may hear a similar program.

BBC's regular sports programs on shortwave are: "Sports Review," Sun. 0230, repeated 0945; "Sportscall," Sun. 1745, repeated 2245; "Sports Roundup," 1245 Monday-Saturday and 1745, 2245 daily; and "Sports International," Mon. 2030, repeated Tuesday 0330 and 1130. These times were valid for late

1980, but there may have been some changes as of January 1981.

Spain. So far all the broadcasts mentioned have been in English, but the only significant sports coverage from several countries is via domestic service relays on shortwave. *Radio Exterior de España* sometimes does this during local evenings (afternoons in North Ameria).

South Africa. *Radio RSA* has its own "Saturday Special" program Saturdays at about the same time as *BBC*—1300-1557, with interruptions for news. Best frequency is 25790. This has included live coverage of the South African Grand Prix. Sometimes an additional frequency is used, 25730, though this is usually in French.

Portugal. Like Spain, *Radiodifusão Portuguesa* broadcasts sports in its native language, on Saturdays or Sundays between 1430 and 2100 on 21700. I've also heard brief sports items on the English broadcasts, e.g. on a GMT Thursday around 0315.

Philippines. *Radio Veritas Asia* has "Sports News" in its Saturday 1130-1200 transmission on 15215, 11770, 9605.

New Zealand. *Radio New Zealand* airs "Sportscall" Saturday and Sunday at 0545; and includes sports reports during news at approximately 1835, 2315, 0945. When play-by-play coverage is available (generally between 2200 GMT Friday and 0500 Saturday), one of the two frequencies may carry separate programming. When there is coverage of N.Z. teams playing in Europe, broadcasts run past the usual sign-off of 1115 GMT.

Netherlands. The last part of *Radio Nederland*'s Thursday broadcasts in Dutch include a sports report. You may hear this after 0700 on 9630 and 9715; 0900 on 9770; 1400 on 21480; 2000 on 21685 and 17695; 2200 on 17695 and 15220; GMT Fridays 0100 on 15315 and 6165; 0500 on 9590 and 6165. During the Special Olympics last summer, *RN* inserted special reports into English broadcasts.

Italy. *RAI* carries "tutto il calcio minuto per minuto" (soccer play-by-play) during championships, Sunday mornings (North American time) at varying times on frequencies such as 21655, 21560, 17795, 17715, 15330, some of which are for North America.

Israel. On the Thursday 2230 and Friday 0100 broadcasts, "Time Out" on *Israel Radio* covers sports and leisure.

Indonesia. *Voice of Indonesia*, 11789 and 15200 kHz, schedules "Sports Highlights" on Monday at 0112-0120, 0812-0820 and 1412-1420. The last transmission is heard best in North America, especially the western part.

Hungary. *Radio Budapest* currently has a Sport segment at the end of Monday and GMT Tuesday broadcasts, ending at 2130, 0230 and 0330.

Germany, West. *Deutsche Welle's* German program includes sports reports, especially on Monday/Tuesday, during "Funkjournal," which is carried

Monday-Friday 2230-2300 and Tuesday-Saturday 0230-0300; longer sports reports are at 0115-0140 and 0515-0540 Sundays; 0045-0100 and 0445-0500 Mondays. Main frequencies are 15410, 9735, 6145. The last hour of transmissions to Africa earlier in the day on Wednesday and Thursday has included "Sport Aktuell," during the summer soccer season.

Germany, East. Probably no country is more sports-minded than the GDR, and *Radio Berlin International* reflects this, with much of the GMT Tuesday and Friday broadcasts in English devoted to sports.

France. *RFI*'s "Paris Calling Africa" at 1705-1755 includes a sports roundup on Mondays. Several other stations not mentioned also review weekend sports events on Monday broadcasts. Broadcasts in French include sports around 0645, 0815, 0903 (Tue), 1905 (Mon). Saturdays at 1830-1900, Sundays 1820-1906 "La vie du sport." Sundays at 1400-1700, "Sports et musique." All these are in the African service, except the last, which is also to North America on 21645, 21595, 17775. All times are one hour earlier from April to September during DST.

Canada. *RCI*'s North American service on GMT Tuesday includes a sports review. *CBC* Northern Service news at 0500 and 0600 includes a sports report, as well as at 2200 Sunday. *CBC* Radio has a weekly 55-minute "Sound of Sports," Sunday at 10:05 p.m. local time on its domestic network. The Northern Quebec Shortwave Service carries the Grey Cup Game; in 1980, it was the third Sunday in November at 1805 GMT.

Brazil. This country is wild about "futebol," and play-by-play announcers have no equals in enthusiasm. You might hear such coverage on various commercial stations in the 25- or 31-meter bands; or on the Amazon Service from Brasilia on 11780 and 15445, weekends or evenings. You might even hear the high-power transmitter on 980-kHz mediumwave since they are said to run it at full power during such events.

Belgium. *BRT* has sports coverage in Dutch, Sunday at 1400-1700 on 21525. One hour earlier in the summer.

Austria. *ORF*'s "Report from Austria" includes a Sports Review on the Monday 1830, GMT Tuesday 0130, 0330, 0430, 0830, and 1230 broadcasts.

Australia. *Radio Australia* airs "Sporting Magazine," Saturday 2240, Sunday 0440 and 1640. "Saturday Sport" has commentaries from the major sporting events around Australia at 0200-0730 GMT on 21680 and 15240 kHz only. The domestic service from Perth does not hesitate to pre-empt its normal schedule and extend it if necessary for cricket, at 1000-1800 on 9610.

Argentina. *Radio Rivadavia's* only appearances on shortwave are connected with live sports coverage. Check 5882 kHz (SSB) in the early evenings, especially on weekends. ◇

NEW LITERATURE

Video Buyer's Guide
The 1981 *Video Buyer's Guide* describes 400 video products in 148 pages. It includes videocassette recorders, accessories, tapes, satellite earth stations, games, big-screen TVs, specialty TVs, program sources, videodisc players, cameras, and furnishings. It provides an overview of each product category and explains advances in technology in the past year. $3.95 plus 75 cents postage and handling from: Reese Publishing Co., 235 Park Ave. South, New York, NY 10003.

DIN Standards Translated
English translations of DIN standards are offered by Heyden and Son, Inc. These standards are propagated by the Deutsches Institut für Normung, the industrial standards organization of the Federal Republic of Germany. Translations of more than 2100 DIN standards are reported to be currently available with more to follow. In addition all DIN standards (more than 17,800 at present) can be supplied in German. A comprehensive catalog/index, in both German and English, provides details of all DIN standards presently available. Address: Heyden & Son, Inc., 247 S. 41st St., Philadelphia, PA 19104.

Heat-Shrinkable Tubing
A 32-page catalog from Remtek includes a complete list of specifications for proper selection of tubing. A Technical Data Section includes: recovered wall thickness calculator; conversions and formulae; and guidelines for cut and marked pieces. Address: Remtek, 3073 N. First St., San Jose, CA 95134

Line Noise Suppression Manual
Topaz Electronics has available a basic text on the protection of sensitive electronic equipment from problems created by ac line noise, transients and spikes. The "Ac Line Noise Suppression Reference Manual" covers the principles involved and includes technical data and typical applications. Address: Topaz Electronics Div., 3855 Ruffin Rd., San Diego, CA 92123.

Communications Coils and Filters
Specifications for over 5,000 coils, filters and other communication components are given in a new 100-page catalog from J. W. Millter Div. of Bell Industries. Catalog 81 includes high-pass, low-pass, audio and ac-power filters. Coils are categorized by frequency from zero through 500 MHz. Schematic diagrams for shielded and unshielded coils show adjustment accessibility. Address: J. W. Miller Div., 19070 Reyes Ave., Compton, CA 90221.

Educational and Instruments Catalog
A 40-page catalog from Heath/Zenith Educational Systems (a licensed school in the state of Michigan) describes 17 self- and group-instruction college-level programs in electronics, microprocessors, automotive, and computer programming. Information on experimental trainers for laboratory sessions is included as well as descriptions and specifications on over 40 test instruments available, including oscilloscopes, power supplies, chart recorders, signal generators, and TV service instruments. Available at Heathkit Electronic Centers or: Heath Co., Dept. 350-370, Benton Harbor, MI 49022.

Micro Switch Catalog
"Manual Switches" is the title of Catalog 30 describing pushbutton, toggle, rotary selector, and interlock switches. A selection guide relates panel area, display, illumination, behind-panel-depth, mounting, and other features to products. Address: Micro Switch, Honeywell Div. 11 W. Spring St., Freeport, IL 61032.

ELECTRONICS LIBRARY

Microprocessor Fundamentals

by Edward Ramirez & Melvyn Weiss

This book covers the microprocessor as a computing tool, programming and application fundamentals. Easy-to-understand language is supported by diagrams, flow charts, and program examples. To avoid limiting material presented to a given microprocessor, the text makes use of a simple generic instruction set that allows the material to be applied to any microprocessor. All 30 instructions are thoroughly explained and supported by many programming examples, and flow charts are used to facilitate program writing. Among the topics discussed are semiconductor memories, the one-chip microcomputer, microprocessor interfacing, and selection and application of microprocessors. Review questions at the end of each chapter allow the reader to gauge his progress and make this a good book for self study.

Published by Gregg/McGraw-Hill, 1221 Ave. of Americas, New York, NY 10020. Hard cover. 320 pages. $11.95.

Weekend Projects for the Radio Amateur, Volume One

edited by Marian Anderson, WB1FSB

This is the first of a series of compendia of simple construction articles that originally appeared in *QST* magazine. It supplies the reader with schematic diagrams, printed circuit artwork, and assembly details of useful projects for the

ham shack. Among the items described are a 10- and 15-meter receiving converter, a low-noise uhf receiving preamplifier, a noise blanker, two- and three-transistor QRP CW transmitters, a vfo, a transistor tester, a simple oscilloscope calibrator, manual- and remote-control antenna switches, a QRP antenna tuner, power supplies, power-line monitors, and a code-practice oscillator.
Published by the American Radio Relay League, 225 Main Street, Newington, CT 06111. Soft cover, 60 pages. $3 in the U.S.

Electronic Assembly

by Jeremy Ryan

Although written for commercial electronics products assemblers, this book also contains a wealth of useful information for the beginner and advanced electronics hobbyist and experimenter. It begins with common-sense safety practices and proceeds to component identification, aided by schematic and line-drawing illustrations, and color codes for electronic components. Hand tools, hardware, and parts mounting are then discussed, leading up to an excellent chapter on soldering. The remainder of the book is devoted to the actual "nuts-and-bolts" assembly operations, and a chapter on blueprint reading.
Published by Reston Publishing Co., Inc., Reston, VA 22090. 166 pages. $14.95 hard cover; $10.95 soft cover.

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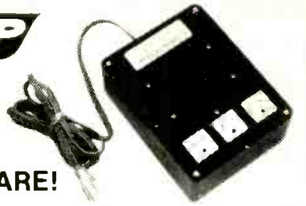

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CIRCLE NO. 32 ON FREE INFORMATION CARD

PROJECT OF THE MONTH

By Forrest M. Mims

A Simple Wind-Speed Indicator

YOU CAN make a very simple but effective, portable anemometer (wind-speed indicator) using only a small dc motor, a propeller and a voltmeter. Figure 1 shows a typical arrangement that works quite well. When wind causes the propeller to rotate, the motor behaves as a dc generator. The voltage produced by the generator is relatively linear with respect to the wind speed.

Not all motors will work in this application. For best results, use a low-friction motor such as one intended for use in photovoltaic solar-energy demonstrators. Some motors of this type are supplied with plastic propellers attached to their shafts. Suitable motors are also available from hobby shops that cater to enthusiasts of radio-controlled model aircraft. Generally, if a motor produces a few tenths of a volt across its power terminals when the shaft is rolled between your thumb and forefinger, it will work well in this application. I've found Mabuchi motors to be particularly effective wind-powered generators.

Hobby shops also sell propellers. Alternatively, you can make your own prop using Fig. 1 as a guide. Cut four blades from light-gauge aluminum or from one end of a metal food or beverage can.

Blade dimensions are not specified in Fig. 1 because motors having a wide range of sizes can be used in this project. For best results, the blades should extend somewhat beyond the housing of the motor as shown. Use care when cutting the blades, and round off their sharp ends to prevent cuts. Twist the base of each blade 45-60° and push the tab at the narrow end of each blade into the side of a balsa model-rocket nose cone (another hobby-shop item) that has been sanded smooth. For best results, use a nose-cone whose base has a diameter close to that of the motor housing. Spread some white glue around the base of each blade and, when it dries, paint the entire propeller assembly.

Next, attach the propeller to the motor's shaft. The easiest way is to force the shaft into the center of the base of the balsa cone. Secure the cone in place with some white glue. Mount the motor on a handle as shown in Fig. 1. Then connect its power leads to the voltage-input terminals of a multimeter that has been set to read dc volts.

You can now calibrate your anemometer. One way is to extend the generator from the window of a moving car. Record the voltage from the generator at increments of 5 or 10 mph and plot the results on a graph. Be sure to perform the calibration on a windless day and to have a friend drive while you hold the generator and record the measurements!

Figure 2 is the calibration curve for an anemometer that I built for use in a homemade, model-rocket wind tunnel. Note the reasonable linearity of the curve.

Going Further. You can easily modify this project. To measure low wind velocities, for example, you can replace the propeller with a four-cup rotor made from two ping-pong balls sliced in half and the multimeter with a solid-state bargraph readout. Use an LM3914 LED driver for best results.◇

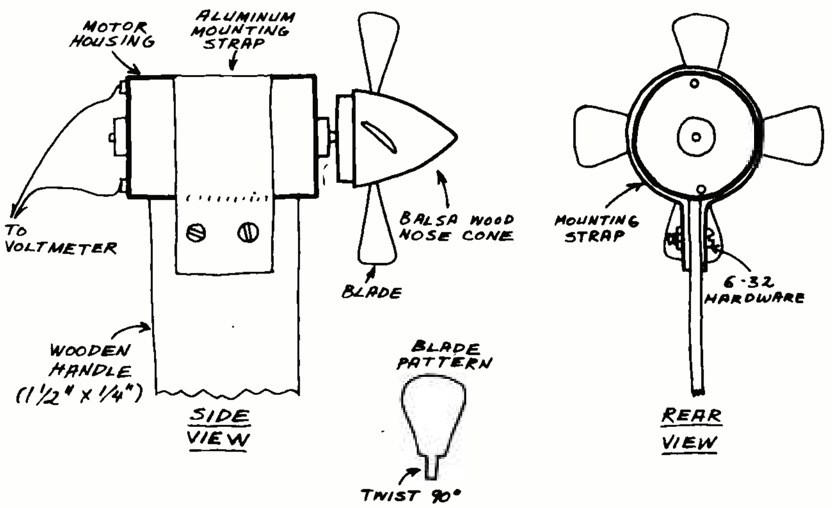
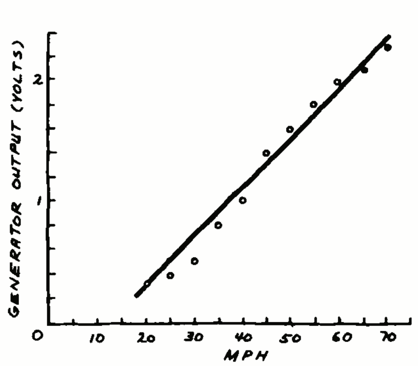


Fig. 1. Design for a portable anemometer.

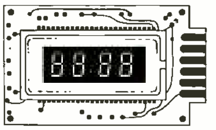


DATA

MPH	VOLTS
<10	0
20	.25
25	.40
30	.55
35	.80
40	1.00
45	1.40
50	1.60
55	1.80
60	2.00
65	2.10
70	2.30

Fig. 2. Typical anemometer calibration curve.

National Semiconductor Clock Modules



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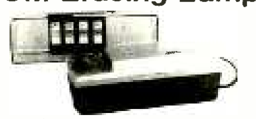

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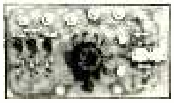

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2716 Intel (2516) TI	16K EPROM (Single +5V)	17.95
2732 Intel (2532) TI	32K EPROM	49.95
2758	8K EPROM (450ns) (Single +5V)	7.95
5203	2048 PROM	14.95
82S23(74S188)	32x8 PROM (Open Collector)	4.95
82S115	4096 Bipolar PROM	19.95
82S123(74S288)	32x8 Tri-State Bipolar PROM	4.95
82S185	8K PROM	29.95

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2516N	Character Generator	10.95
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MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

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M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

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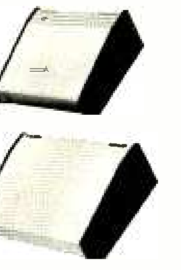
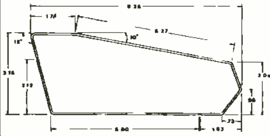
MM57499N	96/144-Key Serial Keyboard Encoder	8.95

DESIGNERS' SERIES
Blank Desk-Top Electronic Enclosures



- High strength epoxy molded end pieces in mocha brown finish.
- Sliding rear/bottom panel for service and component accessibility.
- Top/bottom panels .080 thk alum. Alodine type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency.
- Rigid construction provides unlimited applications.

CONSTRUCTION:
The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to ¼" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.



Enclosure Model No.	Panel Width	PRICE
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DTE-14	14.00"	$34.95

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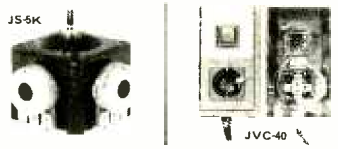

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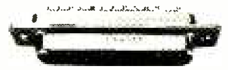
DC 900	120V/60Hz	9 VDC 500mA	$3.95

CONNECTORS



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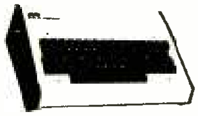
JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14½"W x 8¾"D

JE610/DTE-AK (as pictured above) ... $124.95
JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) .... $ 79.95
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K19 19-Key Keyboard (Keyboard only) $14.95
DTE-HK (case only — 3½"Hx8¼"Wx8¾"D) $44.95

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OPERATION ASSIST

Heathkit model AO1audio oscillator and **Lafayette** model 99-5073 VOM. Need manuals, operating instructions and schematics. Joe Martinez, 1324 Dover St., Caparra Terrace, PR 00920.

Ampex FR100-A tape transport. Need schematic for transport and power supply. E. J. Abbott, 1385-B Central Ave., Harrisonburg, VA 22801.

McMurdo Silver Company model 906 signal generator. Need manual, parts list and schematic. David W. Conner, 218 S. Blvd., W. 57, Jerome, ID 83338.

Dumont oscilloscope #208B. Need schematic and operations manuals. Allan Madsen, 4608 38th Ave. N.E., Salem, OR 97303.

Heathkit grid dip méter model GD-1B. Need coils or coil data. Carl Blackman, 845 Central Park Drive, Paradise, CA 95969.

Hallicrafters HT-32B transmitter. Need manual and schematic. Stan Leiter, W8BDC, 944 Leeson Ave., Van Wert, OH 45891.

Dumont type 164-E scope. Need schemetic. Engineers Radio Shop, 9 David Rd., Port Washington, NY 11050.

Kenwood model KA2500 receiver. Need operation manual and specification sheet. Randy Hartgraves, 303 Tecumseh Dr., Ellettsville, IN 47429.

Hallicrafters model S-120 receiver. Need manual and alignment data. Stephen Serio, 246 Bedell Terrace, West Hempstead, L.I., NY 11552.

Triadex model Muse-1 synthesizer. Need operation manual and catalog. Raymond McGrath, 97 Concord Ave., #2, Norwood, MA 02062.

Precision Apparatus Company, Inc., series #-200-C signal generator. Need operation manual, service manual, schematic and parts list. John Pankow, Box 86, Chiefland, FL 32626.

Heathkit GR-64 shortwave receiver. Need manual. E. G. Dezoysa, 4065 Bathurst St., Downsview, Ontario, Can. M3H 3N9.

Nuclear Chicago model 2585 radiation ratemeter. Need schematic and manual. Michael Schulsinger, 825 Xenia Ave., Apt. 6, Yellow Springs, OH 45387.

Motorola #H21-10 vhf radio. Need owners manual, parts list and schematic. Gary Hedge, 3526 Johnson St., High Point, NC 27260.

General Electric model 300 terminet printer. Need schematic and service information. George H. Haupt, 48 Van Voorhis Ave., Rochester, NY 14617.

Baldwin Organ Co., model 54A electronic organ. Need operation manual, schematic, parts list and source of parts. Robert L. Carney, 20123 S.E. 353rd St., Auburn, WA 98002.

Philco model 41-295 shortwave receiver. Need operation manual and schematic. Bob Creasey, 304 Iroquois Ave., Pittsburgh, PA 15237.

Galaxy GT550 transceiver and SC550 power supply. Need service manual and owners manual. J. Lukomski, 3732 Leigh Ave., San Jose, CA 95124.

Precision Apparatus Co., Inc. model E-310 signal generator. Need schematic and service information. Paul K. Sagi, 364 Upper Gulph Rd., Wayne, PA 19087.

Westinghouse model WR-12 Columnaire radio and Arborphone model DX45 radio. Need schematics and manuals, Art Klinger, 4659 Balboa, Wichita Falls, TX 76310.

Tektronix type 315D scope. Need schematic and manual. Armando Vallesteros, 494 Clauser Dr., Milpitas, CA 95035.

Hallicrafters model SX130 receiver. Need schematic, operations manual and alignment data. Joseph Mitchler, 51 Travis Street, Savannah, GA 31406.

Sperry-Remington model TAS-1 telephone answering machine. Need schematic or manual. Rich Hole N8RL, 296 Mary St., Newaygo, MI 49337.

Fisher Radio Corporation model FMR-1 radio. Need schematic and service manual. R. Otis, 8627 Linderwood Lane, Cincinnati, OH 45230.

Triplett model 2432 signal generator. Need manual. J. Humphrey, 1006 E. 28th St., Los Angeles, CA 90011.

Hammarlund HQ-180A-X receiver. Need operation manual and schematic. Allan Bryant, 38262 Ballard Dr., Fremont, CA 94536.

Pearce-Simpson, Inc., model Bimini 550, transceiver. Need schematic and operation manual. Paul Smith, Box 4839, Kailua-Kona, HI. 96740.

Hallicrafters model HT 17 transmitter. Need oscillator and power amp coils. Larry Jessip, 1112 Whitcher Ave., Sioux City, IA 51109.

Precision Apparatus Co., Inc., model ES-500A cathode ray oscillograph. Need schematic, operating and service manuals. James Olson, 2028 W. Catalpa Ave., Anaheim, CA 92801.

Arvin Industries model TRC-77 or RT-654A 40-meter mobile transceiver. Need 3B4WA output driver tube and/or schematics. Mike Nemeth, 1807 E. Madison, South Bend, IN 46617.

Precision Apparatus series 10-20 tube and set tester. Schematic and instruction manual needed. Joseph Zolik, 153 Lincoln Ave., Elmwood Park, NJ 07407.

Dumont Labs type 304-A cathode ray oscillograph. Need manual and schematic. Robert Dickson, 1714 69th Ave. W. #206-C, Bradenton, FL 33507.

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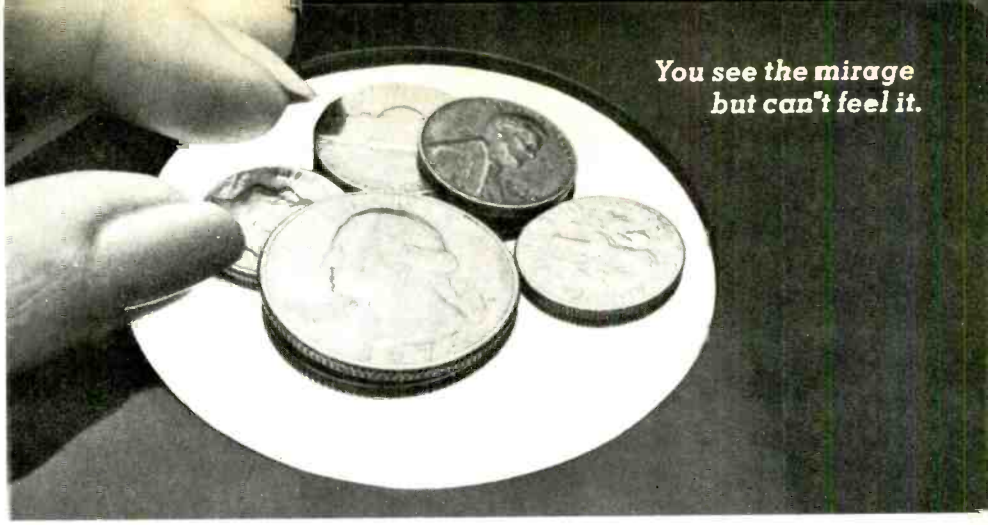

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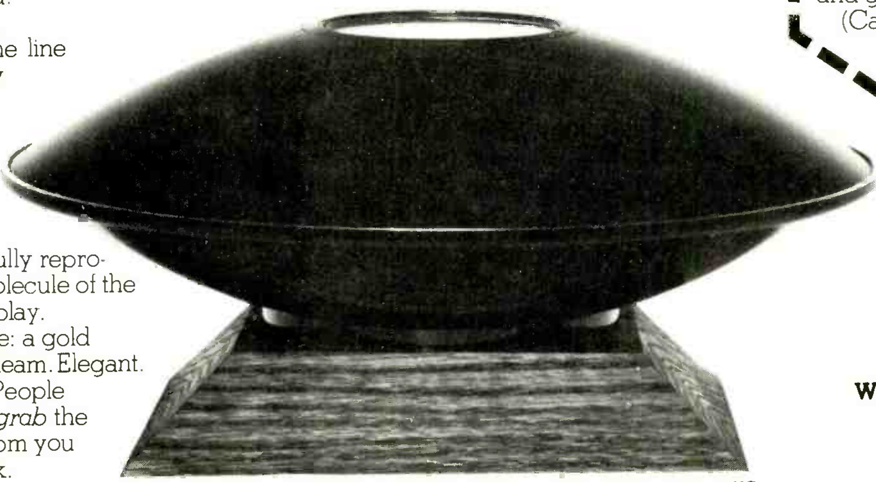

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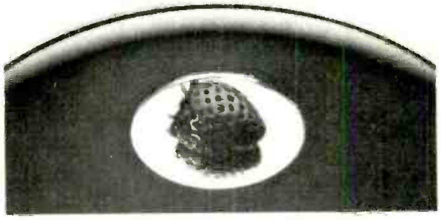

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74LS03	0.34
74LS04	0.38
74LS05	0.38
74LS08	0.36
74LS09	0.36
74LS10	0.34
74LS11	0.36
74LS12	$0.36
74LS13	0.55
74LS14	1.10
74LS15	0.34
74LS20	0.34
74LS21	0.36
74LS22	0.36
74LS26	0.36
74LS27	0.36
74LS30	0.34
74LS32	0.40
74LS37	0.36
74LS38	0.36
74LS40	0.34
74LS42	0.82
74LS47	1.05
74LS48	1.05
74LS49	1.05
74LS51	0.34
74LS54	0.34
74LS55	0.34
74LS73	0.45
74LS74	0.45
74LS76	0.52
74LS78	0.48
74LS83	1.05
74LS85	1.25
74LS86	0.49
74LS90	0.71
74LS92	0.71
74LS93	0.71
74LS95	0.99
74LS107	0.44
74LS109	0.44
74LS112	0.49
74LS113	0.49
74LS114	0.49
74LS123	0.98
74LS125	0.62
74LS126	0.62
74LS132	0.91
74LS136	0.48
74LS138	0.93
74LS139	0.82
74LS151	0.75
74LS152	0.75
74LS153	0.84
74LS154	1.40
74LS155	0.89
74LS156	0.89
74LS157	0.75
74LS158	0.75
74LS160	1.05
74LS161	1.05
74LS162	1.05
74LS163	1.05
74LS164	1.15
74LS168	1.45
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74LS170	1.80
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74LS174	1.20
74LS175	0.89
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74LS192	1.15
74LS193	1.15
74LS194	1.35
74LS195	1.35
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74LS197	1.25
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74LS241	2.25
74LS244	2.25
74LS253	1.01
74LS257	0.86
74LS258	0.86
74LS260	0.38
74LS266	0.49
74LS279	0.73
74LS283	0.99
74LS290	1.05
74LS295	0.99
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74LS366	0.66
74LS367	0.66
74LS368	0.66
74LS373	2.25
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74LS386	0.53
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74S03	0.45
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74S09	0.48
74S10	0.48
74S11	0.48
74S15	0.48
74S20	0.45
74S21	0.48
74S22	0.46
74S30	0.45
74S32	0.70
74S40	0.45
74S50	0.45
74S51	0.45
74S60	0.48
74S64	0.48
74S65	0.48
74S74	0.78
74S76	0.78
74S78	0.78
74S86	0.78
74S112	0.78
74S113	0.78
74S114	0.78
74S132	0.96
74S133	0.48
74S134	0.48
74S135	0.59
74S138	0.97
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74C30	0.34
74C32	0.34
74C42	1.00
74C48	1.27
74C73	0.71
74C74	0.71
74C76	0.71
74C83	1.45
74C85	1.45
74C86	0.49
74C89	3.95
74C90	1.10
74C93	1.10
74C95	1.30
74C107	0.69
74C151	2.35
74C154	3.00
74C157	2.05
74C160	1.17
74C161	1.17
74C162	1.17
74C163	1.17
74C164	1.17
74C165	1.17
74C173	1.29
74C174	1.15
74C175	1.15
74C192	1.37
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74C905	6.00
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4011	0.35
4012	0.35
4013	0.48
4014	1.05
4015	1.05
4016	0.53
4017	1.07
4018	1.07
4019	0.49
4020	1.13
4021	1.13
4022	1.05
4023	0.35
4024	0.79
4025	0.35
4027	0.69
4028	0.88
4029	1.13
4030	0.45
4031	3.25
4034	2.75
4035	0.99
4040	1.20
4041	1.05
4042	0.99
4043	0.89
4044	0.89
4046	1.79
4047	1.99
4048	0.95
4049	0.49
4050	0.55
4051	1.19
4052	1.19
4053	1.19
4060	1.49
4066	0.78
4068	0.39
4069	0.35
4070	0.49
4071	0.35
4073	0.35
4075	0.35
4076	1.29
4077	0.69
4078	0.45
4081	0.35
4085	0.79
4086	0.79
4089	$2.75
4093	0.99
4099	2.10
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4507	0.99
4508	3.00
4510	1.15
4511	1.25
4512	1.25
4516	1.22
4518	1.15
4519	0.62
4520	1.15
4527	1.67
4528	1.50
4539	1.35
4555	0.89
4556	1.09
4582	1.09
4702	7.10
4703	8.25
4704	7.30
4705	9.25
4706	9.75
4720	6.95
4723	1.50
4724	1.50
4725	3.95
40014	1.10
40085	1.69
40098	0.69
40106	0.90
40160	1.17
40161	1.17
40162	1.17
40163	1.17
40174	1.15
40175	1.15
40192	1.37
40193	1.37
40194	1.17
40195	1.17

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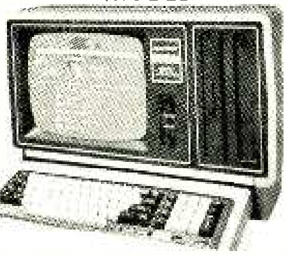

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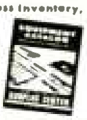

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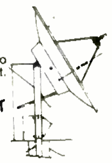

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Popular Electronics

ADVERTISERS INDEX

February 1981

Personal Electronics News

U.S. EXPORTS REACHED AN ALL-TIME HIGH in consumer-electronic products during the first half of 1980, according to the Department of Commerce. Exports were up 34% over the same period of 1979. Also, our first-half 1980 trade deficit in consumer-electronic products was $160 million less than in the first half of 1979, with imports for the first six months of 1980 down 1% from the last six months of 1979. TV receiver exports were up 47%, while imports were up only 8%. Large exports were also found in microphones, loudspeakers, amplifiers, and audio recorders and tapes. Our largest export customer was Mexico, which bought 25% of the total. Although Japan's share of imports to the U.S. from the Far East fell from 61% in 1979 to 56% in 1980, Japan remained the dominant source of consumer-electronic products to the U.S.

VIDEO DISC RIGHTS TO THE FIRST MAJOR SPORTS-INSTRUCTION program created especially for video discs have been acquired by RCA for its "SelectaVision" system. The four-hour-long, two-disc "Total Tennis From the Pros" program features 12 top tennis professionals who give expert and comprehensive instruction. Lessons are divided into specific topics that analyze in depth all strokes from the most basic to the most advanced. Coverage also includes singles and doubles strategy, offensive and defensive games, conditioning, fitness, practice techniques, and the mental game, with tips on tournament play, bad calls, etc.

CLOSE-CAPTIONED VIDEOCASSETTES FOR THE HEARING IMPAIRED have been released by Columbia Pictures Industries, Inc: "Chapter Two" and "China Syndrome" movies. Captioning information is encoded in such a manner that it does not appear on-screen unless a specially equipped TV receiver or a separate decoder is used to retrieve it. Captioned cassettes are sold at the same prices as non-captioned cassettes of the same movies. Columbia, producing the movies as a joint effort with the National Captioning Institute, plans to announce additional titles as they become available.

REMOTE CONTROL OF UTILITIES BY AM RADIO permits system load management by selective switching on and off of nonvital appliances in subscribers' homes. Using commercial AM broadcast stations and receivers containing microcomputers that are mounted on or near the load, the system developed by Altran Electronics (affiliate of Research-Cottrell, Somerville, NJ) transmits coded signals from a computer control center. The system is intended to help utilities avoid large swings between loads and to provide differential-rate power metering.

DOW JONES/APPLE COMPUTER EFFORT lowers prices for the Dow Jones News/Retrievel Service, a business and financial news and information data base. This includes past and current news stories from the Wall Street Journal and Barrons. The "Dow Jones News & Quotes Reporter" program is designed to run in a disk-based Apple II microcomputer. (Owners of other computers can also use the service with a different program.) Apple dealers are said to have the disks now. Fees for personal computer users during nonbusiness hours have been sharply reduced—20¢ and 30¢ per minute for access to the news data base and securities price quotes, respectively, after 7 p.m. Eastern time (6 p.m. in other time zones) and all day weekends and holidays. Minimum charge per usage is 50¢. Formerly, the charge was $3 for the first three minutes and 50¢ per minute thereafter.

AN ELECTRIC SHOCK HAZARD MAY EXIST in approximately 5,600 stereo turntables manufactured by Philips High Fidelity Laboratories, Ltd. of Knoxville, Tenn. The units, identified as models 22AF685/44B and 22AF685/94B, are being recalled by the manufacturer for repair at no charge. Model numbers are printed on a label found on the bottom to the turntable base. Owners of these units should contact the dealers from which they were purchased or the Philips Consumer Affairs Department. The toll-free telephone number is 800-251-9104; in Tennessee call 615-521-4460.

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