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THE MAGAZINE FOR ELECTRONICS & COMPUTER ENTHUSIASTS

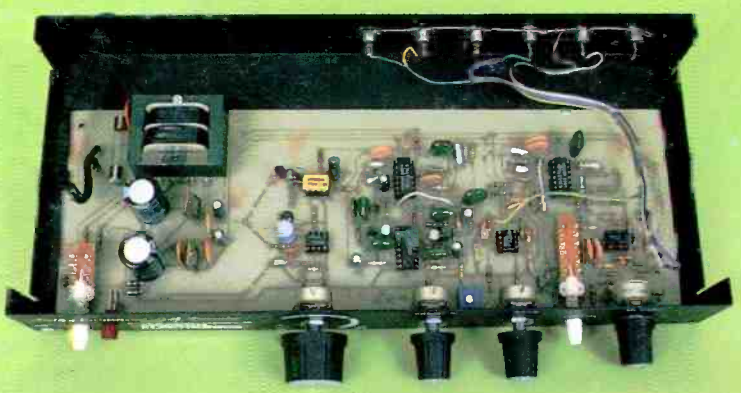
- **ELECTRONIC THEFT-PROOFING FOR AUTOMOBILES**
- **BUILD A DELUXE STEREO SOUND ENHANCER**

Trends In Home Satellite TV Receiving (p. 32)

- **What's New in Home TV Satellite Installations**
- **Creating Circuits from Scratch**
- **Experimenting with Analog Comparators**
- **How to Put New Life into Apple IIe ROM Monitors**

Zenith's Camcorder For Home Video Movies (p. 15)

Build A "Surround-Sound" Stereo Accessory (p. 55)



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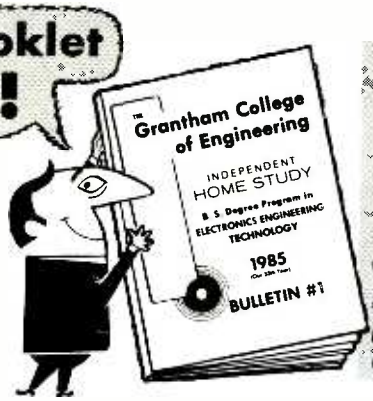

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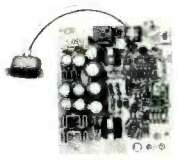

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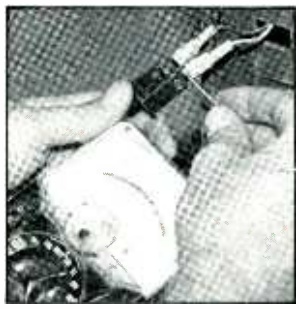

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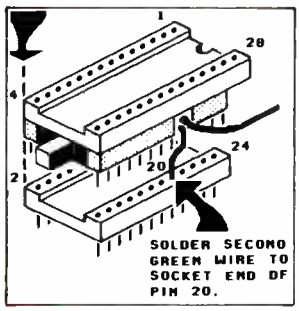

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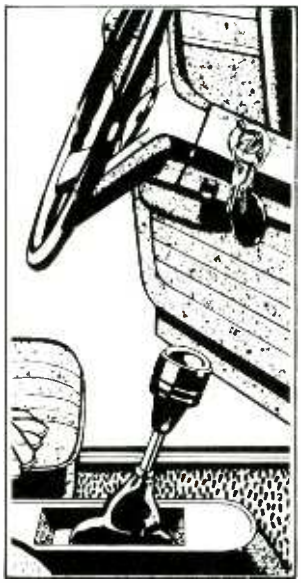

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FEATURES

PRODUCT EVALUATIONS

DEPARTMENTS

EDITORIAL

Price Wars

Here it is, December, and the local merchants in metropolitan New York are promoting electronic gear with a ferocity you cannot believe. Retail prices screaming out in newspapers are so low that anyone with a credit card and a yearning for the good things in life must find this very difficult to resist.

With most goods inching up in price, electronic contrivances of all kinds are wonderfully under-priced . . . or are they?

Let's take a look at personal computers, as an example. IBM dropped a shoe this year when it cut selling prices of its PC line, forcing others to do the same. Maneuverings to make way for new models have driven prices down, too. And bloated warehouses with computers that didn't move as briskly as manufacturers hoped they would called for "clear the decks" action.

As a result of the foregoing, there are even some price wars going on among manufacturers. The Jack Trameil team's move to Atari from Commodore has resulted in the Atari 800XL 64K-RAM computer's price to drop from its orginal $199.95 to a manufacturer's suggested $120. I've seen it advertised for as low as $99.95! And an accompanying 1050 disk drive at $149.95 from its original $299. That's about $250 for the system (less printer).

Trameil's now-arch enemy, Commodore, is in at as low as $180 for its best-selling Commodore-64 model and $250 for its disk drive, for a $430 rock-bottom package. Coleco's ADAM has been promoted for as little as $489 *with* a printer. Moreover, the company offers a $500 college scholarship to purchasers who meet certain requirements: attending a four-year college, satisfactory grades, and a $125 payout each year. (The mathematics on this one eludes me.) Radio Shack, too, has its specials, with its 64K Color Computer going for $199.95, a $60 reduction, plus $349.95 for the disk drive, and its lap computer TRS-80 Model 100 for $399, down from $799.

Apple Computer is also in the act. Its $1295 128K-RAM Apple IIc, with built-in drive, has been advertised for as little as $888 with rebate certificates toward options. The company's 128K Macintosh with built-in drive *and* 9" hi-res monitor is down to $1695 from the opening price this year of $2495. IBM's improved PCjr is now touted at $995 with 128K of RAM, a built-in drive, *and* a color monitor, together with a few hundred dollars of software, while I've seen a 64K IBM PC with *two* drives promoted at $1695, with the regular price noted as $2240.

Wow!

These are, in truth, all bargains. Hidden, though, are some churnings for thought. Will the Atari 800XL continue along in 1985? Jack Trameil says, "Yes," with a company spokesperson observing that it'll be producing 500,000 monthly (sic) by mid-'85. Meanwhile, Atari is putting the final touches on new 8-bit, 16-bit, and 32-bit computers. Commodore, too, is revving up new models. So are the others. Apple's 512K "Fat Mac" will cut into its original model's sales, with more meaningful business software geared toward the higher-memory unit. It costs "only" $1000 to upgrade from a 128K-er. IBM's 64K model has been supplanted by its 256K model, of course, and the company is readying the latter's successor, the PC2. Tandy, in turn, has an advanced lap computer up its corporate sleeve, and recently rolled out an IBM-compatible desktopper that's priced substantially less than an IBM PC.

Nonetheless, with the amount of units and software on the market for the older models, they're all still good buys. Software is the key.

Other consumer electronic bargains abound. Video cassette recorder prices have dropped considerably. Note, though, that many of the low-cost offerings are two-head machines; not the best, but not so bad if you're not a fuss-pot. Just so you know that you're giving up something to get the bargain.

Some "buys" are not really bargains, naturally. For example, cordless telephones operating in the 1.7 MHz and 49.8 MHz bands are being dumped due to a variety of communication problems. The new FCC-allocated frequency of 46 MHz (and 49 MHz) are the ones to get if you want to roam and talk without a phone-line tether; up to 1000 ft. away, that is.

So keep a wary eye on those bargains. Many are indeed great buys. Just be sure you'll be able to live with the older models for a few years . . . and pocket the savings.

Art Salsberg

LETTERS

Travellers Beware

• I am writing about "Countries Using U.S. Video Standard" (October, 1984 issue). Before lugging a TV to another country, check the radio section of the *World Radio TV Handbook* to make sure electric current is compatible with the U.S., and the TV section of the *WRTVH* to make sure the video system and TV broadcast bands are compatible. The compatibility problem is more complicated than indicated: (1) Japan uses NTSC, but most of its vhf frequencies are different than those used in the U.S. A TV with a continuously-variable vhf tuner, as opposed to a "click-stop" detent tuner, would receive several Japanese vhf frequencies, but not the Japanese vhf frequencies allotted to the FM radio band in the U.S. uhf frequencies are compatible with the U.S. (2) I realize tha the list of countries was not specifically labeled as a list of countries also using the same electric current as the U.S., but it would be easy to get that impression. In St. Kitts, for example, current is 220 volts, and plugs and outlets are not compatible with the U.S., necessitating a universal current and plug converter, or a battery-operated TV. I think a few other countries listed in the item also use different electric current than the U.S. (3) Greenland and the Azores do not use NTSC *or* U.S. electric current; however, the U.S. Armed Forces Television Service has low-power TV stations using NTSC in those locations. (AFRTS also uses NTSC in Germany, and perhaps other places.)

Wayne Hedenschoug
Springfield, IL

Fan Letter

• Congratulations. I too was a subscriber to *Popular Electronics* since it's beginning. After they changed to a computer magazine I terminated my subscription. As a token of faith in you I am enclosing a check for my subscription.

Marvin L. Fudalla
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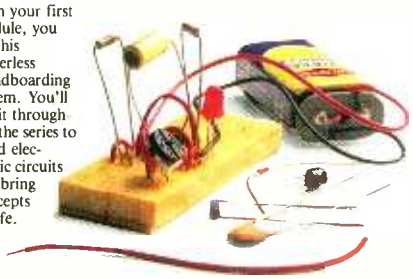

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MODERN ELECTRONICS NEWS

SOLDERING TIPS ON VIDEO TAPE. New video cassettes give pointers on soldering methods and equipment used to replace integrated circuits and other electronic devices. The full-color tapes, available from the Consumer Electronics Group of the Electronic Industries Association (EIA), come in both VHS and Beta tape formats. A 45-minute version targeted for electronic instructors costs $20, while a 15-minute tape for electronic technicians is priced at $15. To obtain one, send check or money order payable to Electronic Industries Association. Adress: EIA/Consumer Electronics Group, Dept. PS, P.O. Box 19100, Washington, DC 20036.

"GETTING STARTED" COMPUTER PROGRAM. Computer and software makers continue striving to make their wares as easy to use as possible, though the mark is more often missed than hit. A new software package from Texas Instruments, its "Getting Started" program, is a tutorial diskette and instruction booklet that starts off with unpacking a TI Professional Computer, setting up the system, and keyboard lessons. Additionally, it teaches users how to use TI's NaturalLink® products which accesses standard software using plain English commands. Continually expanding its product lines, TI recently announced four new font modules for its Model 855 and 865 printers, allowing them to print Bar Code 3 of 9, OCR A, Greek/Math scientific symbols and Script.

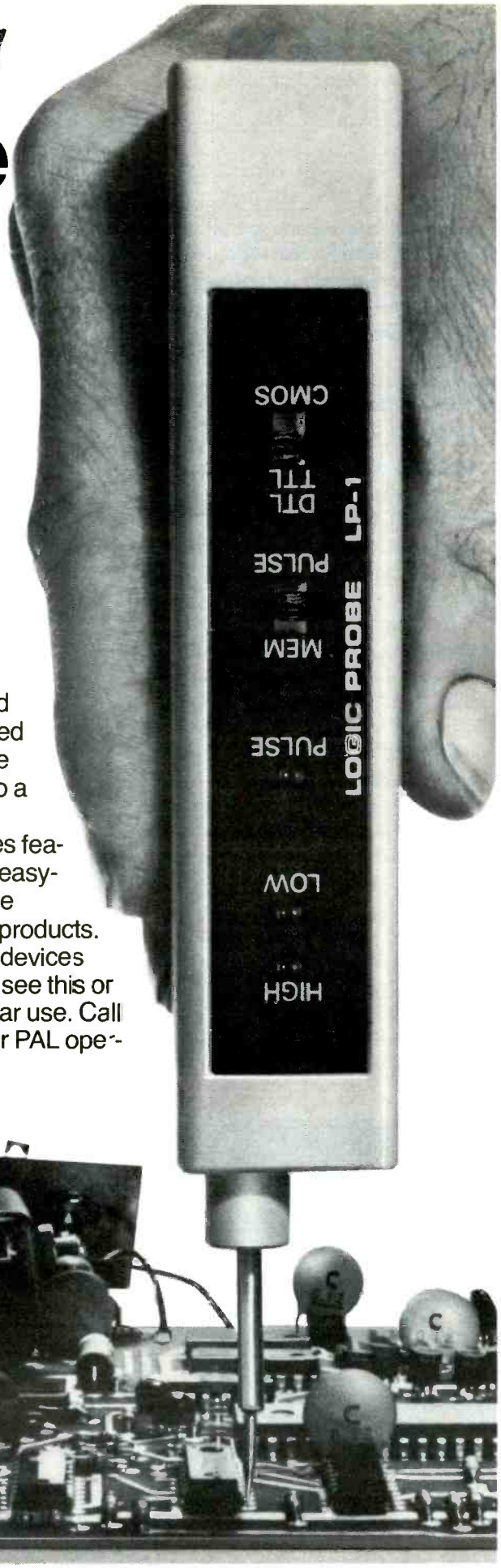
STEREO COMMERCIALS. Memorex is producing an audio tape TV commercial in stereo, marking the first time that stereophonic sound has been used for this purpose. Most people are not yet plugged into TV's stereo sound (nor are broadcasters), but the number will surely grow.

CLOSING THE QUARTZ-CLOCK SECONDS GAP. The Swiss, who ruled the watch industry when clock movements were mechanical, are trying to do the same in the electronic (quartz movement) watch field. An advanced technology is said to have been developed in Switzerland that increases accuracy to five times better than conventional quartz movements can attain, and adds longer battery life and no-adjustment requirement. The trick is said to be accomplished with a CMOS IC that has thousands of transistor equivalents and a nonvolatile memory, and an oscillator "thermostat." Accuracy is claimed to be ±60 seconds for five-years.

VCR SALES SURGE. According to the EIA, home video cassette recorder sales to retailers increased more than 80% in the first ten months of 1984, from 3-million to about 5½-million units. Color TV sales in the same period jumped almost 15% to about 12-3/4-million sets.

TELEPHONES FOR DEAF PEOPLE. A new portable, battery-powered device with an LCD screen attaches to a standard pushbutton phone and enables the caller to communicate with a deaf person. Called the Echo 2000, the varying tones generated by a caller's telephone pushbuttons causes letters to flow across the display in ticker-tape fashion. Measuring 7" x 4" x 1", and weighing only 10 ounces, Echo 2000 sells for $250. It's being made and marketed by Palmetto Technologies, P.O. Box 498, Duncan, SC 29334, under license from General Electric. ME

The Quality Logic Probe At The Amazingly Low Price Of $19.95



When it comes to testing and troubleshooting digital circuitry, you no longer require expensive equipment and complex, time consuming processes. And there's no need to compromise on performance or value. Because we've reduced the price on our LP-1 logic probe from $50.00 to a very affordable $19.95.

This probe is versatile, reliable, and durable. It includes features such as readout indications (high, low and pulse), easy-to-use memory and pulse functions. We've advanced the design and the use of logic probes and other digital test products. And the LP-1 is just one of twelve inexpensive logic test devices we offer. Contact your local Global distributor today and see this or any of the other models you might need for your particular use. Call our ***Product Availability Line:*** 1-800-243-6077, and our PAL operator will direct you to your nearest distributor.

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Prices subject to change without notice.

CIRCLE 87 ON FREE INFORMATION CARD

For more information on products described, please circle the appropriate number on the Free Information Card bound into this issue or write to the manufacturer.

Full-Feature Portable Personal Computer

Texas Instruments has put the power of the traditional desktop computer into its 11.5″W × 10.5D″ × 2.75″H, 10.5-lb. MS-DOS Pro-Lite lap portable. Topping the new computer's list of features are a 12″-wide flip-up LCD screen that can display up to 80 columns by 25 lines in the text mode, a 78-key full-travel keyboard, an onboard 3½″ microfloppy disk drive with 720K capacity, and 768 RAM memory capacity. The battery-powered portable computer is built around a low-power 80C88 microprocessor and can accommodate an optional 80C87 numeric coprocessor. Its LCD screen supports both alphanumerics and graphics (the latter optionally) and features adjustable viewing angle and contrast control. The keyboard has 12 user-programmable function keys, an imbedded numeric keypad, and separate cursor-control keys.

Pro-Lite's standard configuration includes: 256K of RAM, a single 3½″ microfloppy disk drive, two expansion slots, a Solid State Software ROM drawer that holds up to eight 32K EPROM modules, a PC interface cable that allows the computer to be connected with the TI Professional and other MS-DOS computers, and an external parallel printer port.

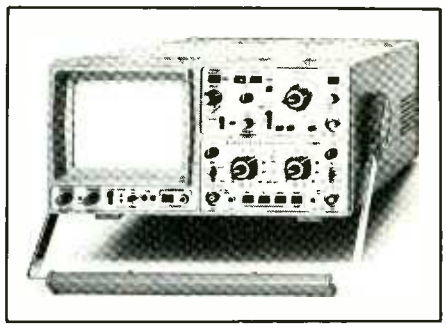
Available options include: an expansion box that attaches to the rear of the computer for adding a second microfloppy disk drive and battery pack; an internal 300-baud auto-dial /auto-answer modem; an RS-232 synchronous/asynchronous interface; an external color or monochrome monitor interface; a portable thermal printer; an add-on 3½″ microfloppy disk drive; expansion RAM; an LCD graphics option; and a soft-sided carrying case.

CIRCLE 90 ON FREE INFORMATION CARD

Wide-Bandwidth/Dual-Trace Bench Oscilloscope

Featuring a dc-to-60 MHz bandwidth, dual traces displayed on an 8 × 10-cm internal-CRT graticle, and a post acceleration voltage boosted to 14 kV, Hameg's new Model HM-605 oscilloscope offers what appears to be an excellent package for the busy service bench. The scope's technical specifications appear to be good, too: 5.8-ns risetime; 1-mV/cm with × 5 expander to 20 MHz and 5-mV/cm to 60 MHz deflection coefficients; 1-s/cm to 50-ns/cm timebase with 2.5:1 variable control and × 10 magnification to 5 ns/cm; 100-ns to 0.1-s variable sweep delay in seven decade steps; and peak value triggering beyond normal bandwidth to 80 MHz at 5-mm display height.

Standard scope features include ac, dc and line coupling, triggering on channel I/II and external, and alternate triggering to view asynchronous signals. Channel I/II sum/difference can be obtained with channel I inverted. The probe calibration signal is selectable between 1 kHz and 1 MHz for hf probe compensation. A component-test capability for checking semiconductors or passive components externally or in-circuit is built in.



Two × 1/ × 10 switchable probes are included with the oscilloscope. $965.

CIRCLE 91 ON FREE INFORMATION CARD

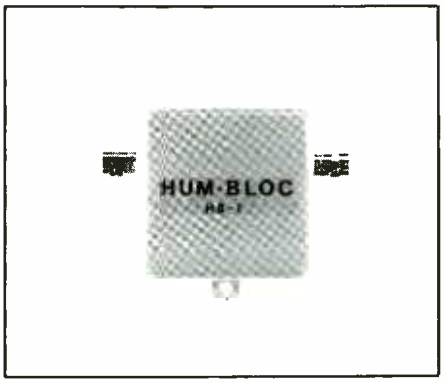
Advanced Radar Detector

Radio Shack's Micronta Road Patrol XK, a new generation, dual-conversion superhet radar detector that uses an advanced gallium-arsenide Schottky barrier diode detector, is said to provide much greater range than conventional systems. The GaAs detector is reported to be extremely sensitive to both X- and K-band traffic radar signals and much less noisy, eliminating false alarms caused by in-band nonradar signals. Sensitivity specifications for the X and K bands are −110 and −102 dBm/cm², respectively. Bandwidth is rated at ±100 MHz, with center frequencies of 10.525 and 24.150 GHz.

Other key features of the system are its multiple warning options, which include a buzzer, a light, or a combination of the two, and an LED signal-strength meter. Automatic polarity switching and a detachable power cord permit fast transfer of the

detector to any vehicle equipped with a cigarette lighter, regardless of ground polarity. Dimensions are 1⅛"H × 5½₂"W × 5⅞₂"D. Hook-and-loop fasteners are provided for mounting. $199.95.

CIRCLE 92 ON FREE INFORMATION CARD



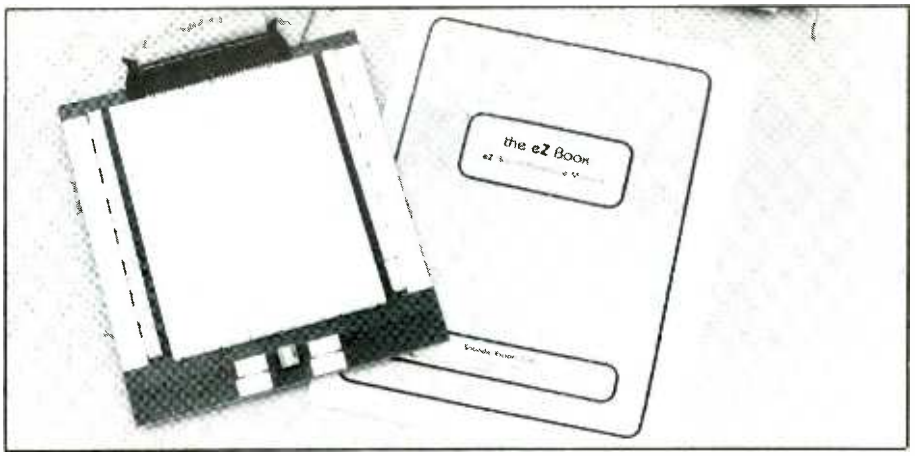
Video Noise Filter

If you video system is plagued by electrical noise from the power line, perhaps what you need is the Model HB-1 Hum Block Humbucker from VAMP, Inc. This new unit inserts into any 75-ohm coaxial video transmission line to remove or suppress power-line interference. It features isolated BNC connectors, compact size (it measures only 2"×2"×1¼"), a color-coded metal enclosure, and convenient mounting tabs. Multiple HB-1s can be arranged to provide high packing densities in applications such as inputs to video switchers, routers, and VTR banks. $89.95.

CIRCLE 93 ON FREE INFORMATION CARD

IBM PC & XT Prototyping Board

If you're a design engineer or the type of owner who likes to build your own circuits for an IBM PC or XT computer, Sabadia Export Corp. has a bus-pluggable prototyping board for you. Called the eZ Card, it is a full-length, double-sided board with

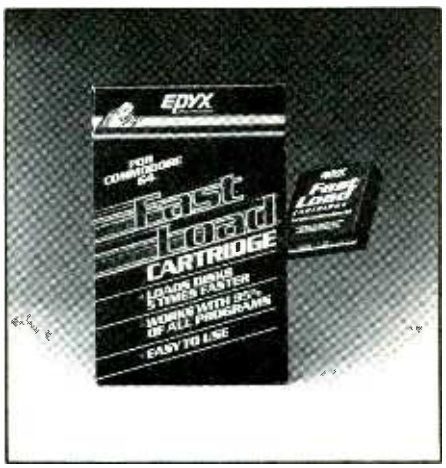


gold-plated edge connectors and two prototyping areas. A large area, containing more than 2100 holes on 0.1" centers, can accommodate 60 or more 16-pin DIP devices, while the smaller area can handle I/O connectors and additional components. On the board are fully socketed buffer ICs, a mounting bracket with hardware for permanent installation in your computer, and power and ground buses on both sides and around the edges. Also on the board is an 8-position DIP switch that permits user selection of up to eight unique addresses that cover the entire I/O address range. All address, data, and control bus lines are fully buffered. A cable connector provides buffered I/O signals to the solderless eZ Board. $89.95 plus $5.00 P&H.

CIRCLE 94 ON FREE INFORMATION CARD

Accessory Loads Disks Six Times Faster

If you own a Commodore 64 computer, you can now load and power up disks up to six times faster and copy disks up to 10 times faster with Epyx's new Fast Load Cartridge, according to the manufacturer. The firmware cartridge plugs into the C-64's cartridge port and operates completely automatically. No extra instructions need to be typed into the



computer. The Fast Load Cartridge is unlike other such products in that it works with even protected disks. Epyx says it works with about 95% of the programs currently on the market for the C-64, including Flight Simulator, Load Runner and Summer Games.

CIRCLE 95 ON FREE INFORMATION CARD

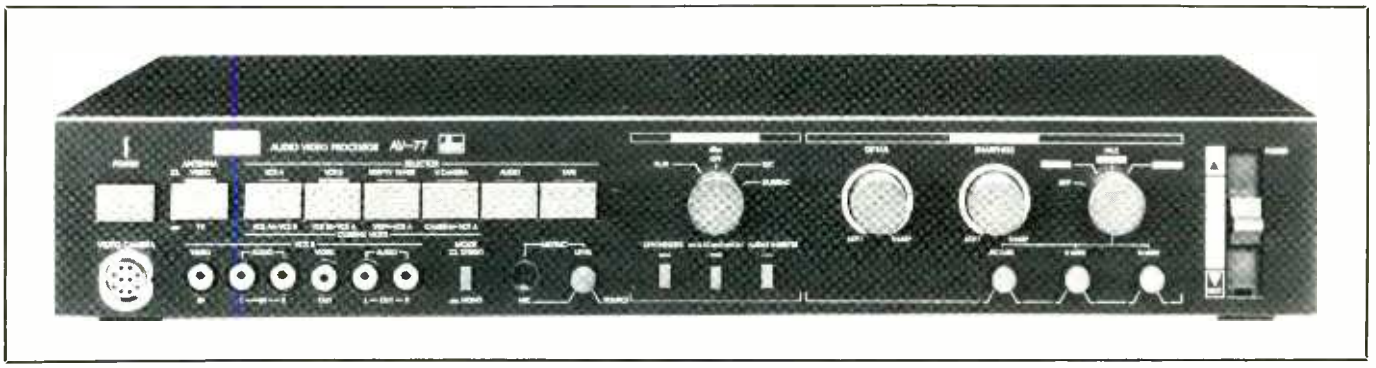
Outdoor Scanner Antenna

Until now, the scanner enthusiast has had to settle for either the built-in whip antenna on his receiver or a large outdoor antenna that required roof mounting with some sort of mast arrangement. Hamtronics' new

(Continued on page 84)

Video

Audio Plus Video Plus Much More:
Sansui's AV-77 Processor-Controller



As you get more and more involved in audio and video, eventually you reach the point where you would like to do more than just record TV programs off the air and play them back on a high-quality video monitor while listening to the sound tracks through your audio component system. That's when many of us turn to home video movie making. With the purchase of a color video camera comes the desire to be able to do some creative video taping.

Sansui's new AV-77 with a $350 suggested retail price, is designed to satisfy such artistic cravings. At the same time, it provides some practical audio and video enhancement facilities as well as a true control center that can easily tie together all the audio and video components you have now or are likely to have in the foreseeable future. For example, it allows you to do tape duplicating between two VCRs or dubbing from a videodisc player, component TV tuner, video camera or audio component to a VCR.

RCA-type phono jack inputs for two VCRs, a video disc player or TV tuner and an audio tape deck are located on its rear panel. For added convenience in making temporary connections to, say, a friend's VCR, there is a second set of inputs and outputs for one VCR on the front panel, as well as a socket for a 10-pin camera connector and a microphone jack.

As for video signal processing, the AV-77 offers SHARPNESS and DETAIL controls to improve picture sharpness and resolution. A selectable HUE control allows you to exchange one primary color for another, or to "add" red, green or blue to the overall picture. Other special effects include picture "solarization," in which outlines of images are intensified, while inner, solid-colored sections of the picture are muted. An overall fader control allows you to fade in or fade out both picture and sound at the same time. Finally, there is a vertical and horizontal "wipe" feature with which one scene can be gradually altered, vertically, horizontally, or a combination of both.

The AV-77 also allows you to do signal processing of the audio portion of a signal. Included is a dbx noise-reduction system and a special circuit for synthesizing stereo from a mono sound track. A microphone/source level control allows you to choose optimum levels when voice-over narration is to be added to previously recorded audio tracks.

The AV-77 has a built-in r-f converter and can, therefore, be connected to antenna terminals of a conventional TV receiver. The unit is supplied with a 6½-ft., 75-ohm coaxial cable for that purpose, and there's also a 3.3-ft. remote control cable for a video camera.

Control Layout

The front panel of the AV-77 is basically divided into two sections: one handling audio signal processing, the other taking care of video signal processing. At the left, near the power switch, is a TV/Video selector, which performs pretty much the same function it does on a VCR. In the TV setting, input signals are fed right out again so that you can watch TV normally; in the VIDEO setting, video signals connected to the AV-77 are converted to an r-f signal and may be viewed on an unused channel (3 or 4). Six SELECTOR/DUBBING pushbutton switches are used to select desired program source, to choose dubbing sources and destinations, or to listen to an audio tape recording. A ten-pin camera connector and video and audio input and output jacks, duplicating one of the sets of jacks on the rear panel, are positioned beneath the selector pushbuttons.

Audio-related switches and controls come next. These include a mono/stereo mode switch, a microphone input jack, a microphone mixing level control, a dbx selector switch (with OFF, RECORD, PLAY, and DUB settings), a noise filter switch, a

switch labeled MULTIDIMENSION and an AUDIO INSERTER switch. The dbx circuit, for those who are not familiar with it, is a two-way noise-reduction system that also improves the dynamic range (difference between softest and loudest sounds) of an audio program. For it to be effective, an audio program must first be recorded using the *encoding* side of the circuit. Then it must be played back using the *decoding* side. The dbx noise-reduction system will only work for newly made audio recordings; it won't reduce noise on older, existing video tapes that have tape hiss. For such tapes, the NOISE FILTER switch would normally be used.

The MULTIDIMENSION switch, when pressed, introduces a phase-shifting circuit between left and right channels, increasing apparent stereo effects of a stereo signal source and creating a synthesized pseudo-stereo effect when mono audio signals are fed to the unit. The AUDIO INSERTER switch, if depressed while playing back a VCR program, will cut out the sound tracks currently on the tape and allow you to play your own background music or add "live" narration (via a microphone). With this switch activated, it is also possible to add an audio source to the video from a VCR and to dub the resulting combination onto a second VCR.

Video signal processing controls are located on the right side of the front panel. They include DETAIL, SHARPNESS and VIDEO ART selectors. For the latter, there is PICTURE (which controls the degree of "video art applied), VERTICAL WIPE, HORIZONTAL WIPE and FADER. As mentioned earlier, the FADER control is used to fade in or fade out video and audio signals simultaneously. The other three VIDEO ART settings relate to the primary color that is added to the existing picture.

Lab Performance

With the AV-77 connected via its video "in" and "out" jacks, the unit introduced virtually no video frequency attenuation, even at the top NTSC video frequency of 4.2 MHz. However, if you have to connect the unit through its r-f modulator (in other words, hooking up the unit to the antenna terminals of your TV set and viewing pictures with unused Channel 3 or 4), you will find that there is some slight loss of high video frequencies. It's not enough to be noticeable with ordinary TV sets or with VCR-taped programs (which lack high picture resolution to begin with) but you might detect a slight loss of detail when viewing live broadcasts or Laservision discs on a high-quality video monitor.

Sharpness and detail controls not only compensate for this slight attenuation, but act to "boost" high video frequencies which, in turn, improves picture detail. The trick here is to use these controls judiciously, balancing the slight increase in "snow" or video noise against an improvement in picture detail.

Fig. 1. Amplitude-vs-frequency response plots from left (upper) and right (lower) outputs of AV-77 with stereo synthesizer circuit activated.

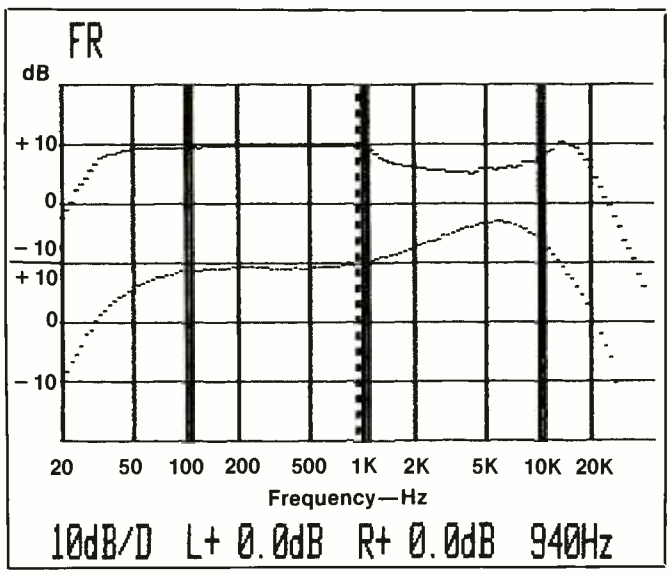
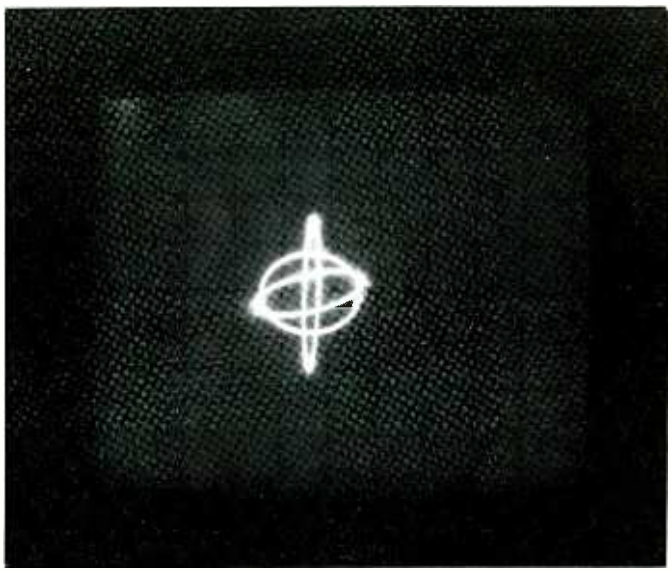


Fig. 2. Multiple exposure shows phase relationship of left and right audio outputs at three different frequencies with stereo synthesizer on.



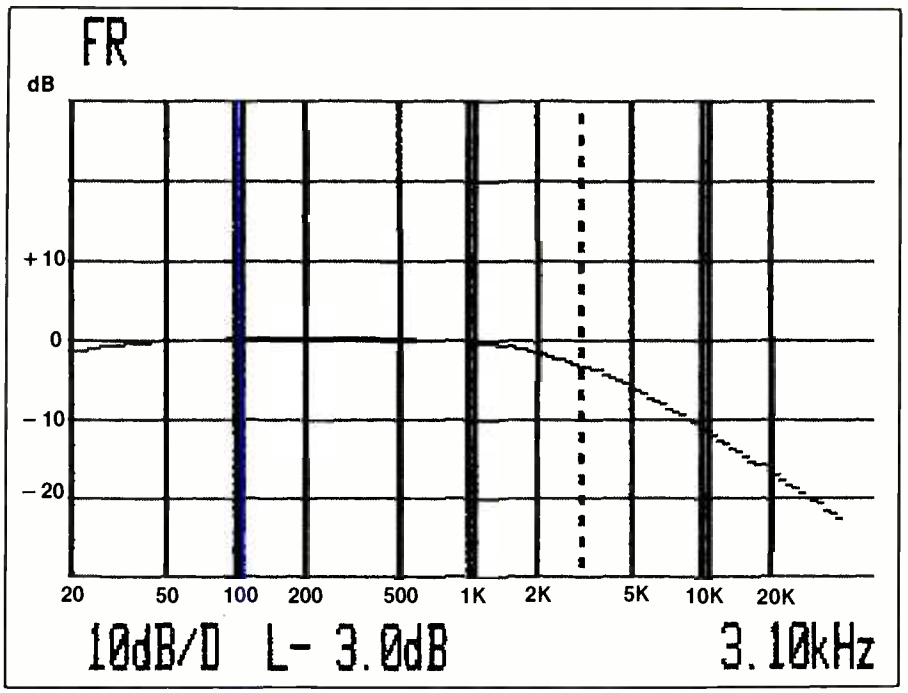


Fig. 3. Sharp cut-off filter reduces audible effects of noisy audio sound tracks from VCR tapes. Dotted-line cursor is set at −3-dB point.

The SHARPNESS control picks up the amplitude of frequencies around 1.25 MHz to 2.0 MHz, while turning the DETAIL control fully clockwise boosts higher frequencies from around 2.0 MHz to 3.58 MHz. The effect upon the picture is precisely what the two terms imply. The SHARPNESS control seems to improve the overall crispness and clarity of a scene viewed on my monitor screen, while turning the DETAIL control to maximum rendered tiny details of the picture more discernible. Using both controls maximally, of course, resulted in both types of improvement, but as is true of all enhancement controls of this type, background noise increased visibly.

Video signal-to-noise was far better than what you can expect from any VCR tape, so long as connection was made via the VIDEO OUT jacks. However, I found that if I hooked up the AV-77 via the TV output (and the antenna input on my TV set), signal-to-noise ratios deteriorated until they were only marginally better than what we normally expect from taped programs played back on a good VCR. This was especially true of noise referenced to luminance or brightness video signal, less so for chroma noise. Therefore, if you expect to use the DETAIL and SHARPNESS controls near their maximum settings, it is especially important that the hookup be made using the direct video output jacks of the AV-77. These settings yielded the poorest signal-to-noise (highest levels of background noise and snow in the picture) when I hooked up the system via the r-f or TV output.

The fader control was effective, although it does not provide a complete fade-out to "black." As for the VIDEO ART 1, 2, and 3 switch positions and controls, it's difficult to describe the visual effects that they produce, beyond what I've already said earlier. The controls provide interesting and colorful "wipes" of parts of a scene, both vertically and horizontally, but don't get the mistaken notion that these controls are going to allow you to do a real "transitional "fade" from one scene to another.

Audio Signal Processing

Audio frequency response, signal-to-noise ratios and harmonic distortion readings were all excellent compared with what you can expect from most VCRs or even from the audio circuits of most TV monitors and receivers. The AV-77 is not likely to degrade audio fidelity of any of your audio or video program sources if you introduce it into the audio signal path of your component audio system.

The stereo synthesizing circuitry works very much like other such circuits found increasingly in audio sections of audio/video devices. Essentially, it alters the phase and the response of one channel relative to the other. The graphic plot of Fig. 1 illustrates this effect. The plot is from 20 Hz to 20 kHz; vertical calibration is 10 dB per division. As for phase displacement between the two channels, this is best illustrated by the 'scope photo of Fig. 2, in which I applied the output of the left channel to the vertical input terminals of the oscilloscope, and the right channel output was connected to the horizontal input. Input to the AV-77 was, of course, a single test frequency. If the two outputs were in phase, we would have seen a straight line sloping diagonally to the right, from bottom to top. Evidence of phase displacement

is apparent, as you look at the three different ellipses that were produced with three different test frequencies (1 kHz, 5 kHz and 10 kHz) in this multiple-exposure photograph.

Frequency response using the noise-filter switch is shown in Fig. 3. The cutoff point (−3 dB) occurs at just above 3.0 kHz when the filter is turned on, so you would use this feature only to decrease extreme tape hiss such as you might have with a VCR tape recorded at the slowest tape speed (EP in the case of VHS; Beta III in the case of Beta-format machines).

Conclusions

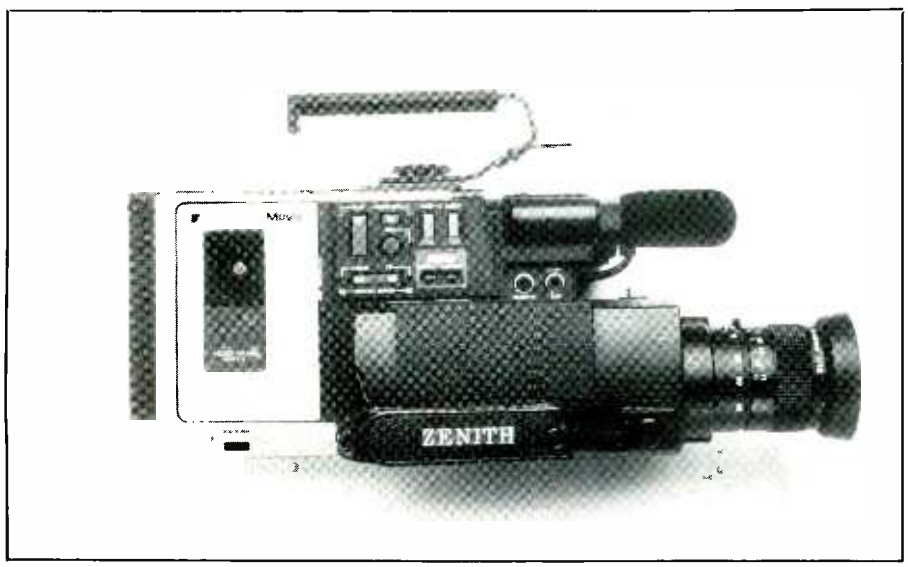
I found the AV-77 easy to install and, after a bit of experimentation and use, easy to work with. You will find that the Sansui AV-77 gives you a measure of switching flexibility that would be difficult to obtain with simple video switchers. Add to that the enhancement capabilities of the Sansui processor and you have a very worthwhile audio/video accessory. As for the "art" special effects, they're for the more creative video recordist. Unless you've in this category, you probably won't be using them all that much, though they are certainly an interesting feature.

As far as I am concerned, the Sansui AV-77 would be worth its affordable price even if those particular special effects were omitted from the product, though it would be less competitive in the marketplace should they not be used at all.—*Len Feldman*

CIRCLE 98 ON FREE INFORMATION CARD

Video

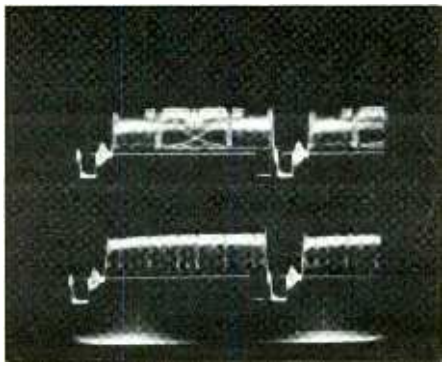
Meeting The 8-mm Threat:
Zenith's New VHS Camcorder



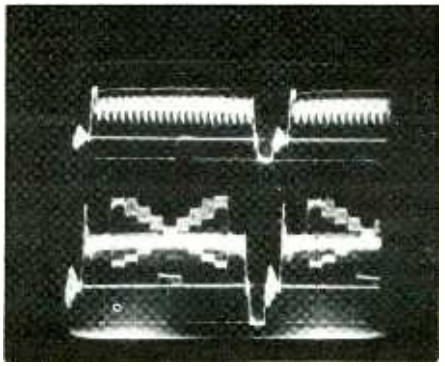
Combination video camera/recorders—so-called "camcorders"—are becoming a hot item for home movie making. Interest in them is being promoted and fanned by both video and photographic-film manufacturers, including such giants as Kodak and Polaroid. (See the review of Kodak's 8-mm camcorder, January 1985, and "Camcorders—A Revolution In Home Movie Making," November 1984.) Not to be outdone in their own area of expertise, JVC and Sony and their VHS and Beta supporters are coming on strong, too, with camcorders designed to use traditional ½" video tape. One of the first VHS offerings in this arena, and the subject of this review, is the JVC-made Zenith Model VM6000 camcorder.

Using existing VHS technology, the Zenith camcorder works with standard ½"-wide tape, though in a compact 20-minute videocassette that requires use of a special adapter to permit playback in a standard VHS deck. Since tape width and track recording format are the same for both standard and compact (the latter called VHS-C by originator JVC) cassettes, a tape recorded in a VideoMovie camcorder (like the Zenith Model VM6000) can be played back in a standard VHS deck.

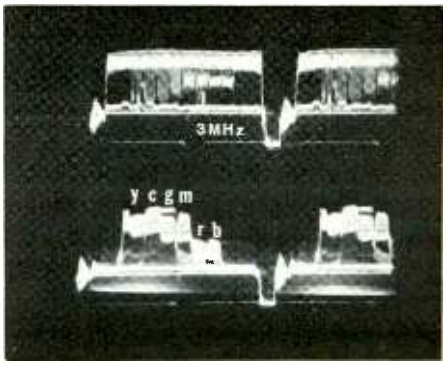
Like its competition, the Model VM6000 is light in weight, compact, and designed to be battery powered. It offers the most-wanted home movie making features and functions, including an electronic viewfinder with multi-function on-screen



Top trace views large resolution chart with extended grey scale, shows good reproduction with no outstanding problems. Bottom trace shows full EIA linearity chart with only slight rolloff on left.



Tektronix chrominance channel evaluation chart reveals blues and magenta a little light (top). Relatively good reflectance chart (bottom) reveals surprising linearity and exact center crossover.



REC horizontal-resolution chart shows usual 3-MHz extended frequency for consumer cameras (top). Bottom trace shows obvious color distortion when pictures are recorded from the screen of a CRT.

displays and a 6:1 zoom lens with macro setting and manual focus capability. Suggested retail price of the Model VM6000 is $1495.

General Comments

The camcorder weighs just 4.3 lbs., less its lightweight battery pack, and measures a compact 12⅜"L × 5⅜"H × 4⁵⁄₁₆"W. Adding its electronic viewfinder and battery pack and add both weight and size, but not to the point where the camcorder is unwieldy.

The business end of the camera contains a ½" static-magnetic high-band Saticon pickup tube. In front of the tube is an f/1.2, 8-to-49-mm zoom lens. Camera sensitivity with this arrangement is 15 lux, or 1.4 foot candles (fc).

Recording and playback are handled by a four-head helical-scan system. With its 270° tape-wrap around its miniature head drum and parallel loading system, the camcorder's transport permits rapid stop, play and pause functions.

Power consumption from the camcorder's 9.6-volt battery pack is 8.9 watts. Charge and discharge times of the rechargeable nickel-cadium battery pack are equal.

The camcorder isn't equipped, as is, to process broadcast programs off the air. However, the sync chain is good enough to record pictures, through the camera, from the screen of any TV receiver and produce passable results on playback.

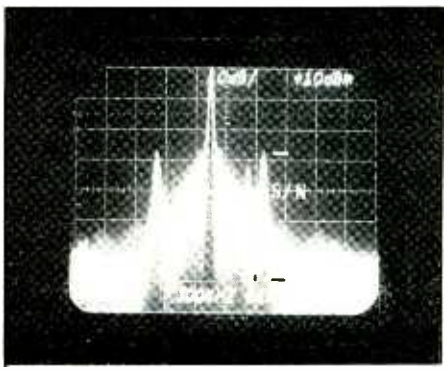
Optional extra-cost items for the camcorder include: a cassette adapter ($39.95) for playing back VHS-C compact cassettes in a standard VHS deck; 20-minute VHS-C videocassettes ($7.99 each); 30-($29.95) and 45-minute ($39.95) rechargeagle battery packs; an ac power supply/battery charger ($129.95); a shoulder mount and strap ($39.95); and a rigid carrying case ($109.95).

Controls & Functions

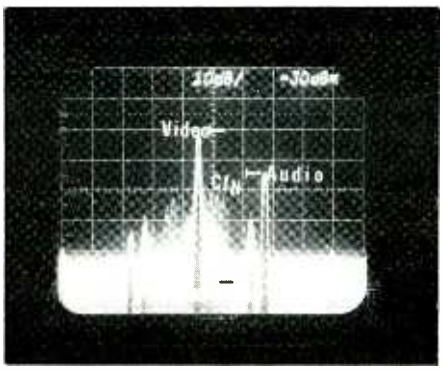
The camcorder has all the usual transport controls, including REC (record), PLAY, PAUSE, STOP, EJECT, TRACKING, F-F (fast-forward), and REWIND. Supplementing there are a power zoom control, with T and W positions for telephoto and wide-angle adjustments; a focusing ring; a manual/automatic zoom selector; automatic/variable iris control; a UP sensitivity switch for low-level lighting conditions; a standard/adjustable white-balance control; daylight/indoors filter switch; memory tape marks; and a counter RESET button.

The final second of any scene is visible through the viewfinder whenever recording ceases. During pauses of longer than 6 minutes, Zenith advises that power be turned off, since there's not low-power standby arrangement for continuously keeping the CRT filament alive.

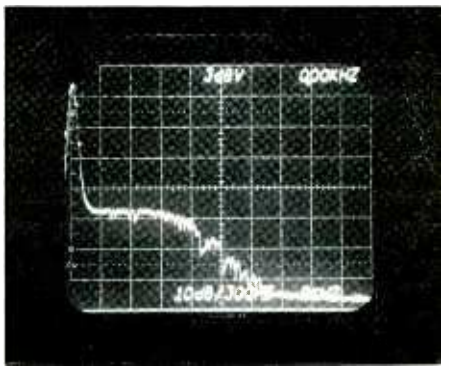
In setting up this camcorder, the appropriate filter position (daylight or indoors) and standard or automatic white balance are selected first. Then standard or increased CRT sensitivity, the latter used under low-light conditions when a white line indicator appears in the lower portion of the viewfinder, is selected. Next, the iris switch is placed in the BLC (backlit), standard, or close position. This setting depends on whether you need special illumination, regular pictures, or closeups. Finally, the camera is turned on, the lens is fo-



Camcorder's good S/N measurement of 43 dB is better than average.



Video (left) and audio (right) carriers separated by 3.58 MHz exhibit excellent C/N, fairly good vestigial sideband suppression (left). Subtract 2.5 dB for the analyzer.



Response of 10 dB down at 10 kHz is not too bad, especially with a microphone input and an "anyspeak" tone signal source.

cused throughout its 6:1 range, the earpiece is plugged into its jack (if sound monitoring is desired), a cassette is inserted, and the camcorder is ready to be set up for recording.

If you wish to preview or rehearse a scene before actually recording it, you press the REC button to view it in the viewfinder. Pressing just the REC button won't start the tape rolling. To actually record on tape, you must press the REC and PLAY buttons simultaneously to first put the system into the record/pause mode. At this point, getting the scene on tape simply requires the recording trigger switch to be pressed.

As the camera "rolls," the iris can be adjusted for various exposures, and fade-ins and -outs can be tried. A fixed iris is suggested when experiencing backlighting and for bright sky under maximum zoom, dark-to-light scene panning, and when there's passage of a white body across the scene being recorded.

Normally, the white balance control doesn't have to be used when recording outdoors under daylight conditions and indoors when using halogen or tungsten lights. If manual adjustment of the white balance control is required, the camera is simply aimed at a white or monochrome area and you zoom in with the telephoto lens while you monitor the viewfinder's white balance indicator to observe when flickering ceases as you adjust the control.

There are eight possible indica-

Zenith Model VM6000 Laboratory Analysis

Dc power drain (at 9.6 volts)	8.9 watts
Tape speeds (with TC-20 tape)	
Record/play	1/31" per second
Shuttle search	3 × normal
Fast forward	2 minutes
Rewind	1 minute
Record/play time (TC-20 tape)	20 minutes
Play start time	1/5 second
Record time (from pause)	1/5 second
Low light level (maximum)	15 lux (1.4 fc)
Luminance S/N	43 dB
Vertical resolution (at baseband)	300+ lines
Horizontal resolution (at baseband)	3 MHz
Grey-scale linearity	good
Color reproduction	fair
Maximum record/play/rewind time with VAC-402 battery	40 minutes
Audio response (with microphone and available speaker	10 kHz at −10 dB
Wow/flutter (NAB at 3 KHz)	0.13%/0.27%
Battery charge time	40 minutes

Test equipment: Tektronix Models 7L5 and 7L12 spectrum analyzers; Hameg Model HM 605 oscilloscope; B&K-Precision Models 1250 NTSC and 3020 function generators and 1035 wow and flutter meter; Data Precision Models 945 multimeter and 585 8-digit frequency counter; Tele-Measurements, Inc., precision registration charts; RCA Model VGM2023S TV receiver/monitor.

Zenith's New VHS Camcorder continued

tions that can appear in the viewfinder:

•A long white line in the pause mode signifies that the REC and PLAY functions are engaged;

•This line diminishes in length and blinks to indicate an approved operating condition during recording;

•Dropping of the line to the lower-left corner indicates that the scene is underexposed;

•Whitening and flickering of the upper-left quarter of the viewfinder screen indicates insufficient battery power;

•An increase in white-line blink rate indicates that remaining recording time is one minute or less;

•Lighting of the lower-left corner indicates low picture sensitivity;

•A flickering white square in the upper-left corner indicates the need for white balance adjustment;

•Red and green lamps indicate selection of the indoors and outdoors filters, respectively.

You'll want to catalog or commit to memory the above before operating this camcorder, since they're not identified internally. If you also want to use the memory locator mark and electronic tape counter, just push the appropriate buttons under the STOP and EJECT buttons.

During playback, operating the PLAY, PAUSE, REWIND, F-F (fast-forward), and STOP buttons causes a small LED to light whenever each function is engaged. For playback, it will be necessary to also select audio and video outputs for feeding a TV monitor or channel 3 or 4 for feeding a standard TV receiver.

Theory Of Operation

The ½" single-color pickup tube used on this camcorder is a high-band Saticon with built-in cross-stripe filter. Its very thin photosensitive layer reduces flare and other incident light-scattering effects. This improves resolution in the frequency special range between 400 and 700 nanometers. Outstanding features of this tube are low dark current, small (capacitive) image lag, and stable black signal level.

Images from the Saticon pass to a preamplifier as horizontal and vertical sync, and high voltages drive the tube's deflection circuits and accelerate cathode electrons. At the same time, iris, zoom action, shading, etc., regulate image pickup quality.

Luminance (Y) information is frequency restricted by a 3.9-MHz trap, while chroma (color) must navigate a 3-to-4-MHz bandpass filter and delay line prior to red and blue separation. R/B tracking and shading circuits then channel their respective colors to red and blue demodulators, which convert them into red-minus-luminance (R – Y) and blue-minus-luminance (B – Y) signals, where they are subjected to white balance adjustement before mixing.

In the modulator/mixer, color is modulated onto a standard 3.58-MHz subcarrier originated in the sync generator (SSG), bandpass filtered, and delivered to the recorder.

Meanwhile, luminance passes through its gamma correction circuit (the logarithmic reciprocal of picture tube nonlinearity), is aperture (opening) corrected in the contour circuit, timing equalized (with delay), SSG mixed with the vertical edge-compensating signal, white and black level clipped, and clamped at pedestal level, with blanking added during retrace. Thereafter, luminance mixed with vertical and horizontal sync passes to both the recorder and viewfinder as composite video in what is identified as E-E and explained as electric-to-electric output.

Standard amplitude-modulated luminance (Y) information becomes frequency modulation and 3-to-4-MHz chroma becomes downconverted to a more convenient 629 kHz. These two signals are processed separately, delayed, filtered, modulated, demodulated, and mixed before finally reaching the recording mechanism.

In ordinary VHS equipment, tape from the videocassette is wrapped around the 62-mm head drum for 180° and drum rotation is at 30 revolutions per second (rps). In this camcorder, which uses a compact VHS-C tape cassette, tape wrap is 270° around a 41-mm drum and rotational speed is 45 rps. This assures equivalent recordings and continuity between standard VHS and compact VHS (VHS-C) formats.

The head drum is driven by a three-phase direct-drive motor. The capstan motor is another direct-drive type, regulated by the mechanism control circuit (meachacon) and the servo circuits. Meachacon controls forward and reverse rotation, braking and speed, while the servo circuit regulates speed and phase during record and playback and counters any load changes.

Along with a 4-bit microprocessor and copious logic, there are three servo systems for drum video head, capstan tape transport phase and speed, and tape back-tension. Unfortunately, dc motors are subject to both load and voltage variations and must, therefore, be rigidly controlled in critical applications.

The 4-head system (each head is separated around the drum's circumference by 90°) writes four slanted individual video tape channels during recording and reads four in playback. Each field and set of heads records at 75° rotation of the head drum, while electronic head switching permits the two sets to complete a full frame.

Audio, of course, is recorded and

(Continued on page 85)

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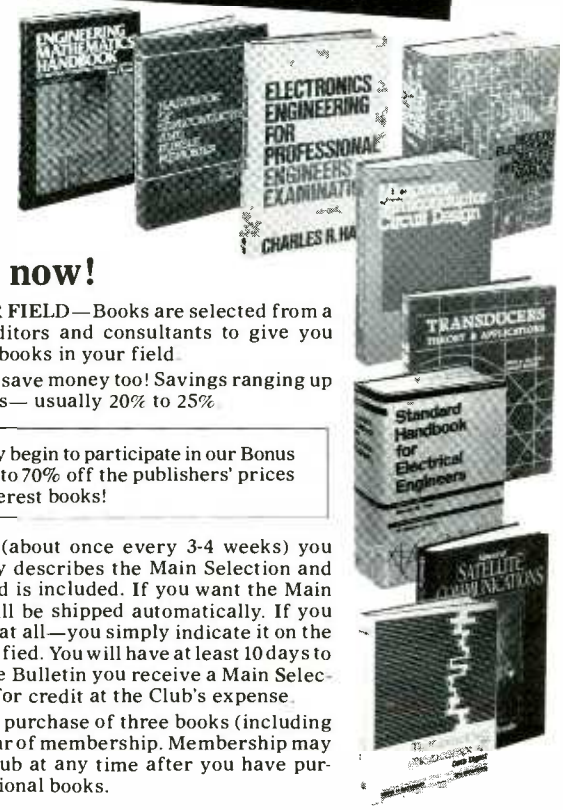

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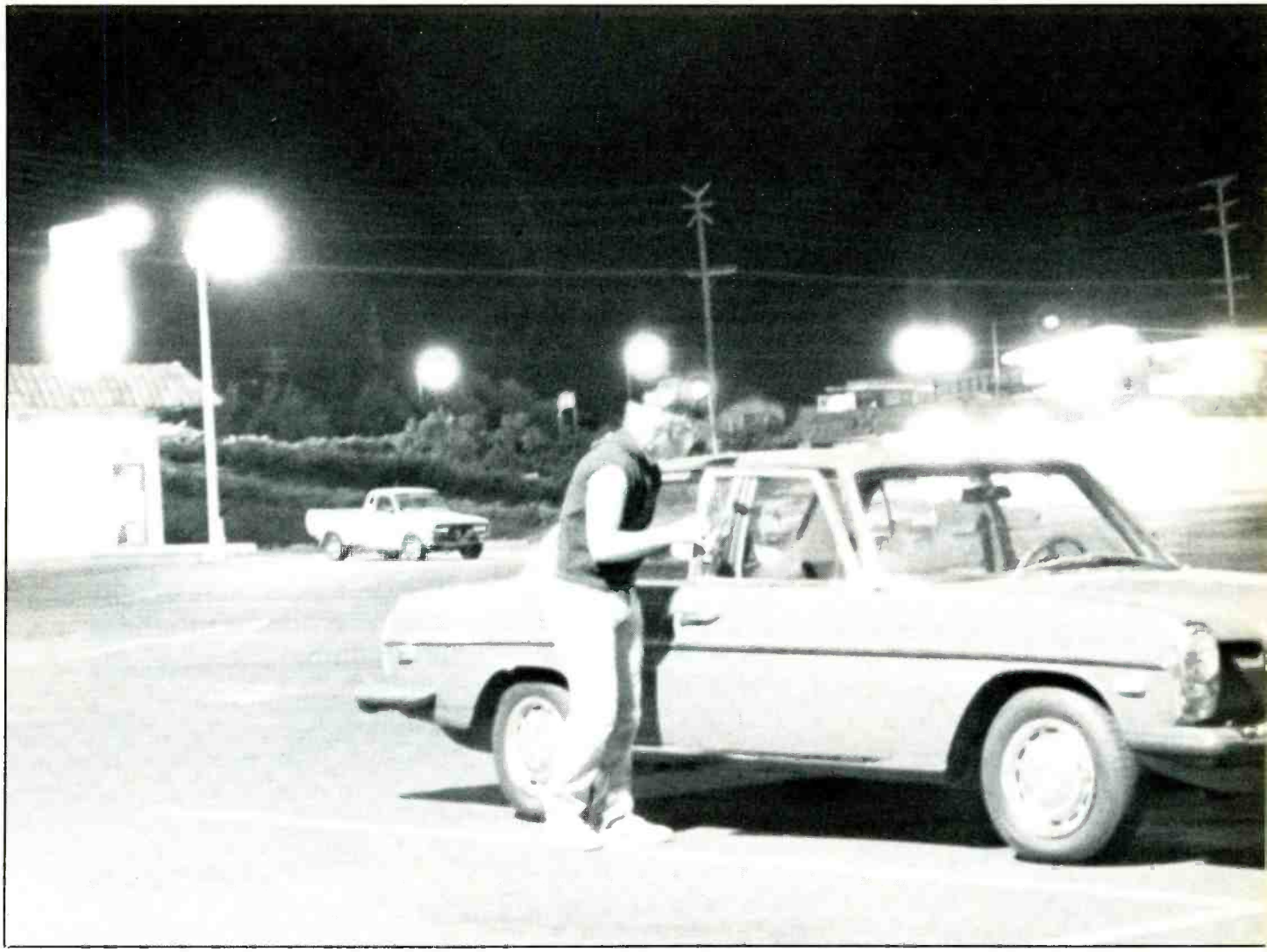


Electronic Automotive Anti-Theft Alarms

A look at the newest offerings, step-by-step installation procedure, and a rundown on some of the best electronic systems to protect your automotive investment

By Ron Cogan

Your car, van, camper or RV can be a target for thieves any time and any place. It doesn't matter is your vehicle is brand spanking new or five or more years old, either. It's an attractive target for every thief, from the professional "chop-shop" artist to the joyrider who simply wants your wheels to go for a spin without your permission. And the easier you make it for a thief to take off with it, the more attractive a target your vehicle becomes.

With auto-theft incidents increasing at an alarming rate with each passing year, it pays in more ways than one to take direct measures to ensure the safety of your vehicle. What you really need is a reliable electronic auto-theft alarm.

Installing an electronic theft alarm in your vehicle adds to your peace of mind. It also has the benefit of probably saving you money on insurance.

Early Theft Alarms

Before the age of solid-state electronics, if you owned a vehicle, your best

bet was to keep a watchful eye on it. With the advent of electronics came a new option—the electronic alarm system. Although early alarms were very basic in design, they did at least afford some degree of protection against theft of a vehicle and/or its contents. It was an important step in the right direction, but it didn't go quite far enough.

There were a number of drawbacks with the simple designs of the early electronic theft alarms. To begin with, you had to *manually* arm these systems with a key-operated switch mounted in an inconspicuous location outside the vehicle. Since the system was manual, its success in protecting the vehicle depended almost entirely on the imperfect memory of the user. If you didn't remember to arm your theft alarm, your vehicle was left without its protection. But even if you always remembered to arm the alarm, an aspiring thief might notice the key switch and simply deactivate the system before breaking into your vehicle.

Other problems also existed. For example, if the alarm was triggered and you weren't in hearing range for hours on end, the system's siren or horn would continuously sound until the battery ran down or you returned to turn if off. Often as not, you came back to a dead battery and irate neighbors or store owners who wanted to lynch you for disturbing their peace. The noise problem became so acute that many municipalities have ordinances on the books requiring the towing away of offending vehicles and disarming of the alarm if the owner couldn't be found—at the owner's expense.

Another irritating problem with early electronic theft alarms was false triggering. This was an aggravatingly common occurrence. Though the pin switches used to guard against unauthorized door entry worked well, the same couldn't be said for the first-generation motion detectors that some alarm systems used. The idea of using motion sensors was to detect a thief in the *process* of breaking in, rather than after he gained entry. Additionally, the sensor would also trigger the alarm if a thief attempted to tow the vehicle away or jack it up to steal the tires and wheels.

Unfortunately, early motion detectors were prone to false triggering at the slightest movement caused by wind or even simply by someone brushing against the vehicle. Another disappointing limitation of the motion detector was its requirement that the vehicle in which it was installed had to be parked on level ground. Parking on an incline immediately triggered the alarm.

A New Day Dawns

Beginning about 10 years ago, a whole new generation of vehicular theft alarms began to come on the market. Using much more refined electronics built around the latest in micro-circuit technology, they were and still are designed to address all the shortcomings of the first-generation designs.

Virtually all of the new vehicle theft alarms sold today can be successfully installed by do-it-yourselfers, even those with no technical knowledge of electronics or automotive mechanics. Only simple tools are needed to perform the installation. And the instructions provided with each model are generally well illustrated to guide you, step-by-step, through installation.

An example of these new generation security systems is the CAT ("Catch A Thief") alarm from California Electronics Industries. Like many of the top-notch alarm systems now available, the CAT alarm offers passive arming. That is, it arms and disarms itself automatically. You don't ever have to even think about the system except when entering or leaving your vehicle.

Arming and disarming of the CAT system is accomplished from the vehicle's ignition switch. When you turn off the ignition and are preparing to leave your vehicle, the system initiates a one-minute exit delay before arming itself. If you wish to remain in your car with the ignition off for longer than the one-minute grace period, all you have to do is leave the key in the ignition switch and turned to the "accessory" position. Upon returning to your vehicle, you have up to one full minute (the time is adjustable to suit your personal preference) to unlock and open the door, slip into the driver's seat, and switch on the ignition to deactivate the alarm.

Monitoring with the CAT system is accomplished in several ways. The alarm is connected to your vehicle's existing dome-light switches located in the car's door jambs. (If no such switch is present, pin switches supplied with the alarm kit must be installed in the jambs to do the job.) The system also has a sophisticated dynamic motion detector, with adjustable sensitivity, that senses har-

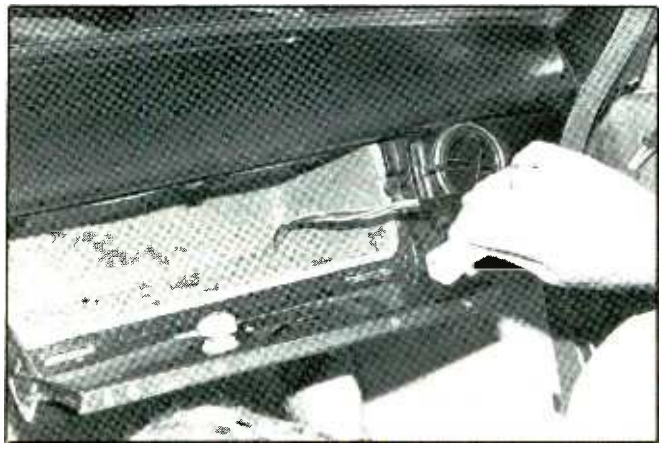
monic disturbances, such as a sharp rap on the window or a jolt to the body. Additionally, a closed loop can be used to protect individual accessories, and a circuit is provided that can be tied to an optional transmitter/pocket-pager system.

When an intrusion is detected, the system's 110-dB (decibel) siren sounds for a full minute after the disturbance ceases. After this, the alarm resets itself to continue surveillance. This feature eliminates the possibility of running down your vehicle's battery in the event a break-in occurs when you're away from your vehicle for an extended period of time.

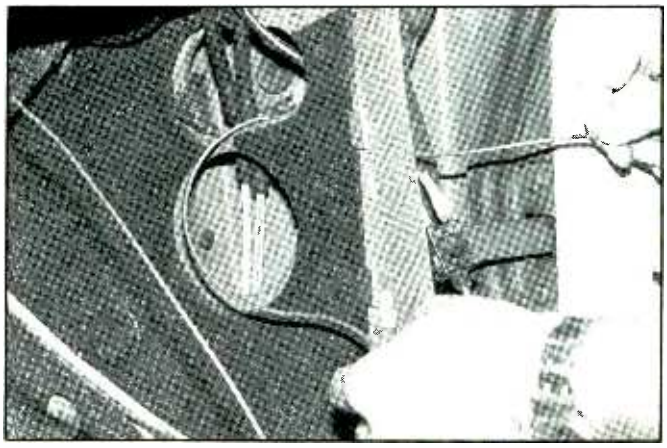
The CAT alarm is simple to install by the average do-it-yourselfer in about an hour. Installation tasks include finding an out-of-the-way loca-

Do-It-Yourself Installation

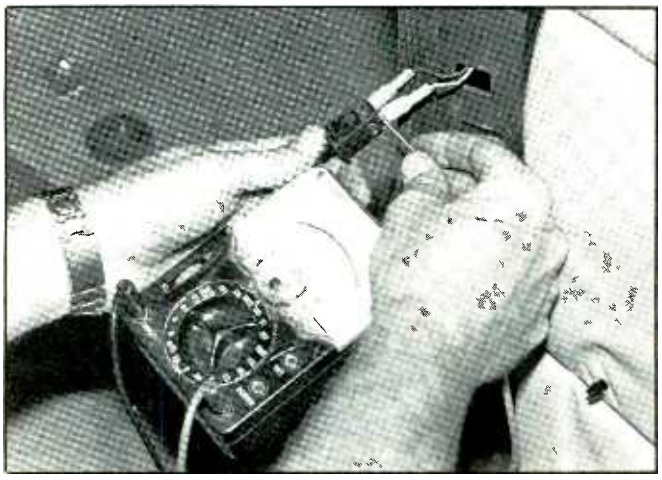
The following series of photographs demonstrate the steps taken to retrofit the California Electronics Industries CAT anti-theft vehicle alarm. The installation procedure described here is generally typical of that for most of the other such security systems on the market. Only very basic tools are required to retrofit the alarm system in a vehicle.



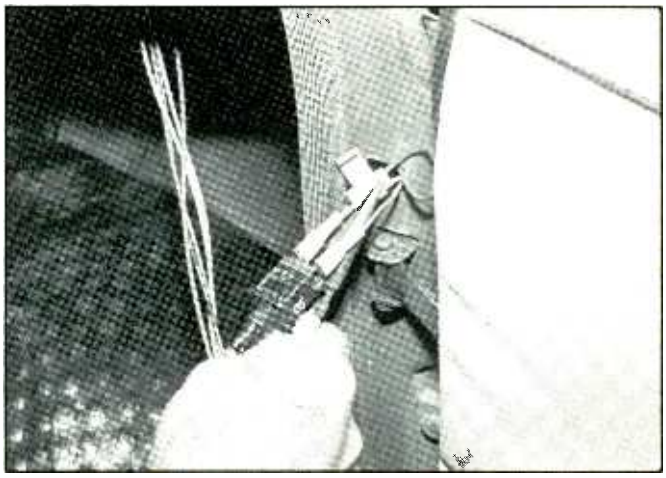
1. *Installation of the CAT security system begins with finding an out-of-the way, hidden location in which to mount the alarm module. A good place is the glove box. Drill a hole through one corner of the glove box to provide a means for routing the wiring to the alarm module.*



3. *Route the appropriate conductor from the glove box under the carpeting or behind the kick panels to the door pin switch. Use the brown conductor for a ground-activated door switch or the yellow conductor if the pin switch is positive activated. (See the wiring diagram in step 14.)*



2. *Dismount the existing door-jamb pin switch to determine if it's positive- or ground-activated. Use the appropriate conductor in the wiring harness—yellow or brown. If your vehicle doesn't have door pin switches, you must install the grounding ones supplied with the CAT kit.*

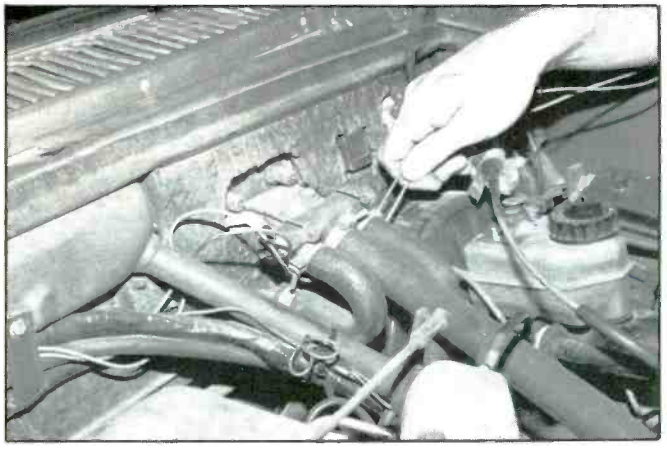


4. *Feed the conductor through the doorswitch hole and connect it to the switch with an insulated Scotch-Lok connector. Remount the switch in its hole. Most cars require connection to only the front door. In the case of Mercedes a wire must also be connected to a rear-door switch.*

tion for the central alarm module, tapping leads to the vehicle's dome-light switches, and routing wiring through the firewall and into the engine compartment. Inside the engine compartment is where you mount the siren and make connections to two separate power leads, one that's "hot" all the time and the other that's "hot" only when the ignition key switch is turned on.

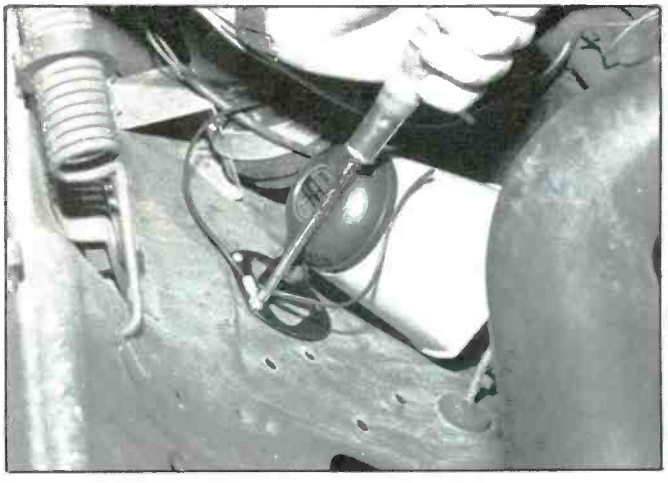
The entire installation procedure for the CAT system is illustrated in the photographs below this article. The steps detailed in this photo sequence are typical of those for installation of all such alarm systems.

In conclusion, it goes without saying that a good hoodlock to prevent a thief from disconnecting the alarm should supplement any alarm.

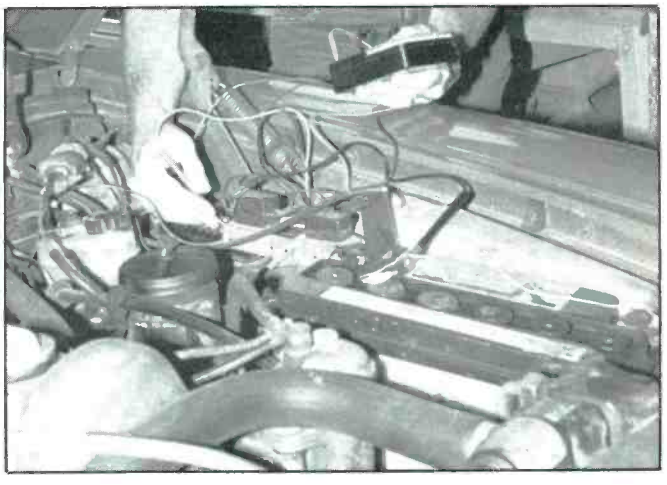


5. *The power, ground, and trumpet conductors must be routed through the vehicle's firewall and into the engine compartment. Be sure to route through a rubber grommet to prevent the metal edge of the hole from cutting through the insulation and shorting out the system.*

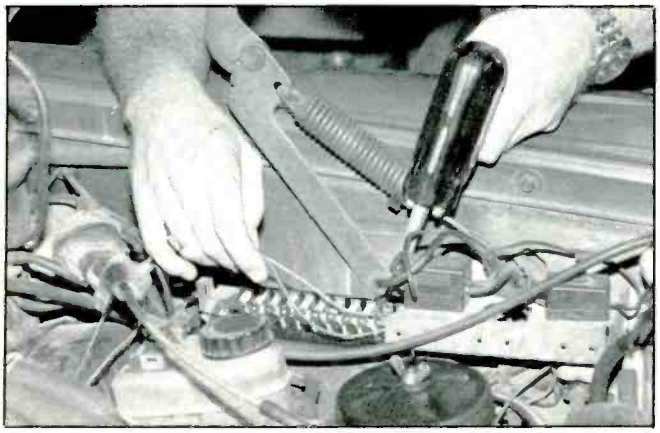
7. *Route the gray conductors coming from the wiring harness and attach them to the terminals on the trumpet speaker with insulated connectors. This done, dress the wires away from other wiring and hoses in the engine compartment and secure them in place with plastic cable ties.*

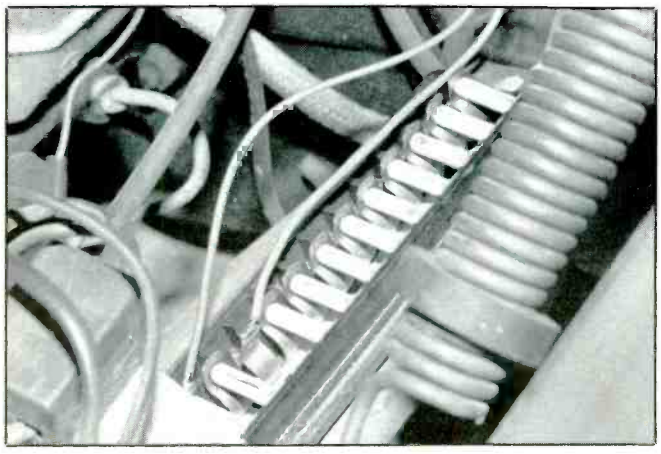


6. *Drill holes for and mount the trumpet speaker in a location inside the engine compartment where it won't be accessible from outside the vehicle. Secure it in place with three screws or rivets. Use one of the mounting screws or rivets to make the system's ground connection.*

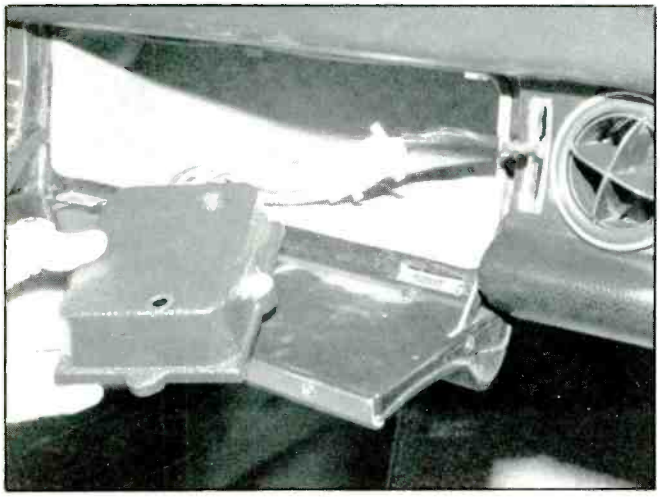


8. *Use a multimeter, set to dc volts, to locate appropriate sources of power for the alarm system. One source must be "hot" at all times, while the other must be "hot" only when the ignition is turned on. Find the first with the ignition off, the second with it first turned on and then off.*



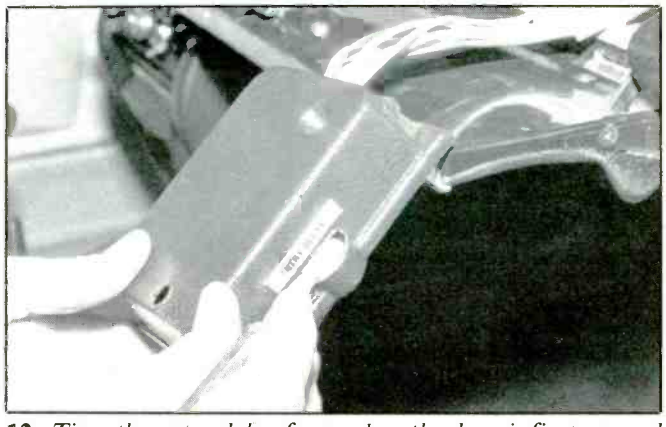


9. *In this installation, the power conductors are being soldered to the terminals of the fuse block. However, if you wish, you can use clip-on fuse taps or insulated tap connectors to tap into the two power sources. You may have to do the latter is there's only limited access to the fuse block.*

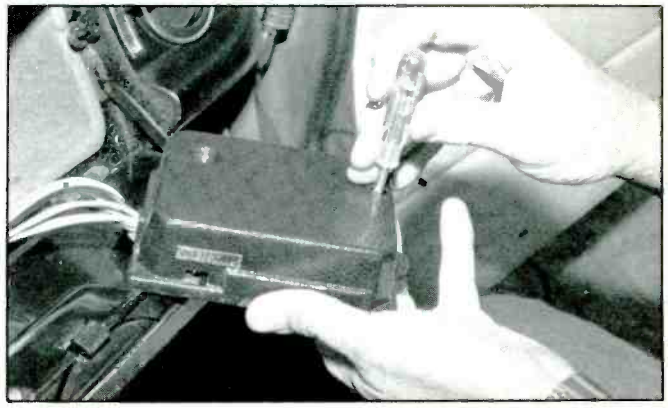


10. *All wiring completed, the alarm module is ready to be set into the glove box (or wherever you've decided to put it). Connection to the newly installed wiring is via a convenient quick-disconnect fitting. Don't anchor the module in place until adjustments are made to make it operational.*

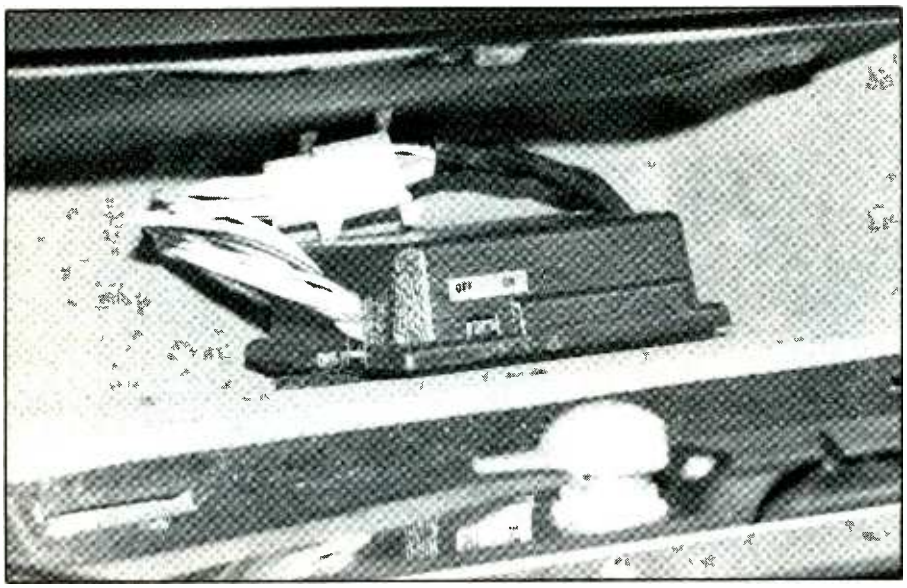
11. *To test the operation of the alarm system, turn on and then off your vehicle's ignition system. Shut all doors and wait a bit more than 60 seconds to allow the system's exit delay to expire. Then open a door. When the preset entry delay time runs out, the alarm sound.*

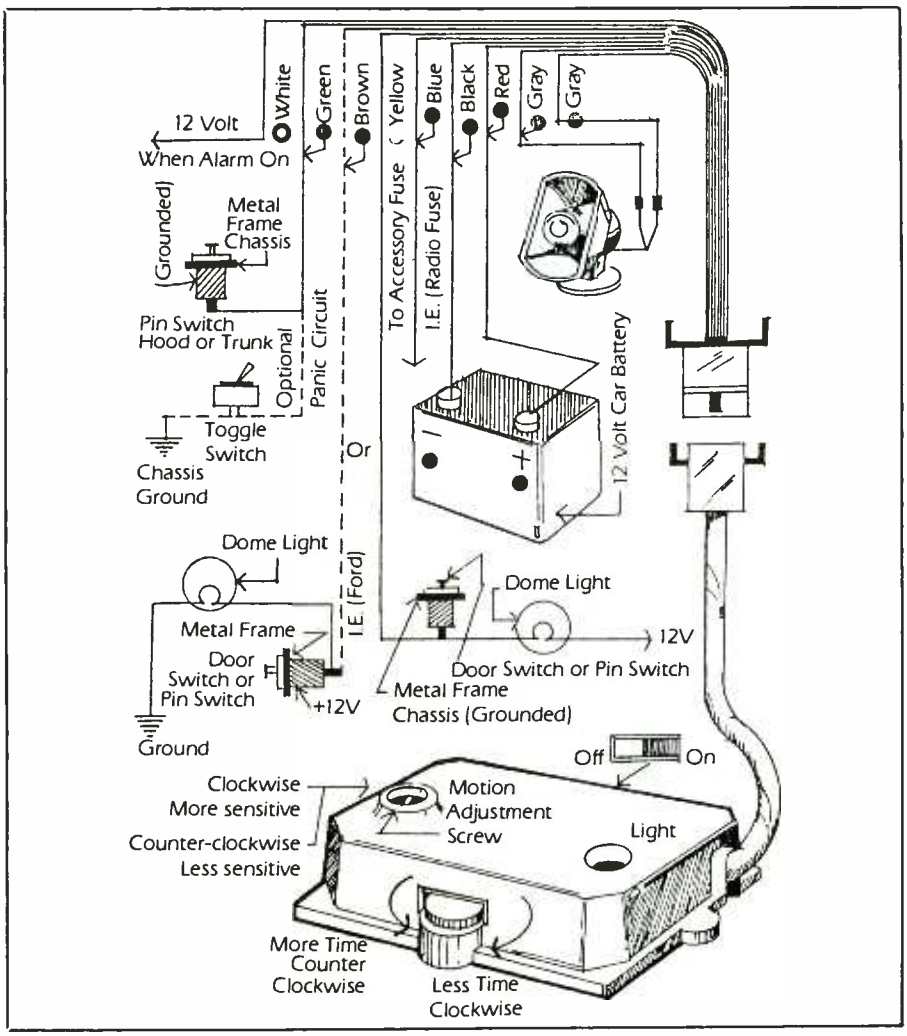


12. *Time the entry delay from when the door is first opened until the alarm sounds. If you find this to be a comfortable amount of time for you to get into your vehicle and turn on the ignition, do nothing. If not, however, adjust the thumbwheel control at the side of the module as needed.*



13. *The sensitivity of the motion-detection system is also adjustable to suit individual requirements. You'll have to make this adjustment by trial and error, delivering sharp blows to a window or tire while adjusting the screw in the alarm module until sensitivity is set as you want it to be.*





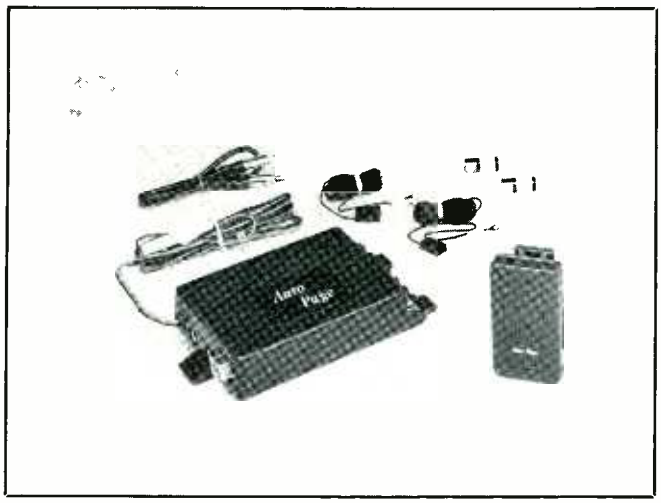
14. *Wiring diagram of California Electronics CAT auto-theft alarm.*

The Best Of The Rest

Here's a look at 10 other sophisticated vehicle alarm systems. The models detailed below and shown in the photos are only representative of the marketplace. There are many more makes and models available; in fact, most of the manufacturers mentioned here offer more than the one or two models described. The bold numerals are keyed to the same numerals below each photo in this section.

1. The Model AP-4200 alarm system ($189.95) from Auto page boasts a radio paging system that personally notifies you in the event of a break-in. This system automatically arms itself whenever the vehicle's engine is turned off, and it monitors for high-frequency metallic sounds, such as those typically made by a "slim jim" or pry bar, with a pair of resonance sensors. The transmitter also houses a plus/minus trigger output for other sensing devices, such as pin switches and motion detectors. Once the system is triggered, the hidden 4-watt transmitter sends out an individually tone-coded signal (up to 30,000 combinations are possible) to activate the beep tone and flashing light in your pocket pager.

2. Cal Custom's Model 981 "Smart Alarm" ($69.95) is extremely simple to install, since one enclosure houses all the electronics, a 115-dB (decibel) electronic horn, and a shock sensor. This alarm is unique in that it has its own built-in battery backup in the form of two 9-volt alkaline batteries. Hence, the alarm is powered even if your vehicle's battery cables are cut. The alarm offers passive operation via the ignition key, an adjustable exit delay, and a valet override switch. The deluxe Model 982 ($99.95) adds a three-LED status monitor and a tone that alerts you to the fact that the entry delay timer is running. It has a logic-controlled exit delay that doesn't arm the system until you actually leave your vehicle, and it flashes the headlights when the alarm is tripped.



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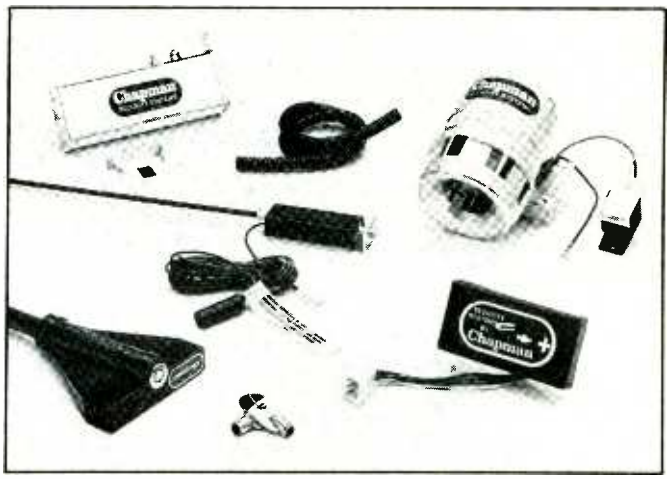

(4)

3. California Electronics Industries' Model 4400 standard "CAT" alarm ($189.95) is a totally integrated, passive security system that is operated by your vehicle's ignition key. Utilizing microcircuit technology, the CAT packs a lot of features into a small central alarm module, including a built-in dynamic motion detector, entry and exit delay, automatic shut-off and rearming, and current sensing to protect against door entry. A 110-dB high/low siren is activated when the system is triggered to attract immediate attention. Also available from CEI is the Model 2000 4-watt pager ($199.95) that alerts you by radio from as far away as four miles if someone tampers with your vehicle.

4. Chapman's "Generation III" System 400 boasts a high-security key lock and hood deadbolt as well as an ignition suppressor that prevents your vehicle from being driven away until the system is disarmed. A detect module and motion detector protect against unauthorized entry, jacking, and towing. When the alarm is triggered, a 110-dB motor-driven siren sounds for three minutes and then shuts off to allow the system to rearm to guard against further intrusions.

5. Featuring very low-power CMOS circuit design, the Crimestopper Model HP-7507 "Remote Guard" alarm system ($399.95 to $429.95) offers a host of features for maximum security and reliability. Dual-channel remote control features a remote panic button for emergencies, or protection for two vehicles with only one transmitter. The system can be armed either actively with the transmitter or passively with the vehicle's ignition. An indicator "chirp" signals whether the system is armed or disarmed and when intrusion has been attempted. Other features include ignition kill, backup battery system, and closed-loop circuit to protect accessories.

6. The "Vandal Alert" Generation II anti-theft system ($129.95) from Criterion Associates incorporates a solid-state electronic design that per-

(Continued on page 86)

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Home Satellite TV For 1985 And Beyond

U.S. installations will soon top one-million, as receiver/antenna systems get better and become less costly

By Stan Prentiss

By March or April of this year there will be one-million television receive-only (TVRO) home earth stations operating in these United States, according to Dr. Taylor Howard of Chaparral Communications and other knowledgeable industry sources. With the TVRO industry now pulling in $9-billion in revenues, projected figures suggest that 60,000 per month will be a reasonable output, with 3.7-to-4.2-GHz downlink C-band equipment predominating for now and in the forseeable future.

Although several programmers, such as HBO (Home Box Office), continue to suggest imminent coding/decoding (scrambling) schemes, as Dr. Howard confirms, adequate and reliable technology "isn't quite there." (HBO predicts scrambling on Galaxy 1 and Satcom in 1985.) Even if HBO should live up to its announcement, there are other satellites and transponders from which to choose. Besides, the Linkabit HBO descramblers have a *dealer* price tag of some $300 each.

General Developments

It's best to concentrate on trends and new developments among TVRO manufacturers as 1985 gets under way. The *huge* Space/STTI satellite earth station show at Nashville's Opryland hotel this past fall set the stage for advanced electronics and dish design for the future. Occupying 531 booths and trailing 330 antennas of all descriptions, the Society for Private and Commercial Earth Stations and Satellite Television Technology, Inc., had a sell-out crowd of more than 10,000 visitors. Technical training certification, dozens of seminars, banquets, and Congressmen W.J. Tauzin (D-LA) and Albert Gore, Jr. (D-TN) were among the show attractions.

Fig. 1. Birdview Model 20/20M stereo satellite receiver comes with aluminum dish, antenna drive controller, remote satscan.

With hundreds of transponders on the C and K bands raining signals earthward from geostationary orbit 22,300 miles up in space, the evident need for dual-polarity (orthogonal) receptors, multiple TV drivers, and higher i-f receiver inputs was apparent. Rapid introduction of both mesh (wire) and perforated (sheet aluminum or steel with holes) dishes for see-through cosmetics, easier shipping, and less wind resistance demanded considerable attention. And to reduce prices still further, as low-noise amplifiers (LNAs) plummet, 6- and 8-ft. receptors were much in evidence, along with the traditional 10- and 11-ft. models for tougher reception areas.

Apparently, some of the manufacturers have the word that TVROs "with thermally noise limited systems will *not* be affected at 32 to 25 log θ within a 6-to-7-dB C/N (carrier-to-noise ratio) limit, since the average person won't usually see interference upon institution of 2° satellite spacing." If there's a 13- or 15-dB C/N and a 6-to-7-dB threshold, signal loss will amount to between only 0.1 to 0.2 dB. Furthermore, small antennas requiring noise relief can be served by 15-MHz (instead of 28-MHz) receivers and pick up an extra 3 dB. So there are apparently lots of ways to beat high costs and backyard monstrosities. However, you're advised to try first and buy later when attempting to shortcut the process.

Transponder signals at −100 dB aren't exactly boomers, especially at K-band frequencies when it rains or C-band frequencies in northern New England. And mismatched or "alien" LNA, LNC, or LNB dish/receiver component systems can only aggravate the problem.

Specific Developments

Birdview's 20/20M stereo satellite receiver (Fig. 1), with 8½-ft. spun-aluminum dish, antenna drive controller, and 140° remote (sat)scan is a ready-to-go system. Its LNB and dual amplifiers require no polarization and synthesized quartz-accurate channel selection needs no fine tuning. A new 4-way line splitter divides signals into four sets, allowing multiple receiver connections and independent tuning of any and all receivers, regardless of signal polarity. The one-piece spun-aluminum antenna handles winds of more than 100 mph without cracking, corrosion, or heat buildup, due to the metal and white, oven-cured polyurethane base paint. Antenna gain amounts to 38 dB, and efficiency is 63%. Feed to the antenna is prime focus.

The dual low-noise block converter has an LNA noise temperature of 90° and an i-f of 500 to 1000 MHz.

Fig. 2. Regency SR5000 comes with block down converter, LNA.

The audio section includes subcarrier 1 and 2 tuning, switch selection of audio stereo format, and L, R, video and 5-Hz to 8-MHz unclamped baseband output.

An infrared remote controller adjusts transponder and local/satellite selection. It also permits selection of one of two transmit data rates. Price for the package ranges from $2995 to $3195, depending on extras chosen.

Regency's Model SR5000 satellite receiver (Fig. 2) also has outstanding qualities and, like Birdview, is 100% American made. Supplied with a block down converter mated to a 95° LNA, the receiver sells for $939.95.

Among the receiver's many features you'll find: handling of multiple, multi-tuned receivers; a fully programmable infrared remote-control system with automatic satellite positioning, polarity and skew; a nonvolatile memory; a SAW resonator modulator; a two-digit LED channel display; a signal-strength meter; baseband video and audio outputs; a loop for connection of an outboard descrambler; a composite output for stereo processing; and a 430-to-930-MHz i-f.

Receiver bandwidth is some 24 MHz wide, and receiver threshold is approximately 9 dB C/N. Best of all, to avoid blooming reds and agc problems, this receiver has an extended 40-dB agc range, and the converter oscillator tracks within ±2 ppm over a −30° to +60° temperature range. You get a choice of antennas to go with the receiver.

The infrared remote controller features up/down channel scanning, volume and video tuning, muting, power on/off switching, run, and direct address.

Radio Semiconductor of State College, PA markets the LOCOM LNB 950, Model BR101 receiver, and Model LA10 line amplifier, all with enviable specifications and

Fig. 3. Radio Semiconductor LOCOM LNB 950, BR101 receiver, and LA10 line amplifier.

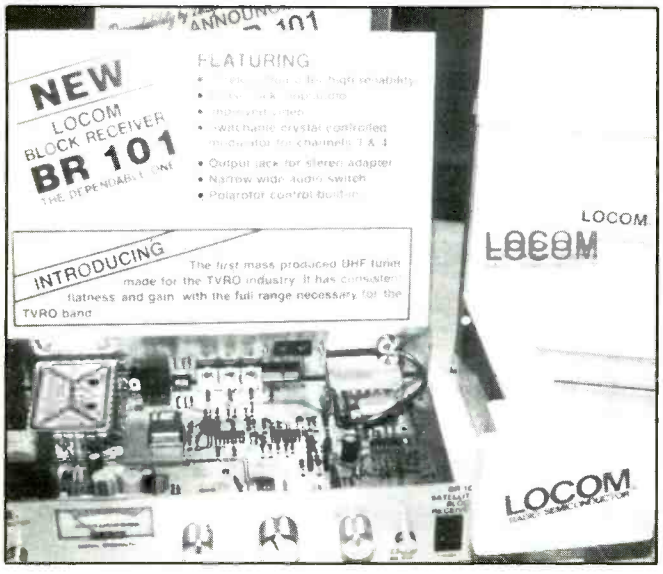

Fig. 4. Tracker Mounts has programmable and hand-crank worm-screw mounts for antennas.

some pretty solid developments (Fig. 3). Once again, this is a block down-converter system, but this time with a twist: you can have LNB outputs at 440 to 940 MHz, 950 to 1450 MHz or 500 to 1000 MHz. Nominal gain is 60 dB, and gain flatness of the filter mixer and post amplifier is ± 1.5 dB. Operating temperature range is from −30° to +60° C.

Its designers say that the Model BR101 is the first mass-produced uhf tuner made for the TVRO industry with a 440-to-940-MHz i-f, 21-MHz i-f bandwidth, and 8-dB C/N threshold. It has a wide/narrow audio band selector, convenient channel scanning, an adjustable signal-strength meter, tunable audio subcarriers, and a channel 3/4 modulator output.

The Model LA10 line amplifier operates from 5 to 950 MHz, at a gain of 10 dB. As are the others detailed above, this is a 3.7-to-4.2-GHz C-band system, working with a built-in Polarotor II.

Jim Morsillo of *Radio Semiconductor* had a number of comments on block system down-converters during his Nashville show lecture. He predicted that only the 440-to-940 and 950-to-1450-MHz i-f ranges would remain, since the former is centered on the uhf TV band and the latter operates beyond it, avoiding all or most interference. However, the 950-to-1450-MHz system costs more due to dual converters, does away completely with image frequencies, and works equally well with 4- or 12-GHz systems. Jim also recommended combining LNA and block converter, eliminating a second metal housing and cable connection, and predicted that LNBs would sweep the TVRO industry with commercial specifications at consumer prices.

Selling price of the Radio Semiconductor system wasn't available at press time.

M/A-Prodelin T1 appears to be another block down-conversion system. It offers 21-channel soft-touch tuning, satscan, stereo-direct and matrix ability, video and audio outputs, infrared remote control, external audio and video inputs, baseband output, LED function displays, automatic polarity selection, Dolby noise reduction, etc. You can buy the entire system, including 8-ft. fiberglass dish antenna, for $2095.

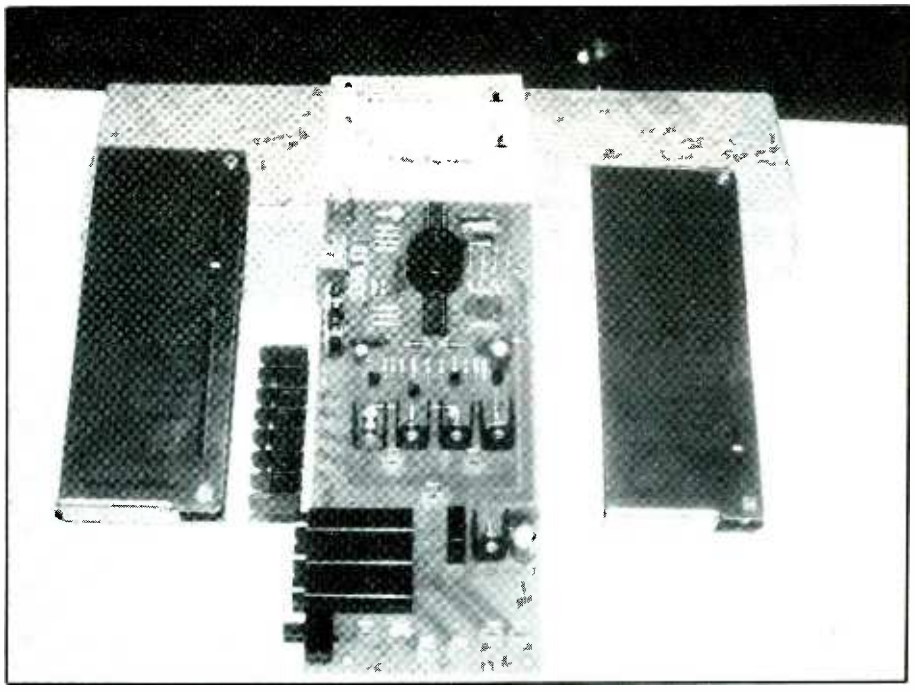

Fig. 5. ACT claims positive positioning of receive dishes via solid-state electronics (shown) and horizon-to-horizon trackers.

Dishes And Mounts

The home satellite industry is undergoing more than considerable changes in both antennas and antenna mounts. Instead of 50° or 60° satscans, current and future designs are calling for azimuth sweeps from horizon to horizon, manually or digitally controlled, at prices that are decreasing constantly as competition and production approach peak.

An excellent example of this trend comes from *Tracker Mounts* of Little Rock, AR. Programmable or with hand crank and positive worm-screw drive, these weatherproof, lightning-protected, ball-bearing mounts (Fig. 4) for all types of dishes sell at the retail level for from $269.95 to $895, depending on antenna size and type and fancy or plebian tastes. Drive systems operate at either 24 or 36 volts dc (your choice), with tracking from 53° to 143° guaranteed.

Tracker control electronics is another phase of the mount picture, with ACT (Actuator Control Technology) claiming positive positioning of receive dishes via solid-state electronics (Fig. 5) and horizon-to-horizon linear-arm trackers. The trackers have upper and lower overtravel limits to prevent the dish from bumping the ground and over-extended arm damage. Solid-state switches (not Hall-effect sensors) and a slide-type potentiometer remote controller precludes inconvenient digital marker resets and resulting reprogramming. This allows precise antenna positioning at minimum cost and reliability. Retail price for the package is $349.

Fig. 6. Winegard Satellite Systems recently introduced a group of 6-, 8- and 10-ft. perforated-aluminum antennas with corrosion-resistant finish, extruded-aluminum support, locking ribs.

The antenna outlook isn't as sharply defined as the major manufacturers hang in there with mainly fiberglass dishes. Newcomers gravitate toward mesh and perforated metal arrays. "Backyard artists," on the other hand, go the "hand layup" fiberglass route, that, if done improperly, results in delamination, bumps, peeling, and general deterioration for the unwary. But don't despair; the big, reputable manufacturers are in the business to stay. Even major names like Amplica and Avantek are now offering complete systems of their own. Birdview, too, will soon be showing a 7½-ft. *elliptical* dish with offset feed, called a Spoon™, which the company predicts will have better than 80% efficiency and improved C/Ns of 1.5 dB.

Forerunner of new technology, *Winegard Satellite Systems* of Burlington, IA, is introducing a group of 6-, 8- and 10-ft. perforated-aluminum antennas (Fig. 6) with corrosion-resistant finish, extruded-aluminum support, and locking ribs. They're lightweight, rugged, easy to assemble, and are shipped in four quarters (for the 10-ft. dish), with a weight of just 92 lbs. Only 16 bolts and eight rim screws are required for assembly. Some models are supplied in smoked-chrome, others in jet-black finish. Companion receivers have remote controls, scan signal bargraph, skew (Polarotor fine tuning) control, 5.5-to-8-MHz audio tuning, a video inverter, and a down-converter switch that allows exchange without disturbing the receiver. Down-converter/LNA i-f is the conventional 70-MHz. Prices for 8- and 10-ft. systems, motorized or not, range from $2495 to $3495 complete.

Antenna-only manufacturer *Jensen Satellite Receiving Systems* has just spent $250,000 to bring a special form back from Ireland to produce 0.040"-tolerance steel receptors that are specially bumped and dimpled to maintain exact measurements. These are 9-ft. steel perforated arrays that have undergone five polystyrene liquid baths in addition to a zinc bath that is baked onto the steel at 480° F. The whole overcoating procedure is for positive protection against rust. Marketer will be *Janeil* of Reseda, CA, and prices will range between $749 and $849. Advantages of the new antenna are said to be weight reduction and better cosmetic appearance, air drain, and heat dispersal.

Remarks

If they're made well and fully guaranteed by a reputable manufacturer, fiberglass, aluminum and steel dishes should serve you well under most conditions. Signal pickup feeds are already proven, but the down-converter and receiver situations remain somewhat fluid, and lots of advances will take place here as competition expands.

If you plan to attach more than one TV set to your satellite receiver, look into an orthogonal (dual-polarity-feed) block down-converter. If only one TV is planned, then a simple LNA (low-noise amplifier) and the usual 70-MHz i-f and Polarotor will probably be sufficient for your needs—it will certainly be cheaper.

For all the foregoing, we do have one word of caution. Although super-low-noise amplifiers will provide an additional margin of signal-to-noise ratio with which to work, the gain difference between the usual 8-and 12-ft. dishes is at least 4 dB, or a power ratio of 2.5:1; so be guided accordingly. In other words, where signals are minimal, you had better look at both 100° LANs, LNBs and LNCs and a 10- or 12-ft. receptor. Sorry to say, there are no cheap electronic bypasses for adequate satellite signal flow. **ME**

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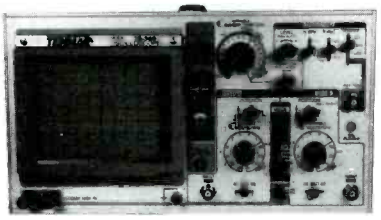

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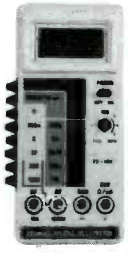

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CIRCLE 69 ON FREE INFORMATION CARD

Once upon a time, in a magic kingdom far away, there lived a truly wondrous automobile. It was the first "no excuses, no apologies" automobile ever available, and was very popular among the princes and the populace alike. Alas, this otherwise stupendous machine had a single and very serious flaw. A flaw so insane that it could only have been placed there by a demented and wicked witch.

For, you see, this wondrous automobile had a large pedal on the floor that was plainly marked "BRAKE." Drivers of this automobile expected and assumed that, when this "BRAKE" pedal was pressed, the automobile would be brought to a swift and safe stop, without harm to the driver, or to any of the passengers, or to any cargo.

But this was nought to be. Forsooth, the "BRAKE" pedal was really a magical pedal under a horrible spell. If the "BRAKE" pedal was pressed by itself, the automobile, the driver, and all contents got magically and instantly whisked back to the carriage house from whence the trip began.

If a driver was foolish enough to press the "BRAKE" pedal at the same time he turned on the windshield wipers, the wondorous automobile did, in fact come to an immediate stop. But, alas and alack, the immediate stop was so sudden and so violent that it destroyed the driver, passengers, and all contents of the magical vehicle.

Well, not really destroyed. For, you see, all that really happened is that a pair of holes, five urflogs in diameter, got neatly punched completely through the driver, any passengers, and all else that happestance had placed inside the wondrous machine.

When the grand vizeers were asked why the "BRAKE" pedal was not really a "BRAKE" pedal, but instead an evil and demonic device, they offered two reasons.

Some vizeers said that the multitudinous makers of hood ornaments and glove compartment door hinges did not want the drivers bringing their vehicles to a quick and safe stop, since the hood ornaments and glove compartment door hinges could then—horror of unspeakable horrors—actually be inspected and possibly modified by the driver.

Others said that there must be some protection to keep the driver from inadvertently and unintentionally pressing the "BRAKE" pedal if he did not, in fact, really want to bring this wondrous automobile to a swift and safe stop. And indeed, a much older model of the same wondrous automobile, did have its "BRAKE" pedal situated where it could easily be mistaken for the horn ring.

Lo and behold, a certain driver of the wondrous automobile finally decided he had more than enough of this male bovine excreta.

He pulled out the old "BRAKE" pedal by its roots and threw it away. Then, he replaced the magical "BRAKE" pedal with a real one that was able to swiftly and controllably bring this wondrous automobile to a safe and sure stop. Having done so, the driver grabbed the nearest handy princess, drove off into the sunset, and lived happily ever after.

Upgrading Apple IIe's ROM Monitor

Here are fixes to change this model's restrictive monitor to an absolute old reset one, giving users an opportunity to unleash the computer's real power.

By Don Lancaster

A fable, you say? Only perhaps.

The wide-selling Apple IIe computer, likely the last Apple computer with reasonable expansion flexibility, including socketed ICs, is not as tractable as adventurous users would like it to be. Its ROM monitor, where the system's routines lie, has a fatal flaw of sorts. It's not in the code itself, but in what a resident monitor should allow a user to do beyond what its creators think you should do.

To got past the built-in restrictions imposed by the machine's system monitor, so that you can do all sorts of wonderful things—emulate a "snapshot" card, replace the entire operating system with your own custom code for dedicated data-acquisition purposes, perform certain CAD/CAM programs, run special turnkey applications, etc.—I'll show you how to design an improved monitor, like those in older Apples before the mass-market syndrome set in. With this ROM change, *you'll* be in control, custom-modifying "Applesloth" to your heart's desire.

Fortunately, the IIe monitor is resident in chips that can be swapped easily for 64K EPROMs. Along the

way I'll show you how to burn in the new EPROMs (which cost only about $6 each), that will replace the original ones including putting in the necessary code. The improved monitor will do everything the original IIe monitor ROM does, as well as open new computing vistas for you. Moreover, there is no "hole blasting" done on a cold restart, which essentially destroyed pages of code on a reset, taking away marvelous tools such as stopping and inspecting. And if you keep your finger on the Open-Apple key for at least four seconds *after* a cold reboot, you will be dropped directly in the "old," more versatile monitor, awaiting your every machine-language command.

The code version covered here applies *only* to the "original" IIe ROMs, shipped in most IIe's up to late fall of 1984. Separate code is required for either the "new" IIe ROMs or for the IIc. (See box at end of article for details on getting code for versions.) You can tell you have an "original" IIe ROM if your scrolling appears disjointed and chunky.

I call this new monitor a KREBF monitor, named after the magic spell that "repairs willful damage" in Infocom's *Enchanter* adventure game. Actually, we won't repair any willful damage . . . we just won't do any in the first place. I'll show you a painless and fully automatic process for converting your own firmware into a form useful for EPROM programming. I will also give you the full *new* source code patch that will return absolute control of your IIe back where it rightly belonged in the first place. (This is also available ready-to-run on a companion diskette, as well.)

About The Firmware

The stock Apple IIe has 16K of ROM-resident firmware that sits between $C000 and $FFFF. As Fig. 1 shows, this firmware is held in two 64K read-only memories. One of these is called the CD memory and sits in main board location E8, while the other is called the EF memory and sits in board location E10.

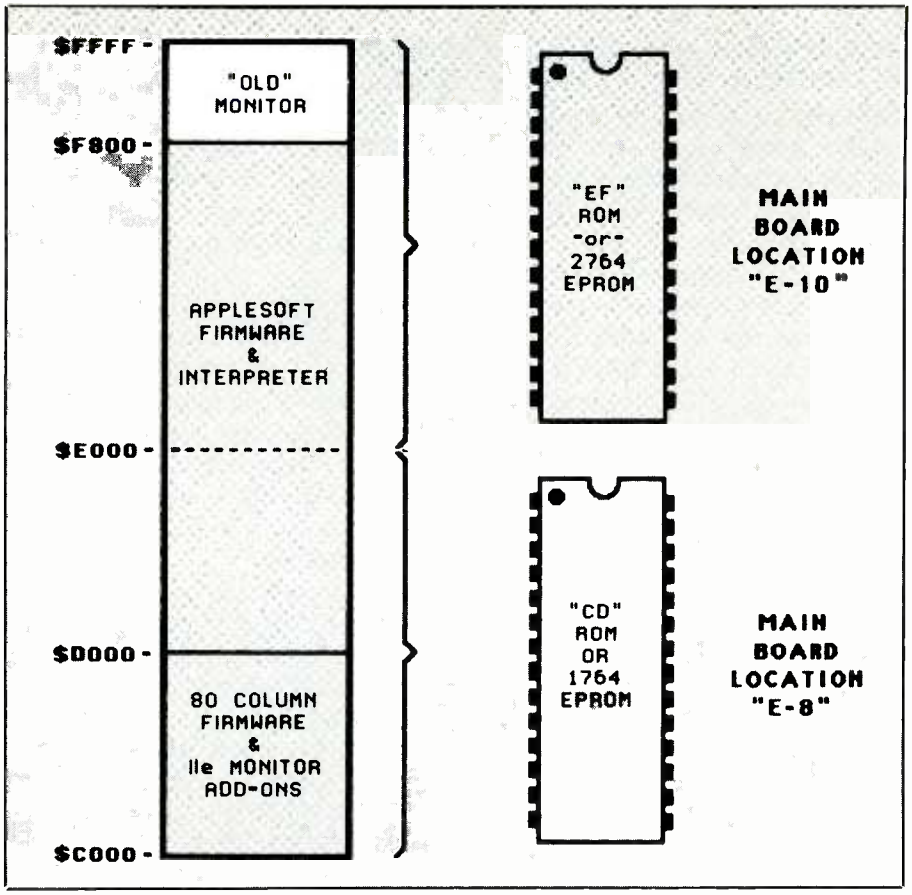


Fig. 1. Apple IIe firmware is held in a pair of 8K × 8 ROMs. Standard 2764 EPROMs can be directly substituted for the supplied ROMs.

The traditional monitor area to older Apple IIs needed only the 8K space from $F800 to $FFFF. This area is still used as a monitor for the IIe. To provide for the many new IIe features, expansion hooks have been added to also allow use of the $C000-CFFF memory area.

Since $C000 to $CFFF is in the I/O (input/output) area, special soft switches are used to pick either "normal" I/O or "monitor" use of this address space. Thus, anything that wants use of the "new" IIe monitor area must first turn off the I/O space and then turn on the CD firmware ROM. When you are finished using the new monitor area, the CD ROM must be turned back off and the I/O space must be reactivated.

There are four soft switches involved. One pair handles only the memory area from $C300 to $C3FF and is used to make the 80-column firmware look like it is sitting in slot 3 of the I/O space. The second pair of soft switches is used to switch everything else. These are called the $CX00 switches. The X here can be a 1, 2, 4, 5, 6 or 7.

The top half of the CD memory and the bottom three-quarters of the EF memory hold the Applesoft firmware. This code is apparently unchanged from earlier models, in the "original" IIe firmware. The "new" IIe and IIc firmware made some changes to Applesloth, such as allowing lower-case commands.

Older Apples used 16K ROMs that were not quite compatible with industry standard 2716 EPROMs. One enable pin was active-high on the

ROM, compared to an active-low state needed by a 2716 EPROM. While you could just change some jumpers around to do some short-sighted 2716 replacements, you really needed a small plug-in card to actually do the job right.

Without the inverter, certain plug-in cards could cause memory contention and hang up the machine. Quite a few articles on adding EPROMs to older Apples ignored this key point, leaving you with a potential time bomb on your hands. Thus, swapping for 2716 EPROMs did not get done much on older Apples because of the hassles involved.

Very fortunately, the 64K ROM firmware used in the IIe is directly and exactly compatible with the standard 2764 EPROM. So, to customize things any way you like, you simply swap chips.

The "CD" or "EF" chips in a IIe may be directly replaced by 2764 EPROMs. In case you've tuned into the microcomputer revolution late, a 2764 is a special "read-mostly" memory that you can custom program and reprogram yourself. You buy these for around six bucks. Erase any old memory contents by using a special ultra-violet lamp. You reprogram the memory to suit your application, using either a programming card for the Apple or a stand-alone EPROM programmer.

EPROM programmers are readily available at any hacker's club if you do not already own one. We will shortly see a sneaky way to program the 2764 on older burners that may not be directly able to handle such a large EPROM.

To customize your IIe, all you have to do is burn one or two 2764 EPROMs and then swap them for the CD or EF memory they are to replace. That quick and that simple.

There is one minor "gotcha" though: the 2764 EPROM used *must* be an Intel or Hitachi brand with 28 pins and an access time of 250 nanoseconds. Real 2764s always come in a 28-pin package, and are the *only* type of 2764 useable as a direct Apple monitor replacement. (Both Motorola and Texas Instruments have their own imitation versions of fake 2764's that come in 24-pin packages.)

About 64K Eproms

Figure 2 shows the pinouts for a real 2764, along with some use details.

To analyze any memory chip, break the package leads down into four groups: supply, address, data, and control lines. Then analyze each group as follows:

- Only a single + 5-volt supply and ground are needed for normal reading of the 2764 EPROM. Supply current is typically around 150 milliamperes in the read mode.
- The 2764 is a 64K memory that is organized as 8K by 8. This means that there are 65,536 bit locations that are programmable to 1 or 0. These bit locations are arranged into word bytes of 8 bits each. Thus, there are 8192 different 8-bit words.

The address lines select which word is to be written to or read from. Thirteen address lines are needed, since $2^{13} = 8192$. To select a particular 8-bit word, the correct binary pattern of 1s and 0s is placed on the address lines. Internal address decoding inside the chip then selects the correct byte for reading or writing. Address lines always input *from* the microcomputer *to* the 2764.

There are eight data lines, used to route the contents of the addressed byte to the microcomputer during a read. The same lines are used to send the data to be written into the EPROM during a write. Thus, the data lines input to the EPROM during a write, and output from the EPROM during a read.

- There are five possible activities an EPROM can be up to:

1) Erase—clears the entire memory when exposed to strong UV light.

2) Program—writes a single byte into memory.

3) Verify—checks a byte just written during programming.

4) Read—outputs a previously programmed data value.

5) Standby—does nothing, allowing other data bus uses.

These activities are handled by four control lines, called VPP, $\overline{PGM}$, $\overline{OE}$, and $\overline{CE}$.

To use an EPROM, you first have to program it. Before you program it, you have to erase anything previously stored in it. Erasure forces all of the data bits to 1s, and all bytes to $FFs. This erasing is done with a special ultraviolet lamp.

The VPP (programming voltage) line provides normal + 5 volts dc for standby and reading. To program, this line must be brought to + 21 to + 24 volts. Earlier EPROMs did not not have this programming voltage on a separate pin, which complicated things. On some micro systems, it is a simple matter to in-socket program a 2764. Unfortunately, the stock Apple IIe does not have this capability. At any rate, leave VPP at + 5 volts to do anything but program. Raise it to + 24 volts to program.

Incidentally, most 2764s can use either a + 21- or a + 24-volt VPP programming voltage. Some older 2732As and a few 2764As demand a maximum of + 21 volts while being programmed and will self-destruct on the traditional + 24 volts. Check the data sheet for the exact brand you are using if there is any doubt.

The $\overline{PGM}$ (program) line is a normal logic control signal. This one is grounded to program and is set to + 5 for everything else.

The $\overline{OE}$ (output enable) line is brought low for a read or a write. A high $\overline{OE}$ line disconnects the outputs of the EPROM, but leaves the chip addressed and fully powered.

The $\overline{CE}$ (chip enable) is used to turn on or off the entire EPROM. During a read, $\overline{CE}$ must be brought

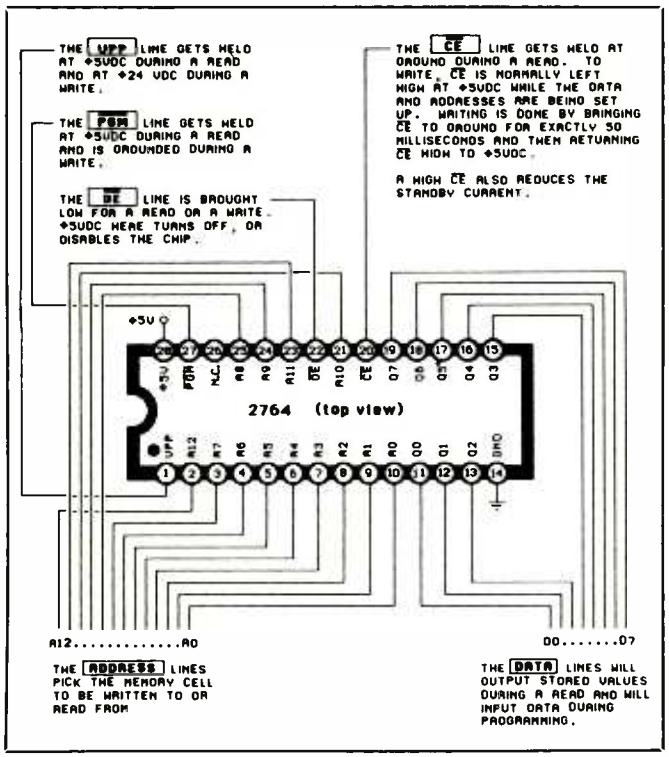


Fig. 2. Drawing shows how a 2764 is used.

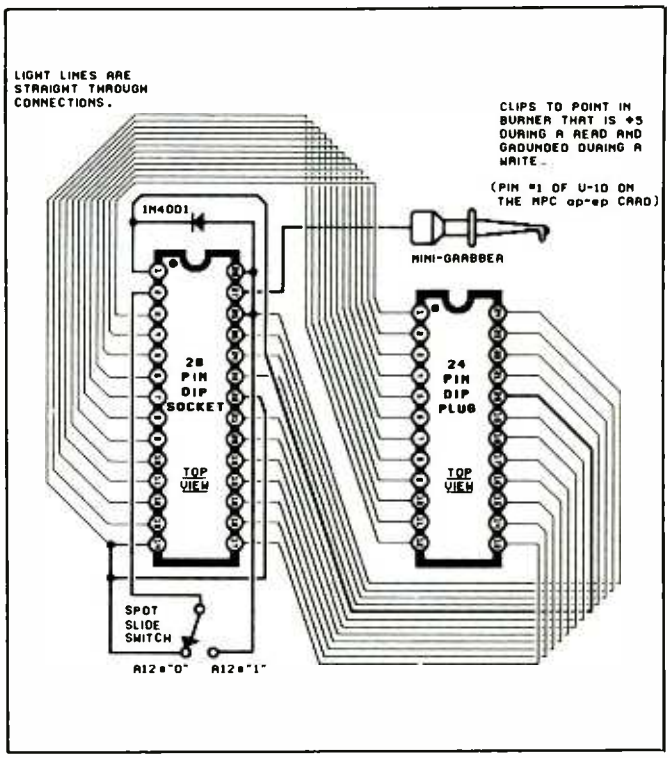


Fig. 3. Adapter for using 2764 in 2732 burner.

low. During a write, $\overline{CE}$ is held high until an address is selected and data is input. Then $\overline{CE}$ is brought low for exactly 50 milliseconds to blast the data value into the EPROM. $\overline{CE}$ is then returned high while the address changes for the next byte. A high $\overline{CE}$ also greatly reduces the standby supply power needed.

Apple chose to use the $\overline{OE}$ line as an alternate chip-enable, since it is faster. They were not in the least worried about saving any supply power, since they already had problems meeting the minimum power supply current drain during the IIe redesign. Apple also permanently grounded the $\overline{CE}$ line and permanently held the PGM line at +5 volts, forcing any 2764 plugged into the main board into a read-only mode.

Thus, unless you want to do some major board carving, "in situ" programming of a 2764 EPROM in an Apple IIe is not normally feasible. Instead, you have to use an EPROM programmer or programming card and then swap out the chips. For more information on this and other memory chips, check into *Don Lancaster's Micro Cookbooks,* SAMS #21828 and #21829.

Programming A 2764 On An Older Burner

Many older EPROM burners cannot directly handle a 2764, and you won't find too many newer models available yet that do. Some of the nasties involved in physically upgrading an older burner include going from a 24-pin to a 28-pin socket, providing that thirteenth address line, getting a PGM signal to the socket, and figuring out how to stuff 8K worth of data into the 4K I/O space normally available on an Apple IIe.

We can bypass all these hassles by adding a fairly simple and easy-to-use adapter to an older EPROM burner. This adpater will make the 2764 to be programmed look like a sequential pair of older 2732s. If you can can program a 2732, as most older EPROM burners can, you can easily program a 2764 with this adaptor.

You will find a two-position slide switch on the adaptor. (*Caution:* Do not use a toggle switch here; it works "backward.") Put the switch in the LOW position to program the low 4K of your 2764 as if it is a 2732. Then flip the switch to the HIGH position so you can program the high 4K of your 2764 as if it is a separate 2732.

Our adapter is intended for use with the MPC "ap-ep" EPROM burner peripheral card for the Apple II or IIe. Certain details might change for other burners.

Listed in the table are the parts you will need to fabricate your adapter. These parts should be readily available anywhere, although you *must* be certain to use the type of premium *machine-contact* DIP socket that can safely be plugged into one another.

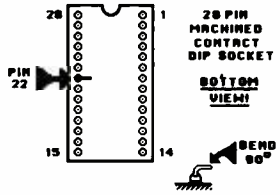
A schematic of the adapter is shown in Fig. 3. Note that this adaptor and the tools required to build it

NOTE This adaptor is needed ONLY if you must burn a 2764 EPROM on an older 2732 burner. You do NOT need this adaptor to replace a IIe ROM with a 2764 EPROM.

1.

[ ] Place the 28 pin machined contact DIP socket pins up and identify pin 22. Carefully bend pin 22 towards the center as shown.

Be sure you are using the long 28 pin socket and not the short 24 pin one. Pins are numbered "backwards" from usual when viewed from the bottom

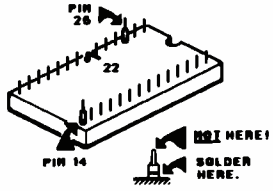


2.

[ ] Push a single bare machined contact socket pin onto pins 14 and 26 as shown.

[ ] NOTE: In any soldering steps, snap an extra DIP strip onto the cool end of the pins being soldered. This keeps the pins aligned should the plastic soften.

[ ] Solder pin to socket at pins 14 and 26. **DON'T GET SOLDER ON THE PIN TIPS!**

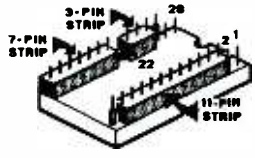


3.

[ ] Push an 11 pin machined contact DIP strip into pins 3-13 as shown.

[ ] Push a 7 pin machined contact DIP strip into pins 15-21 as shown.

[ ] Push a 3 pin machined contact DIP strip onto pins 23-25 as shown.

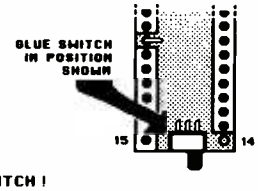


4.

[ ] Carefully roughen one side of the SPDT slide switch and the bottom of the 28 pin DIP socket between pins 14 and 15. Use very fine sandpaper or steel wool.

[ ] Glue the switch to the 28 pin DIP socket as shown using superglue or epoxy. Let sit overnight and then verify that the switch still works.

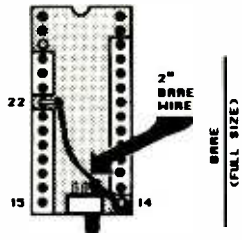
DON'T GET ANY GLUE INSIDE THE SWITCH!



5.

[ ] Prepare a two inch length of bare #24 wire. Connect this wire to pin 14 of the 28 pin socket, then to the nearest pin on the SPDT slide switch, and finally to bent pin 22.

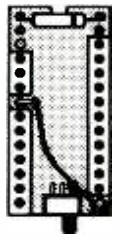
[ ] Solder all three connections, using a spare DIP strip as a safety backup heatsink. Cut off any remaining wire. Be careful not to get any solder on the tip of pin 14.



6.

[ ] Connect the 1N4001 silicon diode from pin 1 to pin 28 of the 28 pin DIP socket. Be certain that the cathode bar of the diode goes to pin 1.

[ ] Make mechnically secure connections, but do not solder them just yet.



7.

[ ] Take a two inch piece of red #24 solid insulated wire and strip 1/4 inch from one end and 3/4 inch from the other.

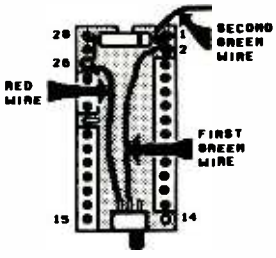
[ ] Solder the 1/4 inch end of this wire to the far unused pin on the SPDT slide switch. Loop the 3/4 inch end of this wire around pin #26 and then to the diode lead coming from pin #28.

[ ] Use an extra DIP strip as a heatsink, and solder the red wire to pins 26, 28 and the diode lead. Make sure you do not contact pin 27.

8.

[ ] Prepare two green insulated #24 wires two inches long by stripping 1/4 inch off each end. Solder one end of the first green wire to the center SPDT switch terminal.

[ ] Solder the other end of the first green wire to pin 2 as shown. Use a dip strip as a heatsink in all soldering steps.



are needed *only* if you are having trouble burning a 2764 EPROM on an older EPROM burner. All you need to do the actual upgrade on your IIe is a programmed 2716 and a simple chip swap.

Figure 4 gives complete construction details for the adapter. It is very easy to build, and should take all of half an hour. Be sure to use an extra machined-contact DIP socket or socket strip when soldering anything. This will keep the pins properly spaced and aligned should the plastic soften. Plug this extra socket into the cool ends of the pins soldered so it straddles any pins to be heated.

If you use the optional epoxy or super glue, be careful not to get any of it inside the slide switch. Carefully test the switch after the glue sets.

You might later want to add a 28-pin ZIF (zero-insertion-force) socket atop the regular socket. Depending on the pins on the ZIF, this may plug in or have to be soldered.

Figure 5 shows you how to use the adapter on the MPC "ap-ep" card. A very slight modification to the card itself is needed. You have to add a small wire hook to the top of pin one of integrated circuit U10. The easiest way to do this is to tin the top of the pin with a very small amount of solder. Then bend a hook in the end of a resistor lead. Reflow solder the resistor lead in place. Finally, cut away all of the resistor except enough lead to form a small loop.

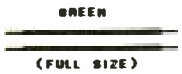
If you are using a different card or a stand-alone burner, make sure you find a place that is at ground during writing and at +5 volts during reading. Add a small wire hook to this point so the grabber can access this signal. Also be sure that pin 1 will be at +5 volts during read and at +21 or +24 volts during programming.

One detail. Note that the 2732 requires a VPP signal of ground for a read and +21 or +24 volts for a write. The 2764 instead requires a VPP signal of +5 volts for a read and +21 or +24 volts for a write. This

9.

[ ] Solder one end of the second green wire to pin 1 of the 28 pin DIP socket and the cathodde (bar) end of the power diode.

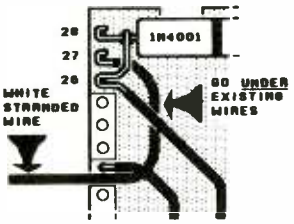
Use a DIP strip as a heatsink. Do not solder the other end of this wire just yet.



10.

[ ] Prepare a 4 inch white #22 stranded wire by stripping 1/4 inch off each end. Route this wire UNDER the bare wire at pin #22 and UNDER the wire between pins 26 and 28.

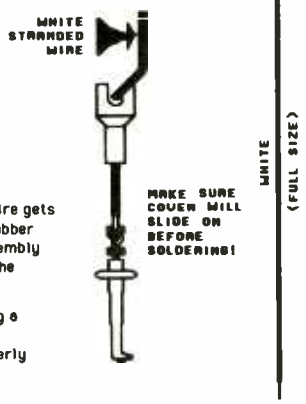
[ ] Solder the "buried" end of the white wire to pin 27. Use a DIP strip as a heatsink.



11.

[ ] If you care to, place a small blob of silicon rubber sealant over all of the wires and the back of the switch.

This will act as a strain relief and further support. Do not get any glop in the switch.



12.

[ ] Study the grabber to see how the wire gets attached. Slide the cover of the grabber over the white wire. Do a trial assembly WITHOUT SOLDERING to make sure the grabber will go together properly.

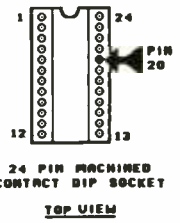
Solder the grabber to the wire using a minimum of solder. Then test the grabber to make sure it works properly

13.

[ ] Take the remaining 24 pin machined contact DIP socket and identify pin 20 by inking the plastic.

[ ] Push the bare end of the flying green wire into the socket (TOP!) end of pin 20 on the 24 pin DIP socket. Solder wire to socket.

[ ] Align the sockets so that pin 14 of the 28 pin socket is above pin 12 of the 24 pin socket. The notches should be at the same end, but staggered from each other.

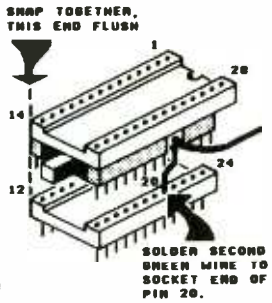


14.

[ ] Snap the two sockets together, being sure the switch end is flush and the notch ends are staggered.

[ ] Verify that pin 3 of the 28 pin socket goes to pin 1 of the 24 pin socket.

This completes the construction of your EPROM adapter.



15.

[ ] Study the schematic of your EPROM burner and find a point that is grounded during a write and at +5vdc during a read. Place a small wire hook or loop at this point in the burner circuitry.

On the MPC ap-ep burner, use pin 1 of U10, per the detail of figure five.

Fig. 4. Detailed in these drawings and accompanying instructions is the step-by-step procedure you should use to build an adapter for programming a 2764 EPROM in an older EPROM burner set up for burning only 2732's.

read supply difference is the purpose of the diode between adaptor pins 1 and 28. If you are using an oddball EPROM burner, make sure that no "hard" ground shorts this diode or a supply line.

To install the adaptor, put it in the existing 24-pin ZIF socket so that the switch points *away* from the ZIF handle. You might have to jiggle the handle slightly, center the adapter, and then slide the locking handle home, as there is a very slight "negative clearance" between the open handle and the adapter. Then glomp the grabber onto the wire hook.

Be *certain* that the EPROM burner or card is configured for a 2732 burn! *Never* try connecting or disconnecting the grabber with a 2764 in place! As a special note to MPC "ap-ep" users, also be sure both *S2* and *S3* are in their OFF position, pointing towards the bottom of the card.

If your EPROM burner uses personality modules, be sure to use the 2732 module and *not* a 2732A module.

Due to lack of space, we're unable to present the entire article at this time. Next month, we'll finish with programming on an older burner, tell you how to capture, modify and test the monitor, and give detailed instructions on how to install the "old" monitor in a IIe. **ME**

Parts Table

1—28-pin machined-contact DIP socket
1—24-pin machined-contact DIP socket
1—11-pin machined-contact DIP strip
1—7-pin machined-contact DIP strip
1—3-pin machined-contact DIP strip
2—bare machined-contact DIP pins
1—extra DIP socket for heat sink
1—miniature spdt slide switch
1—1N4001 silicon power diode
1—mini-grabber test clip
1—¼-watt resistor, any value (see text)
1—4" white #22 stranded wire
1—2" bare #24 solid wire
1—2" red #24 solid wire
2—2" green #24 solid wire
optional—super glue, epoxy, or silicone adhesive.

Circuit Design From Scratch

A hands-on approach to creating new circuits, including a practical car theft alarm you design.

By Jules H. Gilder

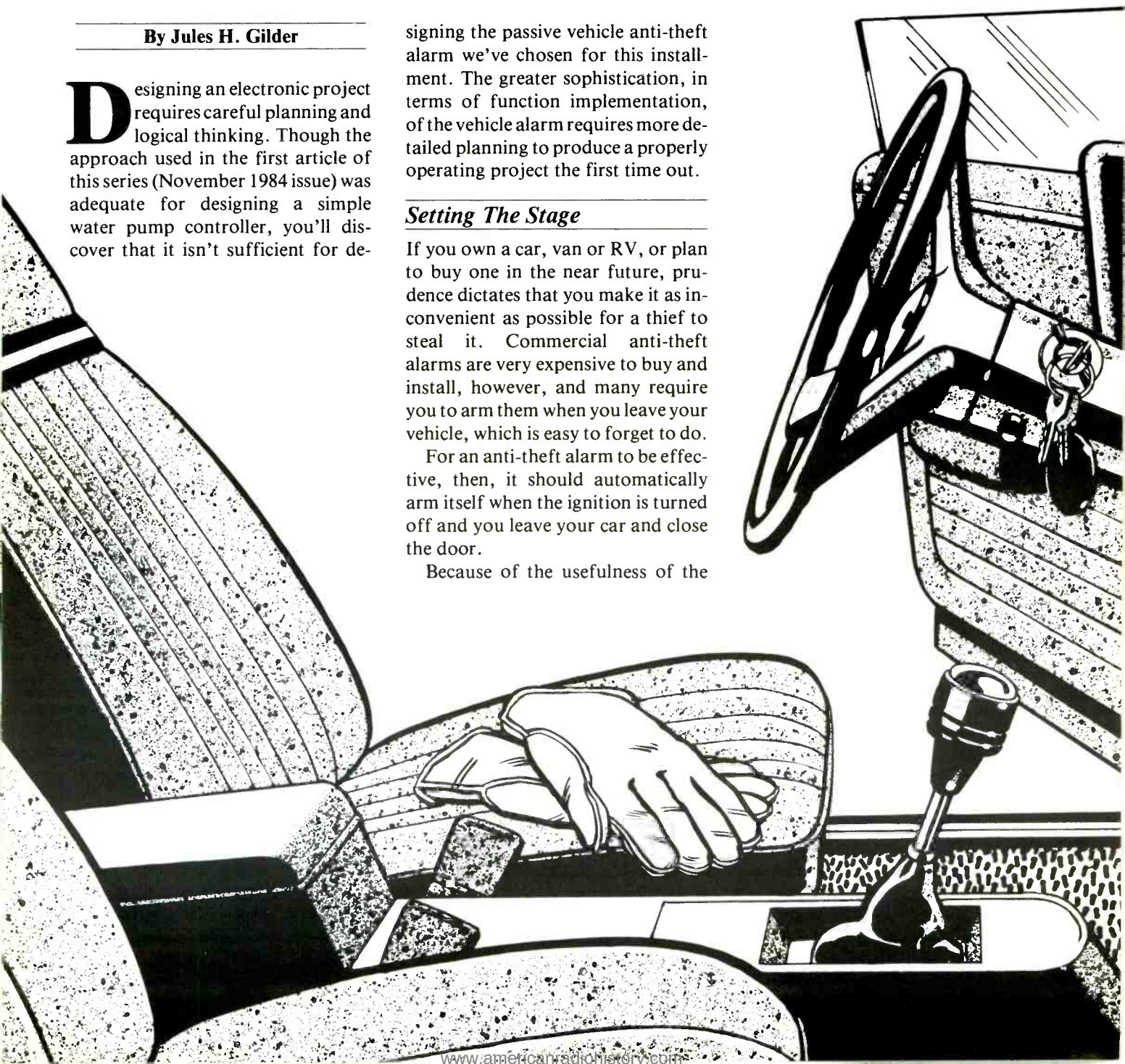
Designing an electronic project requires careful planning and logical thinking. Though the approach used in the first article of this series (November 1984 issue) was adequate for designing a simple water pump controller, you'll discover that it isn't sufficient for designing the passive vehicle anti-theft alarm we've chosen for this installment. The greater sophistication, in terms of function implementation, of the vehicle alarm requires more detailed planning to produce a properly operating project the first time out.

Setting The Stage

If you own a car, van or RV, or plan to buy one in the near future, prudence dictates that you make it as inconvenient as possible for a thief to steal it. Commercial anti-theft alarms are very expensive to buy and install, however, and many require you to arm them when you leave your vehicle, which is easy to forget to do.

For an anti-theft alarm to be effective, then, it should automatically arm itself when the ignition is turned off and you leave your car and close the door.

Because of the usefulness of the



passive alarm and the possibility of reducing car insurance cost, it has been chosen as our design project this time out. In the following pages, we'll show you how to design and build this alarm from scratch. Along the way, we'll develop word descriptions, logic truth tables, and the design equations that you'll use to implement the circuits needed to provide the full range of alarm functions.

Table 1. Power Controller Operating Conditions

	(A) reset switch	(B) door status	(C) current output	(D) ignition switch	(E) turn/keep power on
1	on	—	—	—	off
2	off	closed	off	off	off
3	off	open	off	off	on
4,6	off	open	on	off	on
5	off	closed	on	off	on
7	off	closed	off	on	off
8	off	open	off	on	off
9	off	open	on	on	on

(1) Define The Problem

No matter what anyone tells you, the most important step in the design process is deciding exactly what you want a circuit to do. Though this may sound obvious to you, just stating what you want may not be enough to get you started on the design. You must *fully* define what is to be done and when. I neglected to heed this when designing the project presented here, the result being that my first design failed to operate properly. That failure is the reason why you're reading this in the February 1985 issue of MODERN ELECTRONICS, instead of the December 1984 issue for which it was originally intended. So my advice is: Write down exactly what you expect your circuit to do *before* you do anything else.

Following this counsel, let's list the features that should be incorporated into our vehicle anti-theft alarm:

(1) Automatic arming 15 seconds after the engine is shut off and the door is opened. If the door is not opened (you don't leave the vehicle), the alarm is not armed.

(2) Once armed, any door that opens and turns on the dome (courtesy) light triggers the alarm.

(3) Once triggered, you have 15 seconds to close the door and either start the engine or turn the ignition switch to the accessory position to disarm the alarm. Otherwise, the alarm will sound and cannot be shut off until the door is closed (with the ignition on) or a RESET switch is closed (more about this later).

(4) The alarm is to sound the vehicles's horn intermittently for about 2 minutes. After this, it must shut off and rearm itself to be ready for the next intrusion. Additionally, you want a provision for causing the vehicle's headlights to flash on and off in step with the horn so that the vehicle can easily be located at night.

(5) The system should have either a hidden switch or a keyswitch that can be used to reset the alarm and also temporarily disable it when the vehicle is given to a parking-lot attendant.

(6) The system should work in cars that have door switches that connect to either chassis ground (the most common arrangement) or to the +12-volt line.

(2) Flesh Out Design Details

Unlike the previous project in the November 1984 issue, we cannot go directly from initial project description to logic design. We must first flesh out the details. From 1 above, we see that no system power switch is to be used. Instead, power is to be applied automatically once the ignition is turned off and the vehicle's door is opened. Thus, part of the alarm system is going to have to function as a power controller for the rest of the alarm system.

What the above means is that the power controller portion of the circuit must always be connected to the positive side of the battery, while the remainder of the circuit is to receive power only when the controller decides to deliver it. Since this portion of the system is the key to making this a passive alarm system, let's tackle it first and define its operation in detail.

To begin with, from 3 above, the system must be able to be switched off at any time with a RESET switch. The best place to implement the manual reset function is in the power controller, since without power, the rest of the system won't work. Hence, the power controller must know the state of the RESET switch. If it is on, the output provided by the controller will always be off. Conversely, if the RESET switch is off, sometimes the controller will be on and sometimes it will be off (more about this later).

Since the power controller is to be activated by the vehicle's door switch, it must also know whether or not the door is open. Next, the controller must be provided with information about the state of the ignition switch. From 1 above, the alarm is armed (powered by the controller) only if the ignition is off and the door has been opened.

There's one more factor that influences the decision to provide power from the output of the controller—whether or not the controller is currently providing power. For this, there must be some feedback on the status of the output signal.

Now that we know the factors that are going to control the arming of the alarm system, let's make a list of what is to happen and when:

(1)Whenever the RESET switch is

Table 2. Power Controller Truth Table

	(A) reset switch	(B) door status	(C) current output	(D) ignition switch	(E) turn/keep power on
1	1	—	—	—	0
2	0	1	0	0	0
3	0	0	0	0	1
4,6	0	0	1	0	1
5	0	1	1	0	1
7	0	1	0	1	0
8	0	0	0	1	0
9	0	0	1	1	1

on, no power is provided by the controller, no matter the status of the other signals. (The rest of the items on this list occur only if the RESET switch is off.)

(2) When the vehicle's ignition is first turned off and the door is still closed, power has not yet been applied to the alarm.

(3) Once the door is opened (with the ignition off), for a fraction of a second, the output is still off, but the controller is going to turn it on.

(4) After the initial fraction of a second, the ignition is still off and the door is open, but now the output status is on.

(5) As the vehicle is exited and the door is closed, with the ignition off, we want the controller to supply power to the rest of the circuit and continue to do so.

(6) Upon reopening the door, we want the system to be in the same condition as in 5 above.

(7) If we close the door and turn the ignition switch to on or "accessory" within about 16 seconds, the output is still on for a fraction of a second, but we want the system to turn if off.

(8) After the initial fraction of a second, the output of the controller turns off and remains off.

(9) To meet the conditions detailed in item 3 of our original list of features, we want the controller to continue to provide power with the door open, the alarm system armed (power provided by the controller), and the ignition on.

This list gives a complete word description of how the power controller portion of our passive alarm is going to work. It has been put into easier-to-understand form in Table 1. The line numbers in this table correspond to the numbered items on our latest list. From this summary, it's easy to produce the logic truth table that defines the action of the system.

To convert Table 1 into the logic truth table in Table 2, you simply substitute 1 for *on* and *closed* and 0 for *off* and *open*. The 1 was chosen to represent the door's closed condition because in most vehicles the switch is not grounded when the door is closed and the voltage on the circuit side of the switch is at + 12 volts.

Notice that in Tables 1 and 2 that one set of conditions is repeated (item 4, 6). When we use the information contained in these tables, it is necessary to use this set of conditions only once. Consequently, we'll simply refer to this row as row 4.

(3) Power Controller Equation

With the aid of a truth table, we can now write an equation that describes the task the power controller is to perform (column E). As you already know from the first installment of this series, we use only those rows of the truth table that contain a 1 in column E. In addition, if an element in a column is a 1, that element is represented as the letter that heads the column. If the element is a 0, it is represented as the letter that heads the column but with a bar over it.

Therefore, the first part of our equation would be represented by the term for row 3:

$$E = \bar{A}\bar{B}\bar{C}\bar{D}$$

because all elements in this row are 0. Continuing in the same manner for rows 4, 5 and 9, we obtain:

$$E = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}C\bar{D} + \bar{A}BC\bar{D} + \bar{A}\bar{B}CD.$$

Since $\bar{A}$ is common to all terms, it can be factored out:

$$E = \bar{A}(\bar{B}\bar{C}\bar{D} + \bar{B}C\bar{D} + BC\bar{D} + \bar{B}CD).$$

Similarly, $\bar{D}$ can be factored out of the first three terms:

$$E = \bar{A}\,[\bar{D}\,(\bar{B}\bar{C} + \bar{B}C + BC) + \bar{B}CD].$$

Finally, factoring out $\bar{B}$ gives:

$$E = \bar{A}\,\{\bar{D}\,[\bar{B}\,(\bar{C} + C) + BC] + \bar{B}CD\}.$$

Now we're going to use one of the rules of Boolean algebra that states:

$\bar{X} + X = 1$ (rule 1).

Using this rule, our equation becomes:

$$E = \bar{A}[\bar{D}(\bar{B} + BC) + \bar{B}CD].$$

A second rule of Boolean algebra states:

$\bar{X} + XY = \bar{X} + Y$ (rule 2).

Applying this to our equation, we get:

$$E = \bar{A}[\bar{D}(\bar{B} + C) + \bar{B}CD].$$

We can now expand the middle term of our equation and get:

$$E = \bar{A}(\bar{B}\bar{D} + C\bar{D} + \bar{B}CD).$$

If we now factor C out of the two terms in the equation, the result is:

$$E = \bar{A}[\bar{B}\bar{D} + C(\bar{D} + \bar{B}D)].$$

Once again, we can use rule 2 to simplify matters:

$$E = \bar{A}[\bar{B}\bar{D} + C(\bar{B} + \bar{D})]$$

$$E = \bar{A}(\bar{B}C + \bar{B}\bar{D} + C\bar{D}).$$

Factoring out the $\bar{D}$ term, we obtain:

$$E = \bar{A}[\bar{B}C + \bar{D}(\bar{B} + C)].$$

This is about as compact as the equation is going to get, however it is expressed in terms of OR gates (the addition) and AND gates (the multiplication). To minimize parts count, we'd like to try to express the whole equations in terms of NAND and AND gates. This can be done by us-

ing a third rule from Boolean algebra, which converts an OR term to a NAND term:

$X + Y = \overline{\overline{X}\,\overline{Y}}$ (rule 3).

By setting $X = \overline{B}$ and $Y = C$, we obtain:

$E = \overline{A}[\overline{D}(\overline{\overline{B}\,\overline{C}}) + \overline{BC}]$ and

$E = \overline{A}[\overline{D}(\overline{B\,\overline{C}}) + \overline{BC}]$.

Applying rule 3 once more to the equation, we get:

$E = \overline{A}[\overline{D}(\overline{B\,\overline{C}})\,\overline{BC}]$.

(4) Convert The Equation To A Circuit

Since the last equation uses only AND and NAND terms, we will stop here and use it to build our power controller circuit. A circuit that illustrates how the various input signals combine to produce the final output is shown in Fig. 1. Although any logic family could be used to implement this circuit, it is best for automotive applications to use low-power, high-noise-immunity CMOS devices.

(5) Design The Timers

From our original specifications, we know that three separate timing circuits are required, one each for exit delay, entrance delay, and amount of time the alarm sounds. The system must also have an oscillator to pulse beep the horn, which is used here as the alarm sounder.

It's possible to build the delay and oscillator circuits with ordinary NAND gates. However, if we use a special kind of gate, known as a Schmitt trigger, we can minimize the number of gates needed and simplify the circuit's design.

A Schmitt trigger provides a snap-action output in response to a slowly changing input. Snap action is made possible by the Schmitt trigger's *hysteresis,* which is a dead band throughout which no change in output occurs.

To understand what hysteresis is, refer to Fig. 2. Notice that voltage at the input can increase substantially without causing a change in output voltage. At a point known as the upper threshold voltage, however, the output suddenly and rapidly changes. When input voltage decreases, there's a similar situation during which no change in output occurs for quite a while as the input voltage drops below the threshold at which the device initially switched high. The voltage can continue to decrease in this dead band until a second voltage—the lower threshold voltage—is reached. Output voltage then rapidly drops.

The dead band and rapid switching make Schmitt triggers ideal for cleaning up noisy signals and for use in timing circuits. Except for these special characteristics, Schmitt-trigger gates are identical to other logic gates and can be used as replacements for them.

We're going to use two 4093 Schmitt-trigger NAND gates in our alarm. These quad 2-input NAND-gate ICs function similarly to the standard 4011 NAND gates used in the power controller. Some uses will be in timing circuits, others will be as ordinary logic gates.

Schmitt triggers can be used to produce two basic types of timers. One is a power-off timer whose output goes low for a specified period of time and then goes high and remains high for as long as power is applied (Fig. 3). The other is a power-on timer whose output goes high for a specified period of time and then goes low and remains low for as long as power is applied (Fig. 4).

The power-off timer in Fig. 3 con-

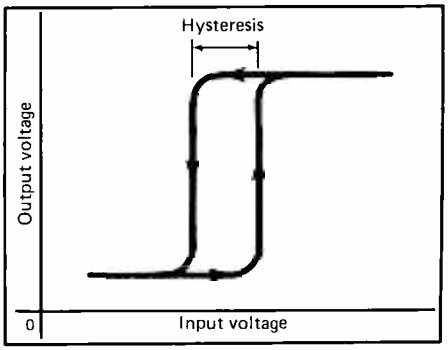


Fig. 2. By plotting input vs. output voltage of a Schmitt trigger, the upper and lower threshold points at which the device switches are obtained, as shown here.

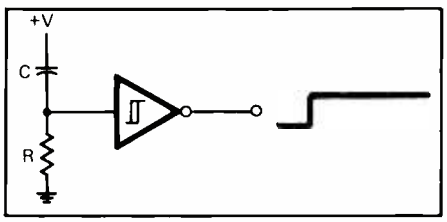


Fig. 3. The power-off timer uses only one gate, a resistor and a capacitor to produce an output that is low for a given period of time and then goes high and remains there.

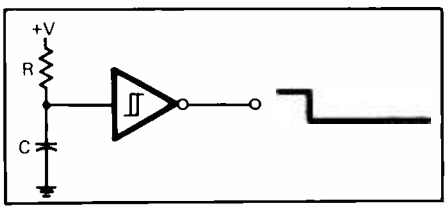
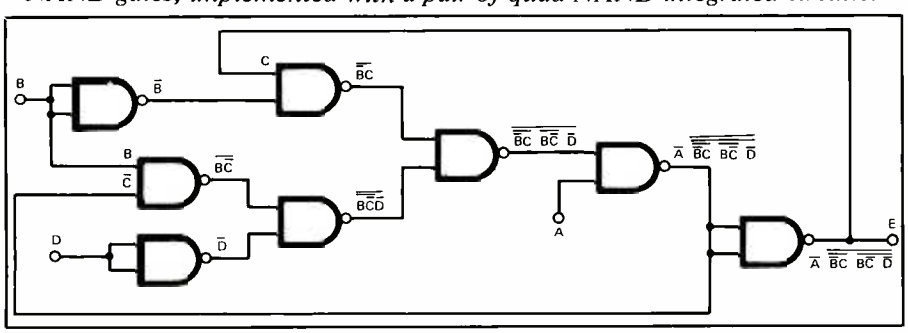


Fig. 4. The power-on timer provides an output voltage for a specified period of time and then goes low

Fig. 1. The power controller of the passive alarm is built around eight 2-input NAND gates, implemented with a pair of quad NAND integrated circuits.



sists of a single gate whose input has a resistor (*R*) to ground and a capacitor (*C*) connected to the positive voltage supply. When voltage is first applied to the circuit, a very rapid input change occurs for a fraction of a second as *C* charges. During this time, *C* appears as a short circuit to the changing voltage, applying a positive voltage to the input of the Schmitt-trigger gate.

Since the gate is an inverter, its output immediately goes low. After the first fraction of a second, the voltage applied to *C* is no longer changing (it's a constant dc voltage), so *C* blocks the flow of current.

In the meantime, the positive voltage that initially got through is decaying. When it drops below the low threshold point, the Schmitt trigger's output switches back to high and remains that way for as long as power is applied. The amount of time required for the voltage to drop to the low threshold point is calculated from the formula $T = 0.7RC$, where *T* is in seconds, *R* is in megohms, and *C* is in microfarads.

The Fig. 4 power-on circuit is very similar to the power-off circuit, except that the positions of *R* and *C* are reversed. In operation, the charge on *C* is initially zero and the output is high. As the charge builds up, it reaches the upper threshold point, causing the gate's output to switch low and remain low for as long as power is applied. The time constant formula for the delay in switching is $T = 1.05RC$.

The only other circuit that requires a Schmitt trigger to operate well is the astable multivibrator (oscillator) shown in Fig 5. It uses only one gate, one resistor, and one capacacitor, with resistor *R* providing the positive feedback required to sustain oscillation. When power is first applied to the circuit, *C* has no charge on it and the input is low, forcing the output high. As the output goes high, current flows back through *R* and starts to charge *C*. The voltage on *C* rises

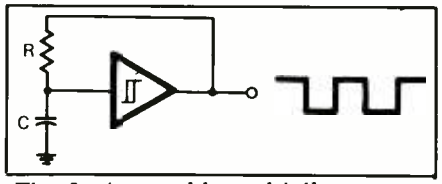


Fig. 5. An astable multivibrator can be formed with a single Schmitt trigger gate when a resistor is used to provide the positive feedback required to sustain oscillation.

exponentially until it is great enough to trigger the input with a logic high and force the output low.

Because *C* is still charging when the input to the gate is triggered, however, current begins to flow through *R* once again, this time in the opposite direction. Capacitor *C* now discharges exponentially until its charge drops below the low threshold point, causing the cycle to repeat itself. Frequency of oscillation is calculated from the formula $F_o = [1/(1.4RC)]$, where F_o is in Hz, *R* is in megohms, and *C* is in microfarads.

If a 2-input NAND gate (Fig. 6) is used instead of a simple inverter, the oscillator can be gated on and off. For example if the second input is connected to the positive supply, the circuit will oscillate as usual. However, if the input is set low, by connecting it to ground or the negative side of the power supply, the oscillator will cease to operate and its output will go high.

(6) Powering The Timers

We now need a circuit to control the power going to the timers that, in turn, controls how long the alarm sounds. We'll call this the timer power controller so as not to confuse it with the main system power controller. The timer power controller must know three things before it can determine that an alarm condition exists and the horn should be sounded. It must know if: the exist delay time has expired; a door has been opened; and the timer that controls how long the alarm is on has been activated.

Let's see how this circuit determines when to turn on the alarm horn:

(1) If the delay time has expired, the door is closed and the alarm is not active, it should remain inactive.

(2) If the exit delay time has passed, the alarm is not yet active and the door has been opened, the alarm should be activated.

(3) Once activated, the alarm should remain on while the door is open.

(4) Even after the door is closed and the alarm is armed, the alarm should remain on for a full 2 minutes.

(5) If the exit delay time has not expired, the door is closed and the alarm is not on, it should not be turned on.

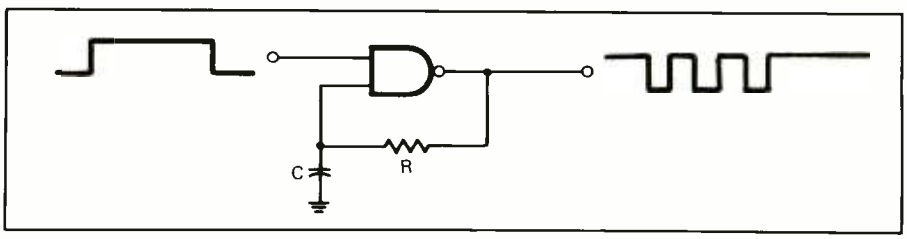
(6) Even if the door is opened while the exit delay is active and the alarm is off, the alarm should remain off.

(7) If the exit delay timer gets stuck in the active mode, the door is open and the alarm is already on, it should remain on.

(8) Even if the door is closed, as long as the alarm is already on, it should remain on.

The last two combinations of inputs could not normally occur in a

Fig. 6. If a 2-input NAND gate is used to build an astable multivibrator, the oscillator can be gated on by applying a positive voltage to the unused input.



properly operating system and can be ignored. They're included here as a safety factor should the exit delay timer get stuck in the active mode. Besides, it doesn't cost any more to implement, even if this capability is never needed.

A summary of the power timer controller's operation, in words, is shown in Table 3. Applying the same rules used for Table 2, this becomes the logic truth table shown in Table 4.

Table 3. Timer Power Controller Operation

	(B) door status	(F) exit delay	(G) alarm timer on	(H) turn or keep power on
1	closed	off	no	no
2	open	off	no	yes
3	open	off	yes	yes
4	closed	off	yes	yes
5	closed	on	no	no
6	open	on	no	no
7	closed	on	yes	yes
8	open	on	yes	yes

Table 4. Timer Power Controller Truth Table

	(B) door status	(F) exit delay	(G) alarm timer on	(H) turn or keep power on
1	1	0	0	0
2	0	0	0	1
3	0	0	1	1
4	1	0	1	1
5	1	1	0	0
6	0	1	0	0
7	1	1	1	1
8	0	1	1	1

(7) Equation For The Timer Power Controller

The next step is to convert Table 4 into an equation that, in its final form, can be implemented with only AND and NAND gates:

$$H = \bar{B}\bar{F}\bar{G} + \bar{B}F\bar{G} + B\bar{F}\bar{G} + \bar{B}FG + BFG$$
$$H = \bar{F}(\bar{B}\bar{G} + \bar{B}G + BG) + FG(\bar{B} + B)$$
$$H = \bar{F}[\bar{B}(\bar{G} + G) + BG] + FG$$
$$H = \bar{F}(\bar{B} + BG) + FG$$
$$H = \bar{F}(\bar{B} + G) + FG$$
$$H = \bar{F}\bar{B} + \bar{F}G + FG$$
$$H = G(\bar{F} + F) + \bar{F}\bar{B}$$
$$H = G + \bar{F}\bar{B}$$
$$H = \overline{\bar{G}\bar{F}\bar{B}}$$

The final equation allows the circuit in Fig. 7 to be implemented. To do this, however, we must have the inverse of both the B and F signals available. The first is available from the system power controller. By choosing the proper timer, in this case, the power-off timer, we can generate the inverse of F directly, without an extra gate.

As in the case with the system power controller, this circuit produces a positive output all the time power is to be applied to the timer circuits. Since neither power controller can directly supply the current required to power their respective circuits, the output of each is used to operate separate transistor switches that *can* provide the required power.

Since the output signal is high when power is required, a transistor that gets turned on by a positive voltage must be used. Hence, we use a general-purpose npn transistor, such as the 2N2222 specified. Of course, just about any other general-purpose npn switching transistor will do as well.

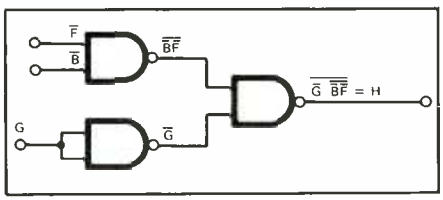


Fig. 7. The timer power controller is a lot simpler than the main power controller and requires only three gates to provide all of the proper signals.

(8) Finishing The Timed Alarm Section

The voltage that turns on the gated astable multivibrator that controls the beeping of the horn must be positive for the on and negative for the off conditions. Therefore, the timer used to control the duration of the alarm must be a power-on timer.

When multivibrator *IC4D* in Fig. 8 is not oscillating, its output is high. Since we want the relay (*K1*) that operates the horn to be off when the multivibrator is not oscillating, an inverter is used to correct the signal. This inverter (*IC5B*) also acts as a buffer for the oscillator. The signal is then fed to 2N2222 transistor *Q3*.

Although the alarm duration timer starts as soon as the door is opened, we want the beeping of the horn to be delayed for 15 seconds to permit you time to get into your vehicle, close the door, and turn on the ignition. A 15-second power-off timer controlling the input to the multivibrator is what is needed. This timer can be implemented by ANDing the signals of the 15-second power-off and 2-minute alarm timers. Since NAND gates are used, the output of a NAND gate must be followed by an inverter to obtain the AND function.

For the reset function, the signal applied to the circuit must be high when the switch (*S2*) is open and low when closed. This is most easily ac-

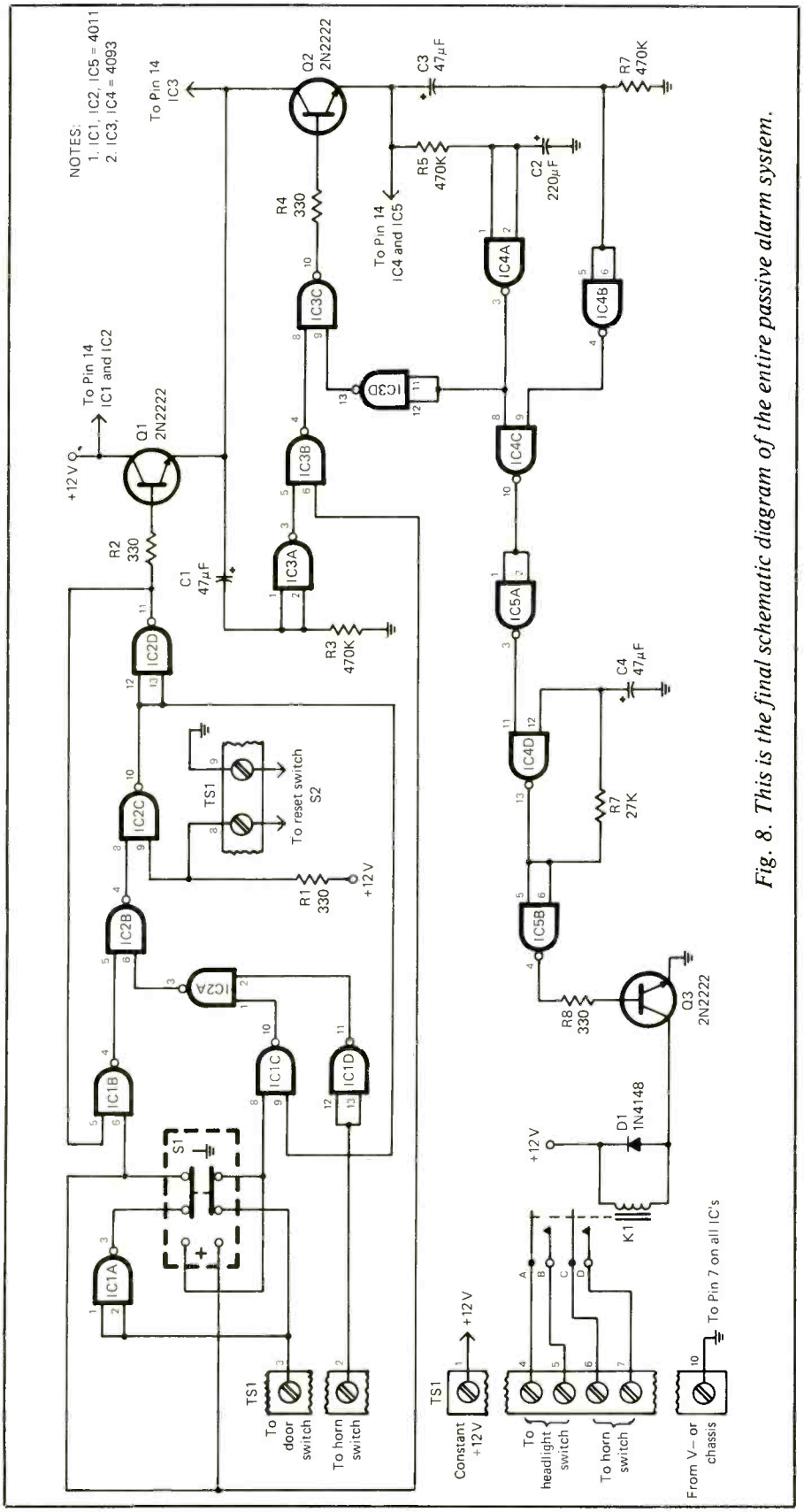


Fig. 8. This is the final schematic diagram of the entire passive alarm system.

PARTS LIST

Solid-state devices

D1—1N914 diode

IC1,IC2,IC5—4011 standard CMOS quad NAND gate

IC3, IC4—4093 Schmitt-trigger CMOS quad NAND gate

Q1, Q2, Q3—Npn switching transistor (2N2222 or similar)

Capacitors

C1, C3, C4—47-µF, 25-volt electrolytic

C2—220-µF, 25-volt electrolytic

Resistors (all ½-watt, 10%)

R1, R2, R4, R8—330 ohms

R3, R5, R6—470,000 ohms

R7—27,000 ohms

Miscellaneous

K1—12-volt dc spdt relay

S1—Dpdt switch

S2—Spst keyswitch or slide or toggle switch (see text)

TS1—8- or 10-lug screw-type terminal strip (see text)

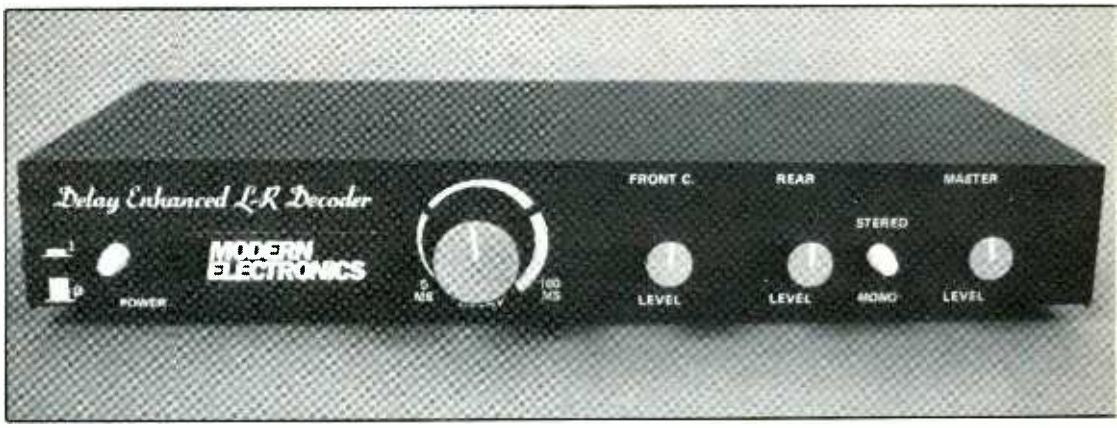
Perforated board and solder posts or printed-circuit board; IC sockets; suitable enclosure; stranded hookup wire; spade lugs; electrical tape; machine hardware; solder; etc.

complished with the aid of pull-up resistor *R1*. When *S2* is open, virtually no voltage is dropped across *R1*. Thus, both ends of the resistor have a high voltage and the output of *IC2C* is high. When *S2* is closed, one end of *R1* is grounded and the input to *IC2C* drops to zero, as required. A single-pole, single-throw (spst) slide or toggle switch can be used here, but it would be prudent to use a more secure key-operated switch instead.

(9) Handling Both Types Of Door Switches

The alarm was designed with the assumption that the door switch in the vehicle shorts to ground when the door is open. Since in some vehicles the switch connects to the positive side of the electrical system when the door is opened, we include a provision that will accommodate either condition—hence the inclusion of *S1*

(Continued on page 82)



"Surround-Sound" Enhancer

Adding this accessory to your hi-fi system recovers ambience information from recordings and adds delay to provide realistic sound

By John H. Roberts

Ambience—so-called "room sound"—is the missing ingredient that makes even the best stereo system sound flat and lifeless when compared to live-performance sounds. Over the years, various techniques have been devised and employed in consumer products to simulate or recreate the ambience of the live performance. To some degree, all have been successful. Until now, however, few have offered the advantages of the Delay Enhanced L – R Decoder described here.

What makes this Decoder project a superior performer is that it uses two of the time-honored techniques that have met with relatively large success. It offers both time delay and L – R matrix (ambience-recovery) capabilities in the same accessory. Combining the two techniques results in a system that works better than either alone.

Performing L – R matrix recovery before adding time delay cuts the expense of using two complete channels, with no deterioration of the ambience information. Adding delay to the L – R matrix corrects that system's localization problems.

Some Background

Artificial reverberation, generated by either mechanical or electronic delays, offer some improvement over the unprocessed sound signals normally delivered to the speakers of a hi-fi system. However, even the most elaborate delay system requires adjustments to make the simulated reverberation match different recordings, the result often sounding unnatural. Discrete and matrixed four-channel recording had the capability of reproducing ambience but was not properly utilized and, hence, fell out of favor.

A certain amount of ambience is automatically captured whenever a microphone is located more than a few feet away from any sound source. Therefore, most recordings already contain significant amounts of ambience just waiting to be unlocked. To unlock it, you need a special signal processor.

Two popular techniques to extract this ambience information from conventional recordings are *time delay* and *L – R matrix*. Pure time delay, not to be confused with delay generated artificial reverberation, was discovered by E. Roerbaek Madsen, who was searching for a way to dramatically improve audibility in conventional recordings.

Some consumer hi-fi delay devices

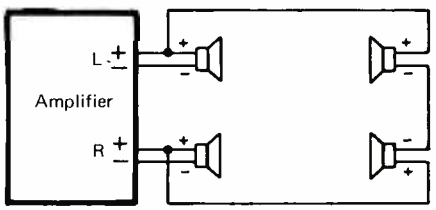


Fig. 1. The Dynaquad™ L – R ambience-recovery scheme places the rear speakers in parallel with the speakers used in the front.

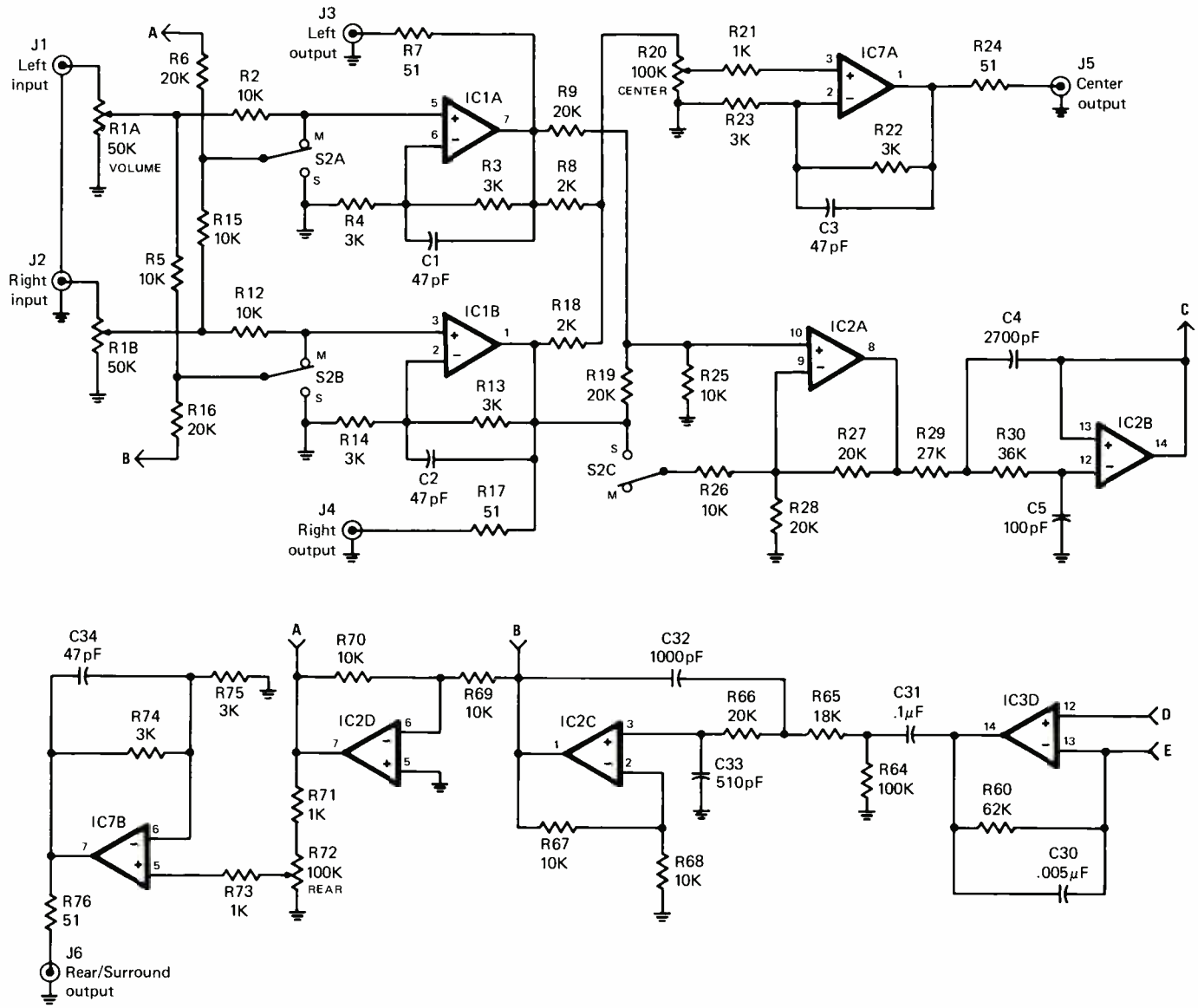
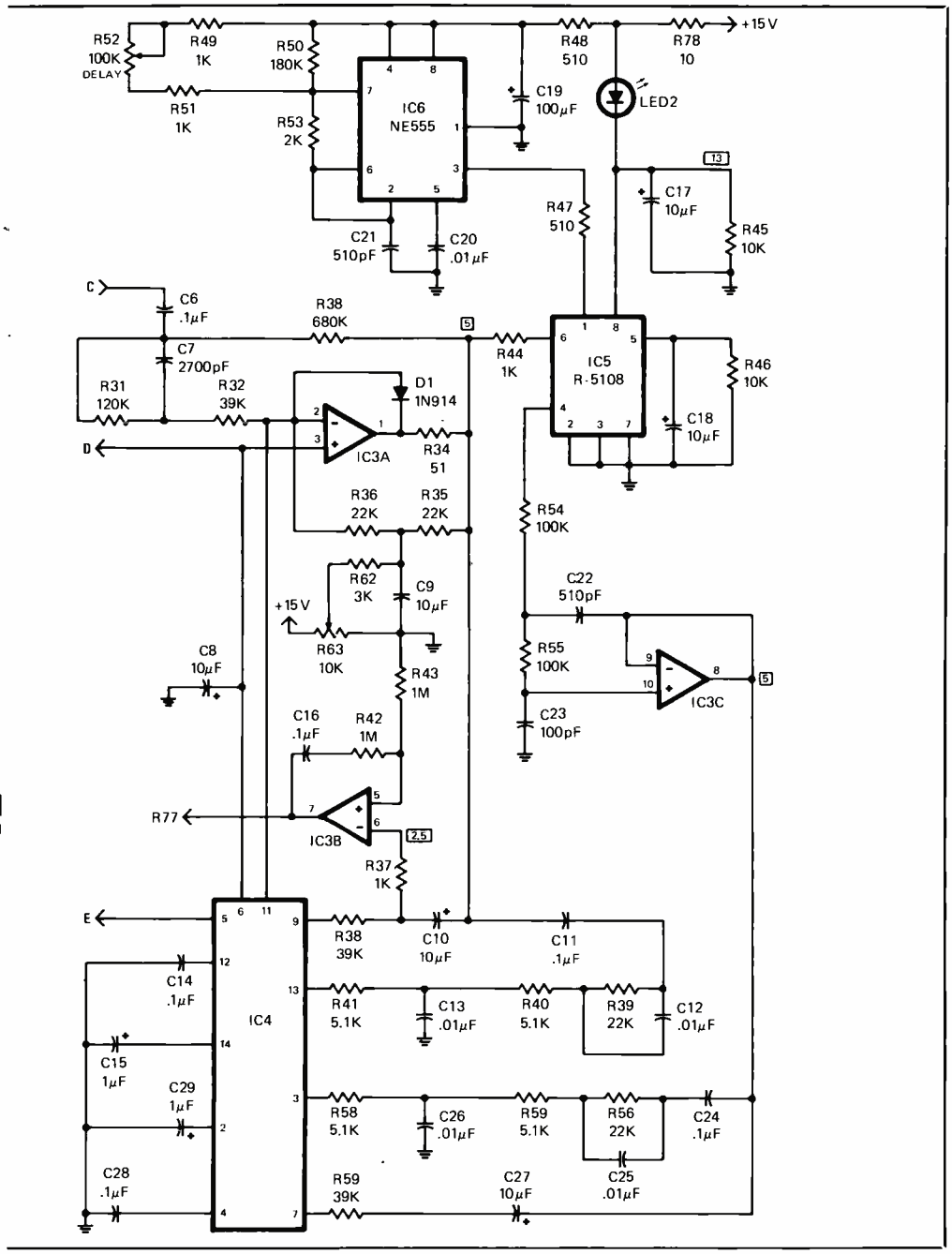


Fig. 2. Entire schematic diagram of the Delay Enhanced L – R Decoder, minus its built-in power supply. Arrowed letters in each part match up with the same arrowed letters in other parts (A goes to A, B to B, etc.). Numbers shown in small boxes are voltages that can be measured with a good circuit, provided here in case you have to troubleshoot

of the late 1970s were based on the Madsen principle. This approach reproduced a delayed version of the front signal through additional speakers located off to the sides or rear of the main front speakers in the listening room. It is interesting to note that this technique also works with mono recordings.

L – R matrix, perhaps better known as Dynaquad™, was a passive system that simply connected a pair of rear speakers differentially across the "hot" or + terminals of the left and right output channels of an amplifier (see Fig. 1). This system operated under the principle that sounds coming directly from an orchestra arrive at both microphones almost simultaneously, while room-reflected sounds arrive from various odd angles with relatively large time differences between the two microphones.

By subracting the output of one microphone from the other, the almost identical sounds would cancel out, leaving predominantly ambience. This system improved the ambience situation quite a bit, but it



suffered from poor front imaging and localization. That is, sounds occasionally appeared in the back that were not supposed to be there.

A note of caution: If you wish to experiment with the passive L – R matrix, keep in mind that the rear speakers will be in parallel with those in the front and may present an unacceptably low impedance to your power amplifier. Additionally, peaks occurring in only one channel may upset the protection circuitry of the other, which must then sink the full current being sourced, even if it is sitting at 0 volt.

In the Delay Enhanced L – R Decoder presented here, the mechanism that allows the time delay to cure the passive L – R matrix's front localization problem is the same mechanism that caused it in the first place, namely the Hass effect (see "Haas Effect" box).

In the passive L – R system, sounds from the rear speaker will reach you before the sounds from the front speakers because they are closer. Because of the Hass effect, your brain will attempt to lock onto these rear sounds, causing you to hear false localization.

Delaying the sounds being fed to the rear speakers by 20 to 30 milliseconds will ensure that the sounds from the front speakers will always arrive at the listener's position before the sounds from the rear do. In fact, when properly adjusted, this project should make it so that you never actually hear the rear speakers as discrete sound sources. What you will get, then, is ambience that simply "surrounds" you as you listen.

The L – R matrix plus delay works equally well with a wide range of program sources, including many that were not originally recorded using stereo microphones.

About The Circuit

The schematic diagram for the ambience-recovery system is shown in three parts, in Fig. 2A, B and C. The system is designed to work with a wide range of both mono and stereo program sources. The output of the ambience/surround channel, available at *J6* in Fig. 1C, offers a full 12-kHz bandwidth. (Listening tests have revealed that the 6-kHz bandwidth used in past designs was inadequate for best ambience extraction from CD and other high-quality recordings.)

In addition to the normal L – R + delay, or surround, mode, a stereo synthesizer is built in to enhance playback of monophonic program sources. Jacks *J3* and *J4* in Fig. 2A provide the outputs for both normal stereo and synthesized stereo, the latter when a mono source is connected to input jacks *J1* and *J2* and switch *S2*

PARTS LIST

Solid-State Devices
D1, D2—Not used
D3 thru D6—1N4002 rectifier diode
D7—1N914 signal diode
IC1, IC7—NE5532 or TL072 dual op amp
IC2, IC3—TL074CN quad op amp
IC4—NE572 dual compander
IC5—R-5108 2048-stage ASR (Reticon)
IC6—NE555 timer
IC8—78M15 +15-volt regulator
IC9—79M15 −15-volt regulator
LED1, LED2—Light-emitting diode

Capacitors
C1, C2, C3, C34—47-pF, 10%, disc
C4, C7—2700-pF, 5%, polystyrene
C5, C23—100-pF, 5%, polystyrene
C6, C11, C14, C16, C24, C28, C31—0.1-μF, 5%, polystyrene
C8, C9, C10, C17, C18, C27, C38, C39—10-μF, 35-volt electrolytic
C12, C13, C25, C26—0.01-μF, 5%, polyester
C15, C29—1-μF, 25-volt electrolytic
C19—100-μF, 16-volt electrolytic
C20—0.01-μF disc
C21, C22, C33—510-pF, 5%, polyester
C30—0.005-μF, 5%, polyester
C32—1000-pF, 5%, polystyrene
C35, C36—1000-μF, 35-volt electrolytic
C37, C40 thru C49—0.1-μF disc
C50—0.022-μF, 600-volt disc

Resistors (all ¼-watt, 5%):
R2, R5, R12, R15, R25, R26, R45, R46, R67 thru R70—10,000 ohms, carbon-film
R3, R4, R13, R14, R22, R23, R62, R74, R75, R77—3000 ohms
R6, R9, R16, R19, R27, R28, R46, R66—20,000 ohms
R7, R17, R24, R34, R76—51 ohms
R8, R18, R53—2000 ohms
R10, R11, R78—10 ohms
R21, R37, R44, R49, R51, R71, R73—1000 ohms
R29—27,000 ohms
R30—36,000 ohms
R31—120,000 ohms
R32, R35, R36, R39, R56—22,000 ohms
R33—680,000 ohms
R38, R59—39,000 ohms
R40, R41, R57, R58—5100 ohms
R42, R43—1 megohm
R47, R48—510 ohms
R50—180,000 ohms
R54, R55, R64—100,000 ohms
R60—62,000 ohms
R65—18,000 ohms
R1—Dual 50,000-ohm, linear-taper potentiometer
R20, R52, R72—100,000-ohm, linear-taper potentiometer
R63—10,000-ohm trimmer potentiometer

Other Components:
F1—¼-ampere pigtail fuse
J1 thru J6—Phono jack
S1—Dpdt push-push pc-mount switch
S2—4pdt push-push pc-mount switch
T1—28-volt, center-tapped transformer

Miscellaneous:
Printed circuit board; sockets for ICs; suitable enclosure; line cord; strain relief; control knobs; panel lens for LED1; machine hardware; hookup wire; etc.

Note: The following items are available from Phoenix Systems, Inc., PO Box 628, Manchester, CT 06040 (tel. 203-643-4484): No. P-250-DL complete kit of parts for $179.00; No. P-250-B etched and drilled pc board for $19.00; No. P-250-T 28-volt, c.t. pc-mount transformer for $7.00; No. R-5108 Reticon 2048-stage ASR IC for $30.00; NE5532N dual op amp for $2.25; TL074CN quad bi-FET op amp for $2.50; NE572N dual compander for $3.25; 78M15 regulator for $1.50; 79M15 regulator for $2.50; No. P-2X50KB dual 50,000-ohm, linear-taper potentiometer for $2.50; No. P-100KB 100,000-ohm, linear-taper potentiometer for $1.00; No. S-1 dpdt pc-mount switch for $1.00; No. S-2 4pdt pc-mount switch for $1.50. Add $1.00 S&H for orders of less than $10.00, $2.00 on COD orders. Connecticut residents, please add 7.5% sales tax.

is set to MONO. Also, an L + R, front-center fill, output is provided at *J5* in Fig. 2A, for use in small movie screen applications and in hi-fi setups as a mono feed to a subwoofer.

For convenience of setup and use, the circuit includes a master volume control (*R1* in Fig. 2A) and separate level controls for the front-center (*R20* in Fig. 2A) and surround (*R72* in Fig. 2C) outputs. Both outputs are capable of boost and cut relative to the master volume control. Hence, it is a simple matter to correct for differences in sensitivity between the front and rear speaker systems. Once relative gains are set, the level controls track the master volume control for routine system level changes.

This circuit uses the newest ASR integrated circuit, the R-5108 from Reticon, to extract ambience signals from stereo sources. This device, shown as *IC5* in Fig. 2B, has 2048 stages of delay, which is twice as long as the popular SAD-1024 and half as long as the SAD-4096. This new chip has the biphase clock drivers and output sample-and-hold circuit built into a smaller chip that is housed inside a compact 8-pin DIP package.

Input and output filters, tuned for −3 dB at 12 kHz, condition the audio in the surround channel to avoid sampling rate aliasing and to smooth out the output waveform. An NE572N, *IC4* in Fig. 2B, companding noise-reduction chip is used

Specifications

Input impedance	10k ohms or greater
Output impedance	50 ohms
Maximum output	
into hi-fi load	8 volts
into 600 ohms	7.5 volts
Gain (each output)	+6 dB to full off
Delay time	5 to 30 ms, adjustable
THD + N	
direct	<0.01%, 20 Hz to 20 kHz
delay	0.5% nominal, 100 Hz to 10 kHz
Noise (IHF A)	
direct	< −100 dBV
delay	−91 dBV
Frequency response	
direct	dc to 20 kHz +0/−0.25 dB
delay	20 Hz to 12 kHz ±3 dB

around the delay chip for noise-free performance with even the most dynamic sources available. The NE572N is an improved version of the popular NE570.

NE555 timer *IC6* in Fig. 2B generates the timebase for the system. The frequency of this time base controls how long an audio sample takes to work its way through the ASR. Potentiometer *R52* provides the means for adjusting the clock frequency to vary the system delay time. High-slew-rate op amps are used throughout the system to deliver maximum audio fidelity.

The power supply for the system is shown in Fig. 3. Note that this full-wave bridge circuit provides full regulation of both the +15- and −15-volt buses. The schematic also shows the pins to which the buses connect on the ICs.

Construction

Owing to its complexity, it is highly recommended that you assemble the delay system's circuit on a printed-circuit board. You can fabricate your own board, using the etching-and-drilling guide given in Fig. 4. Alternatively, you can purchase a ready-for-installation board from the source given in the Parts List. Whichever way you go, you will note from the components-placement guide in Fig. 5 and the photo of the interior of the project in Fig. 6 that all components except the various input and output jacks mount directly on the circuit board.

There is nothing critical about assembly, except that you must carefully observe the polarities and orientations of the integrated circuits, diodes, light-emitting diodes, and electrolytic capacitors before soldering them into place. Sockets are recommended for all ICs, though you can, if you wish, install these devices directly on the pc board and solder their pins to the copper pads.

Approach assembly logically. Start component installation with the lowest-profile devices first and work your way up to power transformer *T1*. That is, install first the jumper wires (indicated by the *J*s in Fig. 5) using bare solid hookup wire, except between pin 1 of *IC2* and the junction between *R16* and *R69* and between pin 14 of *IC3* and *C31*, both of which must be *insulated* solid hookup wire.

The Haas Effect

Haas, an early researcher into psychoacoustics, characterized how we perceive and localize sounds. He determined that, to avoid being confused by the echoes caused by reflections when trying to localize the direction from which a sound is coming, the brain ignores all but the first sound it "hears" for a small fraction of a second. All reflections arriving during this time period, called the Haas Fusion Region, are fused into the first sound, thus increasing its apparent loudness.

As a result of this "fusion," you perceive one louder sound coming from the direction of its first arrival. Reflections and echoes arriving after fusion, delayed by 20 to 30 milliseconds, are once agains perceived as separate sounds. Their density and rate of decay contain information that your brain uses to gauge the nature of the acoustic space you are occupying.

Next, install the resistors and diodes, followed by the IC sockets (if you have decided to use them) or the ICs themselves, trimmer potentiometer *R63*, and the low-profile capacitors.

Before installing *LED1*, trim its leads to 1½" long, taking care to remember which lead is which (it is best

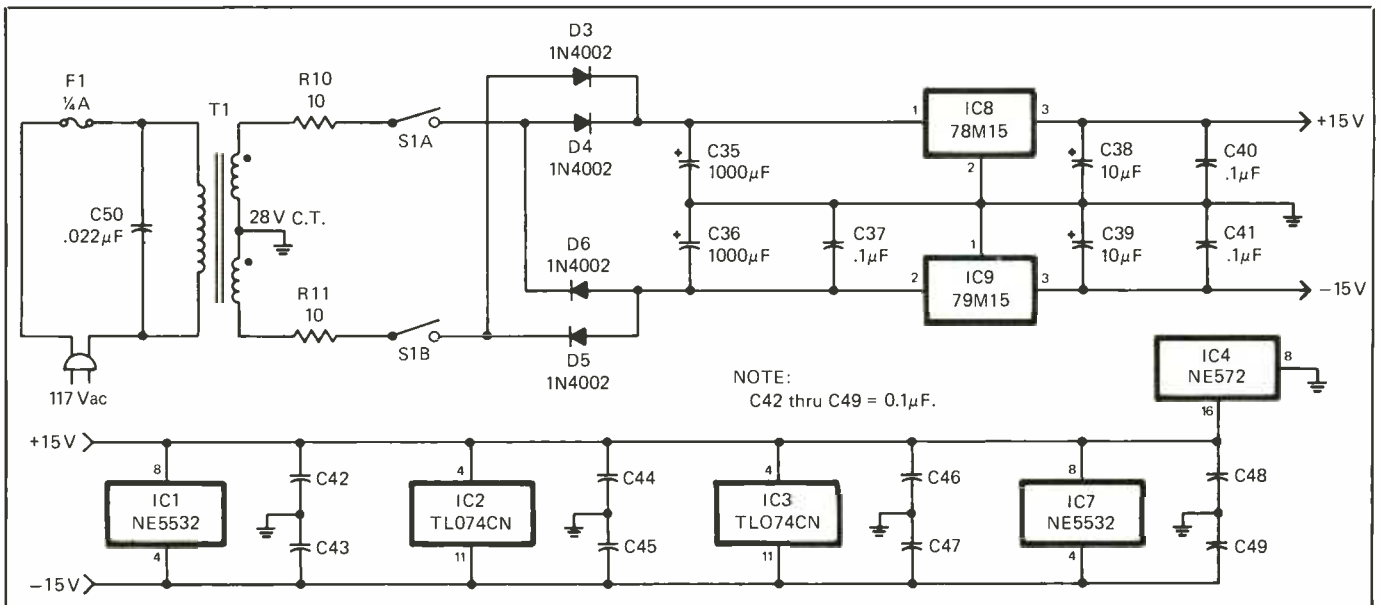


Fig. 3. This is the power supply, showing full regulation of the +15- and −15-volt lines. The lower portion of the diagram shows power connections to ICs.

Dolby Sound Movies

Movie sound tracks are usually recorded in discrete left, right, center (front), and surround (rear) channels. Special effects, like earthquake sounds, can bring the count up to six discrete channels. When these movies are mixed down to the ordinary two-channel stereo track format, the center channel is matrixed onto the left and right channels in-phase, while the surround channel is matrixed onto the left and right channels out-of-phase.

When this stereo mix-down is played back through a stereo system, the mostly dialog center channel is projected from the left and right speakers at equal volume and appears localized between the two. The surround signals also come out of the left and right speakers. But because they are out-of-phase, they appear to take on a diffuse quality with wider apparent separation. If this stereo mix-down is played back through a monophonic system, the surround signal cancels out.

Theater installations use reduced bandwidth, (−3 dB at 6 kHz), Dolby B noise reduction, and logic separation enhancement on the surround channel. This is done to accommodate the significant number of movie-goers who must sit directly beneath one of the surround speakers and would not otherwise receive an acceptable balance of front to surround signals.

to somehow mark the cathode lead for easy identification). After installing and soldering the lead to the copper pads on the board, bend the leads first back away from the lip of the board and then forward, about half way along their lengths. When you are finished, the LED should be about ⅜″ above and its body parallel with the board's surface. Be careful not to flex the LED's leads too much or they will break away from the device's body or the board.

The largest components should be mounted last on the board. These include electrolytic capacitors *C35* and *C36* and transformer *T1* in the power-supply section and controls *R1* (MASTER LEVEL), *R20* (FRONT LEVEL), *R52* (DELAY), and *R73* (REAR LEVEL). Temporarily set aside the pc board assembly.

As with the pc board, you can fabricate your own low-profile enclosure or purchase it ready-to-use, including all machining and labeling, with the complete kit of parts from the source given in the Parts List. If you decide to make your own enclosure, make sure you drill the holes for the controls, switches, *LED1*, input and output jacks, and the line cord in the proper locations. Use the circuit-board assembly to take all measurements for this operation.

Once machined, the enclosure should be spray painted and, when the paint completely dries, labeled. If you use a dry-transfer lettering kit, apply two or three *light* coats of clear spray lacquer to the front and rear panels to protect the lettering. Be careful not to make the lacquer too thick or runny or the lettering will lift off and dissolve.

When the enclosure is ready, install the input and output jacks on the rear panel and wire together all ground lugs with bare solid hookup wire. Then pass the free end of the line cord through its hole and secure it in place with a plastic strain relief. (If you prefer, you can line the hole with a rubber grommet, pass the free end of the line cord through, and knot it about 7″ from the free end.) In any event, leave 6″ to 7″ of loose wire with which to work.

Retrieve the pc-board assembly and install and solder into place seven separate lengths of hookup wire, or use a seven-conductor, preferably color-coded, ribbon cable to the appropriate points on the circuit board. Make the wires long enough to reach their respective jacks, plus some slack, when the board is in its mounting location inside the enclosure.

Twist together the fine wires in

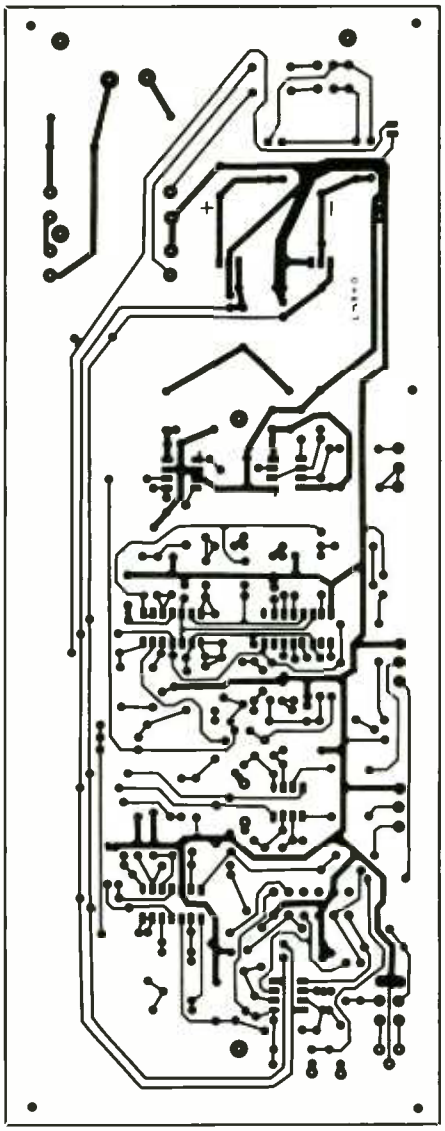


Fig. 4. This reduction of the actual-size etching-and-drilling guide for the pc board requires 2× blowup.

first one and then the other free end of the line cord. Make sure that all fine wires are twisted into the bundles. Then lightly tin each bundle with solder. Slip these wires into the holes provided for them in the pc board, solder them to the copper pads, and trim away any excess.

Carefully align the shafts of the controls and the buttons on the switches with their respective holes in the front panel and slide the board into place. Start hex nuts onto the control shafts but leave them quite loose. Tilt the board upward from the rear.

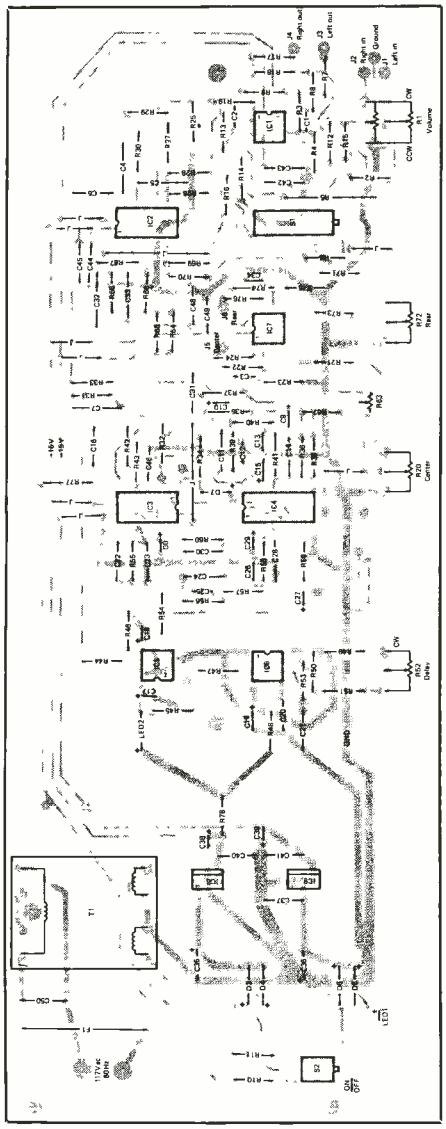
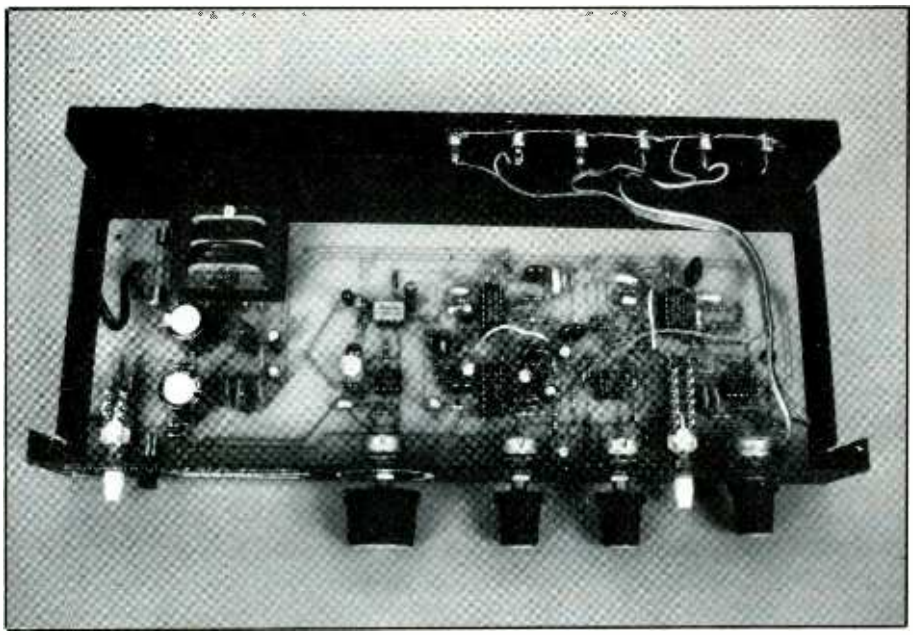


Fig. 5. When installing components on the pc board, be certain to orient them as shown.



All input and output jacks mount on the rear wall of the enclosure. The switches, controls and LED mount on the front panel. All other components mount on the pc board.

Using ¼" spacers and No. 4 machine hardware, mount the board to the floor of the enclosure. Before tightening any hardware, make certain that the buttons on *S1* and *S2* work without binding. This done, tighten the board mounting screws and the hex nuts on the controls. Then press a red panel lens into the remaining hole in the front panel and carefully push *LED1* into the lens. Install knobs on the front-panel control shafts.

Using Fig. 2 and Fig. 5 to guide you, connect the free ends of the wires coming from the printed-circuit board to the appropriate jacks on the rear panel.

Hookup and Use

The delay system is best connected between the outputs of a preamplifier and the inputs of a power amplifier. However, it can also be used effectively in a tape-monitor loop.

The rear speaker system and its driving amplifier need not be as powerful and wide ranging as the front speaker systems and amplifier. Typically, an amplifier for the rear source need not have more than 25% to 50% of the power of that used up front. The rear speaker need not be critical in performance, nor need it be matched to the speaker systems you use for the front, since the surround channel rolls off above 12 kHz and very low frequencies tend to be recorded in-phase and, thus, are suppressed in the surround channel.

To set delay time, begin with the DELAY control set to its midpoint position (straight up). This will be about the 30-ms position. You can optimize the delay time for your room by listening to a recording with impulse-type sounds, like record scratches (they are good for something, after all). When the delay time is set for too long a duration, you will hear discrete repeats or echoes. If it is set for too short a time, the image will shift to the rear speaker. When the setting is correct, the rear speaker will aurally disappear as an actual sound source.

In Closing

The project described above will extract ambience from any stereo program source and deliver spectacular "surround sound" effects from stereo-encoded movies. At least one of the new stereo TV programs, NBC's *Miami Vice*, uses surround sound; others are expected to follow. In the mean time, you can switch in the stereo synthesizer for the old-fashioned monophonic TV programs and still enjoy enhanced sound reproduction.

ME

Experimenting with the Analog Comparator

By Forrest M. Mims III

In this digital age, analog (linear) electronic circuits are sometimes considered obsolete. Of course, nothing could be further from the truth. Indeed, analog circuits can perform many tasks for which digital circuits are totally unsuited. And, using just a few components, they can perform some tasks that would require highly complex digital circuits like programmable microprocessors.

One of the key analog circuits is the *operational amplifier.* This circuit is a two-input, differential amplifier that uses a feedback resistor from its output to one of its two inputs to control the circuit's voltage gain. When the feedback resistor is omitted, even a very small input signal will cause the output of the amplifier to swing wildly from ground to the maximum possible positive or negative voltage extreme. When used in this fashion, the operational amplifier is considered an analog *comparator.*

The comparator has an amazing number of applications. Because of the comparator's two-state (on/off) mode of operation, many of its applications are digital in nature. In this column, I'll explain how the comparator works and provide some sample application circuits with which you can experiment.

The Basic Comparator

Many different analog comparator integrated circuits are available commercially (in future columns I'll describe some of them). Often, however, you can use a commonly available op amp, such as the 741, in a comparator mode simply by leaving out the usual feedback resistor. Figure 1, for example, shows a basic comparator demonstration circuit made from a 741 integrated circuit and several resistors.

In operation, resistors *R2* and *R3* form a voltage divider that places half the supply voltage, or 4.5 volts, at the 741's inverting (−) input. This is called the *reference voltage.* Potentiometer *R1* functions as an adjustable voltage divider that delivers a variable voltage to the noninverting (+) input of the 741. This voltage is called the *input.*

When the amplitude of the input voltage is below that of the reference, the output of the 741 comparator is low (near ground). Therefore, the

Fig. 1. Shown here is a basic comparator demonstration circuit.

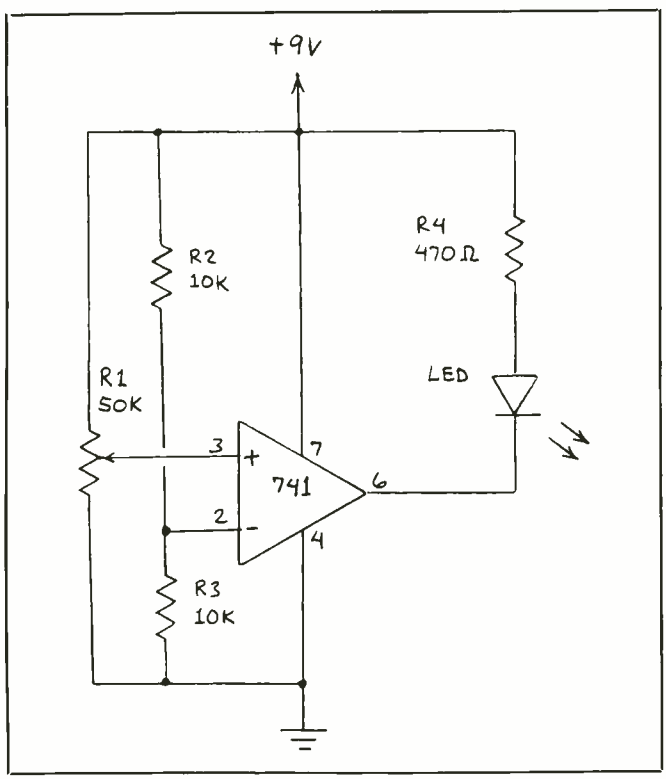
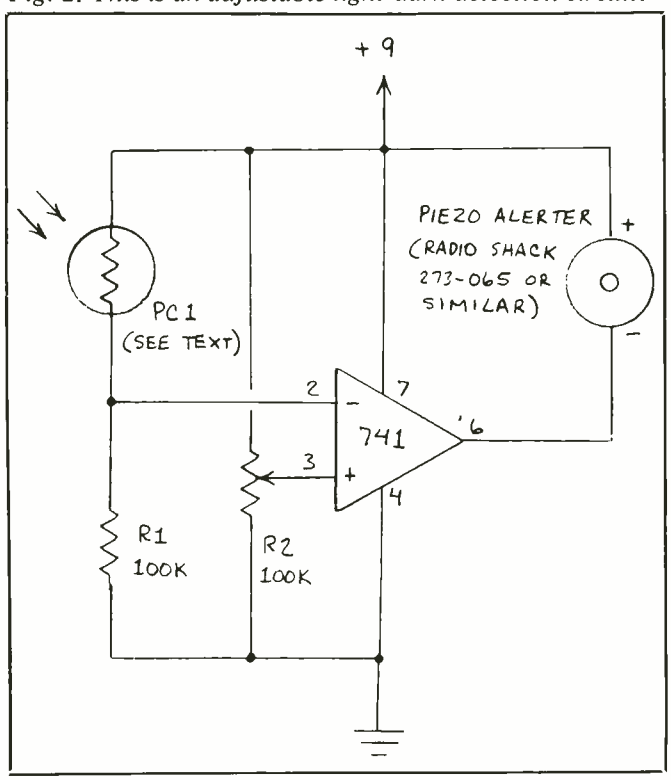


Fig. 2. This is an adjustable light-dark detection circuit.



LED is switched on. When the input voltage rises above the reference, the output of the 741 suddenly switches on, rising to near the positive supply voltage extinguishing the LED.

If the input voltage is made very close to the switching threshold, the 741 may oscillate in an unstable fashion by rapidly and unpredictably switching on and off. But, practically speaking, the comparator output is either full-off (ground) or full-on (near the positive supply voltage).

Note that the inputs of the comparator are designated inverting (pin 2) and noninverting (pin 3). You can reverse the operation of the circuit in Fig. 1 simply by reversing the two inputs. Be sure to keep this in mind when you experiment with the following circuits.

Adjustable Light-Dark Detector

The basic circuit in Fig. 1 may seem simple, but it can readily be adapted for many applications. Figure 2, for example, shows how to use the basic circuit as an adjustable light-dark detector. This circuit can be used to signal the arrival of dawn (or dusk) and to provide a warning when a refrigerator door has been left open. It can also be used as a simple break-beam object detector. Though the circuit uses a piezoelectric buzzer or alerter, an output relay can be included to control an external motor, lamp or other device.

The circuit's light detector is a low-cost, but highly sensitive, cadmium-sulfide (CdS) photoresistor. The circuit activates the alerter when the photoresistor is illuminated by even a very low light level. After a simple modification is made, the circuit will trigger the alerter when the photodetector is dark. In either case, the circuit consumes only about 0.5 milli-

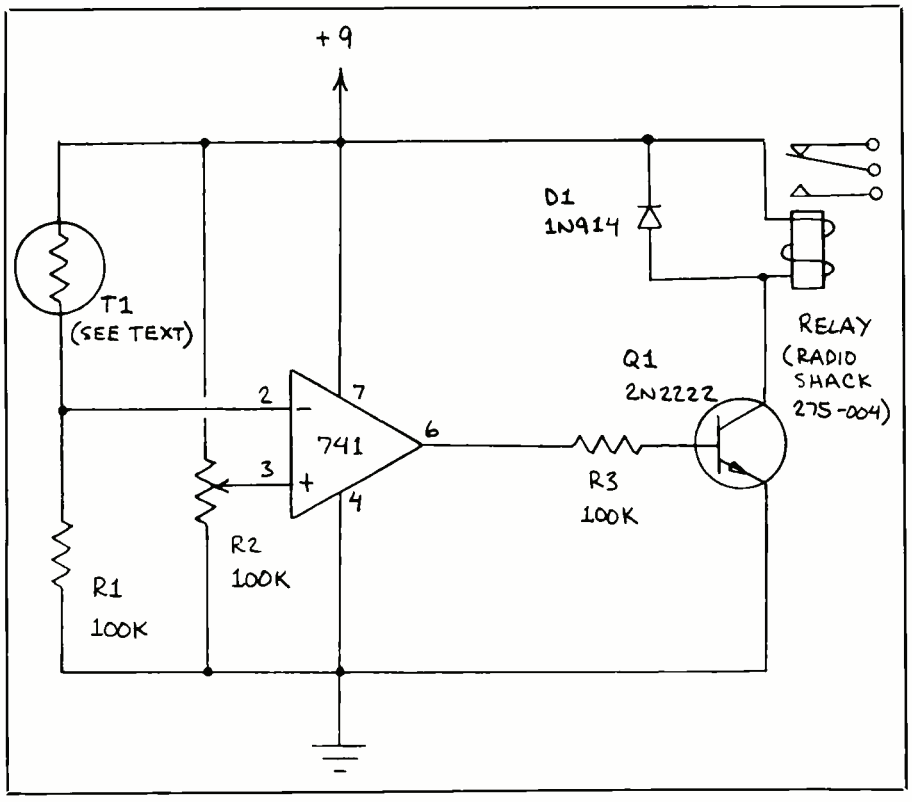


Fig. 3. An adjustable-threshold temperature-controlled relay.

ampere in its standby mode and about 4.5 milliamperes when the alerter is sounding.

Comparing the two circuits, note that the photoresistor in Fig. 2 has replaced *R2* in Fig. 1. Therefore, the photoresistor and *R1* in Fig. 2 form a light-dependent voltage divider. Potentiometer *R2*, which forms a second adjustable voltage divider, permits the reference voltage at the + input of the 741 to be altered.

When the sensitive surface of the photoresistor is illuminated, its resistance is very low, typically a few hundred ohms. Therefore, the voltage appearing at pin 2 of the 741 can approach the supply voltage when the photoresistor is brightly illuminated. The 741 will switch on as soon as the voltage at pin 2 exceeds the reference voltage from *R1* that is applied to pin 3. The alerter will then be actuated.

When the light level at the sensitive surface of the photoresistor is decreased, its resistance is increased. Indeed, the resistance may reach a million ohms or more when the light level is very low. When this occurs, the voltage at pin 2 approaches ground. In any case, when the light level falls to a point where the voltage at pin 2 falls below the reference voltage, the comparator will switch off. The trigger point, of course, can be conveniently altered simply by changing the setting of *R2*.

Incidentally, this operating mode can be reversed simply by exchanging the photoresistor and *R1* in Fig. 2. The circuit then switches off when the photoresistor is illuminated and on when the photoresistor is dark.

The alerter in Fig. 2 can easily be replaced by a relay that can control external lamps, motors and other devices. The circuit in Fig. 3 shows how.

Adjustable Temperature Detector

The photoresistor in the Fig. 2 circuit can be replaced by a thermistor to transform the circuit into an adjustable-threshold, temperature-sensing alarm. Properly calibrated, the circuit can function as a freeze detector.

In operation, the output from the comparator at pin 6 is connected via *R3* to *Q1*, which functions as a switch that turns on and off a low-voltage relay. When the comparator's output is high, *Q1* switches on and, in turn, allows current to flow through the relay coil. Transistor *Q1* can be a 2N2222 or any other general-purpose silicon switching transistor. The relay is Radio Shack's No. 275-004.

Some electronics parts suppliers stock thermistors. You can mail-order purchase them if they are not available locally. Check the ads in this and other electronics magazines. Some of the many thermistor manufacturers include Keystone Carbon Co. (Thermistor Division, 1935 State St., St. Marys, PA 15857); Fenwal Electronics (63 Fountain St., Framingham, MA 01701; Thermometrics, Inc. (808 U.S. Highway #1, NJ 08817); and Omega Engineering, Inc. (One Omega Dr., Box 4047, Stamford, CT 06907).

Many different kinds of thermistors are available. For best results, select a thermistor that has a room-temperature resistance of from 25 to 50 kilohms or so. I prefer to use glass-bead thermistors, since they are very small and can be safely calibrated in water. But they are more expensive than other types of thermistors.

If the thermistor you select can be calibrated in water, you can easily ad-

just the circuit to trigger at the freezing point of water simply by inserting the thermistor in crushed ice or snow. You can set other calibration points with the help of a thermometer. Just adjust the temperature of a small cup of water to the desired point, insert the thermistor, and calibrate *R2*.

Sine- to Square-Wave Converter

The sine wave is among the most important waveforms in electronics. The comparator is well-suited for transforming the ubiquitous sine wave into square and other kinds of waves. As you can see in Fig. 4, this manipulation of waveforms can be achieved with the simplest possible comparator circuit. This circuit can also be used to clip that portion of a signal that rises above or below any preset level.

In operation, the sine wave (or signal) is applied to the noninverting input of the comparator. When the reference voltage applied to the inverting input is ground, the output of the comparator remains at ground until the positive (rising) voltage of the sine wave *exceeds* ground potential. The output then suddenly switches to its maximum positive value and remains there until the voltage of the wave falls to ground potential. The comparactor then suddenly switches off. When the voltage falls below ground potential, the output voltage suddenly switches to its maximum negative value, where it remains until the waveform voltage again reaches ground potential.

It should be obvious that this operating mode transforms a sine wave into a square wave. What is not obvious, however, is that the amplitude of the square wave at the output can be much greater than that of the sine wave at the input. This occurs when the supply voltage exceeds the input voltage by about 1 volt or more. Therefore, it's important to adjust the supply voltage and possibly the amplitude of the input signal if true clipping of the sine wave is required.

The frequency response of the circuit in Fig. 4 depends largely upon the quality of the 741. The 741 I used in a breadboard version of the circuit had a peak response of 42.5 kHz at the −3-dB (half-amplitude) points. Other operational amplifiers or comparators can provide a much wider frequency response.

Interesting effects can be had by connecting the noninverting input of the 741 to potentiometer *R1* instead of ground. This permits the reference voltage and, consequently, the circuit's operation to be altered. For instance, when the reference voltage is *increased* above gound, the positive half of the output wave narrows and increases in amplitude while the negative half becomes broader and decreases in amplitude. The reverse occurs when the reference voltage is *reduced* below ground.

Potentiometer *R1* also permits the shape of the output square wave to be transformed into either a positive or negative triangle wave with a clipped peak. If *R1* is adjusted to provide a sharp peak, the comparator becomes unstable and oscillates.

The circuit in Fig. 4 will work when powered by a single polarity supply (pin 4 connected to ground instead of −V). However, the comparator will then respond to only the positive side of the incoming signal.

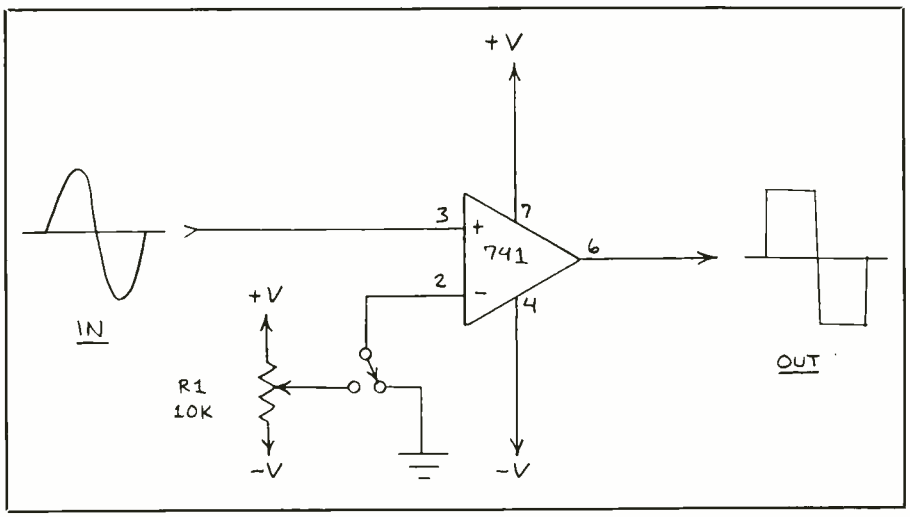


Fig. 4. This circuit demonstrates how a sine wave is converted to a square wave with a comparator.

Incidentally, while experimenting with the circuit in Fig. 4, I applied a square wave to the input. The output was a trapezoid wave with sloping sides. When the amplitude of the input signal was adjusted to match that of the output, a substantial delay could be observed in the arrival of the maximum positive and negative excursions of the trapezoid.

For instance, when the frequency of the incoming wave was 10 kHz, the duration of both the positive and negative peaks of the incoming square waves was 50 microseconds. The positive peak of the trapezoid trailed the positive leading edge of the square wave by 20 microseconds. The negative peak of the trapezoid trailed the negative leading edge of the square wave by 32 microseconds.

This delay, which also occurs when other waveforms are processed by the circuit, has several possible applications. One is the conversion of a single-phase digital clock for a logic circuit into a two-phase clock.

Peak Detector

Often, it's important to measure the maximum amplitude of an event such as rainfall, wind velocity, light level, temperature, revolution rate and many others. If a transducer is available that converts an event to be measured into a proportional voltage, then the simple comparator circuit in Fig. 5 will detect and store for several minutes the maximum amplitude of the signal from the transducer.

The circuit in Fig. 5 is called a peak detector. Digital circuits are available that can perform the same function, but they are far more complex and costly. Furthermore, they require an analog-to-digital (A/D) conversion stage in order to measure the input voltage.

The peak detector in Fig. 5 is placed in operation by pressing *S1* to discharge *C1* and reset the system. Since this removes any charge stored in *C1*, the reference voltage coupled back to the inverting input at pin 2 of the 741 via *R2* is 0. Any signal voltage applied to the input terminals of the circuit will immediately switch the 741 on, since the signal voltage will exceed the reference voltage. Capacitor *C1* will then begin charging to the supply voltage through *D1*.

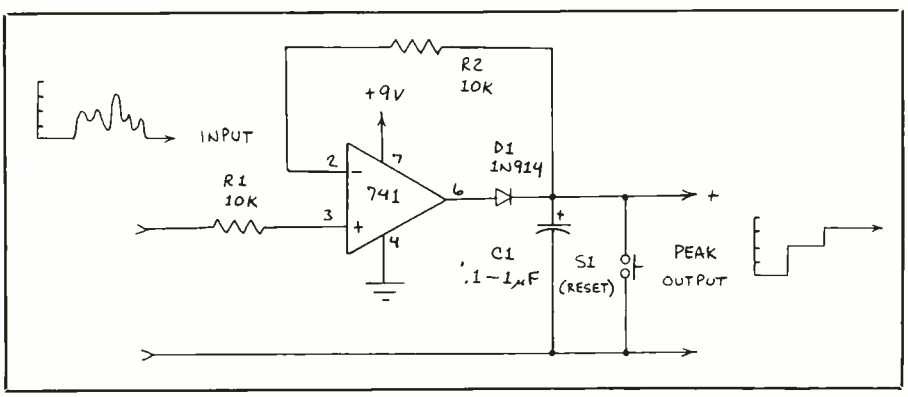
When the charge on *C1* exceeds the input voltage at pin 3, the 741 immediately switches off and *C1* stops charging. At this point, the amplitude of the charge stored in *C1* equals the input voltage. If the input voltage rises above that stored in *C1*, the comparator will again switch on and *C1* will again begin charging until the voltage level exceeds the reference. The comparator will then switch off.

As you can see, the peak detector automatically tracks the input voltage and stores its peak value. At any time, a new cycle can be initiated simply by pressing *S1* to discharge *C1* and reset the system.

Reverse-biased diode *D1* prevents *C1* from discharging through the comparator. The circuit, however, is not perfect, since *C1* will not long re-

(Continued on page 96)

Fig. 5. This circuit uses a comparator as a peak-voltage detector.



Shortwave-Station News And Listening Tips

By Glenn Hauser

Dx-peditions. Unless you're one of the fortunate few already blessed with an electrically-quiet rural location, consider going on a DX-listening expedition. City-dwellers will find a great improvement in reception away from the multitude of urban noise sources. It's more fun, productive, and safe for several DX listeners to go on a DX-pedition together.

It's often surprising how much different propagation conditions can be on an expedition only a hundred miles from your usual location. Australians have several favorite sites in southern Victoria and coastal Queensland. Albertans get away from Edmonton for improved DX listening. Floridians converge on Canaveral National Seashore. An undeveloped beach location is certainly best. Even on relatively flat land, there's a certain amount of horizon blockage of low-angle (and, thus, very distant) signals. But at seaside, especially at some elevation on a bluff or cliff, this is minimized. And there's a psychological boost in DX listening by the ocean, knowing there's nothing but water between you and the next continent. The site should be as far as possible from power lines, of course, so be prepared to operate all equipment off batteries. Antennas several hundred feet long can and should be strung up, but take them down when you leave unless you're positive they won't pose a safety hazard to other visitors.

Here's a summary of what we heard at the most recent CANAVDX: (times UTC) 2145, Libya booming in on 3200 in Arabic; 2200, RRI, Ujung Pandang, Indonesia on 4753; 2210, R. Moscow World Service on 4060, site unknown; 0000, Voz de Sao Vicente, Cape Verde, resuming music after supposedly signing off, on 3930; 0400, Lubumbashi, Zaire, in French on 7205; among many Angolan regionals, at 0500, Benguela on 5043.5; 0522 past 0605, a new Brazilian with an all-night call-in show; ID sounds like Radio Itapora, in Macapa, on 3375 kHz.

The 13-MHz band. If you're buying a new shortwave radio, be sure it doesn't omit the 13600 to 13800-kHz range to be re-allocated for international broadcasting in a few years. But this hasn't kept a number of countries from jumping the gun to establish their own priority on certain frequencies. Among the countries already using this band are Iraq, Iran, Israel, USSR, North and South Korea, Pakistan, Turkey, China, Iceland, Sweden, Netherlands with many more sure to follow.

Harmonic DXing. Some transmitters radiate a fraction of their power on exact multiples of the intended frequency, giving astute monitors a chance to hear some really good DX, and to observe propagation variations on bands normally lacking broadcast stations. Here are a few we've monitored in the last few months: 30830, 30690, 30660, AFRTS from U.S. sites; 30210, BBC-Ascension; 24471, La Voz del Llano, Colombia; 23440, CBC Northern Quebec Shortwave Service; 23840 and 14430, Ivory Coast; 2540, Dominican Republic or Venezuela, with baseball. Times vary widely, but naturally the highest frequencies are heard only in the daytime, the lowest only at night. If you divide the harmonic frequency by exactly 2, 3, 4, etc., until you find the obvious or listed fundamental, and no corresponding signal is heard there, you can be sure you picked up a true harmonic transmission. Now to our roundup of other listening tips:

Listening Reports

Australia. Longtime shortwave listeners will remember the friendly voice of Keith Glover, who once handled Radio Australia's mailbag and DX programs; recently, he's returned with a stamp-collecting show, Sats. 0510 UTC on 17795, 15395, 15320 kHz. There are probably additional airings, but RA doesn't reveal any of them on its printed schedule. *Australian DX News* reports that the Antarctic service in English and French is being transmitted from Perth with 10 kW on 15410, Fridays only at 0300-0500 UTC. A new domestic shortwave service on the 49-and 90-meter bands is due to start late this year for the Northern Territory, with 100-kW transmitters at Katherine, Tennant Creek and Alice Springs. An SSB feeder from Lyndhurst, Victoria, on 12290 kHz, which often provided Radio Austrailia reception when no other frequencies were audible, has been demoted to standby status only. By a year from now all transmitters at Lyndhurst are to be closed down—this includes not only those for Radio Australia, but also for Melbourne domestic service and VNG timesignals; another site will replace some of these.

Bhutan. For those who dream of hearing the almost-impossible, Radio NYAB (National Youth Association of Bhutan) has moved from the middle of the 4-MHz range to 3395 kHz, monitored in Calcutta, India by Prodyut Banerjee of *Asian DX Review*, with English Wed. and Fri. 1330-1400; it's less than 100 watts, but not completely impossible if you have a darkness path, lots of patience, and superb equipment (or a ticket to Calcutta).

Canada. Every few years, a Canadian government scrutinizes the CBC and proposes a massive budget cut; this time it was even suggested that Radio Canada International be split off from the CBC. That could mean a drastic cut in its budget and services, possibly even its termination. Furthermore, labor contracts are up for negotiation this year, which could lead to a series of strikes, as happened before. If RCI is still on the air, and you are new to shortwave listening, "SWL Digest" has a special segment most weeks explaining the basics. Listen Sats. 2135 on 17820, 15325, 15150, 11945; Suns. 2305 on 11710, 9755; GMT Mons. 0306 on 9755, 5960. Most weeks, you can also hear our own extremely current

DX news report. *SWLD* planned to mark RCI's 40th anniversary with a special program Feb. 23-24.

Unlike the mindless entertainment most domestic U.S. and Canadian radio delivers, CBC broadcasts "Ideas," on the following topics at 9:05 p.m. local time (on MW & FM) during Feb.: 3 & 10, Saving China: Canadian Missionaries in the Middle Kingdom; 4 & 11, Yalta: History as Myth; 5 & 12, The Zero Hour: 1945/1985, on shattered dreams for a peaceful postwar world; 6 & 13, Eyes in the Sky; 7, Characters in a Minor Key: novelists and The Other; 14, The Darkening Mirror: Reflections on the Bomb & Language; 17, 18 and 19, Red Flares: Voices from the Soviet Avant Garde: 20, The Social Construction of Female Biology; 21, Profile of I.P. Sharp, a computer company. Three- or four-week series start the final week of February: 24, Catholics; 25, The Cold War in Canada; 26, Feminism and Family: The Debate Among Women; 27, The Hearts of Men; 28, History and the New Age.

China. Radio Beijing has inserted some new programs into its schedule: Mons., Economic Horizons; Weds. biweekly, Martha in Beijing; Fris., Cultural Interchange; Sats., Press Clippings, and China Scrapbook. The same programs are broadcast six times daily—1100 on 9820, 1200 on 9820 and 6160, 0000 on 9880, 11860; 0100 on 11860; 0200 on 9880; 0300 on 11970, 11860, 9860; 0400 on 11970, 9860.

Cuba. Here's the structure of Radio Habana Cuba's English programs, repeating in sesquihour cycles: Mon.-Sat.: Today in History, Newscast, Commentary on International Affairs, Spotlight on Latin America, Today in Sports, From the Land of Music. The remaining three programs change from day to day: Mon., Panorama, Latin American Songs, World of Stamps; Tue., Cuba and the World, Musical QSL, The Cuban Story; Wed., Cuban Profile, Latin American songs, Socialism: the New World; Thu., PO Box 7026, Musical QSL, Marxist Review; Fri., Cuba and the World, Latin American Songs, Socialism: the New World; Sat., Cuban Culture, Musical QSL, Eyewitness Africa. The seven programs on Sundays are: Today in History, Cuban Profile, The Cuban Story, From the Land of Music, PO Box 7026, Latin American Songs, The World of Stamps. During the winter RHC has been using 6090 and 6140 kHz during the evenings.

Radio Earth. Via Radio Clarin, 11700 kHz started a Sunday marathon broadcast at 1600-2300, which may replace its nightly 0300 broadcast.

Equatorial Guinea. One of the stranger developments last year on shortwave was the emergence of the government station in Bata as a missionary broadcaster—probably to bring in some much-needed foreign exchange. First on 7998 kHz, and more recently on 15107, various English-language gospel programs from the USA have been aired between 2000 and 2200 UTC, one of them, "Radio Africa," operating out of the unlikely location of Dexter, New Mexico.

Greece. Voice of Greece joins the small list of legitimate broadcasters operating just above 6.2 MHz, supposedly reserved for coastal communications, but also used by pirates and Central American clandestines. A winter frequency for the North American service at 0000-0350 UTC is 6205 kHz.

Guatemala. Voice of Guatemala dabbles in international broadcasting; in November, Artie Bigley in Texas heard a program in English, also with French and Spanish IDs, on 6180 kHz at 2130-2300; this could also appear on 9760.

Japan. After sticking to the 16-and 19-meter bands for many years, Radio Japan finally had to drop down to 25 and 31 for the 0000-0100 service to eastern North America—11710 and 9645 (with 100 and 200 kW, respectively). March may bring a return to higher frequencies.

New Zealand. This summer (winter to us), Radio New Zealand started broadcasting in shorter blocks rather than continuously for 18 hours a day: 1745-2015, 2245-0015 and 0345-0630 on 15485 and 17705; 0930-1115 on 15485, 9620. There's still hope that the new government will agree to upgrade RNZ rather than kill it.

Saipan. KFBS, another missionary station, is installing three transmitters. It's not clear when all three will be in use, but current schedules have been arranged for each: No. 1: 2100-2300 9515, 0900-1100 11720, 1100-1300 11880, 1300-1600 9515. No. 2: 2100-2400 9650; 0900-1100 11710, 1100-1400 9610, 1400-1500 11940, 1500-1600 11820, 1600-1615 9580. No. 3: 2200-2400 15225, 1000-1300 15115, 1300-1500 15350, 1500-1545 11705. All of this is in Asian languages, not English; per Alok Das Gupta in *ADXN*.

Sri Lanka. Because of its ideal location at the southern tip of the middle of Asia, this country is a favorite spot for relay stations. The Voice of America is already here, but is building a new high-power facility on a par with its other relays; and VOA will have more control over programming content than the previous agreement allowed. Deutsche Welle (West Germany) expected to have the first of its new transmitters here on the air by now: 0600-0755 15105, 0800-0900 17825, 1000-1050 15185, 1130-1220 9510, 1245-1420 7265, 1430-1650 7200, 1700-1855 9685, 1900-2035 11705, 2100-2150 6185, 2200-0050 6065, 0100-0150 15105, 0200-0250 15105 (via Ralf Munster). Since DW may use the same frequencies from other sites, be sure to listen for a Sri Lanka ID at opening and closing. Radio France International is reported to be negotiating for use of the DW transmitters too. Trans World Radio also has a new relay here, high power on mediumwave.

non-Sudan. Radio SPLA is a new clandestine from Ethiopia, on 9610 kHz interfering with Perth at 1300-1400 in English and Arabic.

Switzerland. Hearing SRI is easy, but have you ever caught the Red Cross Broadcasting Service? It uses SRI facilities the last weekend of each month. Try for Arabic Fri. 1700-1720 on 17750, English Sun. 1545-1600 on 11870, or Spanish GMT Mon. 0000-0020 & 0200-0220 on 9635.

United Arab Emirates. UAE Radio, Dubai, is well worth seeking out for news of the Middle East, features on Arab culture and history, and fortnightly on weekends, mailbags. The English schedule effective thru Feb. but subject to change: 1330-1415 on 15320, 17775, 21605; 1600-1700 on 15320, 15300, 11955; 0330-0400 on 9565, 11730, 15435. These are surrounded by Arabic programs; tune it at 0230 for call to prayer and recitations from the Koran.

United Kingdom. A look at some BBC World Service programs on particular topics: Financial News, Sun.-Fri. 2230 and Tue.-Sun. 0445; Stock Market Report, Mon.-Fri. 1939. Business Matters, Thu. 2030, Fri. 0330. British Press Review, daily 0209 and 0909; From the Weeklies, Fri. 2315, Sat. 0730. Commentary, daily 1609, 2309.

From Our Own Correspondent, Sat. 2209, Sun. 0315, 0730, 1115. Letter from London, Sun. 0750, Mon. 0445, Tue. 1115, 2100. Letter from America, Sun. 0545, 1645, 2315. Letterbox (from listeners), Fri. 1445, Sat. 0145, 2315, Mon. 0530.

About Britain, Fri. 1945, Sat. 0030, 0530, 1115. People & Politics Sat. 0230, 2130. Scotland This Week, Tue. 1124, 1739, 2224. Ulster Newsletter, Thu. 2100, Fri. 0145, 1124. The Week in Wales, Thu. 1124, 1739, 2224. Network UK, Mon./Wed./ Fri. 2100, and Tue./ Thu./Sat./ 0215, 0745, 1330. News about Britain, daily 0009, 0309, 1109.

Science in Action, Fri. 1615, 2030; Discovery, Wed. 0330, Thu. 1830. Nature Notebook and The Farming World, Tue. 1830, Wed. 1215, Thu. 0630. New Ideas, Sat. 2230, Tue. 0530, Wed. 1724, Thu. 1115.

The World Today, Mon.-Fri. 1645 & 2209, Tue.-Sat. 0315, 0545. Outlook, Mon.-Fri. 1400, 1900, Tue.-Sat. 0100. Assignment, Wed. 2030, Thu. 0230, 1130, 1615. Omnibus, Tue. 1615, Wed. 0030, 0630. Radio Newsreel, daily 0015, 1200 (exc. Sun.), 1500. 24 Hours, daily 0509, 0709, 1309, 2009.

Request shows: Anything Goes, Sat. 1215, Mon. 0330, 0830. Jazz for the Asking, Sat. 2030, Sun. 0630, Fri. 1215. A Jolly Good Show, Sat. 0815, Tue. 1515, Thu. 2115. The Pleasure's Yours (classical, birthday greetings), Sun. 0815, 2115, Thu. 1515. Sandi Jones Request Show, Sun. 1345.

Other music programs: John Peel (progressive rock), Tue. 0330, Thu. 0830, Fri. 1330. Music Now, Fri. 2115, Sat. 1400, Mon. 0230. Sarah & Company, Fri. 1709, Mon. 0730, Tue. 0030. Top Twenty, Wed. 1830, 2330, Thu. 1215. Recording of the Week, Sat. 0045, Mon. 0545, Tue. 1345, Wed. 2145. Classical Record Review, Sun. 1900, Wed. 0815. Thu. 0430. Meridian (arts magazine), Sat./Wed./Fri./ 1130, Sat./Tue./ Thu. 2330, Sun./Tue./Thu. 1709.

Monitor, Wed. 1709, Thu. 0145. Waveguide, Wed. 0430, 1733, Thu. 0130. In the Meantime (program previews), Thu. 2105, Fri. 0150, 1115.

Report on Religion, Wed. 0130, 0730, 1445, Thu. 1945. Reflections, daily 0455, 0809, 2239, Sun. 1739. Religious Services, Mon. 0030. Sunday Half-Hour, Sun. 2030.

Good Books, Sun. 0530, Mon. 0215, Wed. 1945, Book Choice, Mon. 1709, 2224, Tue. 0540, Wed. 0439, 2224, Tue. 2110, Thu. 0140, Fri. 1739, 2224.

Sports Round-Up, daily 1245 (exc. Sun.), 1745, 2245. Sports Review, Sun. 0230. Sports International, Mon. 2030, Tue. 0230, 1130. Saturday Special, 1515-1600 1615-1745 (starts earlier in the summer).

BBCWS frequencies: 1100-1330 on 21710, 21660, 17790, 15070, 11775, 6195, 5965. 1330-1600 21710, 17790, 15070. 1600-1745 (Sat. and Sun. 1500-) 15260, 9515. 1745-2000 15070. 2000-2200 15260, 11750, 2200-2300 15260, 11750, 9915, 7325, 6175, 5975. 2300-2430 11750, 9915, 9590, 7325, 6175, 6120, 5975. 0030-0230 11750, 9915, 9590, 9515, 7325, 6175, 6120, 5975. 0230-0330 11750, 9915, 9515, 7325, 6175, 6120, 5975. 0330-0430 6175, 6120, 5975. 0430-0630 9510, 6175, 5975. 0630-0730 9510, 6175. 0730- 0900 9510, 0900-0915, 6195.

BBCWS also has a separate program for the Falkland Islands, Tue. & Fri. 2130-2200 on 15390, 12040, 11820, 9915, fascinating listening and surprisingly well-heard here. And an African Alternative, also audible here at times, valuable for those interested in Africa. Listen at 0500-0545 on 11860 and 6005, 0630-0700 on 15400, 11860, 0730-0800 on 15105, 11860, 9600, 1500-1530 on 18080, 1615-1745 on 21710, 17880, 15400. All except 12040, 9915 and 18080 are via the Ascension relay (so far, all out-of-band BBC frequencies are only from Britain itself).

U.S.A. Last month we brought you the tentative winter schedule of KVOH, Rancho Simi, California. Never mind; it now seems construction won't be completed until summer, when the following schedule can go into effect: 1400-1600 on 9525, 1600-2200 on 17775 or 17830, 2200-2400 on 15120, 0000-0400 on 11970, 0400-0600 on 9755 or 9852.5, 0600-0800 on 6005. KVOH will use 50 kW beamed 100° for Central America, the Caribbean, and northwestern South America.

Meanwhile, the nation's largest private shortwave station, WYFR, should now have all ten transmitters on the air from Okeechobee, Florida, and stay on the air 24 hours, "in Jesus' precious name." Be on the lookout for more new U.S. shortwave stations, KCBI in Dallas and NDXE in Alabama.

Good listening!

ME

Hardware, Software & Robotics

By Don Lancaster

For readers who didn't catch me last month, I'll try to answer most any hardware (or related software) questions from you, as well as look at some neat hacker-type stuff. To join in the fun, write or phone me per box at the end of the column.

Show me a tough computer port driver circuit.

The usual microcomputer port chips, such as 6822, a 6832, or an 8212, are typically NMOS chips with very low drive abilities. While fine for just getting ones and zeros into or out of a micro circuit, they simply cannot drive higher power loads.

Figure 1 shows you a medium power "amplifier" for computer output ports, using the Sprague ULN2813 octal peripheral driver. This circuit is best suited for things that need less than 40 volts and less than half an ampere, and where there are no safety isolation hassles noise problems.

Obvious uses include small incandescent lamps, solenoids, air valves, relays, small stepper motors, multiplexed LED arrays, hammer drivers, and the like. I've even used it as a "student proof" driver for plain old light-emitting diodes. Cost is under $3.

The chip holds eight darlington transistor pairs, each of which can drive up to half an ampere and block up to 40 volts. You are not allowed to run all eight outputs at full current at the same time, but the derating curves on the data sheet are very generous. You can easily drive the 2813 directly from almost any micro port chip. A few milliamperes at the input is all you need.

Note that a separate power supply is recommended for the loads. Note

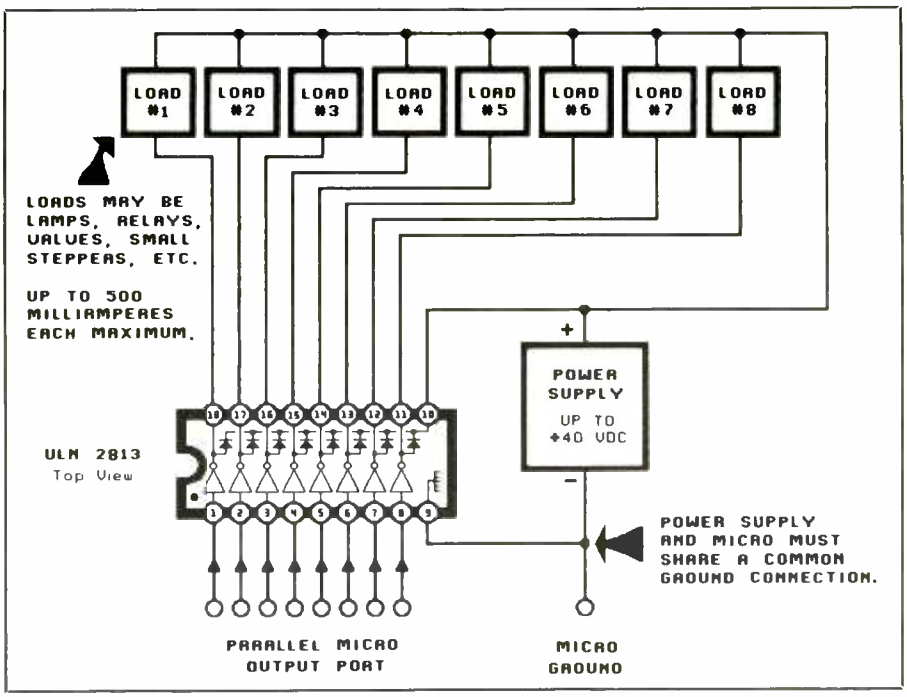


Fig. 1 Tough octal output circuit is suited for "medium-power" loads that require up to 0.5 ampere each.

also that a common ground must be shared between the loads, the power supply, the ULN2813, and the micro that is sourcing the ones and zeros to be output. It is especially important to avoid ground loops when you have high-power loads sharing the same ground circuitry as the computer circuitry.

Since the darlington pairs invert, a high at the input produces a low at the output. In turn, this lights, powers, or turns on the load. A low at the input produces a no-current high at the output, which unlights, depowers, or turns off the load. Thus, you get what you would expect—a positive logic one turns on the load.

There are also eight freewheeling diodes in the package. These diodes *must* be used if you are powering an inductive load. The common connection to all the diodes is connected to the positive end of the load voltage. It is a good idea to always connect this protection circuitry for most loads.

How can I get started in assembly language?

Check into the "top 30" programs for any major personal computer, and you will find that 30 out of 30 either run directly in machine language or else make extensive use of linked machine-language routines. The marketplace has spoken—if you want to sell a decent program, it *must* run in machine language. BASIC and Pascal need not apply.

The usual way of getting a program to run in machine language is to use an assembler program. The assembler speaks assembly language to you and machine language to the computer, letting you automate and simplify the creation of machine-language routines.

So how do you get started? The

best way I know of involves four steps. First, and by far most important, is to hand code and hand debug several hundred lines of machine language code without use of any assembler at all. Then check out a simple mini-assembler, acting as an "automated pocket card." Then tear apart the winning programs of others as a detailed study to find out how it's done. Finally, step up to a full-blown assembler or macroassembler of your choice. Then get with the program.

The tools and resources you need along the way will, of course, change with your choice of microprocessor and personal computer. Let's assume you are a 6502 person doing Apple II development, and look at the tools I feel are important. Naturally, if you are into other things, you'll need "alike but different somehow" tools that one-on-one replace these.

Start with a 6502 pocket card. These are free or cheap from Rockwell, Synertek, MOS Technology, and Western Design Center. Larger plastic cards are available from Micro Logic and are sometimes easier to use. You will also need a programming manual for the micro you are using. The 6502 Programming Manual, again by Rockwell, Synertek, and MOS Technology is absolutely essential. A 6502 Hardware Manual is also available, although not quite as useful as the programming manual.

You will also need some books on machine-language and assembly-language programming. I'm laboring under the delusion that my *Micro Cookbook I* (SAMS #21828), *Micro Cookbook II* (SAMS #21829), and my brand new *Assembly Cookbook* (SAMS #22331) can help you bunches here.

You will need some debugging tools. First and foremost, you will need a way to unconditionally reset your machine so you can stop any program at any time for any reason. (An absolute reset mod for the IIe and IIc appears elsewhere in this issue.)

Next needed is a way to mini-assemble, single step, and debug a working program. There was a mini-assembler in older Apples available in the monitor at $F666 and activated by an $F666G while in the "old" Apple II ROM. This has recently been upgraded into a major and essential debugging package called the BUGBYTER. This is available from Apple Computer as part of DOS Toolkit #A2W0011.

You will also need a disassembler or two.

A dumb disassembler is built into all Apples, activated by getting into the monitor and typing the address, followed by an L, such as "$0800L." For serious use, though, you will want to get an intelligent disassembler that lets you capture the source code of any program you care to. I think that DISASM IIe by Rak-Ware is a good choice. (It is the only one I personally use.)

The technical reference manuals for your machine are obviously needed. Normally, these do not come with the machine but have to be seperately ordered. Apple offers a *IIe Technical Reference Manual (#A2L2005), a IIc Technical Reference Manual* (#A2L4030) and *Inside MacIntosh*. It is unthinkable to attempt any useful programming without these products.

You will need a good set of books for your disk operating system. On the Apple, *Beneath Apple DOS* and *Beneath Apple ProDOS* by Quality Software are essential. Naturally, you will also want the factory manuals for your particular disk system. Same goes for printers and modems, of course.

Oh yes. Somewhere along the way you will need an assembler program, although this is only a tiny part of the resources you need to do assembly work. Apple has newly overhauled their EDASM assembler so it now includes macros and lots of other new goodies. It's available on either the DOS or ProDOS toolkits. One neat thing about EDASM is that it lets you do "new way" editing, using Applewriter to make entry and editing far simpler and far more fun.

Of the two dozen or so other Apple assemblers, some people consider the "best" one to be the S-C Assembler, while the "best buy" is *Big Mac* by CALL A.P.P.L.E..

The final resource for assembly programming is you yourself with lots of hands-on programming experience. In theory, you can get up to where you can just barely write second-rate assembly- or machine-language programs in less than three years of solid and dedicated effort. Only it hasn't happened yet. Not even once.

But, as someone once said, the longest journey starts with a single step. And the reason for doing it, of course, is for the nickels, since there is *no other alternative* to writing winning and commercially successful programs.

Have at it!

Any ideas on low-cost robotics?

It ever ceases to amaze me that low-pressure pneumatics has never taken off. Yet air pressure systems in the 3-to-6-psi range have enormous advantages.

First off, low-pressure air is cheap and low-tech. It gives you lots of linear force easy and simply. It can

"amplify," since most of the "muscle" comes from the air source. This means you do not directly have to provide high-power electronic drivers as you do with solenoids or servo motors. Air also goes around corners beautifully, particularly robotic elbows.

Most important to us, low-pressure air has fantastic hacker potential. You can literally beat one of these systems out on a brick in your back yard, and still come up with a promising and useful product.

You will need an air source. The larger aquarium pumps are ideal, when combined with a small storage vessel. The latter are easily made from plastic toilet tank floats. You can instead use a storage tank, filled with a tire pump, or even a scuba tank or a Scott airpack bottle.

Hoses and connectors are no big deal. Get your hoses from Hygenic and the connectors from a larger plastics supply house.

A regulator is also needed. I've had best luck running at 3.5 psi. You can get regulators for around six bucks from most of the surplus houses mentioned below.

Now for the fun part. You need a control valve. Unlike electronics, you cannot simply connect your air supply to an actuator to move it and then disconnect it to return. Try this, and the air stays stuck in the pipe and the actuator will remain extended. So, you need *three-way* air valves that act like electronic spdt switches. Powered, the air supply gets connected to the actuator. When the control signal is turned off, the pressure remaining in the actuator vents to ambient through the second arm of the valve.

You simply will not believe the price of an electronic three-way air valve for low pressure robotics. How does thirty cents sound? Thirty *cents*!

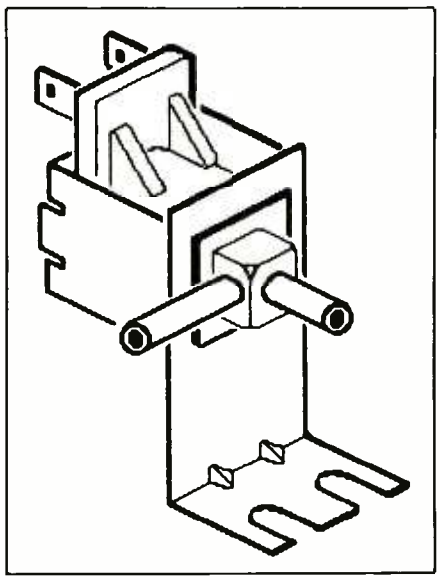


Fig. 2. Typical surplus automotive EGR three-way valve is super cheap and ideal for low-pressure pneumatics. Third port vents to the atmosphere at the rear.

They are called automotive EGR valves, and originally were made by Carter Carburetor. For many years now, they have been available surplus from Jerryco, C&H Sales, Herbach and Rademan, BNF Sales, Surplus Center, and all of your usual mechanical surplus outfits. Your nearest handy-dandy junkyard is also crammed full of them. Incredibly, these have gone begging.

Jerryco has far and away the lowest valve pricing, the most outrageous catalog, and the most bewildering and mind-blowing array of other goodies. Where else under one roof can you get a real joystick for a B-17 bomber, some lumber grading crayons, scented ballpoint pens, candle molds, or a dummy howitzer shell? Check them out.

The valve is shown in Fig. 2. You power it with + 12 volts dc to connect the air source to the load. Removing power vents the load to ambient through a filtered vent at the rear of the valve coil. The side pipe goes to the load. The front pipe goes to the air source. You can make a simple manifold for several valves by taking a piece of thick, large-diameter tubing and punching one pinhole in it for each valve. Then push the front arm of each valve into the pinhole. A push-on pressure seal is all you need at 3.5 psi. The driver shown in Fig. 1 works beautifully on these.

What do you use for actuators? Traditional miniature air cylinders are available from Clippard. Unfortunately, they are also available at traditional prices. Instead, let's get nontraditional. There's a key secret to any useful low-power, hacker-based pneumatic actuator: *never* have a seal that must move! All of your low-power air will either be wasted trying to move the seal, or else will leak right by it.

Figure 3 shows three different ways to build actuators that do not have moving seals. The rolling diaphram is interesting; suitable diaphrams are available from Bellofram.

I like the bellows actuators myself. I actually had a bunch of these blow molded long ago, to use in a pneumatic attachment to use an office Selectric typewriter as a computer printer. It worked, more or less, but never became a viable product. Polypropylene is probably the best choice of material. Some scientific supply houses sell bellows pipettes that are almost useful as bellows actuators. I've also ripped apart those "pump the water" toys that were available a few years back. The bellows pump inside these worked fine.

Chances are that you will prefer the "bladder" or "balloon" actuator instead, since these are the cheapest and

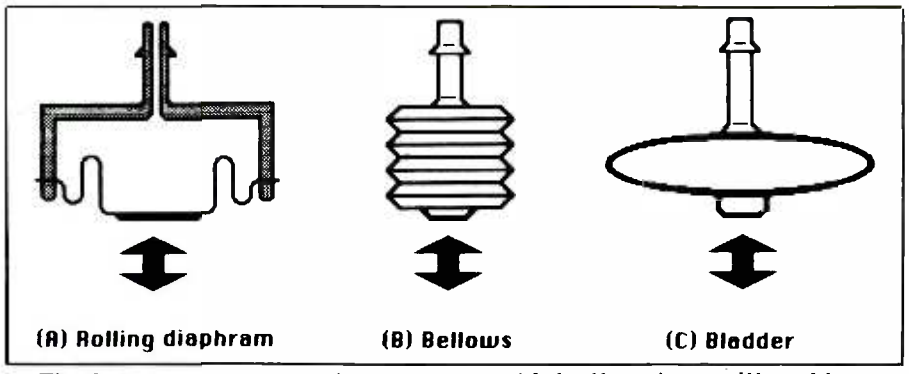


Fig. 3. Low-cost pneumatic actuators avoid the "moving-seal" problem.

are the simplest mechanically.

By the way, if you must have a seal anywhere at all, use an O-ring. These are far and away the best route, besides being reasonably cheap and standard.

Let us know what you come up with here. We may work up an article or an information exchange service if this thing really takes off the way it rightly deserves to.

How can I run Applewriter IIe on an Apple IIc?

There is a new version of Applewriter intended specifically for the IIc. It is ProDOS-based and includes new features such as a scrollable 240-character-wide-screen (spreadsheets anyone?), settable screen margins for "what you see is what you get," display of page/line position in a document, a modem link, and a few other goodies. Price of the new Version 2.0 is $150 from your Apple dealer. An upgrade is separately available for $50 from Applewriter Upgrade; just mail them your old AWIIe first diskette and the cover off your manual. But neither of these are needed.

The only serious problem preventing your use of Applewriter IIe on a IIc is that the status line gets trashed. This happens because older Apples had two possible codings for inverse uppercase letters. One of these is reserved by the IIc as a "mouse nest" to hold icon characters. You guessed it. Older Applewriter made the wrong choice.

Anyway, the program here is a simple patch that fixes the status line so older DOS 3.3 Applewriter IIe will run just fine on a IIc. Be sure to make this patch on only your third or higher backup copy of AWIIe. Run the patch as an Applesloth program, and it will do the rest.

A minor IIc bug still remains with the cursor temporarily changing to a flashing bell or whatever when you park on an uppercase character. This is both cute and rare, so don't sweat it.

By another one of those most astounding coincidences, the Hardware Hacker phone number is also an independent Applewriter help line. I've been working with the Gila Valley Apple Growers Association to maintain this service. They have lots of free patches, as well as a mind-blowing eight-diskette-side AWIIe toolkit package.

Show me a small and attractive MacPaint font.

If you haven't met MacPaint or MacDraw yet, boy are you in for a surprise. There is absolutely nothing that goes on paper involving electronics or hardware hacking that cannot be done much faster, much more simply, and far more joyously on a Macintosh.

Not that there aren't any problems, though. Their smallest type fonts are the Monaco 9-point and their Geneva 9-point. To make these look good on the screen, they are letterspaced. Letterspacing means that a small lowercase *i* is the same width as a capital *W*. Worse yet, these fonts have only one pixel between the letters. The result looks OK on the screen, but for a schematic, pc layout, engineering drawing, or logic diagram, the printed result looks both awkward and cramped.

Fortunately, there are two utilities available that make custom fonts quick and easy on the MAC. One of these is called the Font Mover, and it is provided to everyone as part of MacPAINT. The second is called the Font Editor. This one is normally sold only to system developers as a minor part of a $350 package.

The mover lets you store fonts or install them in your machine. The editor lets you change the character shapes and their spacing any way you like. Early versions of the font editor have very poor error trapping, so expect the bomb icon every now and then, and be patient.

At any rate, I've designed a few fonts of my own, and "improved" a few others. You can easily do the same, or else I'll be glad to send you all of mine on disk for $19.50, sent or VISA phoned per the box.

Included are a variant of Monaco 9 that is proportionally spaced with double-pixel spacing. I call it Thatcher 9. This is just what you need for schematics and other electronic stuff. A modified version called Thatcher 12 has enough extra vertical

```
This AWIIe CLARIFIER Applesloth program modifies
your Applewriter IIe backup diskettes to eliminate
trashing of the IIc status display line.

100  REM

110  REM ************************
120  REM *                      *
130  REM *    "CLARIFIER FOR"   *
140  REM *                      *
150  REM *    APPLEWRITER IIe   *
160  REM *                      *
170  REM *       VERSION 1.0    *
180  REM *......................*
190  REM *                      *
200  REM *  COPYRIGHT 1984 BY   *
210  REM *  DON LANCASTER AND   *
220  REM *  SYNERGETICS,  BOX   *
230  REM *  1300 THATCHER AZ.   *
240  REM * 85552. 602-428-4073 *
250  REM *                      *
260  REM *    ALL  COMMERCIAL   *
270  REM *    RIGHTS RESERVED   *
280  REM *                      *
290  REM ************************

300  REM  This mod changes a
310  REM  backup copy of AWIIe
320  REM  to eliminate trashing
330  REM  of the IIc status line.

340  REM  This lets you use a
350  REM  DOS 3.3 version of AWIIe
360  REM  on either a IIc or IIe.
370  REM
          ..................

380  TEXT : HOME : CLEAR
390  HIMEM: 8000
400  VTAB 1: HTAB 8:
      A$ = "Applewriter IIe CLARifier":
      GOSUB 910
410  PRINT : GOSUB 960
420  PRINT
430  FOR N = 1 TO 39: PRINT  CHR$ (127);:
      GOSUB 950: NEXT N
440  GOSUB 960
450  VTAB 5: HTAB 1:
      A$ = "This program will patch Applewriter IIe":
      GOSUB 910: PRINT
460  VTAB 6: HTAB 1:
      A$ = "to eliminate trashing of the IIc status":
      GOSUB 910
470  VTAB 7: HTAB 1:A$ = "line.": GOSUB 910
480 : GOSUB 960
490  VTAB 10: HTAB 4:
      A$ = "Patch ONLY your THIRD BACKUP copy!":
     GOSUB 910
500  GOSUB 960: GOSUB 960
510  VTAB 14: HTAB 4:
      A$ = "Please put your THIRD BACKUP copy":
      GOSUB 910
520  VTAB 15: HTAB 4:
      A$ = "of AWIIe into Drive #1. Then push":
      GOSUB 910
530  GOSUB 960
540  VTAB 17: HTAB 12:
      A$ = "<SPACE> to CONTINUE": GOSUB 910
550  VTAB 19: HTAB 19:A$ = "-or-": GOSUB 910
560  VTAB 21: HTAB 13:
      A$ = "<ESCAPE> to ABORT": GOSUB 910
570  VTAB 23: HTAB 19: PRINT "-< >-"
580  VTAB 23: HTAB 21: GET Z$
590  IF Z$ <  > " " THEN 900
600  REM
          Check Validity
610  PRINT
620  PRINT "[D]BLOAD OBJ.APWRT][E,A$2300
630  IF  PEEK (14472) <  > 188 THEN 880
640  IF  PEEK (14709) <  > 41 THEN 880
650  IF  PEEK (14753) <  > 57 THEN 880
660  PRINT "[D]BLOAD OBJ.APWRT][F,A$2300
670  IF  PEEK (14815) <  > 188 THEN 880
680  IF  PEEK (15052) <  > 41 THEN 880
690  IF  PEEK (15096) <  > 59 THEN 880
700  POKE 14815,60: POKE 14816,36: POKE 14817,207:
      POKE 14818,16: POKE 14819,2: POKE 14820,169:
      POKE 14821,62
710  POKE 15052,208: POKE 15053,42
720  POKE 15062,96
725  IF PEEK (20365) = 176 THEN POKE 20365,182:
      REM  RECONNECT HELP SCREENS
730  POKE 15096,41: POKE 15097,127: POKE 15098,201:
      POKE 15099,96: POKE 15100,176: POKE 15101,208:
      POKE 15102,201: POKE 15103,64
740  POKE 15104,144: POKE 15105,204: POKE 15106,41:
      POKE 15107,63: POKE 15108,176: POKE 15109,200
750  PRINT "[D]UNLOCK OBJ.APWRT][F"
760  PRINT "[D]BSAVE OBJ.APWRT][F,A$2300,L$30D3"
770  PRINT "[D]LOCK OBJ.APWRT][F"
780  PRINT "[D]BLOAD OBJ.APWRT][E,A$2300"
790  POKE 14472,60: POKE 14473,36: POKE 14474,207:
      POKE 14475,16: POKE 14476,02: POKE 14477,169:
      POKE 14478,62
800  POKE 14709,208: POKE 14710,42
810  POKE 14719,96
815  IF PEEK (19988) = 176 THEN POKE 19988,182:
      REM  RECONNECT HELP SCREENS
820  POKE 14753,41: POKE 14754,127: POKE 14755,201:
      POKE 14756,96: POKE 14757,176: POKE 14758,208:
      POKE 14759,201
830  POKE 14760,64: POKE 14761,144: POKE 14762,204:
      POKE 14763,41: POKE 14764,63: POKE 14765,176:
      POKE 14766,200
840  PRINT "[D]UNLOCK OBJ.APWRT][E"
850  PRINT "[D]BSAVE OBJ.APWRT][E,A$2300,L$2F5A"
860  PRINT "[D]LOCK OBJ.APWRT][E"
870  TEXT : HOME :A$ = "IT WORKED!": GOSUB 910:
      PRINT : PRINT : PRINT : PRINT : END
880  TEXT : HOME :
      A$ = "Will not verify as AWIIe; patch ABORTED":
      GOSUB 910: PRINT : PRINT : PRINT :
      PRINT : PRINT : END
890  GOTO 890
900  TEXT : HOME : CLEAR : END
910  REM
          Noisy screen machine

920  FOR N = 1 TO  LEN (A$): PRINT  MID$ (A$,N,1);
930  GOSUB 950: REM  Clickety clack
940  NEXT N: RETURN
950  ZZ =  PEEK (49200) +  PEEK (49200):
      FOR M = 1 TO 17: NEXT M: RETURN
960  FOR N = 0 TO 700: NEXT N: RETURN
```

Gotchas:

Fixes only the status line. Rare and brief changes in the flashing cursor symbol will remain.

In the above listing, [D] stands for "control-D". All other brackets are real.

Only the "F" version patch would normally be used by the IIc. We have also included an "E" patch for possible use by gonzo hackers only.

This program is avaiable ready-to-run on the Gila help line's AWIIe Toolkit package.

Manufacturer & Supplier Names and Addresses

Apple Computer
10260 Bandly Dr.
Cupertino, CA 95014
(408) 996-1010

Applewriter Upgrade
Box 306
Half Moon Bay, CA 94019

Bellofram
30 Blanchard Rd.
Burlington, MA 01803
(617) 272-2100

BNF Sales
119 Foster St.
Peabody, MA 01960
(617) 531-5774

C&H Sales
2716 East Colorado Blvd.
Pasadena, CA 91107
(213) 681-4925

Call A.P.P.L.E.
21246 South 68 Ave.
Kent, WA 98032
(206) 872-9004

Carter Carburetor
9666 Olive Rd.
St. Louis, MO 63132
(314) 997-7400

Clippard Minimatic
7390 Colerain Rd.
Cincinatti, OH 45239
(513) 521-4261

Gila Valley Apple Growers
Box 809
Thatcher, AZ 85552
(602) 428-4073

Herbach & Rademan
401 East Erie Ave.
Philadephia, PA 19134
(215) 426-1700

Hygenic Manufacturing
1245 Home Ave.
Akron, OH 44310
(216) 633-8460

Jerryco
601 Linden Pl.
Evanston, IL 60202
(312) 475-8440

Micro Logic
Box 174
Hackensack, NJ 07602
(201) 342-6518

Mos Technology
950 Rittenhouse Rd.
Norristown, PA 19401
(215) 666-7950

Quality Software
6660 Reseda Blvd.
Reseda, CA 91355
(213) 344-6599

Rak-Ware
41 Ralph Rd.
West Orange, NJ 07052
(201) 325-1885

Rockwell International
3310 Miraloma Ave.
Anaheim, CA 98203
(800) 854-8099

S-C Software
Box 280300
Dallas, TX 75228
(214) 324-2050

Howard S. Sams
4300 West 62 St.
Indianapolis, IN 46206
(800) 428-SAMS

Sprague Electric
115 Northeast Cutoff
Worchester, MA 01606
(603) 224-1961

Surplus Center
1000 West "O" St.
Lincoln, NB 68501
(402) 435-4366

Synertek
Box 552
Santa Clara, CA 95052
(408) 988-5600

Western Design Center
2166 East Brown Rd.
Mesa, AZ 85203
(602) 962-4545

spacing that it is ideal for vertical spacing inside an integrated circuit, for the individual pin callouts.

The boldface option on Mac ruins the *W* and *M* characters. So, a version called Thatcher 10 is available that is bold to start with. It appears bold as normal text, and there are no problems with certain characters being blocked out. I also have a miniature 3 × 5 dot font called Thatcher 14. This one is ideal for the little numbers inside the pin circles on an integrated circuit, but is too tiny and awkward for most anything else.

Rounding out the package are some larger numerals, some fonts for printed-circuit overlays, and the usual samples and demos, and a bunch of ready-to-use 7400 series integrated-circuit schematic icons.

Since these are intended as single sized fonts, I used the trailing numerals as a variation number, rather than as a font size. This is allowed, though not standard, and lets you install all of the fonts under a single name. MacPaint or MacDraw will merrily pick the font for you, instead of the size, without knowing you just put one over on it.

If you have any favorite fonts of your own design, send them along so others can share them. There's lots of room left on the disk. **ME**

NEED HELP?

Phone or write your hardware hacker questions and comments directly to

Don Lancaster
SYNERGETICS
Box 809
Thatcher, AZ 85552
(602) 428-4073

BOOK REVIEWS

The latest technical books and literature in the electronics and computer field.

The Handbook of Computers and Computing. Edited by Arthur H. Seidman and Ivan Flores. (Van Nostrand Reinhold Company Inc.; 869 pp.; hardcover; $77.50.)

This impressive handbook consists of 50 original articles on recent developments in the computer field. It's directed to readers who have some background in computers rather than to the neophyte. The text is divided into six subject areas: components, devices, hardware systems, languages, software systems, and procedures, with articles written by industry experts. Enough basic information is provided in supporting discussions of new developments to make this a handy reference book for some fundamentals as well as more current innovations and applications. Material includes VLSI concepts, Computer Speech Recognition, Robotics, the ADA language, Data Base Technology, Graphics, Documentation, and Installation Management, to name a few articles. It's amply illustrated, too, and written very tightly to avoid superfluous material.

Satellite Communications by Stan Prentiss. (Tab Books Inc.; soft cover; 280 pages; $11.50)

An apt subtitle for this book might be "Everything You Always Wanted to Know About Satellite Communications But Didn't Know What To Ask." Packed between its covers is a veritable one-source encylopedia of information ranging from satellites in orbit and under construction to types of services offered to home reception systems to security and scrambling devices. Numerous photos, drawings, block diagrams and tables are used throughout the text. There are eight chapters in all, each devoted to a specific topic. Though the book starts off with general coverage of all types of satellite communication, both video and non-video, it devotes some 35% of its pages to home satellite TV reception (TVRO). Two chapters are devoted to TVRO, one dealing with the receivers required for intercepting satellite video and the other dealing with the considerations and design for TVRO installations.

222 BASIC Computer Programs For Home, School & Office by Don Roberts. (ARCsoft Publishers; soft cover; 285 pages; $9.95.)

A collection of short, key-in programs for the computer owner who has the BASIC programming language is bound to provide many hours of entertainment and/or education. This book's 223 (one more

than its title claims) BASIC programs are designed to do this and more. The programs listed are not machine-specific, nor are they written in a particular BASIC language. You must make changes in the listings as required to fit your system's particular needs. The programs are broken down by category, beginning with fun and games and working through a repertoire of home finance, learning and "business' programs, and finishing with a nice series of math and random-number programs. Most of the programs listed run less than a page in length and are, therefore, relatively easy to load from the keyboard of a computer and can be stored on tape or disk for loading and running at a future time. Not all of the programs will appeal to all users of this book, but everyone who invests in the book will find enough of merit and/or interest to make the book worthwhile.

NEW LITERATURE

Communications Equipment Catalog. Hamtronic's 1985 mail-order catalog lists items for the vhf/uhf/OSCAR communications enthusiast. The 40-page, two-color catalog highlights such new products as a simplex autopatch kit, a repeater COR with courtesy beep, GaAs FET receiver preamps, active antennas for scanners, and repeater PA kits. Also included are FM and AM receivers, FM transmitters, vhf and uhf transmitting and receiving converters, repeaters, Space Shuttle receivers, 800-MHz scanner converters, and other products that have been in previous Hamtronics catalogs. For a free copy, write: Hamtronics, Inc., 65 Moul Rd., Hilton, NY 14468.

Equipment & Parts Catalog. Catalog No. 9 from MCM Electronics contains 128 pages with more than 4500 test equipment, computer accessories, CATV equipment, and parts listed. Among the miscellaneous items listed are telephone accessories, speakers, TV parts (flyback transformers, yokes, etc.), switches, resistors, capacitors, fuses, lamps, phono cartridges and styli, and a large selection of Japanese semiconductors. For a free copy of Catalog No. 9, call: 1-800-543-4330 (1-800-762-4315 in Ohio).

Precision Tools Catalog. A comprehensive 31-page catalog of electronic production assembly tools is available from the Vigor Tool Co. Catalog BK-132 lists cleaners, dividers, drills, drill press, eye loupes, files, gauges, holders, knives, lamps, magnifiers, flexible-shaft motors, pin vises, pliers, nippers, screwdrivers, torches, and more. Each item listed is accompanied by a photo or drawing, complete description, shipping weight, and stock number. You can obtain a free copy by writing to: Vigor Co., 53 W. 23 St., New York, NY 10010.

in Fig. 8. This cross-connected double-pole, double-throw (dpdt) switch has positions for both positive-voltage and ground switches.

Building The Project

Using Fig. 8, you're now ready to build your alarm. Assembly is simple and straightforward, requiring only standard construction techniques.

The project's electronics can be assembled on a piece of perforated board, using solder posts and IC sockets. However, if you're ambitious, you can design and fabricate your own printed-circuit board and use it instead.

Keep in mind that the CMOS ICs used in this project can be damaged by static electricity. So take proper precautions when handling them, and save installation of them in their sockets for last.

Though IC sockets aren't normally recommended for an automotive project (vibrations and other mechanical stresses cause ICs to work loose from their sockets), they are here to reduce to a minimum the possibility of static damage. You can guard against the possibility of the ICs working loose by applying a small daub of silicone adhesive to the bottom of their cases just before plugging them into their sockets. Don't overdo the adhesive, though, or you'll get it in the socket slots or on the IC pins.

You can use either an aluminum or a plastic box to house the project. Machine the box and mount screw-type terminal strip *TS1* and polarity selector *S1* (and RESET switch *S2* if you've decided against having remote control of this function) on the box. Then install the circuit board assembly in the box and connect and solder the free ends of the wires coming from it to the appropriate lugs on the terminal strip and polarity switch. Do *not* connect the various grounds on the circuit board to the case if you're using a metal box. The

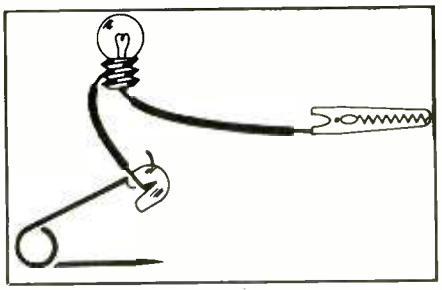


Fig. 9. Shown here are the connections that must be made between a screw-type terminal strip (TS1) and various points in the alarm circuit and vehicle's electrical system.

+12-volt and ground connections will be made via *TS1*.

Installing The Alarm

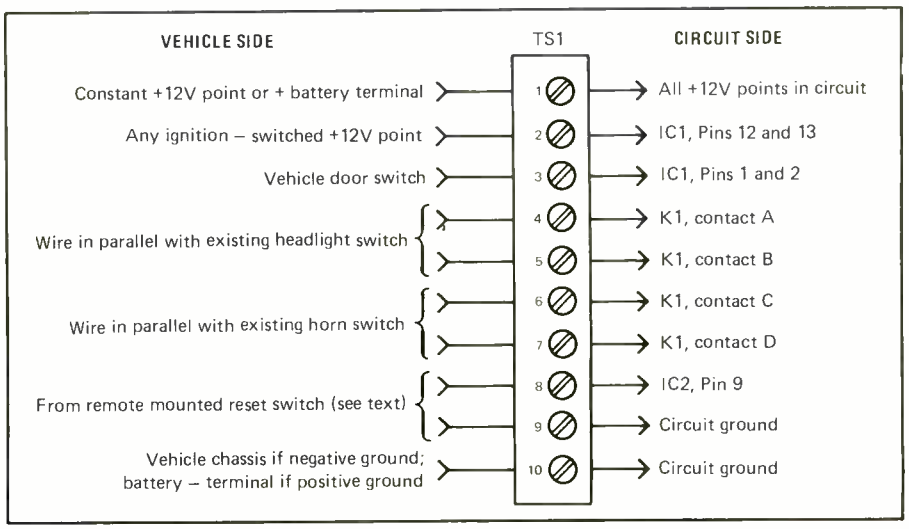
Remember that this is a *passive* alarm and, thus, doesn't require any action on your part to arm it. For maximum security, therefore, the box containing the electronics is best mounted where it won't easily be detected, preferably in a location that's inconvenient for even you to access. (You'll have to mount the box in a more accessible location if you've decided to mount the RESET switch on or in it.) Way up behind the dashboard or, if your vehicle has a deadbolt-type hood lock, on the firewall inside the engine compartment are good places.

If you use a relatively secure key-switch for the RESET switch, you can mount it in a location that isn't too obvious but where it's easy for you to get at in a hurry. A slide or toggle switch, however, must be located in a hidden part of your vehicle, where a thief isn't likely to find it in the 15 seconds before the alarm sounds. Hide all wiring inside panels, under carpeting, etc.

Before mounting the electronics package in its location, cut to length the 10 wires (eight if you've decided against using the flashing headlights option) that connect from *TS1* to the various points in your vehicle's electrical system. Install a spade lug on one end of each wire and trim away ½" of insulation from the other end, twist together the fine conductors, and lightly tin them with solder.

Connections to be made between the alarm's terminal strip screws and the various points in the vehicle's electrical system are detailed in Fig. 9. If you wish, you can reduce the number of wires needed by eliminating the connections to the headlights

Fig. 10. With this simple tester, you can safely determine which wires in a vehicle are connected to the positive side of the battery.



and/or mount the RESET switch on the box.

The drawing shows one wire that connects to the car's door switch. Make sure you connect this wire to the appropriate wire on the door switch. If the door switch has only one wire, that's your wire. If there are two wires, however, you'll have to determine which is the correct one. To do this, you'll have to make the simple tester shown in Fig. 10. To use the tester, fasten the alligator clip to any convenient chassis ground point in your vehicle and, with the door closed, pierce first one and then the other door switch wire's insulation with the point of the pin and observe whether or not the tester's lamp lights. You'll know you've located the correct door switch wire when the tester's lamp is off with the vehicle door closed.

Having determined which door switch wire to use, carefully trim away a small portion of insulation (do not cut the wire) to expose the conductors. Wrap the free end of the door-switch wire coming from the alarm around the exposed conductors, solder the connection, and wrap with electrical tape. Reinstall the door switch.

Connect the remaining wires coming from the alarm box in the following sequence: ignition switch; chassis ground (under any screw head that provides a positive electrical connection to the vehicle's chassis) for a negative-ground system, or directly to the negative terminal of the battery in a positive-ground system; RESET switch, if mounted outside the alarm box; horn; headlights; and any part of the electrical system that has +12 volts at all times. The connections from the relay's contacts connect in parallel directly across your vehicle's headlights and horn switches.

Now you have a very practical design and should understand how to map out the general strategy to be used when creating a sophisticated digital electronics project. **ME**

NEW PRODUCTS ...

(from page 11)

compact Model ACT-1 Power Antenna neatly solves this problem. Easily installed on any vertical surface with just four woodscrews, the ACT-1 provides a broadband whip antenna with a low-noise preamplifier in its base. Although much smaller than a full-size outdoor antenna (it's only 25" tall), the ACT-1 is claimed to provide good coverage of distant signals and is reputed to frequently outperform much larger antennas because of its active booster amplifier.

The built-in preamp has a gain of up to 15 dB. A low-noise microwave transistor in the preamp provides a 30-to-800-MHz bandwidth for coverage of the low-band, high-band, and uhf channels. By amplifying the weak signal from the antenna before feeding it to the scanner, the ACT-1 is said to solve the age-old problem of feeder-cable losses that can seriously degrade the signal. The supplied 50-ft. cable from the ACT-1 plugs directly into the antenna and 12-volt jacks on the rear of most scanner receivers. If your particular receiver doesn't have a 12-volt terminal, a plug-in adapter is available. $79.

CIRCLE 96 ON FREE INFORMATION CARD

Soldering Iron Tip Cleaner

New from Davle Tech Inc. is the Model EL-200 soldering-iron tip cleaner for the electronics workbench. The electrically operated device is claimed to clean a soldering tip in less than a second. Cleaning is performed by moist sponge rollers that surround the soldering tip without twisting or turning the soldering iron. The Model EL-200 is available in 117- and 230-volt ac versions.

CIRCLE 97 ON FREE INFORMATION CARD

PRODUCT EVALUATIONS

Zenith's New VHS Camcorder *(from page 18)*

played back monaurally. For the audio, there is a full erase head, and recording is directly controlled by meachacon with signal information on the usual top horizontal track.

Whenever a problem occurs, the equipment stops and a LED at the affected location flashes at a 1-Hz rate for 5 minutes and power is cut off. If the drum motor should quit during record/pause, the stop mode continues for 1 second and power shuts down, effecting the emergency mode. This mode can be caused by a no-supply-reel sensor input, no capstan flywheel pulses, mode control loading and unloading for more than 10 seconds with no shift, or undetected drum pulses.

User Comment

Like its competitors, this Zenith camcorder is a first-time attempt at a combined video camera/recorder. In spite of some faults, it does the job for which it was designed. Its easy-touch control buttons and clearly labeled switches are a pleasure to use, as are its good sensitivity, zoom, and iris controls.

The REC button permits a scene to be previewed *before* you begin recording, and the stop/record function revs up the motor so that it's up to speed and permits recording to be instantaneous when the trigger switch is touched. Rewind and fast-forward gallop along at three times the normal $\frac{1}{3}$-in.-per-second writing speed, and a memory feature will locate tape positions you want the camcorder to remember later on during playback and stop.

This is primarily a hand-held—not a shoulder—product. Its small 4-to-5-lb. weight rests mostly on the heel of one hand. Therefore, you may want to steady the camcorder with the other hand when shooting certain scenes and engaging controls.

Vertical and horizontal resolution, S/N, and low light level pickup are either average or better than average for a camcorder. Grey-scale linearity is almost exceptional. We wish, however, that colors did not contain so much yellow on playback, that recording could be controlled with a single button, that the motor be made a little quieter, and that battery and cassette operation lasted considerably longer than they do.

These slight negatives aside, we give JVC and Zenith at least an A for effort and an 8 out of a possible 10 for execution. The first time out of the gate, the Model VM6000 represents a worthy VHS challenger to 8-mm camcorders. —*Stan Prentiss*

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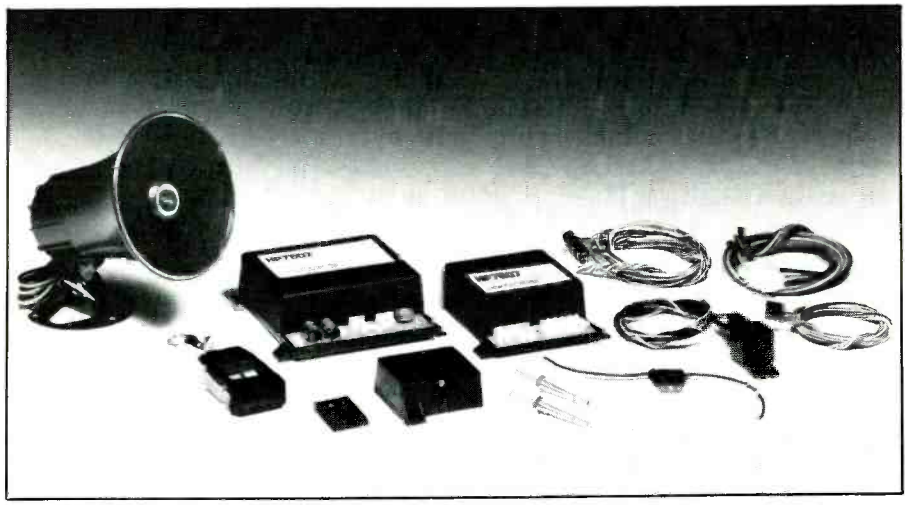

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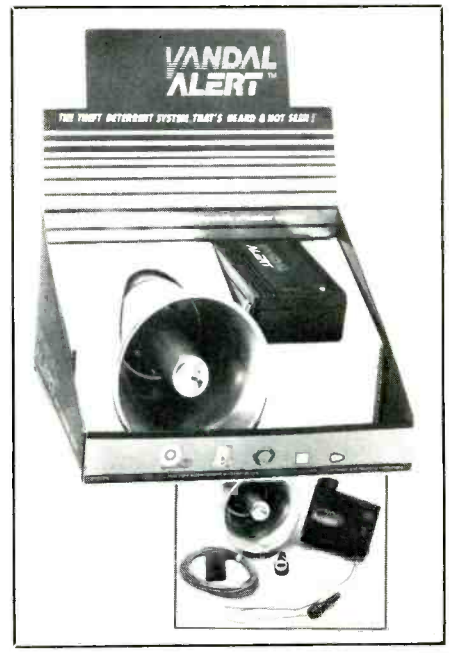

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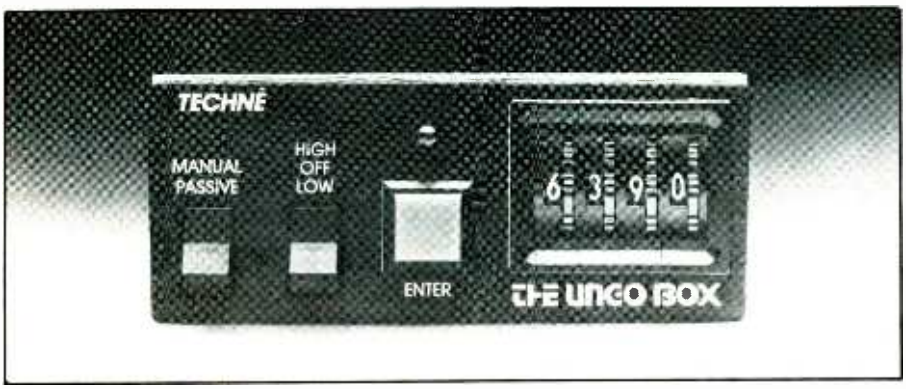
mits it to be mounted in any orientation without disrupting its sensitive motion-sensing system. This provides complete perimeter protection without the problem of false alarms caused by wind, variations in temperature, or parking conditions that aren't level. Using passive arming and instant triggering, it requires a disarming activator (supplied) to permit entry without tripping the alarm. The system has an automatic shutoff and rearm feature and is expandable to incorporate other security devices, such as pagers, system interrupters, etc. It can be installed in vehicles with 6- or 12-volt, negative- or positive-ground electrical systems.

7. The Model 5980 ($99.99) from Sears, Roebuck & Co. is a passive alarm system that automatically arms itself when the ignition is turned off and the last door is closed. The alarm "chirps" briefly after door closure to signal that the system is arming. An adjustable motion detector monitors for illegal towing, jerking and jarring, as well as entry via hood, doors, and trunk. Once activated, the system's high/low siren sounds for one minute before shutting down to allow the sys-



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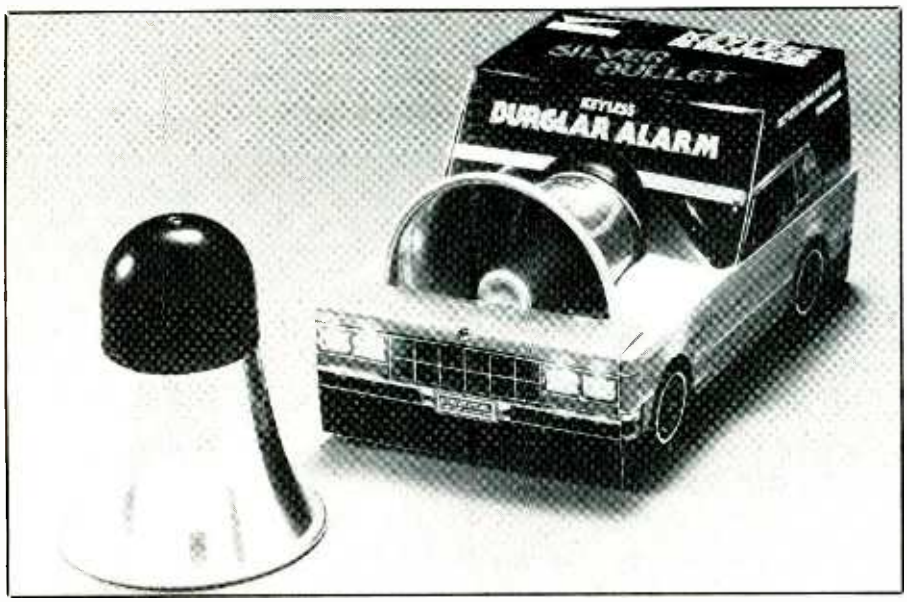

(10)

tem to rearm itself. A starter disabling switch is also included in the alarm package for optional use.

8. Sun Electric markets a complete line of vehicle security systems, including the Model VP9002 ($52.60) shown here. This alarm is one of the simpler and least expensive models available. It's manually armed via an auxiliary key switch that mounts in an inconspicuous location on the vehicle's exterior. Triggering is accomplished by current-sensing circuitry that monitors the vehicle's existing door-jamb switches and pin switches installed under the hood and trunk lids. A mechanical police-type siren (not legal in some municipalities) is supplied with this system. If you prefer a legal solid-state siren, you can obtain the Model VP9001 ($36.75) that operates identically, except that it sounds a high/low siren.

9. The Model TL-3000 "Ungo Box" ($369.00) from Techne Electronics is one of several excellent alarm systems available from this company. Using low-power CMOS gate-array-circuitry, Ungo offers either passive or manual arming and has beeping audio and flashing LED visual reminders that temporarily come on to inform you that the system's time-delay arming countdown has begun. To disarm the system, you must dial in a four-digit numeric code known only to you. All doors, hood and trunk are "bugged" with pin switches, and a motion-sensing system protects against jacking and towing.

10. Universal Security's "Silver Bullet" alarm ($70.25) utilizes custom single-chip technology to offer one of the slickest, easiest-to-install auto alarms ever. Only four wires connect to the vehicle's electrical system, all inside the engine compartment. So there's no need to drill holes to route wiring through the firewall. The alarm is armed by briefly flicking the headlights on and then off after the engine is shut off to initiate a 45-second delay before the system arms itself. A 13-second entry delay allows you to enter your vehicle and switch on the ignition to disable the alarm. Three different alarm sounds are offered by this system. **ME**

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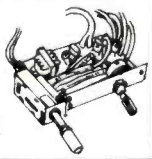

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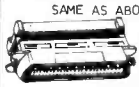

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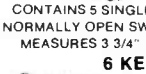

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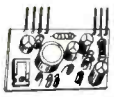

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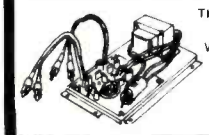

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You learn at your own convenience, in your own home, at your own comfortable pace. Without classroom pressures, without rigid night-school schedules, without wasted time. Your own personal NRI instructor and NRI's complete technical staff will answer your questions, give you guidance and special help whenever you may need it.

New from NRI—the only home study course that trains you as you assemble a top-brand computer!

After you construct this digital logic probe, you'll install the "intelligent" Sanyo detached keyboard, with its dedicated microprocessor.

You next assemble the power supply into the main unit of the computer. Using the digital multimeter, you check all keyboard connections and circuits.

After you install the disk drive and monitor, you'll make a backup copy of the MS-DOS operating disk, explore the 8088 microchip and additional circuits.

The Exciting Sanyo MBC-550-2—Yours To Keep

Critics hail the new Sanyo as the "most intriguing" of all the IBM-PC compatible computers. It uses the same 8088 microprocessor as the IBM-PC and the MS/DOS operating system. So, you'll be able to choose thousands of off-the-shelf software programs to run on your completed Sanyo.

As you build the Sanyo from the keyboard up, you'll perform demonstrations and experiments that will give you a total mastery of computer operations and servicing techniques. You'll do programming in BASIC language. You'll prepare interfaces for peripherals such as printers and joysticks. Using utility programs, you'll check out 8088 functioning. NRI's easy step-by-step instructions will guide you all the way right into one of today's fastest growing fields as a computer

service technician. And the entire system, including all the bundled software and extensive data manuals, is yours to keep as part of your training.

How the pro computer critics rate the Sanyo 550:

"Sanyo BASIC is definitely superior to IBM Microsoft. . . lets you use two or three keystrokes for entering BASIC commands."

—MICROCOMPUTING Magazine

". . . compares favorably with the IBM PC, even surpassing it in computational speed. . ."

—COMPUTERS & ELECTRONICS Magazine

Your NRI Course Includes a Sanyo MBC-550-2 Computer with 128K RAM, Monitor, Disk Drive, and "Intelligent" Keyboard; The NRI Discovery Lab®, Teaching Circuit Design and Operations; a Digital Multimeter; Bundled Spread Sheet and Word Processing Software Worth $1500 at Retail—and More.

"I went to have a look at the MBC-550. . . what I found made me an owner the next day!"

—Bill Sudbrink, BYTE Magazine

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(from page 66)

tain its charge if it is not of high quality or if a low-impedance voltmeter is used to monitor the level of its charge. The circuit will, however, hold a charge for several minutes or even much longer if a good quality, low-loss Mylar or polystyrene capacitor is used for *C1*. It's also important to monitor the output voltage with a high-impedance voltmeter to prevent *C1* from being inadvertently discharged.

Going Further

The comparator applications discussed here are among the simplest. Many other applications are available, and you can find representative circuits in semiconductor applications manuals and books about linear integrated circuits. I'll include additional comparator applications in a future column. **ME**

Reader Question

I find infrared diodes work very well for intrusion alarms, particularly across windows, where they can be left on continuously. I put a plastic lens, used for threading needles, in front of the IR emitter. But I don't think this is a rugged enough system for outdoors use, where light fluctuations are greater, distances are longer, and the lens would get dirty. Therefore, I wonder if lasers would work better outdoors. If so, what direction would I take with lasers?
Gary Novak
Highmore, SD

In principle, both helium-neon and diode lasers might work better outdoors. But AlGaAs infrared-emitting diodes will provide a more reliable, less costly system. For high output power, drive the diodes with hefty current pulses. For optimum sensitivity, use a pin photo-diode detector. This detector has a linear response over a very wide range of light levels and will, therefore, work outdoors in daylight. You'll need an infrared filter if direct or reflected sunlight strikes the detector. For more information about infrared-emitting diodes and photodiodes, see The Forrest Mims Circuit Scrapbook *(McGraw-Hill, 1983).*

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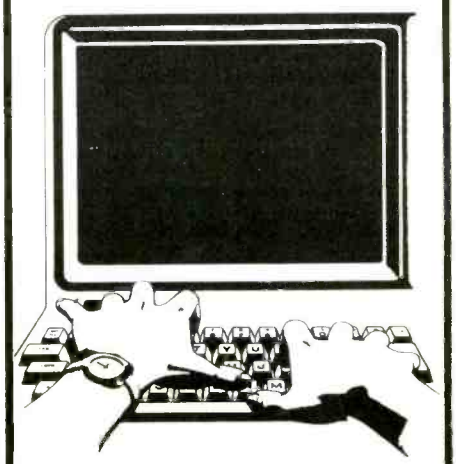

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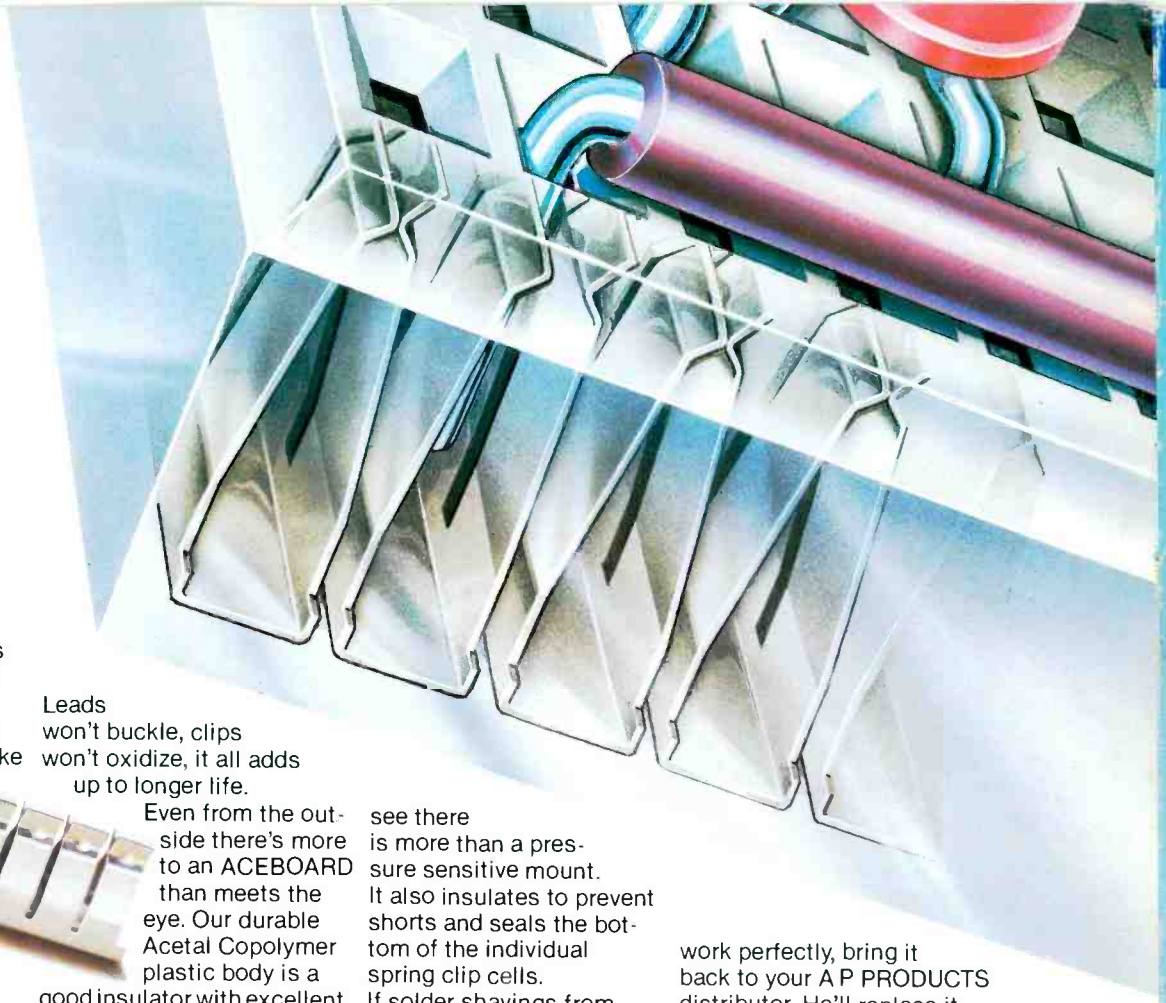

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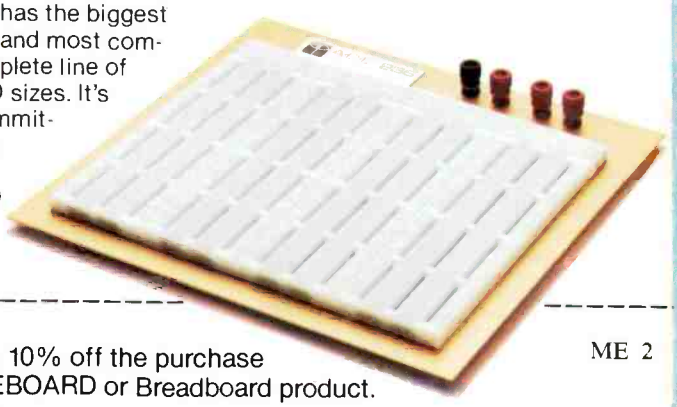

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