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THE MAGAZINE FOR ELECTRONICS & COMPUTER ENTHUSIASTS

- **ANALOG ACQUISITION UNIT COMPARES, PLOTS & ANALYZES CIRCUIT DATA**
- **MAKING VCR HOOKUPS WITH CABLE TV BOXES**

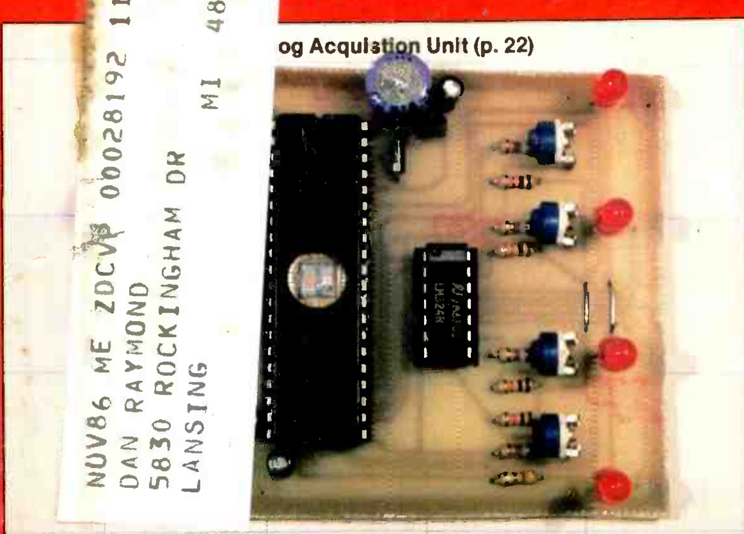

10-Channel Wireless Home Security System (p. 38)

Full Construction Plans:

- A 10-Channel Wireless Home Security System
- An EPROM Programmer For C... e-64 Computers
- A ... Type Desoldering Tool

Also:

- Optical Isolator Basics
- Adding Sound to Video Monitors
- Automatic Telephone Ringer Silencer


...og Acquistion Unit (p. 22)


EPROM Programmer For Commodore C-64 (p. 52)

Plus: Forrest Mims's "Custom Timer Circuits" • Eric Grevstad on Student WordPerfect, Multifunction Modem and Le Menu • Don Lancaster discusses the Apple II GS, a Cheap EPROM Eraser, D/A Converters • Evaluating John Fluke's $12 Current-Measuring Accessory and a Computer-Interactive Construction Kit • Electronic & Computer News . . . and more.

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VOLUME 3, NUMBER 11

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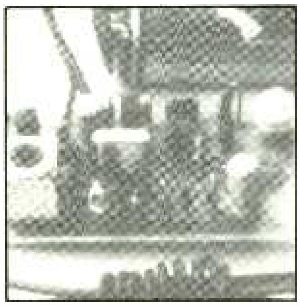

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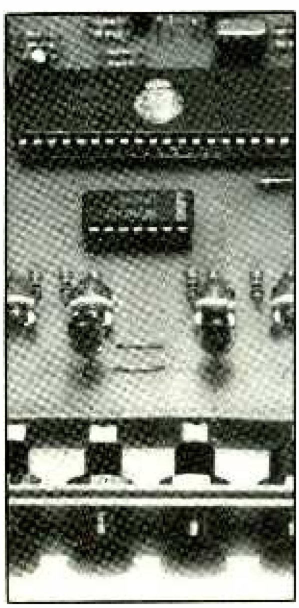

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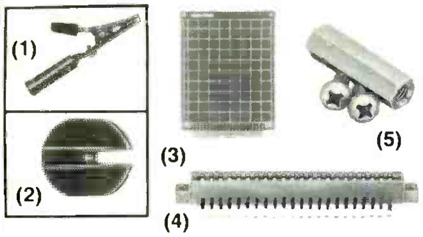

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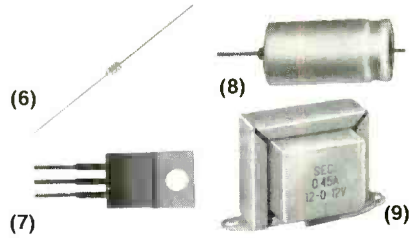

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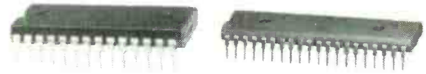

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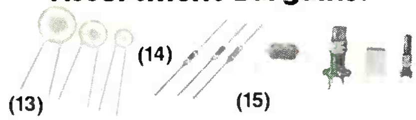

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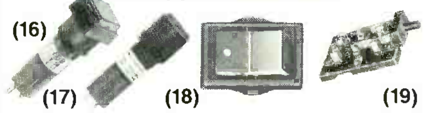

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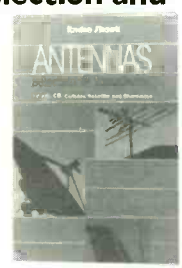

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EDITORIAL

Breaking The Bell Connection

There are three apparent results from the breaking up of AT&T: higher consumer prices, more advanced telephone equipment, and long-distance phone service competitors such as MCI and SPRINT.

The first, higher consumer prices (for local service), might have people wondering about the benefits of breaking up Ma Bell. Shouldn't such costs go down instead of up? Well, yes and no. Part of the answer has to do with the introduction of technologically advanced equipment, but in a way you might not imagine.

AT&T, before divestiture, was able to get depreciation of its equipment stretched out to as long as 40 years. With such a wonderful cost recovery deal, it paid to keep existing equipment running instead of upgrading. Great for AT&T's then-subsidiary, Western Electric, which made electromechanical relays, I suppose, but certainly such archaic equipment imposed limitations on communications advances that end users could enjoy.

Without the long-term equipment depreciation deal and competition all over the place, the change to solid-state switching and other new technologies increase costs, which, in turn, caused our local phone rates to rise. The truth is, though, that the present rates are not terribly outrageous. It's just that earlier rates were so nice and low. (As proof of this, phone service costs since the AT&T breakup have risen only about half as much as did the Consumer Price Index.)

The new, smaller Bell regional operations actually subsidize local phone service, believe it or not. The tinier Bells, like its earlier parent, have to offer phone service to everyone, while competitors can pick and choose areas.

Meanwhile the new Bells (there are seven regional ones) are acquiring and starting a host of new businesses. And making plenty of mistakes, too, that come out of profits. Some have computer retail stores, equipment leasing companies, software publishing companies, real estate operations, credit companies, and so on. It's nice to be able to do this out of profits. But what happens when profits dwindle, as they might as tough competitors force phone service prices down? After all, MCI's sales-per-employee doubles that of AT&T's. Furthermore, non-Bell fiber-optic cable systems that are moving ahead provide long-distance hookups while bypassing local ones. This has the makings of hitting the Bells where it hurts (and where they're getting the profits to take care of in-the-red operations like local service and trying to become retail entrepreneurs in a hostile, unfamiliar world).

We've all gone through some bad times with the phone companies and equipment makers since the Justice Department put an end to a benign monopoly. Much equipment made by new competitors was poorly made; private-line connections often dropped out in the middle of a conversation or were unintelligible, and so on. But things are improving. It's not as nice and neat as in the old days, but certainly more exciting.

Art Salsberg

• Several errors crept into my "Digital Measuring System" article (August 1986). In Fig. 1, J2 should be numbered in ascending order from top to bottom and a shorting link with the legend "typical" should bridge R_Z. In the Panel Meter Parts List, change the transistor number from 2N2222 to 2N2907A (shown correct in Fig. 1) and the manufacturer name to "Bourns" for R4 and R5. In the Technical Specifications Table change the "accuracy at 25° C" entry to read "±0.1%, ±1 count." Finally, reverse the J2 numbering in Fig. 6.

Charles R. Ball
Snellville, GA

• Yours was a very welcome article on upgrading the CoCo II to 64K RAM, Extended BASIC and the 64-column video output in September 1986's *Modern Electronics.* I carefully opened my CoCo II, but the layout was nothing like your illustrations. The eight 16K RAMs are across the front of the motherboard in a single line. There appear to be no pads marked 64K RAM, and every socket is filled.

This model is possibly an early one that doesn't have the shield over the RAM, but I don't recall whether or not Extended BASIC was mentioned although the 64K RAM was listed in the manual. Possibly, you might know how this type of CoCo II can be changed. I hope to use this computer for my electronic organ service business.

Herbert O. Karnes
Gorham, ME

Sorry you cannot use the article directly to upgrade your CoCo II, but it was clearly stated that the upgrades were for the latest version: the model Radio Shack was selling at a "bargain price." You have an older version; from your description, I would say the first of many CoCo II models. If, as you say, there is no empty socket, your CoCo most likely already has Extended BASIC.

What you need is a retrofit kit and instructions specifically for your model. It is possible that the kit is still available from the source in the article.—Author.

COMPUTER UPGRADES. You can expect new computer models to be introduced in quick succession by major players in the industry. IBM has already announced its upgraded PC-XT with Intel's faster "286" cpu and a 20-MB hard disk drive, while Compaq debuted its "286"-based computer, to be followed shortly by a new multiuser machine using Intel's more powerful 80386 microprocessor. Another major, this time a software one--Lotus Development--is shipping Symphony Release 1.2, an enhanced version of its original...An open-architecture Macintosh with IBM-PC compatibility is rumored as soon to debut...So is a WordStar 4.0. For both, it would be long overdue. Software giant Microsoft has introduced a new version of its Windows operating environment package, now Release 1.03, that has drivers for Apple Computer's Laserwriter, Hewlett-Packard's LaserJet Plus, and more.

R-F ANALOG ENGINEERS WANTED. In a supposedly digital world, it's interesting to observe a great shortage of engineers with radio-frequency analog experience. There's been an increase of about 30% in demand over the last year, noted Dick Govatski of Christian & Timbers, a Boxborough, MA and Cleveland, OH-based executive search company.

VIDEOCASSETTE HAPPENINGS. "VCRfacts" tech service documentation for videocassette recorders has been introduced by Howard W. Sams & Company. The new repair information product retails for $21.95 for each brand model, with a format similar to the company's line of "Photofact" and "Computerfact" packages. Sams promises to have 52 brand and model-specific units by February 1987...Educational TV in the form of a video tape that documents various uses of bar-code data in a manufacturing environment has been introduced by Intermec Corp., Lynnwood, WA. Titled "Introduction to Bar Code Applications," a VHS (1/2") cassette costs $25.

COMMUNITY COMPUTER SERVICE. A free, open-access community computer information service has been started for the Cleveland metropolitan area. It's arranged like an electronic city, with a "post office" for electronic mail, a "schoolhouse" for use by Cleveland area public and private schools, and a "hospital" and "courthouse" where medical, dental and legal questions can be asked with answers by teams of qualified professionals. There's also a "government house" where area residents many contact their elected representatives and a "public square" with a "podium" where users can give electronic "speeches." Credit Tom Grundner, an assistant professor at Case Western Reserve University, for conceiving the system and a $50,000 donation from AT&T's Information System Division, as well as individuals and organizations in the Cleveland area who volunteer skills and time. Users can access the system with a computer and modem, dialing 216-368-3888 to read anything they wish. To place material on the computer and have electronic mail privileges, however, one simply needs to fill out a form, send it to CWRU (University Communication, 1 Adelbert Hall, Cleveland, OH 44106), and get an ID number and password in return. There's no charge. If any qualified group wishes to duplicate this system in other cities, the software is available for one dollar (that's $1).

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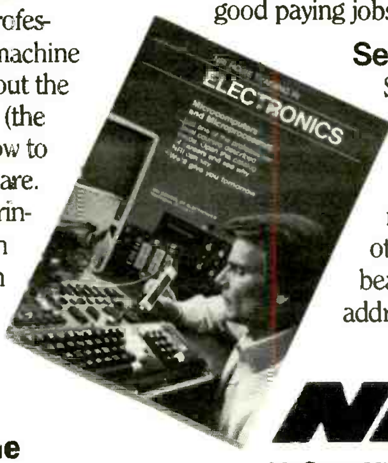

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NEW PRODUCTS

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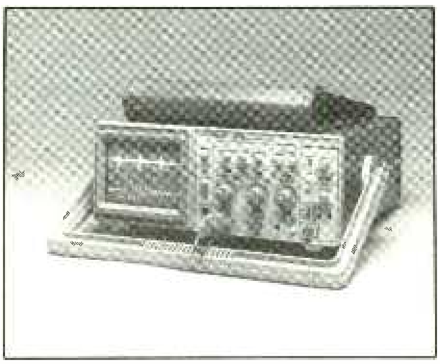
Tektronix' $995, 50-MHz Dual-Channel Oscilloscope

With its new $995 Model 2225 two-channel, 50-MHz portable oscilloscope, Tektronix sets its sights on the lower-end general-purpose instrument market. Primary among this scope's features are a rated sensitivity of 500 microvolts, alternate magnification, auto trigger mode and high/low-frequency trigger filtering. Alternate magnification allows the user to view both magnified and unmagnified sweeps simultaneously and to independently position the magnified sweep with reference to the unmagnified sweep. Magnification is selectable in 5×, 10× and 50× levels.



With its 500-μV sensitivity, the Model 2225 is four times more sensitive than previous Tek Model 2200s, which makes it ideally suited to applications involving low-level signal measurements. The high-sensitivity vertical channels can be used in a differential mode for making signal comparisons, as well as in an add mode.

Trigger filtering allows the user to selectively filter out unwanted low- or high-frequency components from the trigger signal. Other features include: normal, peak-to-peak auto, single-sweep and TV line and field triggering; variable holdoff for triggering on complex waveforms; a beam-finder for quick waveform location; simplified front panel layout; high-brightness/contrast flat CRT with built-in graticule; and carrying handle that doubles as a tilt stand. Also available is a Model P6103 10×, 50-MHz passive probe with screw-in replaceable probe tip. $995 for Model 2225 oscilloscope; less than $50 for Model P6103 probe.

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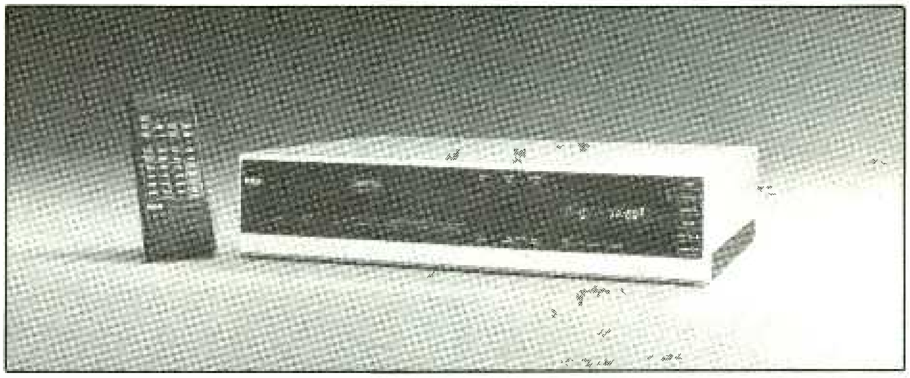


Picture-Within-Picture VCR

RCA has announced the first videocassette recorder for the home market capable of providing two separate programs simultaneously on the same TV screen. Its picture-within-picture capability lets the viewer watch a taped program and, in a separate on-screen window, a second picture on any of the VCR's TV channels. The window first appears about 1/12 size in the lower-right corner, but it can be moved to any other corner and can be blown up to fill the screen as desired.

New digital technology is responsible for the picture-within-picture feature. It lets the viewer "freeze" the live picture on the broadcast channel and enhances special effects to provide virtually noise-free pictures. On top of this, the digital circuitry can give the picture a "mosaic" or a mottled oil-painting appearance like that used in professional music videos. A scene transition stabilizer minimizes picture breakup in pause.

Standard features include: remote programming with on-screen display; delayed-start express recording; VHS HQ circuitry for compatibility with other VHS machines; frequency synthesized 119-channel tuning; automatic program tuner; 4-event/1-year timer; automatic rewind; and a full-function wireless remote controller. $700.

CIRCLE 31 ON FREE INFORMATION CARD

Digital LC Bridge

Heath's Model IT-2240 kit is reported to be a laboratory-accurate digital LC bridge that measures capacitance, inductance and their associated dissipation (loss) factors. Measuring range is from less than 1 pF to 2,000 F and 1 μH to 2,000 H with a rated accuracy of ±0.5%, each in eight user-selectable ranges. Resolution is 0.1 pF/01 μH on the lowest ranges. Dissipative factor range is from 0.000 to 1.999, ±3.0% on all ranges. Stray capacitance on the lower ranges is nulled out with a front panel control.

A 4-terminal Kelvin connector and an accessory cable make it possible for the instrument to accommodate any size component. Connectors on the rear panel allow an external 0 to 10 volts dc to be fed in for batch testing and provide an output that can be used to drive a plotter for charting capacitance/voltage curves. All inputs and connectors are overvoltage protected.

Measurement results appear in a 3½-decade LED display that features automatic decimal-point location. The instrument measures 12.5"D × 10"W × 3.75"H and weighs 6.5 lbs. $269.95.

CIRCLE 32 ON FREE INFORMATION CARD

Notebook Computer With 4-Color Plotter/Printer

Sharp Electronics' new PC-2500 portable notebook computer offers on-the-go users built-in business software and a register-tape-width 4-color plotter/printer. It features a QWERTY-style keyboard with eight special function keys; a 150×32-dot graphics or 24-character×4-line text LCD screen; cassette interface; and serial I/O port.

The built-in color plotter/printer provides hard copy text and graphics in black, red, blue and green. The built-in business software includes a spreadsheet and utilities for plotting graphics patterns. Optional 8K and 16K battery-backed RAM cards allow the computer's user memory to be expanded to a maximum of 21K.

Including built-in plotter/printer, the PC-2500 measures just 11.75"W ×8.25"D×1.75"H, and weighs only 3 lbs. with built-in plotter/printer. $395; $75 and $125 for optional 8K and 16K RAM cards.

CIRCLE 33 ON FREE INFORMATION CARD

Satellite TV Receiver With "Bells & Whistles"

Built into R.L. Drake's microprocessor-controlled Model ESR2400 satellite TV receiver are virtually all the features one can conceive: an antenna positioning system, a VideoCypher II decoder, DNR audio noise reduction and an on-screen display generator, among others. The receiver can also be had without the decoder, which can be added later. The on-screen display contains such information as tuned channel, satellite selected, polarity and signal strength.

Among the receiver's other features are: priority view (allows up to 19 channels to be preprogrammed into memory for instant recall); parental lockout; antenna positioning programming (up to 30 channels); block system technology; full-function IR remote controller; composite video input and i-f loop-through for TI filters; and the ability to accommodate either matrix or discrete stereo transmission modes.

Using a 950-to-1450-MHz block input frequency, this block-conversion receiver also features dual-input switching that eliminates a need for external relays or switching splitters. It accommodates either two C-band LNBs or one C- and one Ku-band LNB and is compatible with all Drake LNBs and BDC24 block downconverter. About $1,500.

CIRCLE 34 ON FREE INFORMATION CARD

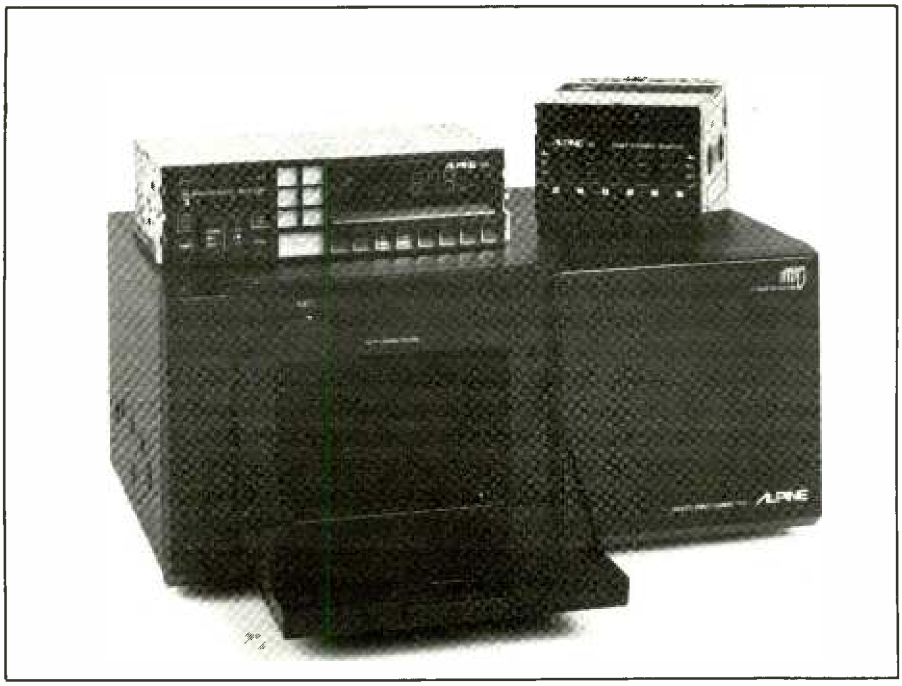
SMD Soldering Kit

New from Jensen Tools Inc. (Phoenix, AZ) is a shop/field soldering kit designed specifically for work on surface-mounted devices (SMDs). The kit includes a Soldermaster miniature soldering iron for use on high-density board assemblies and a variety of SMD-style tips for leaded and leadless SMD packages. The tips are shaped for use on most popular size 1206 chip components, SOT-23 transistors and SOIC packages.

Incorporated into the soldering iron is a Posi-Ground feature that is claimed to ensure less than 2 millivolts of leakage to comply with MIL Specs, making it safe to use on voltage-sensitive components. A self-compensating heating element maintains tip temperature at 750 degrees Fahrenheit. Adapters are also in-

cluded for using the SMD tips with other soldering irons and workstations. The kit comes in a handy clear-plastic case.

CIRCLE 35 ON FREE INFORMATION CARD



Car Radio With Cassette Changer

Alpine's Model 7375 car radio system features a trunk-mounted cassette changer/player that plays up to six tapes in any order. A fiber-optic link that uses a single pulse-coded digital light beam couples the control head unit and the player/changer to greatly reduce ignition noise from entering the system. The cassette changer features: a tape magazine that can be individually set to the appropriate type of noise reduction (dbx, Dolby B or Dolby C) for each tape; an HLTAC tape head; Alpine's GZ transport mechanism; an Auto Cassette Initializer that rewinds the selected tape to its beginning; and a Programmable Music Sensor that locates any of nine selections per tape.

The AM/FM-stereo radio unit offers 12 FM and 6 AM presets. A unique Radio Monitor function allows listening to the radio when a tape is in fast forward or rewind. The LCD time/frequency display appears in green in the tape and red in the radio modes.

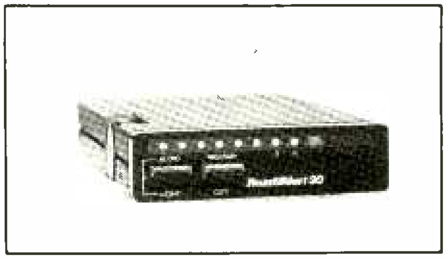
Specifications: Tape—0.05% wrms wow and flutter; 20 to 20,000 Hz +3 dB frequency response; 40-dB separation; 86/72/64/55-dB S/N with dbx/Dolby C/Dolby B/no noise reduction. Tuner—1.8 μV usable FM sensitivity (12 μV AM); 2.0 dB capture ratio; 35-dB separation; 80 dB alternate-channel selectivity; and 60-dB S/N. The control unit measures 7"W × 2"H × 13$^{15}/_{16}$"D, while the trunk unit is 13$^{13}/_{16}$"W × 5$^{7}/_{8}$"H × 9¼"D.

CIRCLE 36 ON FREE INFORMATION CARD

New Radar Detector

Road Alert 30 heads up a new line of radar detectors from Sparkomatic. This dual-conversion X/K-band detector features antifalsing circuitry that identifies and eliminates interference signals to assure accurate radar detection. Among its other features are: a LED signal-strength "meter"; illuminated X- and K-band (short-range) signal indicators that tell the driver which kind of radar is being received; another indicator that lights when correct radar signals are being received; and a highway/city control that adjusts filtering and sensitivity to prevent false alarms.

Upon power-up the Road Alert goes into a test mode to inform the driver if the system is working properly. A three-position switch permits selection of audible, visible or both types of alerts. A variable audible alarm indicates signal strength and radar intensity. A photoelectric sensor automatically adjusts the brightness of the front panel displays for daylight and night driving conditions.



The detector measures 4.25" × 2.72" × 0.75", making it small enough to mount on a visor or on a dashboard. It comes with all mounting hardware and cables. $199.95.

CIRCLE 37 ON FREE INFORMATION CARD

Replacement RTC Battery

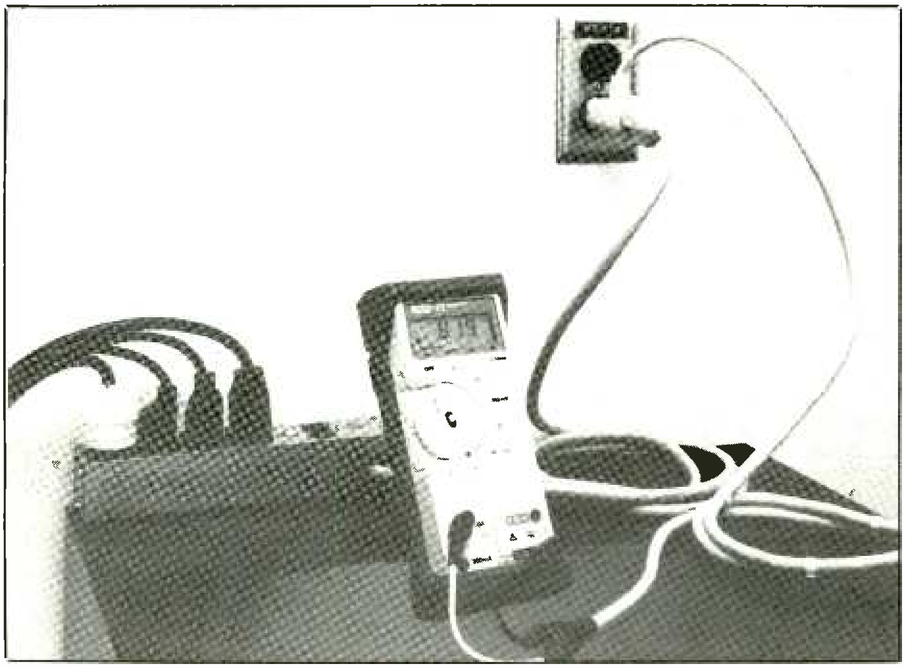
International Battery Corp.'s (Reseda, CA) Tadiran battery is a replacement for spent batteries in the real-time clocks (RTCs) in IBM PC/AT

and compatible computers to maintain the integrity of data when ac power is turned off. The lithium battery installs on the motherboard with a Velcro adhesive strip. $27.50.

CIRCLE 38 ON FREE INFORMATION CARD

CIRCLE 29 ON FREE INFORMATION CARD

John Fluke's New Development: A $12 Current-Measuring Accessory



Fluke's low-cost Line Current Adapter is shown plugged into a model 23 DMM, while the other end has devices to be tested plugged in and the accessory in turn is plugged directly into a 120-V ac wall socket.

John Fluke Manufacturing Company has introduced a wonderful multimeter accessory that's priced at only $12. It enables a multimeter to read ac current of most 120-volt appliances without having to cut into or separate any wire leads.

The line current adapter, model LCA-10, is so simple it's a wonder that no one ever developed it earlier. Resembling a heavy-duty yellow electrical extension cord, the 5-ft.-long accessory has a combination three-prong plug and receptacle at one end and white and black leads terminated in banana plugs at the other end. To use the accessory, simply set a multimeter to its 10-ampere ac range and plug the leads into the meter's appropriate inputs.

Then the electrical device whose current drain is to be measured is plugged into the adapter's receptacle while the three-prong plug at the same end is plugged into a 120-V ac outlet. This places the meter's current shunt in series with the 120V ac live wire.

Turning on the device, which may be a toaster, refrigerator, air conditioner, computer, etc., enables the multimeter to display turn-on surge current, normal current, or standby current without any muss or fuss.

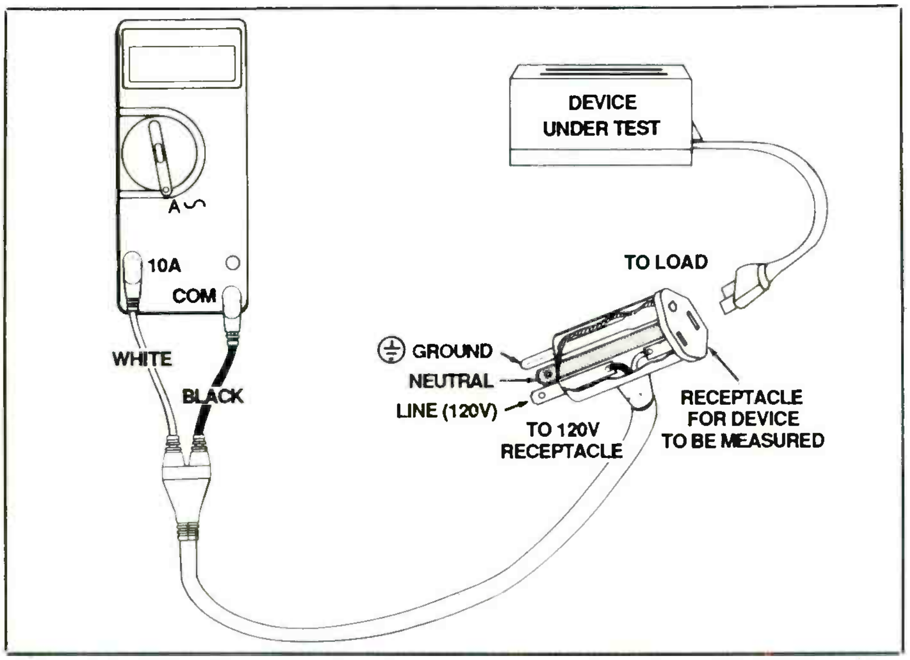
The plug/receptacle is rated at 15A, 125V ac, with maximum continuous current of 10A ac. It can withstand 20A ac safely for 30 seconds, according to the manufacturer.

I tried the adapter out with an old window air conditioner to learn how much current it was drawing, using a new Fluke Model 23 digital multimeter. Pressing "High" on the two-speed unit caused "OL" (overload) to be displayed on the DMM, which quickly changed to 8.5. Thus, the compressor's initial surge exceeded 10 amps, while the running current was 8.5 amps. I followed the same quick procedure with a multiple-tap/surge protector that has a computer system (640K of RAM and a hard disk drive) plugged into it along with other devices. With two telephone answering machines on, the meter displayed 0.03A. Turning on the computer increased the reading to 0.7A initially, which settled to 0.69A. Switching on a dot matrix printer rasied this to 0.86A (reaching 1.19A when operating), while adding an electric typewriter boosted the reading to 1.03A.

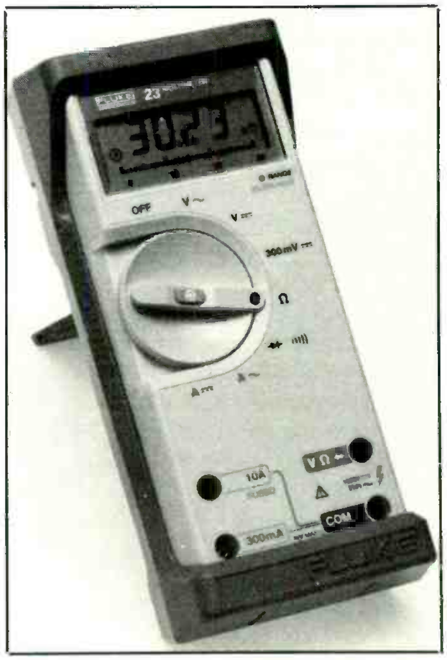
Setting up for measuring current was therefore a snap. All made possible with a $12 accessory.

The accessory can be used with any multimeter that has a 10A ac range and recessed inputs to accommodate shrouded banana plugs. Not all multimeters are designed this way, of course. Some meter brands have safety recessed inputs that require shrouded female plugs. In such a case, the plug leads can be easily changed, taking care that spliced connections are sound and properly insulated. Fluke, of course, designed the plugs to mate with their instruments. Be sure, too, that the accessory is not used on lower-than-10A ranges, especially since turn-on current is often many times greater than normal running current.

This accessory does not spell the



A break in LCA-10 receptacle places an ammeter in series with 120V ac line, making it easy to accurately measure current drawn by a device.



Fluke's 3½-digit Model 23 also features an analog bargraph display.

death knell for clamp-on current probes, which are much more costly. They are still as useful as ever for measuring current that greatly exceeds 10 amps and for checking out an integrated electrical device, say, a clock timer that's part of a refrigerator's innards, which has separate leads . . . all without touching a live wire. But to quickly (and accurately) measure current drawn by the whole unit (up to 10 amperes steady power consumption), nothing beats this little, low-cost device since you needn't uncover a separate wire, as you'd have to with a clamp-type probe.

The meter we used, a $149 Fluke Model 23 portable, is a neat DMM unto itself. It has recessed inputs to accept shrouded banana plugs, naturally, and its internal fuses include high overload protection and a fused (0.36-ohm fusible resistor) 10-amp range. The latter provides interrupt protection to 100,00 amps, says the manufacturer, while a 430V MOV (metal-oxide varistor) in series with a spark gap gives volt/ohm protection. Among its generous features are autoranging, auto-zero, auto-polarity, an audible beeper for continuity and diode tests and an appropriate easy-to-use rotary dial.

Additionally, the DMM has a 31-segment analog bar graph display for easier reading of fluctuating signals and for zero adjustments, as well as large, bold LCD numeric readouts, Another useful feature is the 23's "Touch Hold" button that locks in a displayed reading when the button is pressed, enabling the tester to concentrate on where he's touching the probes. The DMM goes through a two-second self-test when turned on, emitting a chirping sound to show that everything's okay. The beep sounds to indicate continuity, too, so you don't even have to look at the display.

Ensconced in a rugged, yellow-color case that measures 1.12″ × 2.95″ × 6.55″ and weighing only ¾ lb., the Model 23 also comes with a protective holster case in which it can be set in. The holster provides a belt hook for convenient carrying purposes.

Both DMM and the line current adapter performed admirably, independently and together. Again, we tip our hats to Fluke for introducing the $12 current adapter. It's certainly an innovative accessory.

—*Art Salsberg.*

CIRCLE 26 ON FREE INFORMATION CARD

The Multibotics Workshop: A Computer-Interactive Construction Set

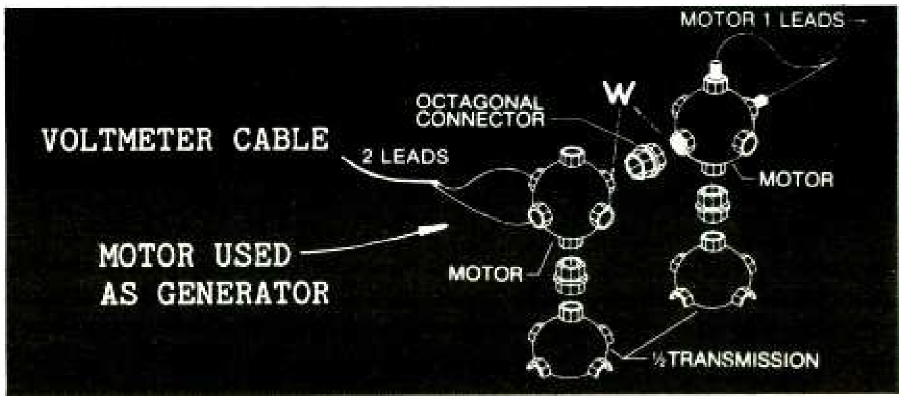
The Multibotics Workshop line of kits is designed to teach principles of computer-controlled electro-mechanical operation through experiments with hardware and software. Distributed by Access Software, Inc. (2561 So. 1560 West, Woods Cross, UT 84087), each Workshop model contains a computer interface unit, motors, sensors, snap-together mechanical parts, software, and project/experiment instructions in a 136-page spiral-bound manual.

The Model MB230 workshop model we examined, which included an interface for a Commodore C-64 or C-128 computer, costs $129.95. Similar Workshops are available for Atari 8-bit computers ($139.95), with Apple, Amiga, Atari ST and IBM versions expected to be available soon.

At the heart of the system is a B100 interface that plugs into the C-64's user port. Powered by six "AA" batteries, it has switch selections for setting up motors to be powered on or off, and switches for choosing meter/scope, infrared sensor, and audio applications. A variety of input and output jacks are included. Eight LEDs are incorporated to provide activity information.

A floppy disk contains the "Robotic Operating System" (R.O.S.), which uses the BASIC language while adding 25 special commands to make computer control more powerful, such as FLIP (reverse a motor's direction), TMR (for setting up an interrupt timing interval), and other extraordinary commands not common to BASIC.

The mechanical parts, about 50 of them, are rugged snap-together Capsela® plastic components, two of which contain tiny motors. Other parts include speed reducers to slow speed while increasing torque, a worm gear to change drive direction, a transmission to extend a motor shaft's length, an axle, four wheels and tires, connectors, couplers, a 10-ft. remote-operation cable, two pair of infrared sensors, coax cables with phono plugs, and so on.



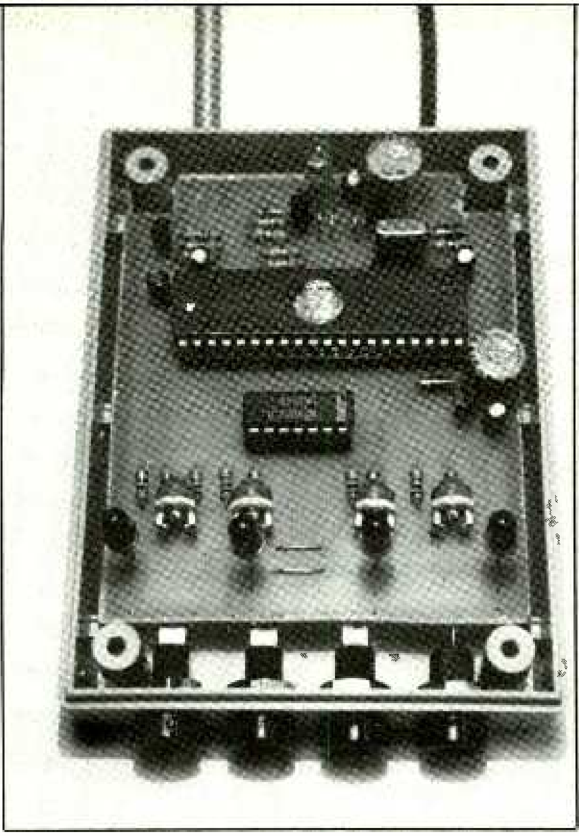
Here's an example of how to connect Multibotics Workshop's components as part of a Motor Efficiency Test experiment.

Accompanying the equipment, which requires one to also have a Commodore C-64 or C-128 computer, a video monitor or TV set, and a disk drive, is the especially fine project/experimenter's manual cited earlier. It contains 50 well-illustrated and documented projects/experiments to interact with "real-world" objects that are computer controlled. For example, the Workshop enables you to easily build a gyroscope and a generator; experiment with joysticks, light, color, check battery voltage (up to +3.6V; higher with a shunt resistor); measure rpm and speed; build a counter, burglar alarm, a car that can be controlled to go forward, reverse, left, right, brake, slow down, speed up; digital speech recording and playback (with the addition of an audio amplifier that has an auxiliary input), and a host of other applications.

In Use

It was easy to get started with the MB230 system. Instructions take you through "Getting Started," "About Electronics," and "About Mechanics" before presenting actual projects. We did bump into a problem at the onset, however, but it was easily solved. There was a poor electrical connection on one of the plugs that terminate each lead in the 10-conductor, 10-ft. ribbon cable. This was discovered when we couldn't activate one of the motors from the computer's keyboard. The motor is encapsulated in a clear plastic ball with input jacks at different ends. After correcting the problem with a touch of solder, everything else went along smoothly. The motor turned, changed direction, slowed up and speeded up in selected increments, all controlled by keyboard input.

(Continued on page 96)



An Analog Acquisition Unit

Lets a computer store, compare, plot and analyze data from your experiments and circuits

By Eugene Weber & Wayne Slugocki

One of the more interesting uses for a personal computer is to have it store, compare, plot and analyze data from your electronic experiments and circuits. Such data is usually put into the computer via its keyboard or, on a more advanced system, through a digitizing tablet. These entry methods, however, are cumbersome and subject to error. A far better approach would be to connect the experiment or circuit directly to your computer. This would provide direct data acquisition and eliminate the possibilities of errors due to manual entry of data. You can build the Analog Acquisition Unit described here to give your computer this capability.

With the AAU interfaced with your computer, you can connect up to four analog signals directly to your computer via the latter's RS-232 serial I/O port. The project is relatively inexpensive and easy to build, simple to program, and requires no modification to your computer system.

About the Circuit

At the heart of the AAU is a Motorola MC68705 microcomputer on a chip. This versatile device contains all the circuitry needed to make a complete analog data acquistion system. As shown in Fig. 1, on-chip elements consist of an 8-bit CPU, 112 bytes of RAM memory, 3.8K bytes of EPROM memory, a 4-channel analog multiplexer, an 8-bit A/D converter and all the support circuitry needed to form a complete microcomputer.

A complete schematic diagram of the AAU's processing circuitry is shown in Fig. 2, while Fig. 3 shows the power-supply circuitry for the project. Microcomputer chip *IC2* in Fig. 2, has in its EPROM a program that constantly checks for a valid serial ASCII command on pin 13. This command is generated by the computer with which the AAU is being used and is coupled into *IC2* through *Q2*. Transistor *Q2* shifts the signal level from that used for standard RS-232 transmission to the 0-to-5-volt level required by *IC2*.

Upon receiving a valid command from the computer, *IC2* samples one of the AAU's four analog inputs, shown along the left side of Fig. 2. Quad op amp *IC1* buffers the analog iputs and shifts the 0-to-1-volt input levels to the 0-to-5.4-volt levels required by *IC2*. Gain in each input channel is individually adjustable by *R2, R6, R10* and *R14*.

After *IC2* samples an input, it converts the analog voltage on that input into an 8-bit binary number. This number is then converted to its decimal or hex value, the format depending on the instruction command received from the computer. Then *IC2* outputs this number, in a serial ASCII-format data string, at pin 14. Thereafter, *Q1* converts *IC2*'s 0-to-5-volt level to the +5 volts required for RS-232 data transmission to the computer.

Light-emitting diodes *LED1* through *LED4* indicate which of the analog inputs is being sampled and are under direct control of the *IC2* microcomputer. Crystal *XTAL*

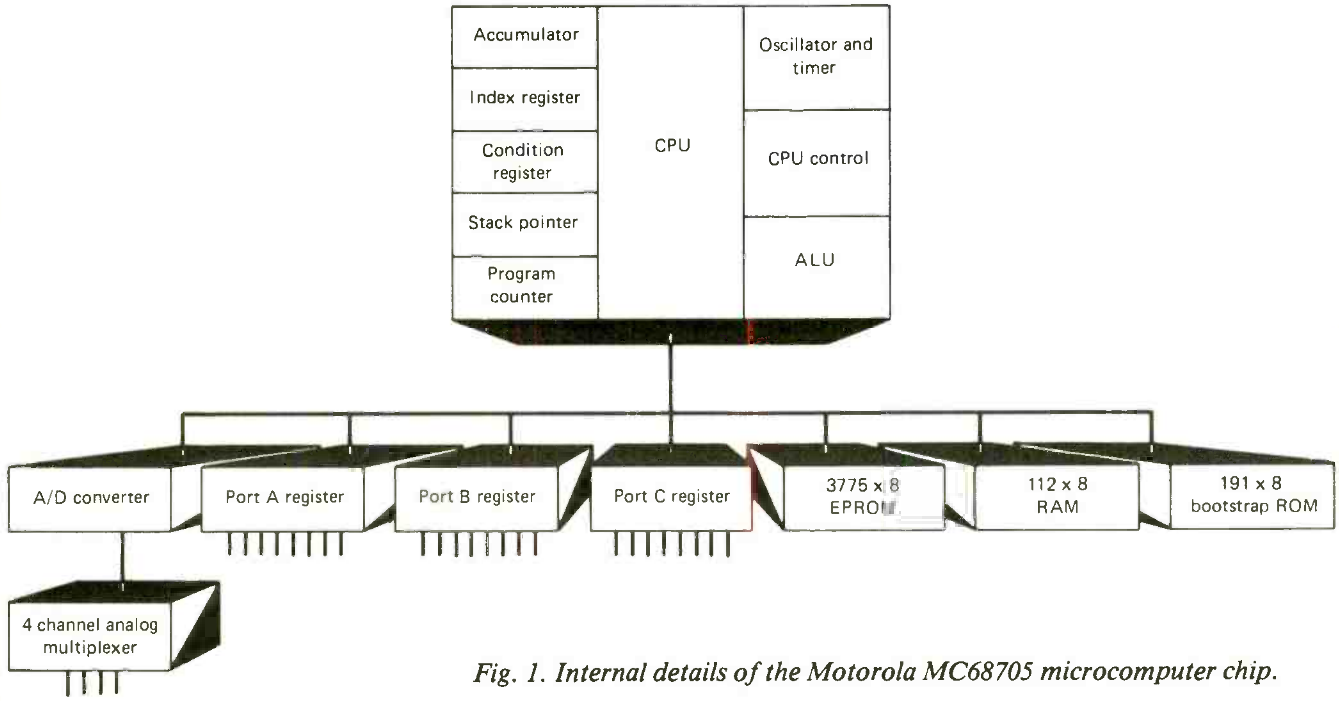


Fig. 1. Internal details of the Motorola MC68705 microcomputer chip.

Table 1. Baud Rate Options

Jumper 1 (J1)	Jumper 2 (J2)	Baud Rate
in	in	300
out	in	1,200
in	out	4,800
out	out	9,600

keeps the microcomputer chip's internal oscillator operating at a stable 4.000 MHz.

Jumpers *J1* and *J2* permit selection of the proper baud rate for communication with the computer. Table 1 lists the available baud rate.

As shown in Fig. 3, power for the AAU is supplied via a 12-volt ac plug-in transformer. The positive voltage is rectified by *D1*, filtered by *C1* and *C2* and regulated by *IC3*. The negative supply consists of rectifier *D2* and filters capacitors *C3* and *C4*, with regulation supplied by zener diode *D3*. Power-on indication is supplied by *LED5*.

Construction

Owing to the relatively low component count and the fact that there is nothing critical about parts layout, the AAU can be assembled using just about any wiring technique. Even so, a printed-circuit board is recommended. You can fabricate your own board, using the actual-size etching-and-drilling guide given in Fig. 4, or you can purchase a ready-to-wire board from the source given in the Note at the end of the Parts List. Note that this board has been designed to fit inside a popular Series 200 Unibox enclosure.

PARTS LIST

Semiconductors
D1,D2—1N4001 rectifier diode
D3—1N5232 or similar 5.6-volt zener diode
D4,D5—1N4148 switching diode
IC1—LM324 quad op amp
IC2—MC68705R3 microcomputer (Motorola)
LED1 thru LED4—Red light-emitting diode
LED5—Green light-emitting diode
Q1—2N4403 or similar pnp transistor
Q2—2N4401 or similar npn transistor

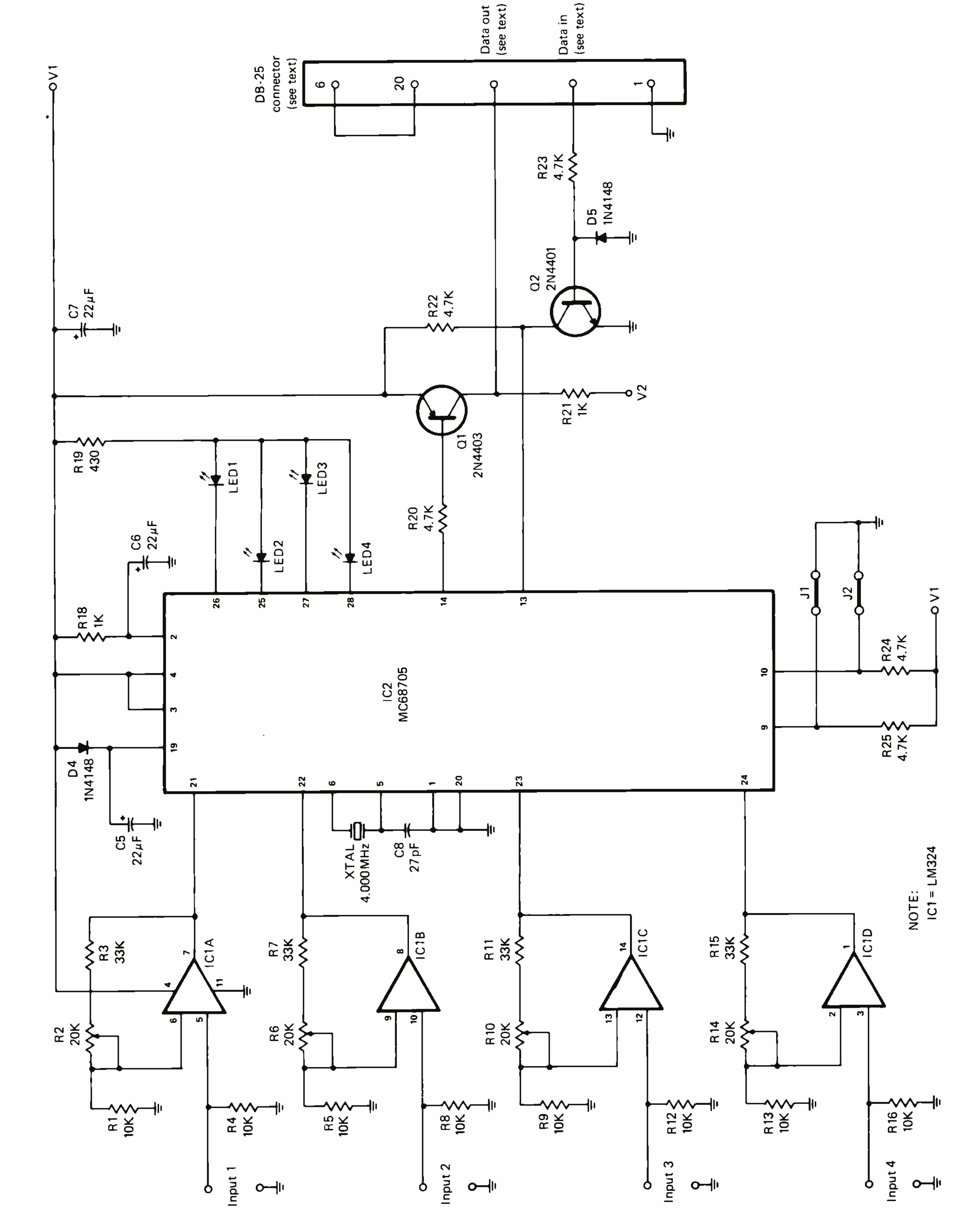
Capacitors
C1,C3—220-μF, 16-volt radial-lead electrolytic
C2,C4,C5,C6,C7—22-μF, 16-volt radial-lead electrolytic
C8—27-pF ceramic disc

Resistors (¼-watt, % tolerance)
R1,R4,R5,R8,R9,R12,R13,R16—10,000 ohms
R3,R7,R11,R15—33,000 ohms
R17—560 ohms
R18,R21—1,000 ohms
R19,R26—430 ohms
R20,R22, thru R25—4,500 ohms
R2,R6,R10,R14—20,000-ohm upright pc-type potentiometer

Miscellaneous
XTAL—4.00-MHz HC-18 crystal
Printed-circuit board; 12-volt ac plug-in transformer; sockets for ICs; input connectors; 5-conductor cable; hookup wire; solder; etc.

Note: The following items are available from GTC Industries, P.O. Box 443, Hinsdale, IL 60522: Programmed MC68705 microcomputer chip for $29.95; etched and drilled pc board for $12.50; kit of all parts, not including enclosure, for $69.00. Add $2.50 P&H for each order. Illinois residents, please add state sales tax.

Fig. 2. Overall schematic of Analog Acquisition Unit without power supply.



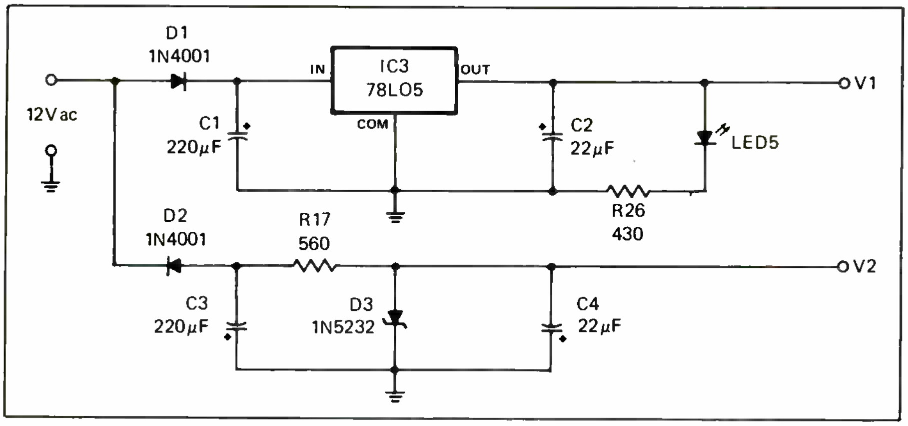


Fig. 3. This power supply for the Fig. 2 circuit uses 12-volt ac transformer.

Though not essential fcr proper project operation, sockets are recommended for *IC1* and *IC2*. If you do decide to use them, install the sockets first on the board and carefully solder their pins to the copper pads. Make sure that you do not create solder bridges between the closely-spaced pads. Then proceed to installing the remaining components exactly as shown in Fig. 5, starting with the resistors and diodes and working up to the largest-size components. Do not install *IC1* and *IC2* until directed to do so. Make sure that the electrolytic capacitors, diodes, LEDs and transistors are properly oriented before soldering their leads into place. Keep the crystal's leads as short as possible.

Install the jumper wires identified in Fig. 5 with the letter "J" with no suffix number, but do *not* install the *J1* and *J2* jumpers just yet. Connect and solder 1" to 2" lengths of hookup wire to the INPUT 1 through INPUT 4 holes, preferably using black wires for the grounds (holes nearest the edge of the board) and red wires for the signal lines.

If you have decided to use the Series 200 Unibox as the AAU's enclosure, mount all LEDs directly on and spaced about ¼" above the surface of the board. In this case, temporarily mount the board in the bottom half of the enclosure shell and carefully mark the locations for the holes to be drilled for the LEDs on the top half of the shell, the front-panel INPUT 1 through INPUT 4 jacks and the rear-panel accesses for the 12-volt ac line and interface cable, all in the bottom half of the shell. Remove the circuit board and drill appropriate-size holes.

Mount the INPUT jacks in the front-panel holes. Cut off and discard the plug at the end of the 12-volt ac plug-in transformer's cable. Separate the cable's conductors for a dis-

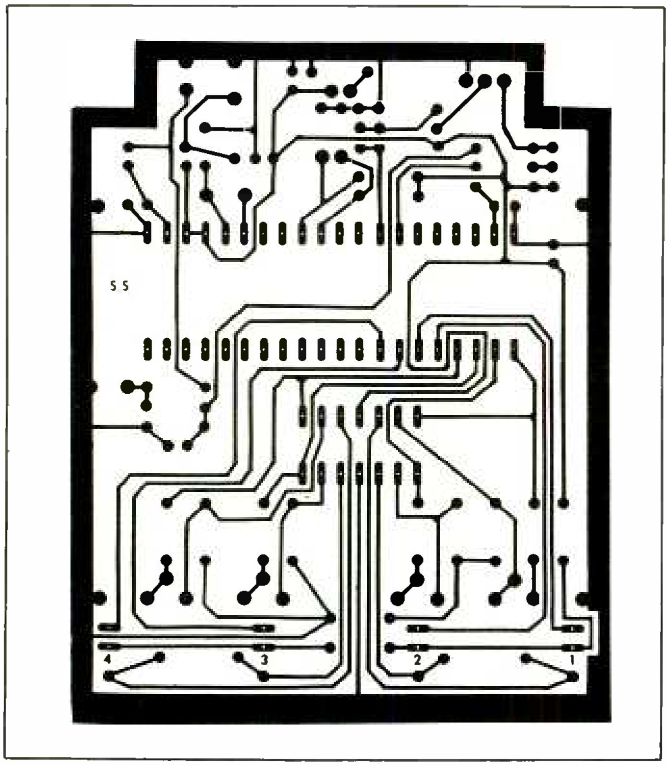


Fig. 4. Actual-size etching-and-drilling guide.

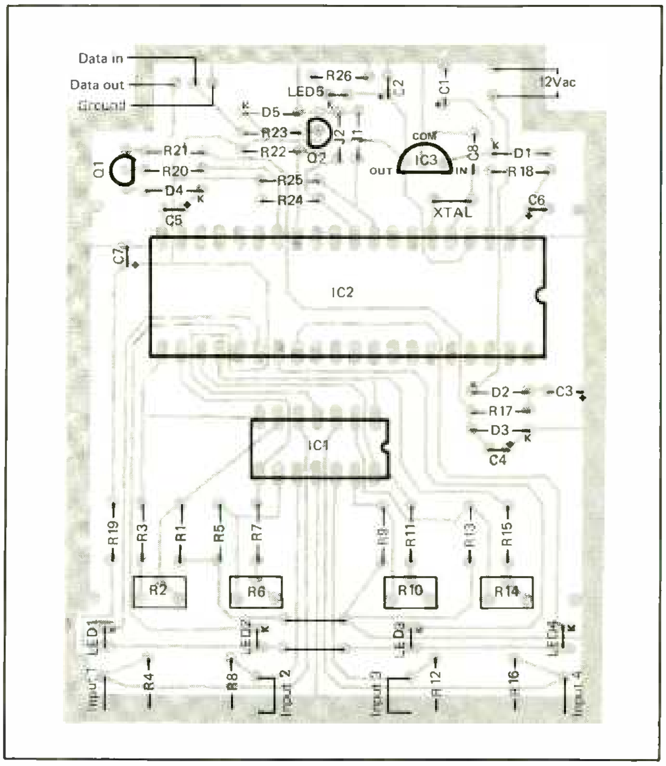


Fig. 5. Components-placement/orientation diagram.

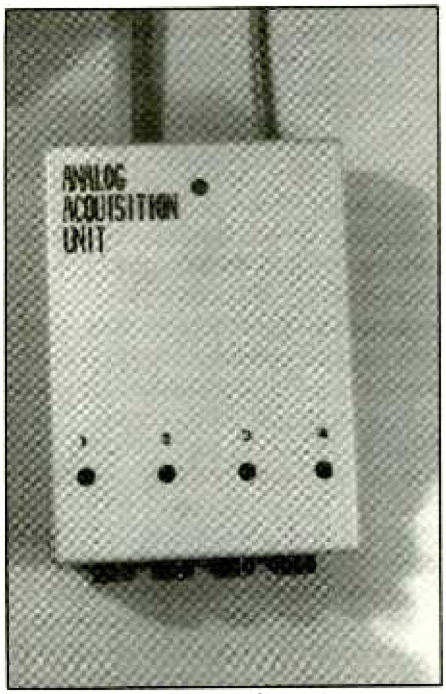


Fig. 6. AAU in its final form with LEDs labeled for easy identification.

tance of about 1″ and trim away ¼″ of insulation from each. Tightly twist together the fine wires in each conductor and sparingly tin with solder. Pass the cable through its hole in the rear of the Unibox and tie a knot in it about 3″ from the end inside the box.

Now prepare the interface cable. This five-conductor cable can be as long as needed, but a practical length is between 3 and 10 ft. Prepare both ends by cutting away 1½″ of outer insulation. Separate the conductors and trim ¼″ of insulation from each. Tightly twist together the fine wires of each conductor and sparingly tin with solder. Pass one end of the cable through the remaining hole in the rear panel and tie a knot about 4″ from the end inside the box.

Connect and solder the wires coming from the INPUT 1 through INPUT 4 jacks on the front panel to the appropriate pads on the circuit board. Then do the same for the 12-volt dc and interface cables. Make all connections to the bottom of the board (see Fig. 6).

If you decide to use a different type of enclosure than the Unibox, you might want to select a larger, less flat one. This will allow you to arrange things so that the LEDs mount on the front panel via small grommets or panel clips and the 12-volt ac and interface cables plug into standard power and DB-25 connectors, respectively, mounted on the rear panel. Locate the LEDs directly in line with their respective input jacks. Make sure to use insulating tubing on the leads of the LEDs.

Connect the positive probe of a dc voltmeter to pin 3 or 4 of *IC2*, the negative probe to ground. Set the meter to a 10-volt full-scale range, and plug in the wall transformer. You should obtain a reading of approximately +5 volts. Now connect the positive and negative probes to the + and − pads of *C4* and note that the reading now is approximately −5 to −5.6 volts. If everything appears to be okay, unplug the transformer and install *IC1* and *IC2* in their respective sockets. Make sure both ICs are properly indexed as shown in Fig. 5 before seating them in their sockets.

Finish assembling the project. Then use a dry-transfer or other type of lettering kit to label the LEDs, as shown in the lead photo.

Interfacing & Calibration

A 25-pin DB-25 is the most likely serial port connector on your computer. Since the gender of this connector can vary from computer to computer, you must obtain the mating half to connect to the Analog Acquisition Unit. If the serial port on your computer is configured to operate as a terminal (DTE mode), wire the connector as shown in Fig. 7A. Alternatively, if your computer's serial port operates as a host system (DCE mode), wire the connector as in Fig. 7B. Check your manual to determine the configuration of your computer's serial port.

If your computer fails to communicate with the AAU, try reversing the wires to pins 2 and 3 of the serial connector. Many computers also require that pins 6 and 20 of the serial port be connected together with a jumper wire.

Table 2. Communication Protocol

baud rate	see Table 1
parity	none
data bits	7
stop bits	1
handshake	off

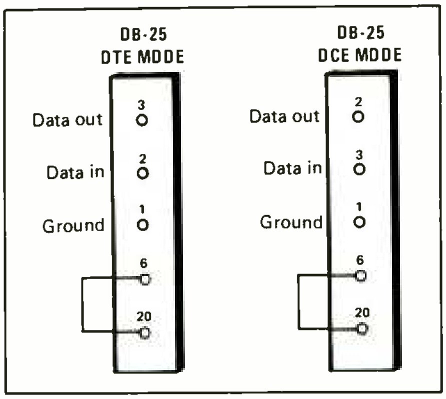


Fig. 7. Connector wiring details for DTE and DCE modes.

You must also set your computer's RS-232 serial I/O communication protocol, as shown in Table 2. Be sure that the baud rate matches that selected by installing the appropriate *J1* and/or *J2* jumpers on the AAU's circuit board.

On power-up, the program in *IC2*'s EPROM initiates a self-test. At completion of this test, the four red LEDs (*LED1* through *LED4*) will flash and "TEST OK" will be transmitted out of the serial data output connection. Verification of data transmission can be obtained with an oscilloscope connected to the data output point while observing the screen for a series of pulses after self-test has run.

Connect the AAU to your computer via the latter's serial port. Power up the system and send a capi-

(Continued on page 91)

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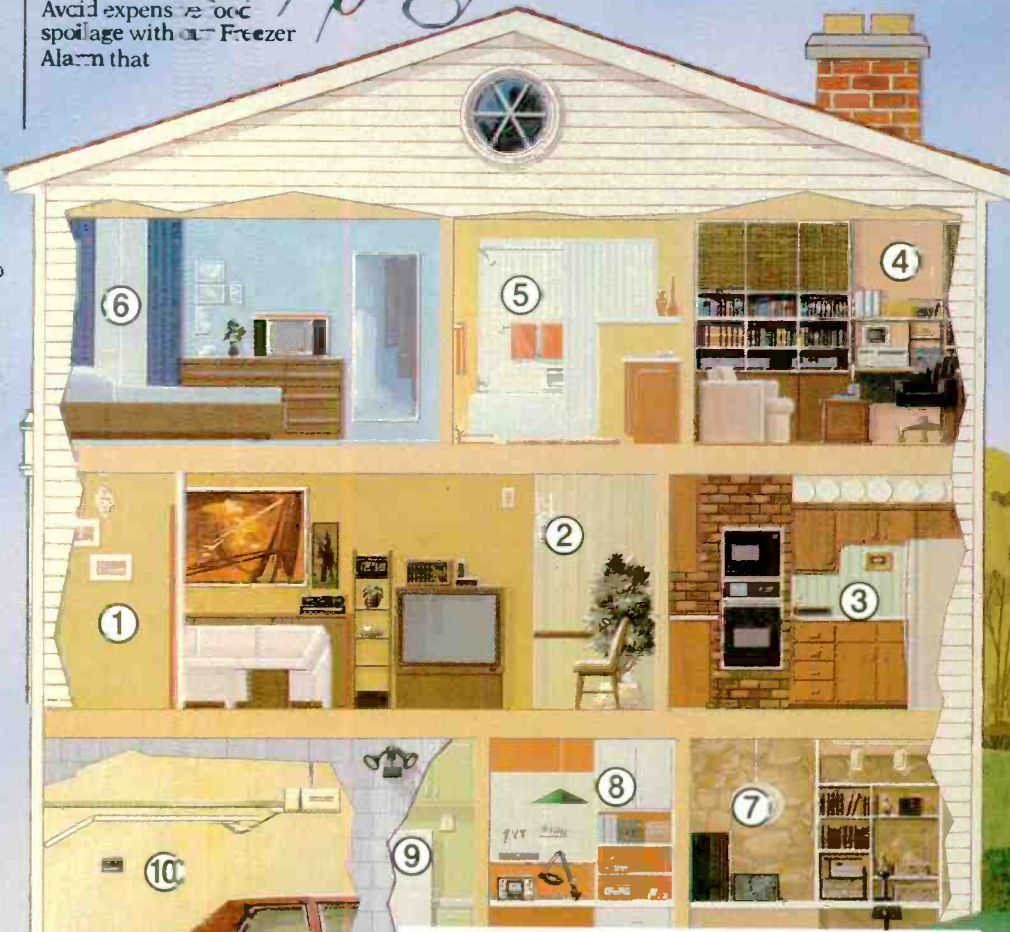

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The Optical Isolator (Part 1)

In this first of a two-section focus on optical isolators, our emphasis is on the various types of optical couplers available to experimenters and hobbyists, thėir technical characteristics, and typical applications. In the second half, which will appear next month, will be construction details for building an inexpensive and versatile tester that can be used in conjuction with a dual-channel oscilloscope and a digital multimeter to test all types of optical isolators in dual-inline packages, low-voltage zener diodes and 9-volt batteries.

Exploring Optical Couplers

By Ralph Tenny

Optical couplers—or opto-isolators, as they are commonly called—have been available in one form or another for more than 25 years. The earliest such devices consisted of a light bulb and a light-sensitive sensor, both housed inside a container with a tube to couple them together. The sensor was usually a photoconductor like a light-dependent resistor, and the bulb was matched to the voltage that drove it. Over the years, advances in technology and the need to meet special requirements forced development of a wide variety of optically linked devices that solve tough design problems at very low cost and with high reliability.

In this article, we will explore the various types of solid-state optical isolators that are commonly available to the designer and experimenter. Our basic intent here is to familiarize you with the various devices available.

"Plain-Vanilla" Devices

Although the early lamp/photoconductor (a photoconductor is a light-sensitive resistor) optical coupler is still available, it has long since been eclipsed in availability, popularity and reliability by devices in which are a light-emitting diode (LED) and a phototransistor, shown in Fig. 1A in the 6-pin dual-inline package (DIP) that typifies the optoisolator family of devices. Note that this is a 6-pin IC-like device.

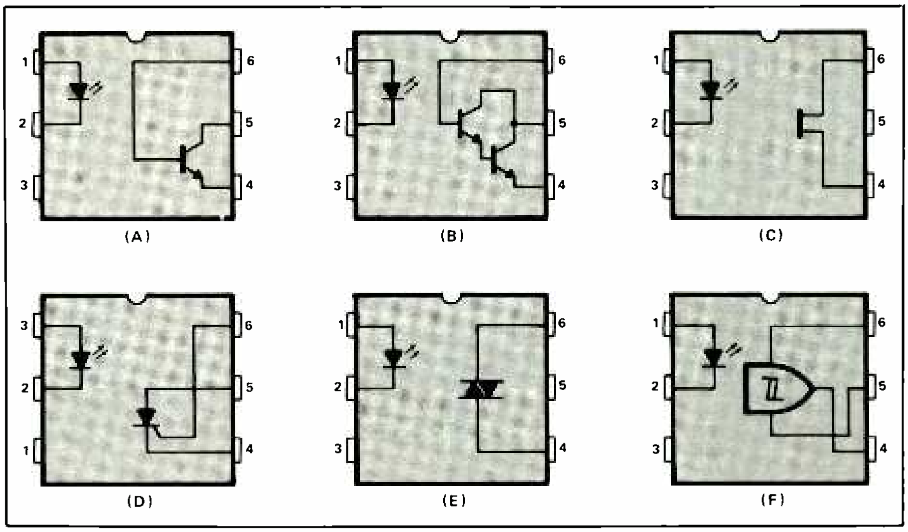


Fig. 1. Schematic symbols and pinouts for: (A) general-purpose transistor; (B) Darlington transistor; (C) bilateral FET; (D) light-activated silicon controlled rectifier (LASCR); (E) triac; (F) Schmitt trigger.

A LED is a common element in virtually all types of optoisolators. Most optoisolators use a single gallium-arsenide LED and all use a plastic device for light coupling. The coupler conducts the LED's output radiation (which can be visible light or invisible infrared radiation) to the photosensitive surface of the output device.

Figure 1's output device is a phototransistor, which is shown with the traditional transistor symbol. This transistor's functional base lead is frequently not used. Instead, the transistor is turned on by the beam from the LED through the light coupler. The same principle applies with whatever output device is used in the optoisolator. Each type of output device beyond the basic transistor has its own specific characteristics and was designed to meet one or more specific application needs that previous optical isolators could not handle.

Advanced Output Devices

Other output devices that are available include: Darlington transistors, bilateral FETs, light-activated silicon-controlled rectifiers (LASCRs), triacs and Schmitt triggers.

• *Darlington Transistor.* Shown in Fig. 1B is the schematic representation of the optical coupler with a Darlington-transistor output. Note that the Darlington arrangement consists of two transistors. The emitter of the input transistor drives the base of the output transistor.

Two effects result from use of the Darlington arrangement. The first is that much lower LED drive current is needed to turn on the Darlington output device with a given load. The second is that the Darlington stage has a much slower response time than the single-transistor output device. Response time refers to the period beginning when a drive-current pulse is fed to the LED in the optoisolator and ending when the output device switches on. A good transistor will typically switch on in 3 to 5 microseconds, while a Darlington arrangement of similar quality will require about 50 microseconds.

In terms of cost, you can obtain the single-transistor optoisolator for just slightly less than $1.

• *Bilateral FETs.* Shown in Fig. 1C is the schematic representation of the bilateral-FET-output optical isolator in its 6-pin DIP package with pinout information. The bilateral FET output stage is symmetrical so that it is not polarity sensitive. This is one of the more recent developments in optical coupler technology.

Two types of applications dictated

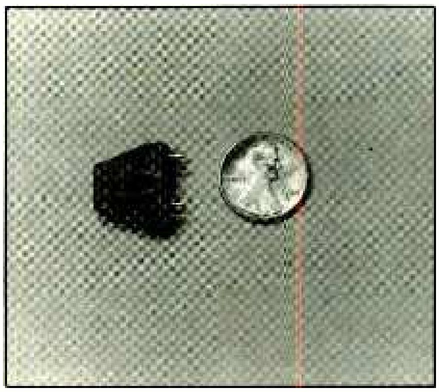


Fig. 2. Reflective optical sensor.

development of the bilateral FET optical isolator. One was the need for a remote variable resistor in automatic gain and similar applications. The other was the need for an isolated switch to turn on/off power-Darlington transistors and other devices that must be isolated from the switching system.

Bilateral FET optical isolators have a linear resistance range from 100 ohms to beyond 10,000 ohms and a 60-volt peak-to-peak signal-handling capability. Unit cost is about $4, which is a bargain, considering the versatility of the device.

• *Light-Activated SCR.* Shown in Fig. ID is the schematic/package representation of the optical isolator with light-activated SCR output. This device shares the normal characteristics of any discrete silicon-controlled rectifier. Its gate lead is usually connected to the cathode through a resistor to improve immunity to noise.

With a 300-mA current capability, the LASCR optical isolator provides remote switching control for relays, lamps and other low-to-medium-power devices. For the average LASCR device that can be used with 117-volt ac circuits, one can expect to pay just a bit more than $1.

• *Triac.*With a triac output stage (Fig. IE), isolated control of low-power lamps and other ac loads is possible using digital-logic circuits. The most common use for triac output is for triggering higher-power triacs, since the same digital-logic circuits can now control thousands of watts of power. This type of device retails for about $1.50.

• *Schmitt Trigger.* Shown in Fig. 1F is the logic/package representation for the Schmitt-trigger-output optical isolator. A Schmitt trigger is a special logic element that rejects noisy input signals. Additionally, it tolerates slow-rising input signals and switches reliably with them—a feature not possible with ordinary logic devices.

Isolation of high-speed digital signals (a 1-MHz data rate is typical) is the most popular use for the Schmitt-trigger optical isolator. High-speed capability in any optical isolator is always premium priced; hence, Schmitt-trigger optical isolators will usually cost about $4 apiece.

Technical Details

From the designer's point of view, the two most important technical specifications of an optical isolator are current transfer ratio (commonly abbreviated CTR) and voltage isolation. In transistor-output optical isolators, current transfer ratio is the ratio of the output current developed by the transistor to the drive current needed by the internal LED to produce the output current. The optical isolators discussed above have a 20% CTR, which means that 10 mA of LED drive current will develop 2 mA of output current from the transistor.

For about a 20% increase in price, you can obtain optical isolators with 100% CTR, in which input and output current are equal. Where the slower speed of a Darlington device is acceptable, CTRs of 500% (output current is five times input current) can be had for about the same price as the better single-transistor optical isolators.

(The "Opto Tester" article that will appear next month will contain details on construction of an acces-

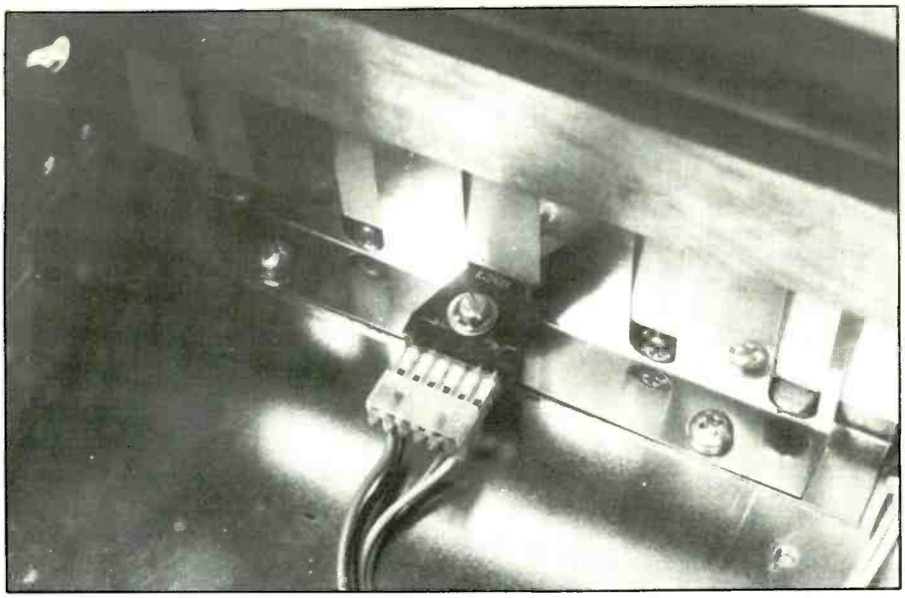


Fig. 3. Reflective sensor signals when a ticket is placed in a ticket printer.

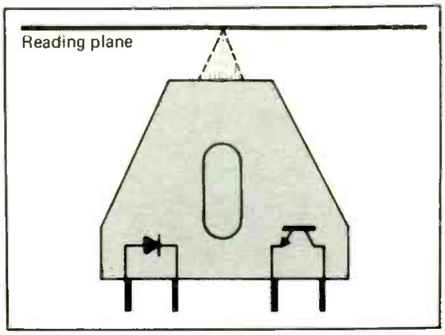


Fig. 4. Internal and package details of a typical reflective sensor.

sory that tests all types of optical isolator, including their CTRs.)

Isolation ratios for most optical couplers will be typically 1,500 volts minimum. However, optical isolators with up to 5,000 volts of isolation are available. Ratings are expressed for dc voltages or peak-to-peak ac voltages or the sum of both.

Bilateral FET devices are rated for isolation voltage, maximum and minimum resistance (output FET off and on, respectively), and turn-on and turn-off times. Important characteristics of LASCR optical isolators are output current capability and voltage isolation. Triac devices do not offer a wide variety of choices except with regard to higher voltage isolation. Their output is suitable for driving most power triacs. Schmitt trigger units are rated according to turn-on current (less is better, with 1.6 mA being about typical) and maximum data rate.

When choosing an optical isolator for a particular application, select one with at least 25% excess capability, more if you can afford it.

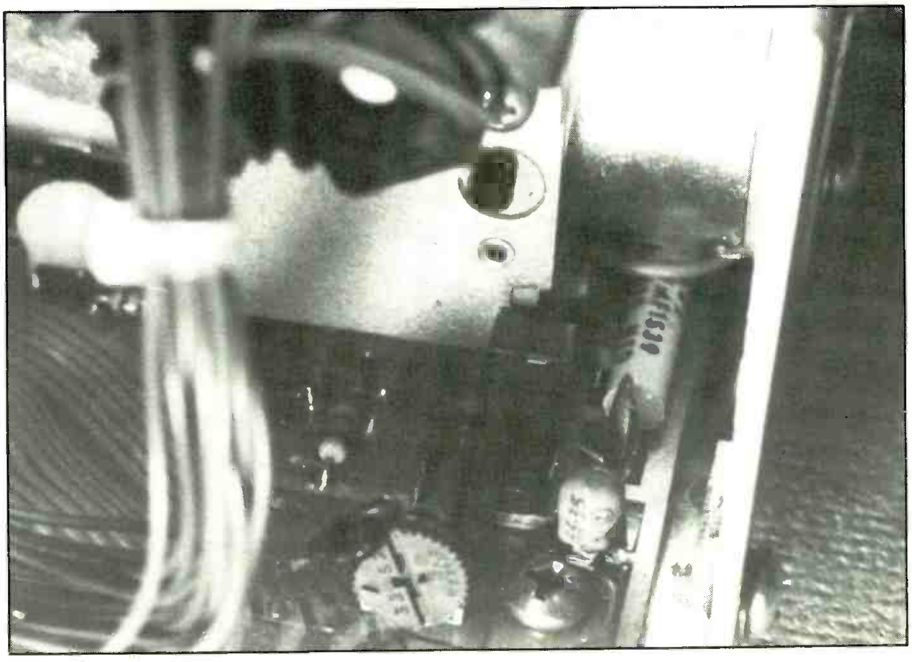
Related Devices

Two types of industrial sensors use the same type of technology as the optical isolator. These are interrupter modules and reflective sensors. Shown in Fig. 2 is a reflective sensor that gives some idea of size. Figure 3 shows the sensor in use.

A sketch of this sensor is shown in Fig. 4. Its internal structure contains a LED emitter whose energy is directed at a slight angle out through a slot in the device's housing. Any reflective substance that appears at the LED beam's focal point is reflected at an incident angle back through the slot onto the photosensitive surface of and turns on the internal transistor. Figure 3 shows this device being used to signal when a ticket has been placed into a ticket printer.

An interrupter module is similar in size to the reflector module but is shaped like a "C" with the LED emitter and transistor output device in opposite "jaws." Transparent plastic windows in each jaw allow the LED's radiation to reach the transis-

Fig. 5. An interrupter module detects the edge of a printer's carriage.



tor's photosensitive surface. Between the jaws is a narrow open slot through which thin items like cards can pass.

Figure 5 shows the interrupter module at the sensing edge of a printer carriage. The printer also has an interrupter module that "looks" through the spokes of a serrated wheel. Each wheel spoke causes a pulse signal to be generated by the interrupter module. These pulses are counted by a microprocessor to compute carriage speed and position and uses this data to print characters with precisely controlled spacing.

The reflective module has two other common uses besides detecting paper in a printer. If a narrow reflective stripe is attached to a rotating shaft and the sensor is placed the proper distance from the stripe, a pulse will be generated for each revolution of the shaft. Counting these pulses reveals how many revolutions are made over a given period of time. Adding a time measurement can then give speed in rpm.

In some punched-card readers, a bank of eight reflective sensors are used to detect data holes punched in the cards. Reflective sensors can also be used in home security systems. Window and door sensors are usually magnet/relay devices that can be defeated relatively easily. Replacing these with reflective sensors that require critical alignment of reflective tabs greatly adds to the effectiveness of the system. An intruder must work within a 1/16" margin to defeat the sensor—assuming he is aware such a sensor is being used in the system.

From the foregoing, it should be obvious that the optical isolator, in its many guises, is an important and exciting component to use in electronic circuits. It is also one of the best buys in electronic devices on the market. With a firm understanding of optical isolators, you can design circuits and systems that would otherwise be impossible without them.

Automatic Telephone Ringer Silencer

Have you ever wished that the phone wouldn't ring while you're sleeping? One solution is to add a ringer on/off switch. Besides the trouble of turning the switch on and off, there is also the possibility of forgetting to turn it back on and missing calls. A better solution is described here. With it, the ringer automatically silences when the room lights go off and turns back on when the lights go on.

A photocell installed in line with the ringer circuit of an inexpensive electronic telephone does the trick. To make the modification, simply open the phone's case and drill a ½" hole through the top half to provide an opening for the photocell to show through. Cement the photocell with its sensitive surface facing outward over the hole, using plastic cement or silicone adhesive. Then connect and solder an 8" hookup wire to each lead.

Snip one of the wires going to the ringer's piezo buzzer. Trim the wires attached to the photocell as needed and connect and solder them to the ends of the wire you just cut.

For best results, place the phone directly under the source of light, for example a bedroom lamp. When light hits the cadmium-sulfide (Cds) photocell (Radio Shack Cat. No. 276-116 or equivalent), the resistance decreases and the phone rings normally. In the absence of light, the resistance increases to the point where the phone will not ring. The calling party will get the normal signal just as if the phone was ringing and you didn't answer it. You can rest assured that your sleep will not be interrupted.

As always, no modification should be made to telephone company property.

—Rich Vettel

VCR Hookups With Cable Boxes

VCR connection arrangements most user manuals fail to address

By Cass R. Lewart

The modern videocassette recorder is a marvelous entertainment appliance. But most operating manuals that accompany VCRs fail to give extended information on how to connect them into a system, especially ones with cable boxes that have built-in decoders for premium pay-TV channels.

We will address this deficiency here by presenting a few basic VCR hookups that may solve your cable/VCR/TV receiver dilemma. Each hookup arrangement introduced is explained in detail, including its relative merits and disadvantages. If you follow the instructions given here, there should be no reason why you can't take full advantage of your VCR's capabilities. Our emphasis here is on using your VCR with a cable box that has pay-TV decoding capabilities, rather than on complex video systems that contain a multiplicity of signal sources and more than one TV receiver or VCR.

VCR Basics

To better understand the hookups detailed here, you should be familiar with some VCR basics. Figure 1 illustrates the simplified block diagram of the typical videocassette recorder. The built-in vhf/uhf tuner and channel-selecting mechanism duplicate those in your TV receiver. This section is followed by a video/audio system of circuits that terminate in the video tape unit. The latter is the electromechanical tape transport that actually moves the tape and "reads" the program information from it via its tape heads.

In the play mode, the tape unit feeds a signal to the r-f modulator. In other modes (record, search, etc.) the video/audio strip directly feeds the incoming signal to the r-f modulator. The output signal from the r-f modulator is preset by the user to TV channel 3 or 4. The specific channel assignment to which the modulator is set depends on the TV broadcast channels available in a given locality. For example, if in your locality a signal is being broadcast on channel 4, you would set the VCR's output switch to channel 3 to obviate interference with the channel 4 signal, and vice-versa.

If you closely examine Fig. 1, you will note that the typical VCR has all the circuitry a typical TV receiver has with the exception of the final video stages and the picture tube. Consequently, the VCR is completely independent of the TV receiver in terms of its recording capabilities. This means that you do not have to have your TV receiver on to be able to record a program.

One important operating control on all VCRs is the TV/VCR switch.

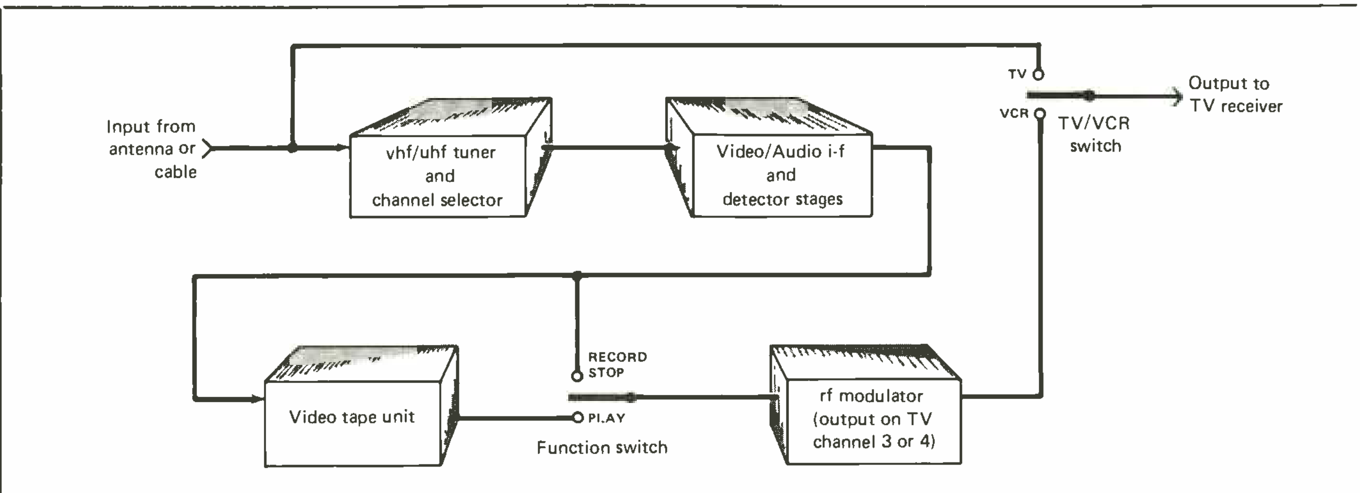


Fig. 1. Simplified block diagram of the typical videocassette recorder.

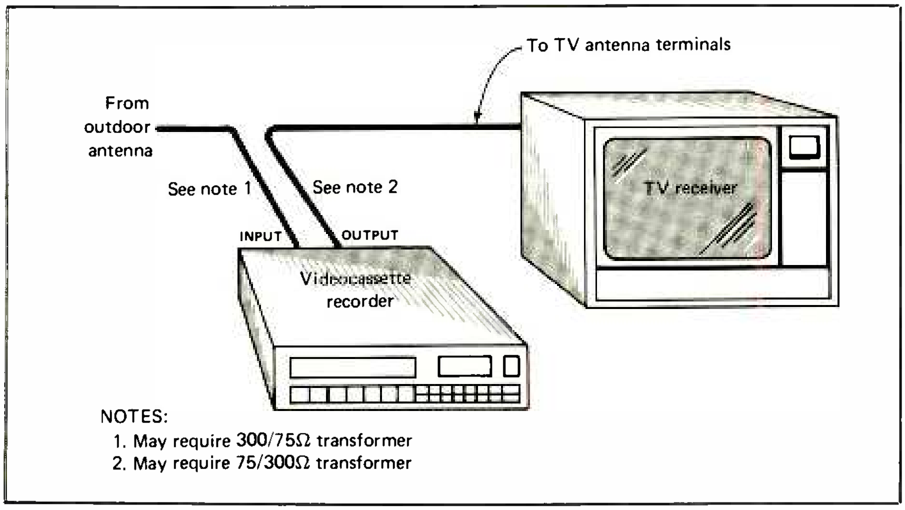


Fig. 2. Simplest VCR hookup is to an outside antenna, which allows you to record and view different channels simultaneously but not to decode premium scrambled cable channels.

This usually lights up in the VCR position. When it is in the TV position, the VCR's output is directly connected to its input such that the outside antenna or cable box that feeds the TV signal into the video system bypasses the VCR's circuits altogether.

With the TV/VCR switch in the VCR position, the VCR's output is connected to the internal r-f modulator. When this is done, your TV receiver must be on and be tuned to the selected modulator output channel for the program to be viewed.

In every mode but play, the TV/VCR switch is automatically set to the TV position. It is also automatically set to the TV position whenever the VCR is switched off so that you can view your TV programs in the normal manner as though there is no VCR in the system. Finally, you can manually switch between TV and VCR whenever the VCR is powered up, allowing you to view one channel while recording another.

Components Needed

To be able to make the connections suggested here, you need short (about 2-ft.) coaxial cables with F-type plugs on both ends. Also required are signal splitters to distribute the r-f signals as needed and A/B switches (like those used with video games and home computers) to selectively route the signals to either of two destinations. These items are commonly available from local electronics parts distributors like Radio Shack and video equipment stores.

When shopping for components for VCR installation, avoid the bargain-basement variety. Particularly avoid cables that have thin inner conductors that tend to bend and break off very easily.

From here on, we will assume that your TV receiver and VCR are "cable ready," allowing you to receive all nonscrambled channels without requiring the decoder box supplied by the cable company. If this is not the case in your particular setup, simply change all references to "all nonpremium channels" to "channels 2 through 13."

The Hookups

Let's now examine specific VCR hookups, using splitters and A/B switches and assuming either an outside antenna or a cable feed that can deliver both premium scrambled and nonpremium channels.

● *Outside Antenna, No Cable.* This simplest of hookups is illustrat-

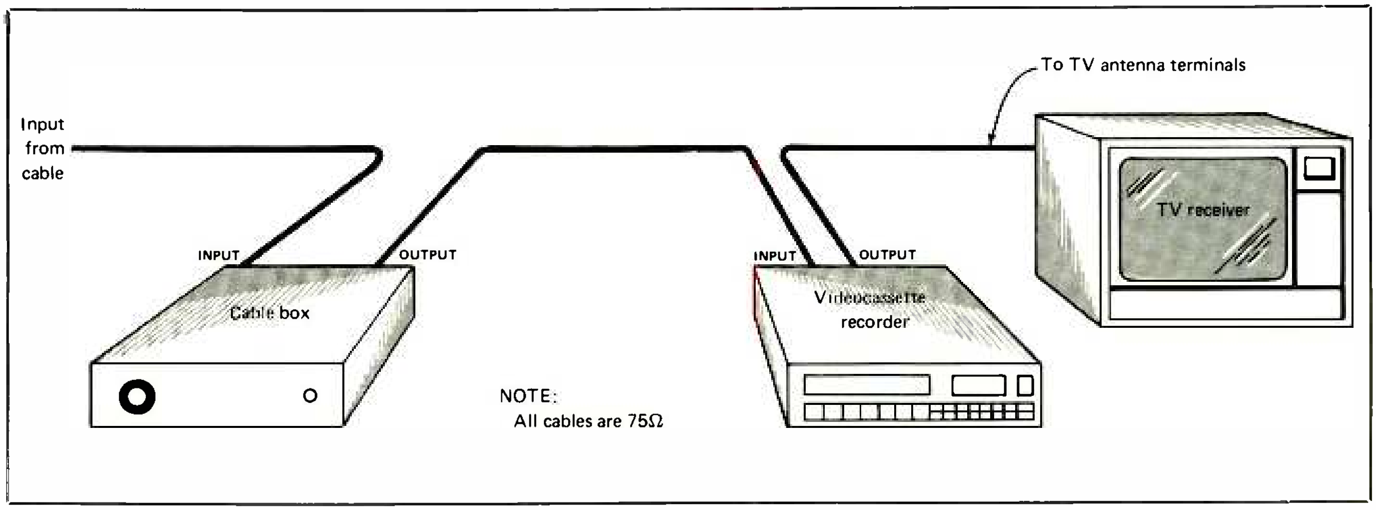


Fig. 3. This simple VCR/TV-cable hookup's channel selection is governed by the cable box's channel selector.

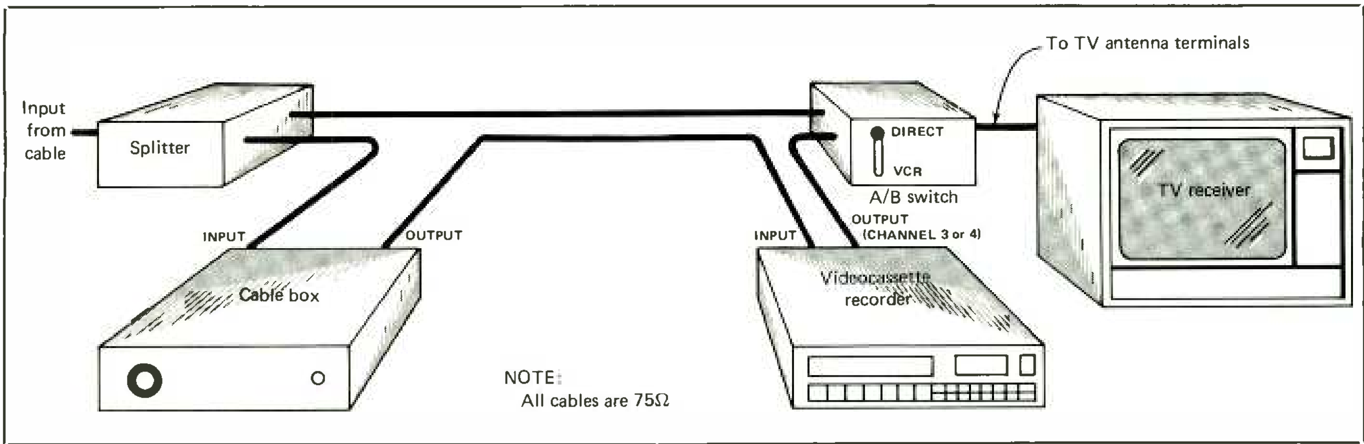


Fig. 4. This more elaborate arrangement has a signal splitter and an A/B switch that permit recording on one channel while viewing another. Recording channel selection is made with the cable box's channel selector.

ed in Fig. 2. With this arrangement, you select the channel to be recorded with the VCR's channel selector. You can then view the same channel as that being recorded or, by setting the VCR's TV/VCR switch to TV and your TV receiver's channel selector as needed, any other TV channel can be viewed. In the playback mode, your TV receiver must be tuned to the selected r-f modulator's output channel.

Throughout this article, TV receiver and VCR channel selection can be accomplished with the individual unit's remote controller if it has this capability. When using the VCR's remote controller, the TV/VCR switch can be in the VCR position and the TV receiver can be tuned to the output channel to which the VCR's modulator is set so that you can view the same channel as that being recorded by the VCR.

All connections in all hookup arrangements illustrated in this article must be made with 75-ohm coaxial cables with F-type connectors on both ends. If your TV receiver or outside antenna use standard 300-ohm twin-lead you will also need 75/300-ohm transformers to match impedance and to make the required connections.

● *Cable With Premium Channels.* The cable company supplies its subscribers with a channel selector box that contains the decoder circuitry required to unscramble the pay-TV channels. The output of this box is usually on TV channel 3. Both your TV receiver and your VCR must be tuned to channel 3 when connected to the output of the cable box. However, if your VCR or TV receiver are connected directly to the cable ahead of the box, you should be able to view and record all nonpremium channels by selecting them with your VCR or receiver channel selector (or via their respective remote controllers).

All methods that allow you to view one channel while recording another simultaneously are based on the concept that the VCR or TV receiver are connected directly to the cable ahead of the cable box.

When a program is recorded through the cable box, the choice of

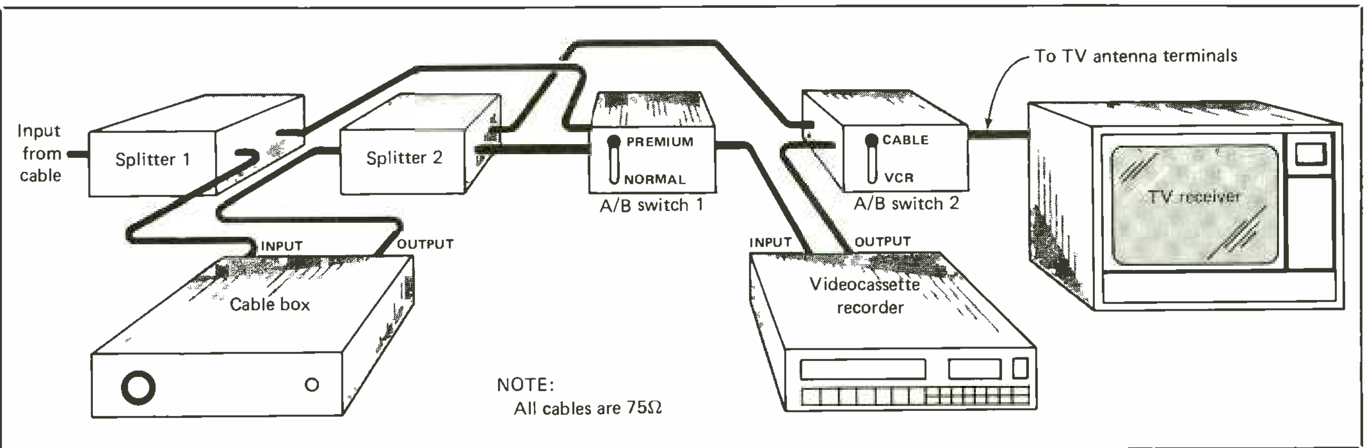


Fig. 5. This full-feature VCR/TV-cable hookup arrangement gives substantial flexibility. Its only real disadvantage is that when recording a premium scrambled channel, only that channel can be viewed.

channel is determined by the box's channel selector, not by the VCR's or TV receiver's channel selector. As a result, you will not be able to preset the VCR to successively record programs on more than one channel, though you can set it to record two or more programs on the *same* channel. If you do preset your VCR to record a desired program, there is the danger that someone may come along and change the selected channel on the cable box, leaving you with a program you did not want to record. The obvious solution to this probelm is to record from the cable ahead of the cable box.

Shown in Figs. 3, 4 and 5 are increasingly complex hookup arrangements that yield increasingly greater flexibility. Of course, there are other possible hookup arrangements you can use. However, the ones illustrated here are relatively simple and inexpensive to implement.

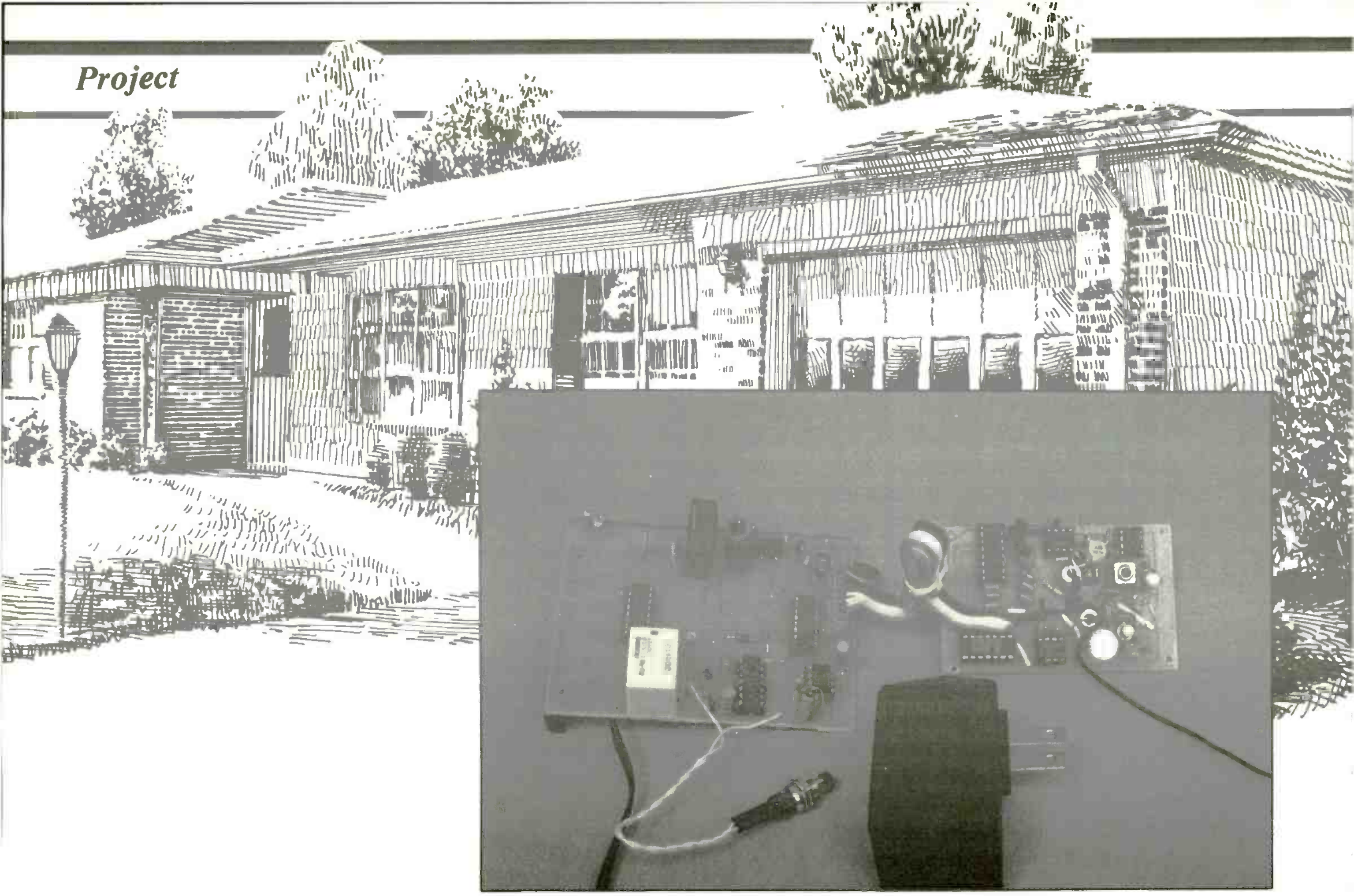
With the arrangement shown in Fig. 3, the VCR and TV receiver must always be set to channel 3. You select the channel to be recorded or viewed with the channel selector on the cable box. The major advantage of this arrangement is its simplicity. Its disadvantages are: when recording you can view only the channel being recorded; and you cannot preset the VCR to record two or more different channels during your absence.

With the slightly more sophisticated arrangement shown in Fig. 4, an A/B switch and a signal splitter increase your options. The advantages of this arrangement are its relative simplicity and the ability while recording to view the same channel or any other nonpremium channel. Disadvantages are twofold: the channel to be recorded must be set with the cable box's channel selector, which eliminates the possibility of presetting the VCR to record different channels during your absence; and you cannot view a premium channel while another is being recorded.

While the hookup arrangement detailed in Fig. 5 may look complicated, it is really relatively simple. Even so, it provides adequate flexibility and is not too prone to errors. With A/B switch No. 1 set to NORMAL, the VCR is independent of the cable box's setting, allowing you to view any channel selectable with the cable box's decoder. Only when you record a premium scrambled channel, with A/B switch No. 1 set to PREMIUM, are you restricted to viewing the same channel as you are recording. A/B switch No. 2 allows you to select between viewing a cable program or the prerecorded output from the VCR.

Substantial flexibility is the major advantage of the Fig. 5 hookup arrangement. The major disadvantage of this scheme, of course, is that when recording a premium channel, only that channel can be viewed.

If your video system has sources of video signals other than an outside antenna and/or cable—such as a videodisc player, electronic game console or a home computer—all sharing the same TV receiver, splitters and A/B switches are no longer practical. In such a case, use of a video selector box with inputs and switching for multiple sources is the only practical way to go. The only real disadvantage to this arrangement—as compared to the alternative "jungle" of cables, splitters and A/B switches—is an occasional "ghost" caused by impedance mismatch. ME



A 10-Channel Wireless Home Security System

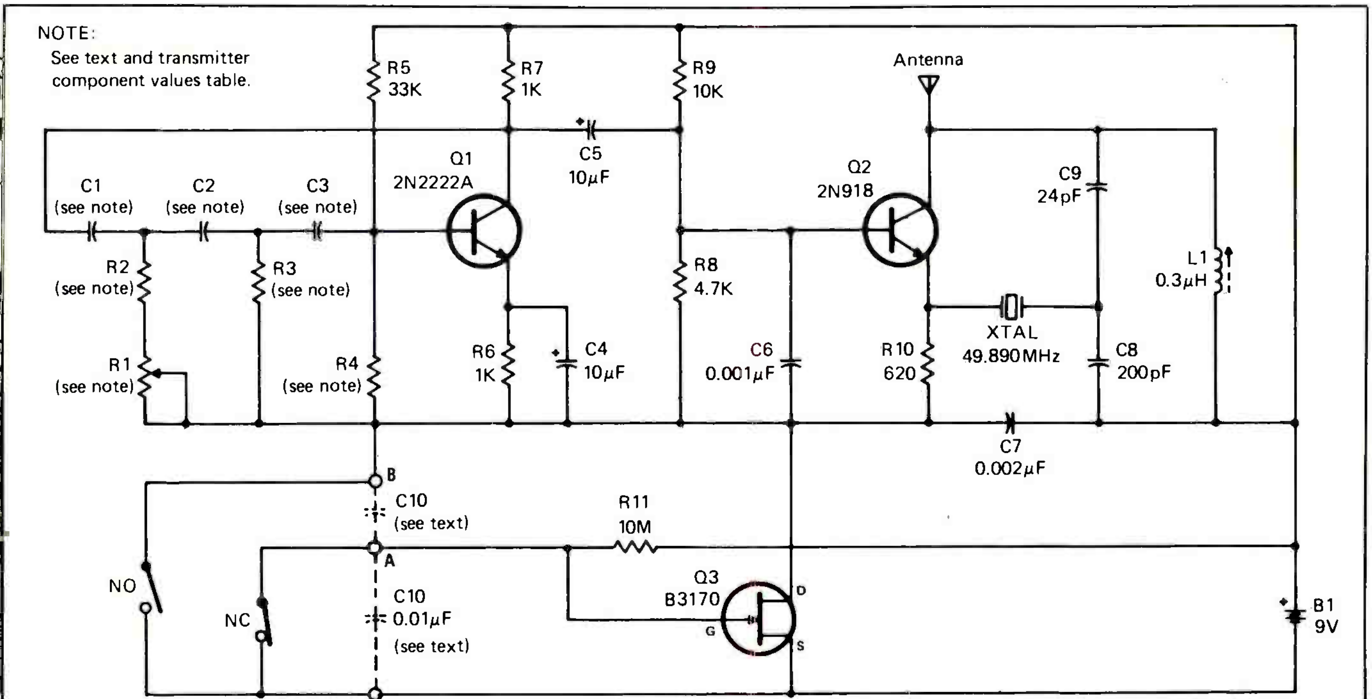
A flexible, highly effective wireless security system with the economy of hard-wired devices

By Dan Becker

A variety of security alarm systems are available to the home owner. The simplest and least expensive are little more than a relay with hard-wired sensor switches; the most elaborate—and very expensive—feature a microprocessor-controlled receiver and digitally encoded radio transmitters. Though the latter can be very elaborate, it isn't necessarily a better alarm. Because it eliminates unsightly wires and the time-consuming task of running them throughout a house, however, it's the system of choice for many home owners who can afford it.

Our 10-Channel Wireless Home Security System offers an inexpensive approach to the radio-type system used in the more costly setups. Though it doesn't employ microprocessor control, each of its 10 transmitters has its own unique "code." Hence, the system not only alerts you to an emergency condition, it even tells you its location.

Transmit/receive range is up to 150 feet, so you can use the system to monitor entrances, windows, your car, etc. Depending on the types of sensors you use to trip the transmitters, you can monitor for fire, smoke, frost, flood and any of a host of other physical conditions for which there are sensors available. The system can activate an audible



TRANSMITTER PARTS LIST

Semiconductors
Q1—2N2222A npn transistor
Q2—2N918 npn transistor
Q3—BS170 PMOS switch

Capacitors
C1,C2,C3—Low-voltage metalized film (see Table)
C4,C5—10-µF, 16-volt electrolytic
C6—0.001-µF ceramic disc
C7—0.002-µF ceramic disc
C8—200-pF high-Q ceramic disc
C9—24-pF high-Q ceramic disc
C10—0.01-µF ceramic disc

Resistors (¼-watt)
R2,R3,R4—1% tolerance (see Table)
R5—33,200 ohms, 1% tolerance
R6,R7—1,000 ohms, 5% tolerance
R8—4,700 ohms, 5% tolerance
R9—10,000 ohms, 5% tolerance
R10—620 ohms, 5% tolerance
R11—10 megohms, 5% tolerance
R1—Trimmer potentiometer (see Table)

Miscellaneous
B1—9-volt battery
L1—0.3-µH variable inductor (TOKO 10K Series)
XTAL—49.890-MHz series-resonant crystal
Printed-circuit board; snap connector for B1; stranded 22-gauge hookup wire; machine hardware; solder; etc.

Note: For components and kit availability, see Note at end of Power Supply/Display Parts List

Fig. 1. All transmitters in the system are identical, varying in their tone coding by varying values of frequency determining parts in the Q1 audio oscillator.

alarm and can simultaneously turn on a lamp and/or siren.

When assembled as outlined here, the Wireless Home Security System complies with the FCC Rules and Regulations part 15, subpart D, for the "experimental" 49-MHz band. Though other devices share this band, including toy walkie-talkies, the narrow bandwidth, rapid scanning technique employed makes the decoder reasonably immune to voice-modulated transmissions.

The receiver/decoder sequentially monitors 10 channels in scanner-like fashion. When a transmitter is active, the decoding circuit locks on and sounds a buzzer and turns on an LED that corresponds to the location of the active transmitter. In addition, an ALARM LED turns on and a relay's contacts lock close to indicate that the system has been tripped. After a few seconds, the circuit returns to scanning.

You can use the relay to control a siren or/and a lamp or floodlights. Additionally, you can use channel 1 as a wireless remote reset switch that allows you to pass through a security zone without setting off the alarm.

The Transmitters

All transmitters in the system are identical, except that each is "tuned" to a different tone code that makes it unique and immediately identifiable. The transmitters (Fig. 1) operate on

Transmitter Component Values

Channel Number	Frequency (Hz)	C1, C2 & C3 (μF)	R1	R2	R3	R4
				(kilohms)		
1	4,300	0.01	1	1	1.2	33.2
2	670	0.047	1	1.2	2	15.8
3	460	0.047	1	3	3.6	15.8
4	3,300	0.01	1	1.5	1.8	33.2
5	2,340	0.022	1	0	0.75	20
6	950	0.022	5	2.2	3	20
7	830	0.022	5	2.2	3	20
8	540	0.047	1	2.2	2.8	15.8
9	340	0.1	1	1.2	2	15.8
10	240	0.1	1	1.5	2.2	15.8

49.890 MHz and are crystal controlled for stability. They are basically amplitude-modulated oscillators, with *Q2* dc biased by *R8*, *R9* and *R10*. Capacitor *C6* operates as a short circuit at 49 MHz, which places *Q2* in a common-base configuration, thus maximizing stability and preventing unwanted spurious oscillations.

Because the crystal is in series with the emitter of *Q2*, emitter current is very sinusoidal and free of a strong second harmonic. Capacitors *C8* and *C9* make up a voltage divider that feeds a small amount of the r-f output back into the emitter of *Q2*. Inductor *L1* and capacitors *C8* and *C9* tune the circuit to resonance. Capacitor *C7* bypasses *B1* at 49 MHz.

Audio oscillator *Q1* modulates r-f stage *Q2* and is dc biased by *R4* through *R7* so that *Q1* operates as a common-emitter amplifier. Capacitor *C4* connects the emitter to ground for ac signals to maximize gain. The *Q1* stage has an open-loop gain of 1 to maintain oscillation. Since *Q1*'s gain is directly proportional to the dc emitter current, the value of bias resistor *R4* must be chosen to provide unity gain at the selected frequency (see "Transmitter Component Values" table for the values of this resistor and other frequency-determining components).

To adjust the percentage of modulation, the value of *R4* can be varied by + or − 5,000 ohms. Trimmer *R1* permits fine tuning of the operating frequency. The audio output of *Q1* is coupled by *C5* to the base of *Q2* to modulate the dc bias level and r-f amplitude. This is readily accomplished because *Q2* operates as a common-emitter amplifier at audio frequencies.

Transistor *Q3* is a power MOSFET that provides connection to a normally closed security switch. This external security switch connects the gate to ground, thus biasing off *Q3*. Should this switch open, *R11* forward biases *Q3* and applies battery power to the transmitter.

When a normally open security switch is used, *Q3* and *R11* must be omitted, allowing the external security switch to turn on and off the transmitter directly.

The Receiver/Decoder

Shown in Fig. 2 is the complete schematic diagram of the receiver/decoder with *Q1* operating as a superregenerative detector. It serves as

RECEIVER/DECODER PARTS LIST

Semiconductors
IC1—LM358 op amp
IC2—LM567 tone decoder
IC3—CM7555 CMOS timer
IC4—74LS90 TTL counter
IC5—74LS42 TTL decoder
Q1—2N918 npn transistor

Capacitors
C1,C3—0.0033-μF ceramic disc
C2,C4—24-pF high-Q disc
C5—10-μF, 16-volt radial-lead electrolytic
C6—0.037-μF Mylar
C7—0.1-μF Mylar
C8—10-pF high-Q disc
C9—22-μF, 16-volt axial-lead electrolytic
C10,C11—1-μF, 50-volt axial-lead electrolytic
C12—0.0022-μF Mylar
C13—0.015-μF Mylar
C14—0.022-μF Mylar
C15—0.0027-μF Mylar
C16—0.0039-μF Mylar
C17—0.01-μF Mylar
C18—0.012-μF Mylar
C19—0.018-μF Mylar
C20—0.027-μF Mylar
C21—0.039-μF Mylar
C22—220-μF, 16-volt radial-lead electrolytic
C23—5-pF high-Q disc
C24—100-μF, 6.3-volt miniature radial-lead electrolytic

Resistors (¼-watt, 5% tolerance)
R1—2,200 ohms
R2,R12—10,000 ohms
R3—47 ohms
R4—2,000 ohms
R5,R6,R13—100,000 ohms
R7—470,000 ohms
R8—4,700 ohms
R9—6,200 ohms
R11—20,000 ohms
R14—56,000 ohms
R10—100,000 ohms, 1% tolerance

Miscellaneous
FB1,FB2—Vhf ferrite bead
RFC1,RFC2—R-f choke (14 turns 28-gauge magnet wire wound on No. FT-23-43 toroid core—see text)
T1—Receiver transformer (special order only—see Note below)
Printed-circuit board; sockets for ICs; 22-gauge stranded hookup wire; 8" 7-conductor ribbon cable; machine hardware; solder; etc.

Note: For components and kit availability, see Note at end of Power Supply/Display Parts List

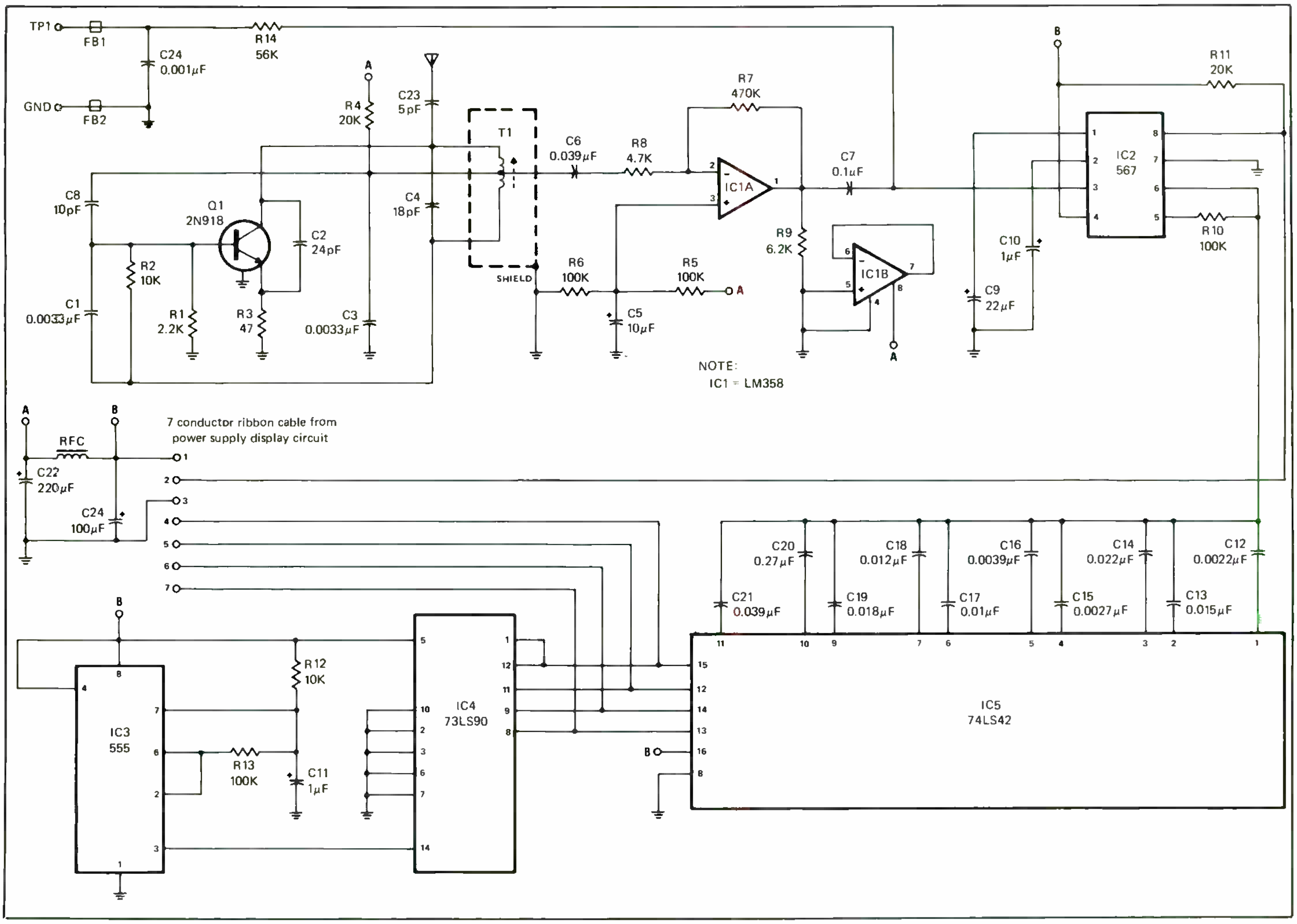


Fig. 2. Schematic diagram of receiver/tone decoder circuit.

both an r-f amplifier and an AM detector. Transformer *T1* is tuned to the 49.890-MHz carrier.

The incoming signal from the antenna goes into the *C4/L1* tank circuit and combines with the 49-MHz oscillator signal, causing the amplitude of the oscillations to increase. If the incoming signal is amplitude modulated, oscillation strength varies in accordance with the variations in amplitude of the received signal.

Any audio tone that amplitude-modulates the transmitter appears as amplitude variations across *Q1*'s base-emitter junction. Although it's tuned to oscillate at radio frequencies, *Q1* has considerable gain at audio frequencies and thus amplifies the audio modulation.

Capacitor *C6* couples the detected audio signal into op amp *IC1*, which provides about 10 dB of gain. Because a single-ended power supply is used (see Fig. 3), *IC1* is dc biased to 2.5 volts by *R5*, *R6* and *C5*. Otherwise, the input signal would be rectified. The amplified audio is fed to tone decoder *IC2*, which outputs a logic 0 when the audio tone for which it is tuned appears at the input.

Because each transmitter uses a different audio frequency to modulate its carrier, *IC2* must be tuned to each of the 10 possible different frequencies. To accomplish this, 10 different capacitors (*C12* through *C21*) are sequentially connected to ground. As each capacitor is grounded, it's placed in series with frequency-determining resistor *R10*.

A clock signal, generated by *IC3*, determines the rate at which *C12* through *C21* are scanned and goes to BCD counter *IC4*, whose outputs drive 1-of-10 BCD decoder *IC5*. Since *IC4* continuously counts up from 0 to 9, *IC5* continually grounds *C12* through *C21*, causing *IC2* to select each capacitor in succession.

The Power Supply/Display

The four BCD output lines from *IC4*, the output from *IC2* and the

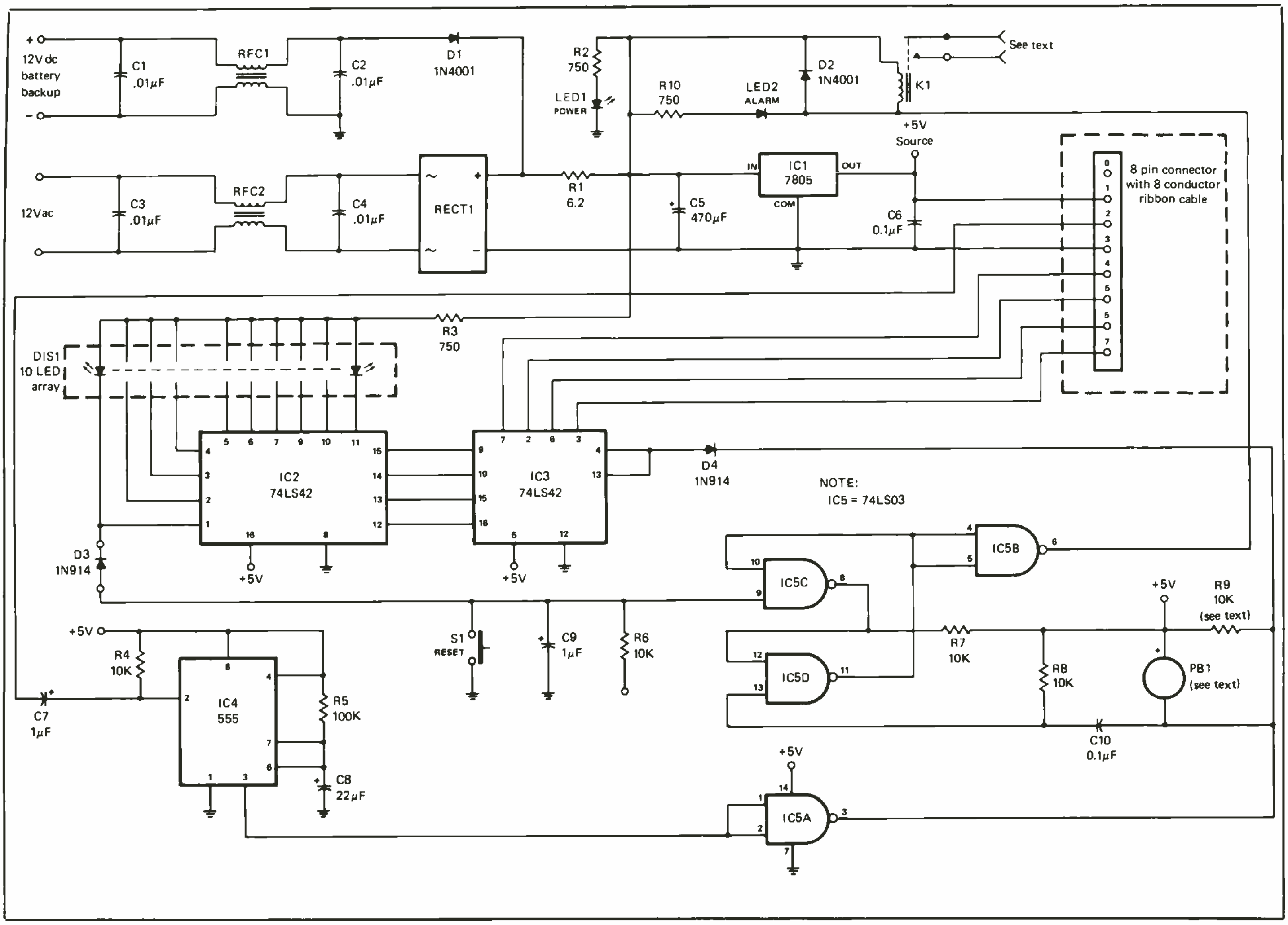


Fig. 3. *Schematic diagram of power-supply/display circuit.*

power buses go to the power-supply/display subsection shown in Fig. 3. Ac line power for this circuit is delivered through a 12-volt ac wall transformer via the "12 Vac" input connectors. An optional 12-volt backup battery can be wired across the connectors at the upper left.

Electrical noise is filtered out of the line by *RFC1* and *RFC2* (radio-frequency chokes) and *C1* through *C4*, and *D1* prevents current flow from the ac-driven supply into the battery supply.

A +5-volt power supply is made up of *RECT1*, *IC1*, *C5* and *C6*. Except for *K1* and the LEDs that make up the display and indicator systems, which operate from the pulsating 12 volts dc available at the + output from *RECT1*, all receiver/decoder/driver circuits are powered by the 5-volt supply.

When a tramsmitter is active, the logic-0 pulse generated by the tone decoder in the receiver is coupled into the Fig. 3 circuit via pin 2 of the miniconnector through *C7* into timer *IC4*'s trigger input at pin 2. The timer lengthens this pulse to a few seconds and passes it to *IC5A*. The low signal at pin 3 of *IC5A* is then used to arm piezoelectric buzzer *PB1* to tell you that a transmitter has been activated. The low output from *IC5A* also sets a flip-flop made up of *IC5C* and *IC5D*, causing its output to latch in a low state, *K1* to energize and ALARM *LED2* to light. The relay RESET switch *S1* is operated to reset the flip-flop.

If a piezoelectric buzzer isn't used, a 10,000-ohm resistor must be installed at *R9* in Fig. 3. You can have either *PB1* or *R9*—not both.

The four BCD lines from the receiver/decoder go to the Fig. 3 circuit via miniconnector pins 4 through 7. These lines carry a number between 1 and 9 that indicates which of the 10 channels the decoder is tuned to has been activated. These four lines go to quad storage latch *IC3* and then on to *IC2*.

POWER SUPPLY/DISPLAY PARTS LIST

Semiconductors

D1,D2—1N4001 rectifier diode

D3,D4—1N914 switching diode

DIS1—10-LED array (Panasonic No. LN10204P)

IC1—7805 +5-volt regulator

IC2—74LS42 TTL decoder

IC3—74LS75 TTL quad latch

IC4—CM7555 timer

IC5—74LS03 quad NAND gate

LED1,LED2—Light-emitting diode

RECT1—DB101 or similar bridge rectifier

Capacitors

C1 thru C4—0.01-μF ceramic disc

C5—470-μF, 16-volt axial-lead electrolytic

C6—0.1-μF ceramic disc

C7—1-μF, 50-volt axial-lead electrolytic

C8—22-μF, 16-volt axial-lead electrolytic

C9—1-μF miniature radial-lead electrolytic

C10—0.1-μF Mylar

Resistors (5% tolerance)

R1—6.2 ohms, ½ watt

R2,R3,R10—750 ohms, ½ watt

R4,R6,R7,R8,R9—10,000 ohms, ¼ watt

R5—100,000 ohms, ¼ watt

Miscellaneous

K1—12-volt spst relay (Omron No. G2U-112P-US)

PB1—Piezoelectric buzzer (any 5-volt type)

RFC—R-f choke on No. FT-23-43 toroid core (see text)

S1—Normally open, momentary-action spst pushbutton switch

T1—12-volt ac wall transformer

Printed-circuit board; suitable enclosure to house both receiver/decoder and power supply/display boards; sockets for ICs; 4-40 machine hardware; hookup wire; solder; etc.

Note: The following items are available from Dan Becker, 101 Highland Dr., Chapel Hill, NC 27514: complete transmitter kit No. SS-10-TR, minus enclosure and external security switch(es) for $17.95 plus $2.00 P&H (specify channel desired); complete receiver kit No. SS-10-RC including all components in Receiver/Decoder and Power Supply/Display Parts Lists but not including piezoelectric buzzer and enclosure for $69.95 plus $4.50 P&H; inductor kit containing r-f transformer and three RFCs for $9.95 PPD.

Each of the 10 output lines from *IC2* is sequentially held low, causing one of the 10 LEDs in *DIS1* to light at a time. As long as the output from *IC5A* remains low, *IC3* will hold the last BCD number from the receiver. This means that each LED in the *DIS1* array corresponds to a unique transmitter location.

After pausing for a few seconds, *DIS1* returns to scanning. If a transmitter is still active, the display again pauses on the appropriate LED.

Construction

You build the Wireless Home Security System in stages, starting with the transmitter(s). Printed-circuit-board wiring is recommended for all circuits. The actual-size etching-and-drilling guides for the transmitter, receiver/decoder and power-supply/display pc boards are shown in Figs. 4, 5 and 6, respectively. You can fabricate your own pc boards using these guides or purchase ready-to-wire boards from the source given in the Note at the end of the Power Supply/Display Parts List.

Select a plastic enclosure (it can

COMPLIANCE WITH FCC RULES

The receiver in the Wireless Security System described in this article can be home built without you having to obtain special permission from the Federal Communications Commission and without violation of the FCC Rules and Regulations. You can build up to five transmitters without obtaining permission from the FCC, provided you comply with the requirements set forth in sections 15.133 and 15.119, which require the following:

To each transmitter you build, you must attach a signed and dated label that reads: "I have constructed this device for my own use. I have tested it and certify that it complies with the applicable regulations of FCC Rules Part 15. A copy of my measurements is in my possession and is available for inspection."

The measurements mentioned on the label are those required by section 15.118, which states:

"a) The r-f carrier and modulation products shall be maintained within the band 49.82-49.90 MHz.

"b) The power input to the device measured at the battery or the power line terminals shall not exceed 100 milliwatts under any condition of modulation.

"c) The antenna shall be a single element 1 meter or less in length permanently mounted on the enclosure containing the device.

"d) The device shall, with the exception of the microphone, be completely self-contained with the antenna permanently attached to the enclosure containing the device. The microphone may be external to the device, provided it is permanently attached to the enclosure with a cable not longer than 1.5 meters.

"e) Harmonic emissions shall be suppressed at least 20 dB below the level of the unmodulated carrier."

If you build and tune the transmitter as detailed in this article, it will comply with the FCC rules. If you should decide to build more than five transmitters, you must make the measurements detailed in section 15.118 and file an application for certification. Consult Volume II of the FCC Rules and Regulations, available at many libraries, for more information. As of September of this year, the FCC charges a fee for certification.

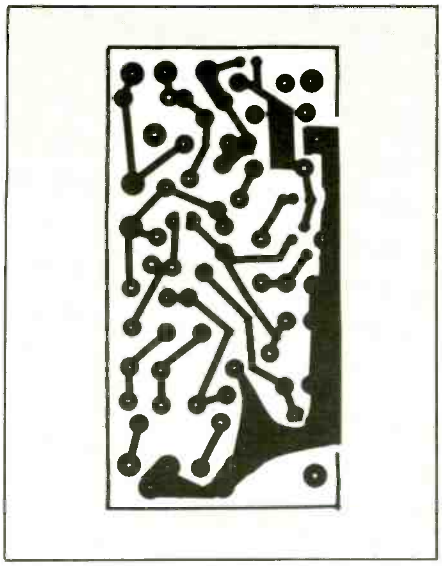


Fig. 4. Actual-size etching-and-drilling guide for transmitter pc board.

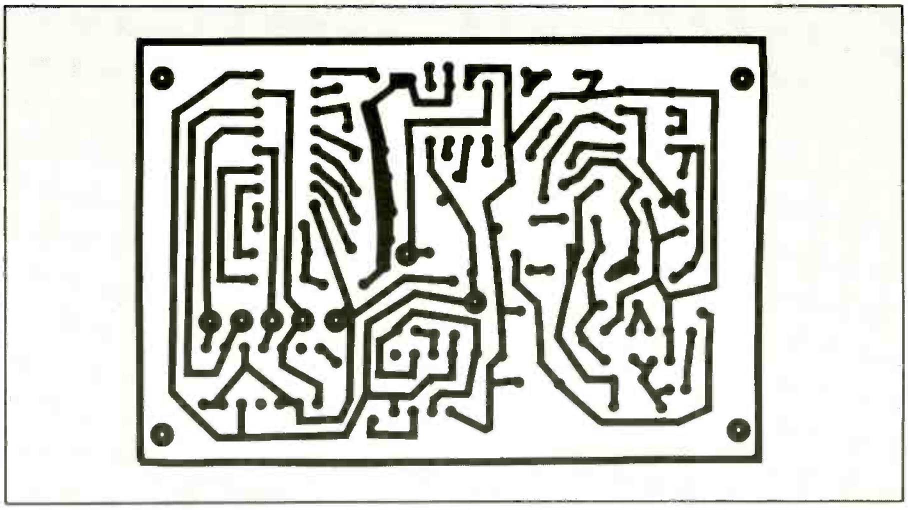


Fig. 5. Actual-size etching-and-drilling guide for receiver/decoder board.

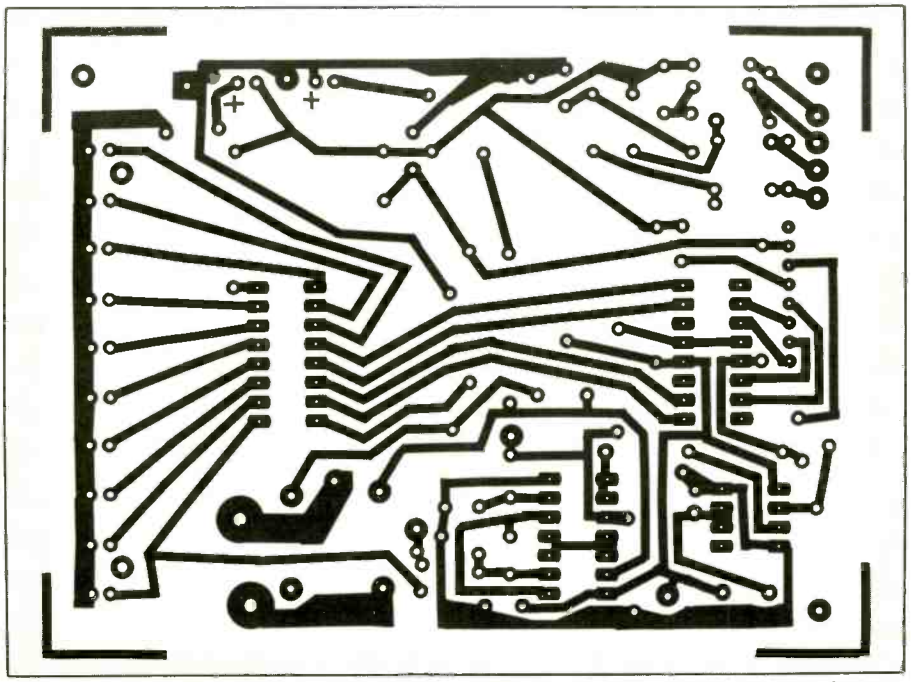


Fig. 6. Actual-size etching-and-drilling guide for power-supply/display board.

have a metal panel) that will accommodate the transmitter circuit board and 9-volt battery. Using the board as a template, position it inside the enclosure and mark the case for the two mounting holes. Then mark the hole locations for the antenna wire, sensor wires and access for *R1* and *L1*. Use a 3/32" bit to drill the antenna hole and a 1/8" bit for all other holes. Prepare as many enclosures as you will be using transmitters.

Decide how many transmitters you are going to have in your system and the audio tone frequencies you wish to use. then wire each board exactly as shown in Fig. 7, using the appropriate values for *R1* through *R4* and *C1* through *C3* from the transmitter Component Values table in each case. Wire only one transmitter board at a time to avoid confusion. Install all components (except the transistors, which mount 3/16" above the board's surface) flush with the board.

Note that most resistors on this board and many on the other two boards in the system mount vertically. Make sure the electrolytic capacitors are properly polarized and that basing is correct for the transistors before soldering them into place. If you plan to use a normally closed sensor, install *C10* between ground and point A. For a normally open sensor, omit *Q3* and solder a jumper wire between the drain (D) and source (S) pads and connect *C10* between ground and point B. Use heat jusiciously when soldering the transistors and crystal to the transmitter board and the diodes, LEDs, transistors and ICs on the other boards in the system to prevent heat damage to these delicate components. A photo of the wired board is shown in Fig. 8.

Trim 1/4" of insulation from both ends of three 36" lengths of 22-guage stranded hookup wire. Loosely twist together two of these wires and tie a knot 2" from the prepared end of the third wire. Pass one end of the twisted pair through the sensor-wire hole in the enclosure and connect and solder it to either the NC or NO (depending on the type of sensor you're using with the specific transmitter) pads on the board. Solder the prepared end of the single wire to the ANTENNA pad on the board. Then solder the red and black wires from *B1*'s snap connector to the B+ and B− pads, respectively.

Label each board as it is wired with its channel number. Mount the board in the enclosure with the channel number of the board installed in it and the sensor type (NC or NO) for which the circuit is wired. Pass the free end of the antenna wire through its hole and plug a 9-volt battery into the snap connector. Assemble the enclosure.

Referring to Figs. 9 and 10, wire the transmitter/decoder and power-supply/display boards exactly as shown. It's a good idea to use sockets for all ICs, except *IC1* in the power supply. Again, note that many resistors mount vertically. Make certain that all components are properly oriented before soldering their leads or pins to the board. Also note that the test point and ground on the receiver/decoder board consist of insulated hookup wire with the tops looped over to retain ferrite beads *FB1* and *FB2*. Don't forget to install insulated jumper wires on the receiver/decoder and bare jumper wires on the power-supply/display boards at all indicated locations.

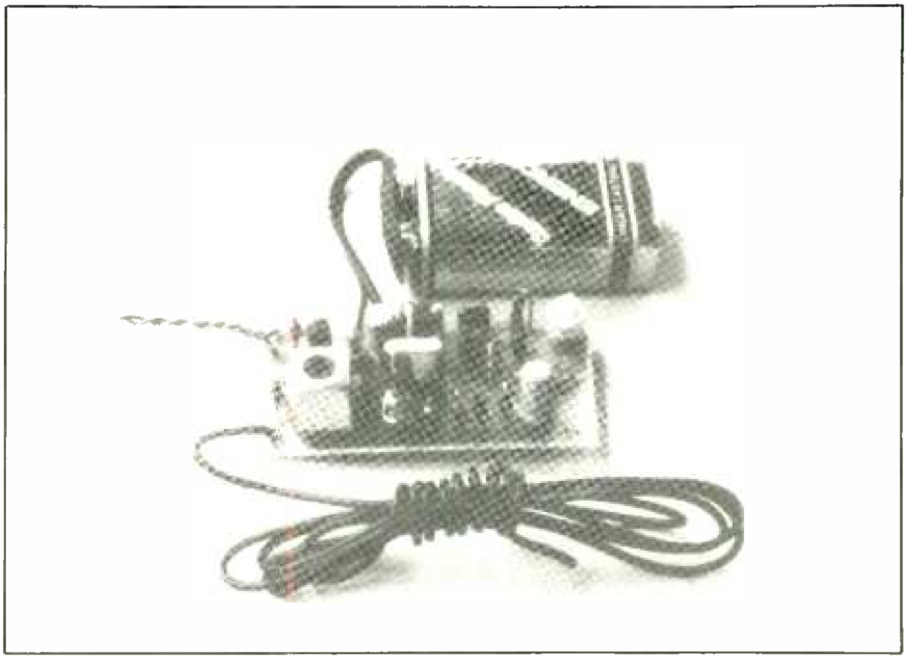


Fig. 8. The wired transmitter board.

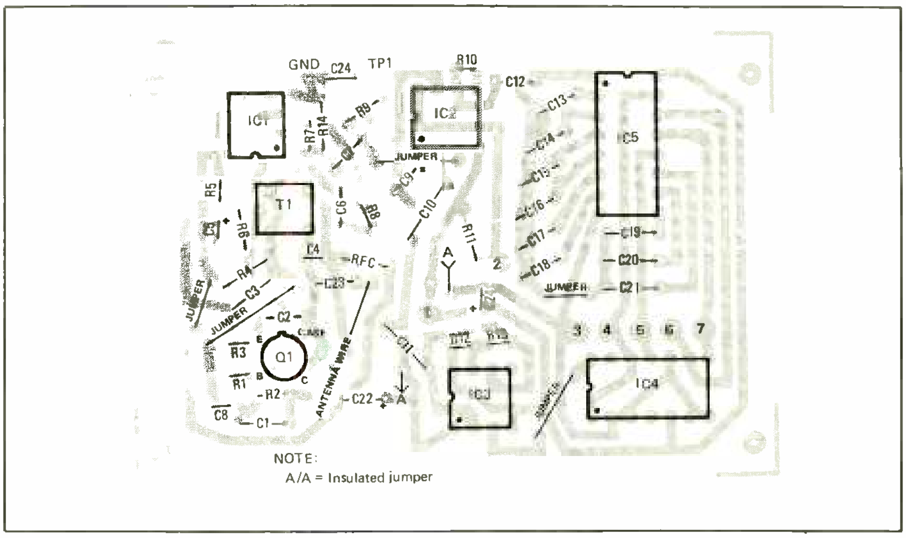


Fig. 9. Wiring guide for receiver/decoder board.

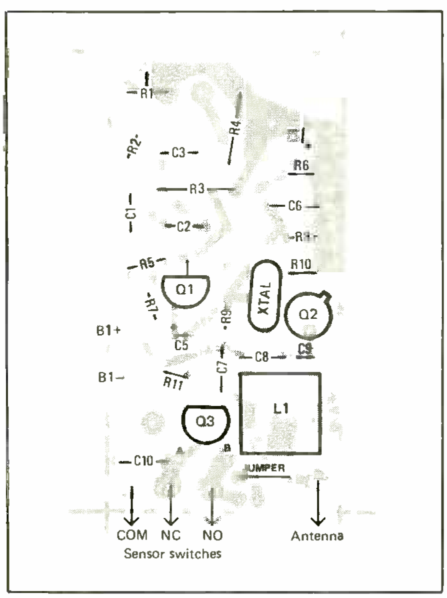


Fig. 7. Wiring guide for transmitter.

If you want the LEDs that make up *DIS1* on the power-supply/display board to protrude through the front panel of your enclosure, mount the display array, *LED1* and *LED2* on the *foil* side of the board, as in Fig. 11. Make sure the discrete LEDs are at the same height as the LED array and that they and *DIS2* are properly polarized.

Use a 7-conductor ribbon cable with an 8-pin connector at the power-supply end to link the receiver/decoder and power-supply/display boards. The power supply end can be terminated in a miniature 8-pin connector or be soldered directly to the board. (Install a mating connector on the board itself.) To prepare the receiver end, shorten lines 4 through 7 by ½", and solder the conductors in the appropriate holes in the board. Use a 24" length of stranded insulated hookup wire for the antenna

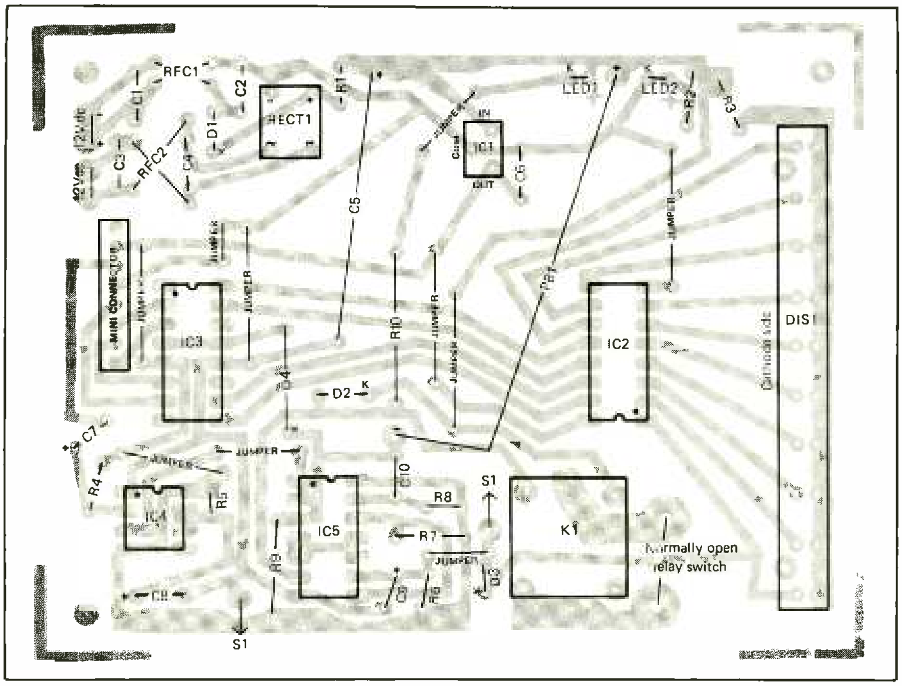


Fig. 10. Wiring guide for power-supply/display board.

and any type of hookup wire for the leads that go to *S1*, the piezoelectric buzzer if it is to be used, and the Normally Open Relay Switch pads.

For *RFC* on the receiver board, wind 14 turns of 28-gauge magnet wire on a No. FT-23-42 toroid core. Both *RFC1* and *RFC2* on the power-supply board are wound on the same No. FT-23-43 toroid core. To prepare this double RFC, twist together two 6″ lengths of 30-gauge magnet wire (about 30 twists) an wind five turns of the twisted pair on the toroid form. Be sure to start and end with the same conductor for each RFC, as shown in Fig. 2, when installing the assembly. Don't cross-connect the windings!

If you wish to have the wireless pass-through option, install diode *D3* as shown in Fig. 3. Now *K1* will reset whenever the transmitter for channel 1 is activiated, allowing you to pass through a monitored entrance without tripping the alarm. The wired receiver/decoder and power-supply/display boards are shown in the lead photo.

Select an enclosure for the receiver system that is large enough to accommodate the receiver/decoder and power-supply/display boards without crowding, as well as the backup-battery option if you plan on using it and installing it internally. Drill holes for mounting the receiver/decoder and power-supply/display boards (receiver on the bottom panel, power-supply on the top panel); the antenna and transformer cable (in different sides); and the LEDs and the *S1* RESET switch. Line the hole through which the wall transformer cable is to enter the enclosure with a rubber grommet.

Cut a slot for viewing the LED display. Then drill mounting holes for a 2-contact screw-type terminal strip on the rear wall and for the piezoelectric buzzer (if you decide to use it) on the front or one of the side walls of the enclosure. The wires from the relay's contacts go to the terminal strip.

If your wall transformer has a connector on it, cut it off and prepare the cable for soldering. Pass the cable through the grommet and tie a knot in it about 6″ from the prepared end. Solder the conductors to the pads labeled 12 VAC. If you plan on using the battery backup option, solder 8″ lengths of hookup wire to the pads labeled 12 VDC.

Mount *S1* in its hole and the terminal strip on the enclosure. Then use ¼″ spacers and 4-40 × ½″ machine

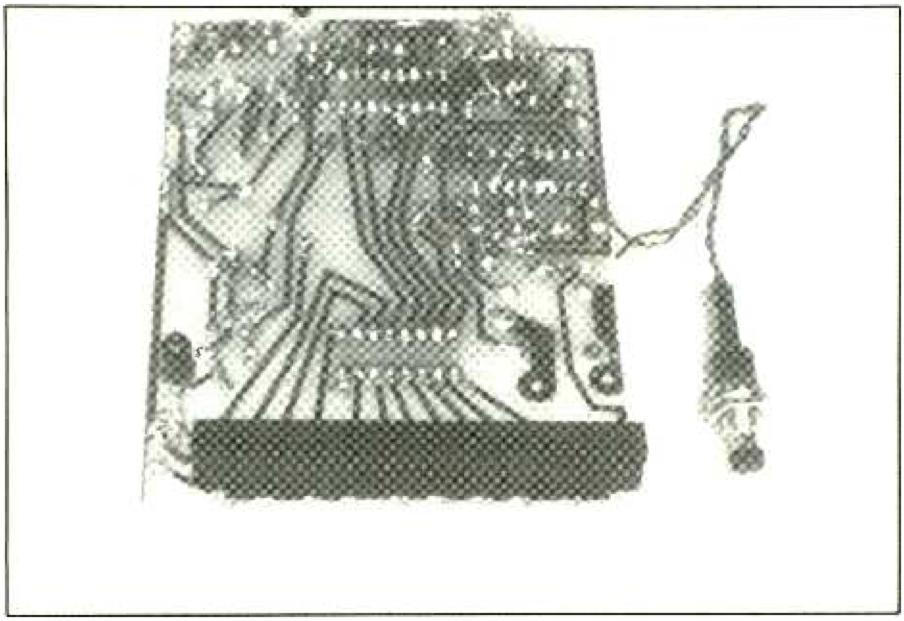


Fig. 11. If display array and discrete LEDs are to protrude through front panel, mount them on the rear of the board. Observe proper orientations.

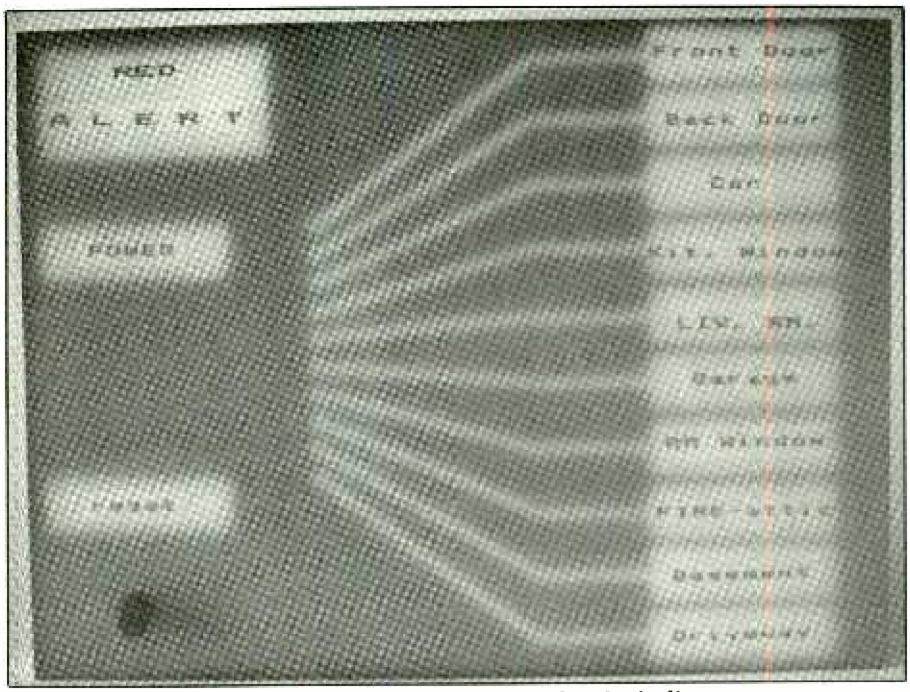


Fig. 12. A suggested front-panel layout for the indicator system.

hardware to mount the pc board assemblies. Plug the ribbon cable onto the connector on the power-supply board and route the antenna wire through its hole. Connect and solder the wires to *S1*, *PB1* and the terminal strip.

Label *LED1* POWER and *LED2* ALARM (or ALERT), the various LEDs of *DIS1* according to location (such as FRONT DOOR, KITCHEN WINDOW, GARAGE, etc. in Fig. 12) and *S1* RESET.

Calibration and Installation

Starting with the receiver system, place it within about 3 feet of a TV receiver turned on and tuned to channel 2. Plug the projects's wall transformer into an ac outlet and note that the POWER LED immediately comes on and that all 10 LEDs in *DIS1* light for a few seconds and then shut off. After this, the array's LEDs will turn on and off sequentially in scanner-like fashion.

Use a small screwdriver to adjust the tuning slug in *T1*. (*Caution*: the tuning slug is very fragile; so work carefully.) With the slug about halfway out, begin slowly turning it clockwise while monitoring the TV picture. Lines of interference should appear. Continue clockwise adjustment until most or all of the lines fade out and a light snow remains, indicating that the r-f detector is operating in the correct frequency range.

Connect an audio amplifier to testpoint TP1 and GND on the receiver/decoder board (see Fig. 7). Turn up the volume to about halfway and listen for the hissing noise that indicates correct receiver operation. If a TV station is broadcasting on channel 2, you can detect the video portion of the signal by backing *T1*'s slug about halfway out until you hear a harsh buzzing sound.

To calibrate the transmitter(s), start by setting trimmer control *R1* to mid-position and the slug in *L1* flush with the top of the coilform. Place the transmitter near the TV receiver, still turned on and tuned to channel 2. Drape the transmitter's antenna wire over the TV receiver's rabbit-ears antenna and turn on the transmitter. Adjust *L1*'s slug until interference lines appear on the TV screen (an audio tone might also be heard, but not clearly), indicating that the transmitter is working.

Use the 450-Hz transmitter to make the following adjustment. Place the transmitter about 15 feet from the receiver and adjust *T1*'s slug until you hear a tone coming from the amplifier's speaker. Adjust for best signal. Once tuned, check to make sure that each transmitter causes the receiver's relay to latch and the display to pause at the correct location.

Decide on the locations in which to mount the transmitters. If possible, orient the antennas vertically, off the floor and away from metal objects, including electrical wiring. Fasten the sensors so that they toggle when monitored doors and windows are opened. You can locate the receiving module in any convenient location within the protected premises where there's an ac outlet into which it can be plugged. Then when the system is fully installed, make several test runs to ascertain that the system is working properly. Orient the antenna vertically.

At this point, you can elect to have your system sound a siren or loud bell, activate a sump pump, turn on a sprinkler system, turn on flood lights, etc. via the relay in the receiver. Be aware, however, that this relay's contacts are rated for relatively light-duty loads. If you wish to have it control an item that draws a lot of power, such as floodlights, have the internal relay control an external power relay that, in turn, controls the load.

Parting Comment

The 10-Channel Wireless Home Security System described here provides the convenience of wireless operation with the basic economy of a hard-wired system. Its ability to inform you of the location of an attempted break-in or other emergency situation is a benefit that most hard-wired systems do not offer. **ME**

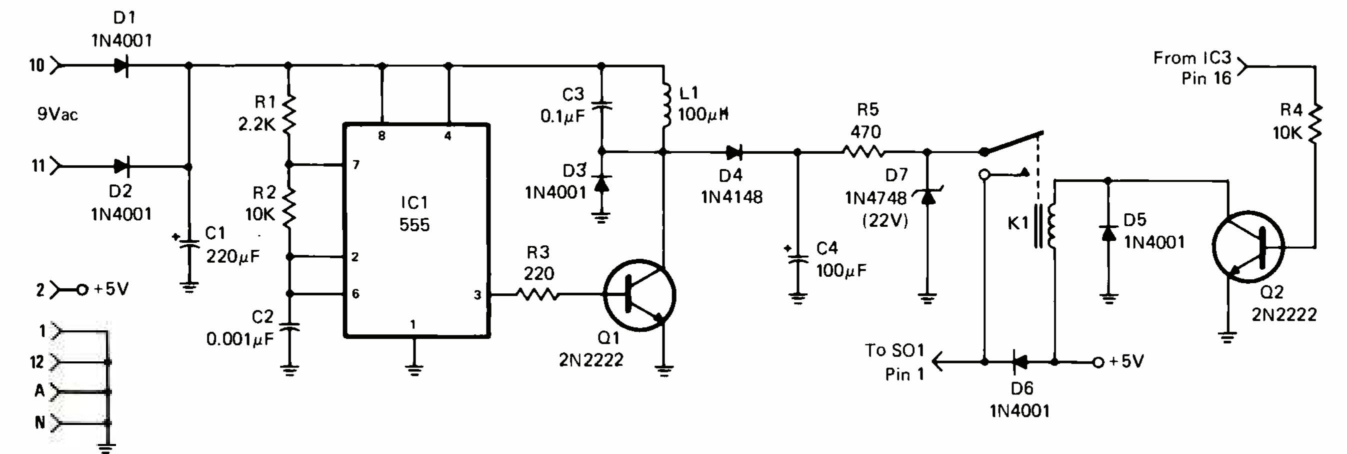
An EPROM Programmer For the Commodore 64

Computer-driven plug-in board inexpensively programs popular 2764 EPROMS with the C-64 computer

By Paul Renton

Programming EPROMs often requires dedicated and exsive hardware. The home user who wants to program just a few EPROMS can build a device that can be controlled by a computer, but if he wants to program a large variety of different types of EPROMS, the cost of the increasingly more expensive hardware would negate any monetary advantages to be gained by going this route. However, programming hardware that handles a very limited variety of EPROMS greatly simplifies the requirements and dramatically reduces the cost. Fortunately for the home programmer, there is a single type of EPROM that is widely used in computers and many other digital circuits and systems. It is the 8K by 8-bit 2764 EPROM that, in most cases, is the only type you need consider.

Presented here is a low-cost EPROM Programmer that allows



PARTS LIST

Semiconductors
D1,D2,D3,D5,D6—1N4001 diode
D4—1N148 diode
D7—1N4748 or similar 22-volt zener diode
IC1—555 timer
IC2—74LS273 octal flip-flop
IC3—74LS373 octal latch
IC4—CD4040 12-bit binary counter
Q1,Q2—2N2222 npn transistor

Capacitors
C1—220-μF, 25-volt electrolytic
C2—0.001-μF disc
C3,C5—0.1-μF disc
C4—100-μF, 35-volt electrolytic

Resistors (¼-watt, 5% tolerance)
R1—2,200 ohms
R2,R4—10,000 ohms
R3—220 ohms
R5—470 ohms

Miscellaneous
K1—5-volt spst relay
L1—100-μH coil
SO1—28-pin zero-insertion-force IC socket
Printed-circuit board; female 24-contact (12 contacts on each side to conform with the C-64's User Port arrangement) card edge connector with 0.156″ contact spacing; sockets or Molex Soldercons for all ICs (see text); solder; etc.

Note: The following items are available from Paul Renton, P.O. Box 1525, Mercer Island, WA 98040: complete kit including pc board, ZIF socket and all components (but not IC sockets) and software on disk for $34.00; double-sided pc board for $12.50; software on disk for $5.00. Washington residents, please add state sales tax.

Fig. 1. Power supply section delivers 22 volts to program the 2764 EPROM.

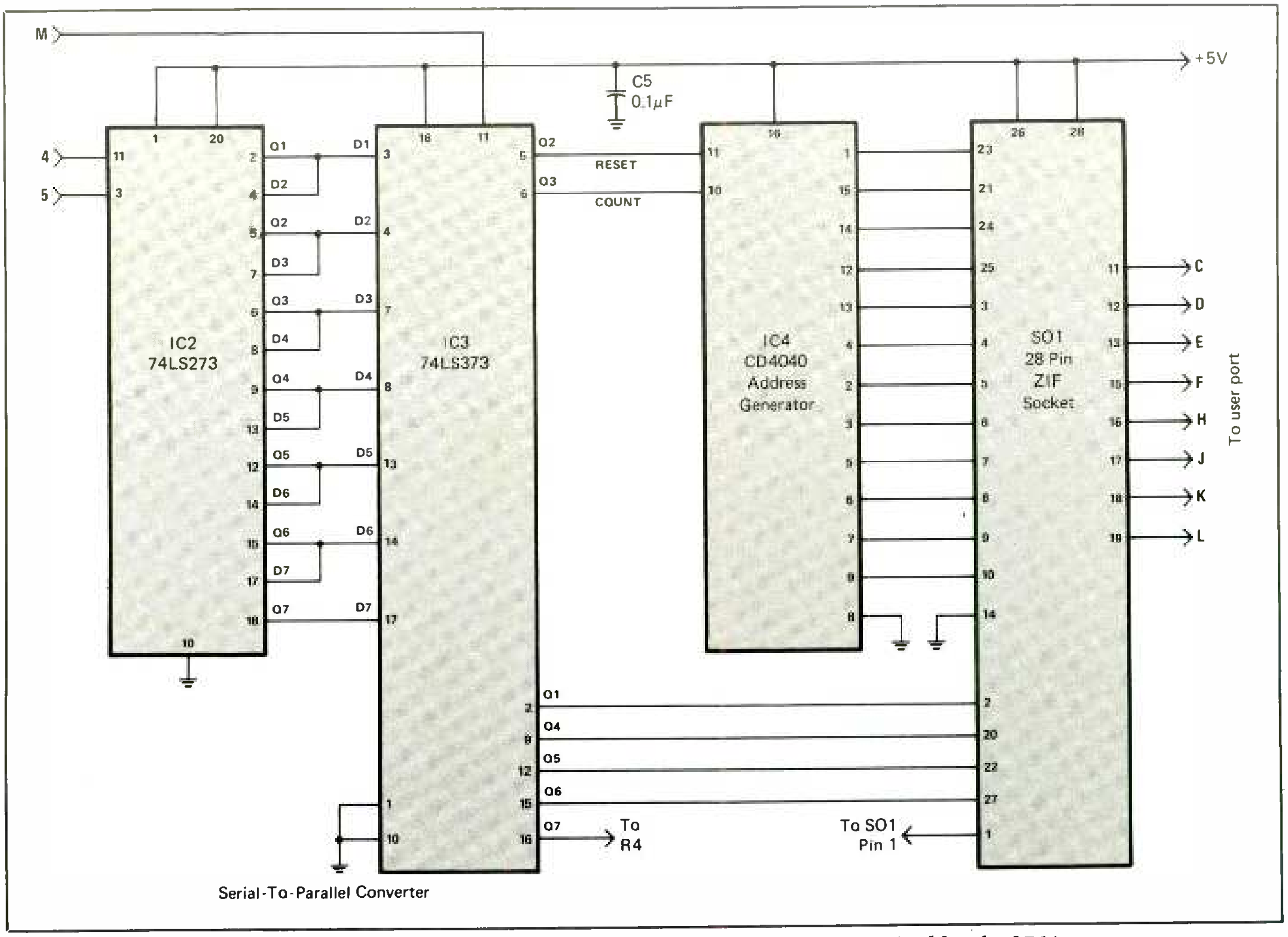


Fig. 2. Digital section supplies the 25 input and output lines required by the 2764.

you to program 2764 EPROMs with a Commodore 64 computer. With the Programmer plugged into the C-64's User Port, you key into the computer a software routine that allows 2764s to be read and programmed. Additionally, the Programmer allows the contents of an EPROM to be read and saved to disk. These functions can be performed either from the direct mode or under program control.

About the Circuit

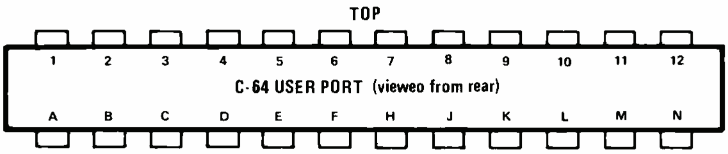
The 2764 EPROM Programmer consists of a power supply (Fig. 1) and a digital section (Fig. 2). The power supply develops and delivers to the EPROM being programmed the 22 volts required to actually accomplish the programming.

Power for the EPROM Programmer is obtained from the 9 volts ac available at pins 10 and 11 of the C-64's User Port, as shown in Fig. 1. This 9 volts ac enters the Programmer and is rectified by *D1* and *D2* and filtered by *C1* to produce about +11 volts dc. Timer *IC1* then generates a roughly 50-kHz square wave that is fed to the base of and turns on and off *Q1*. Coil *L1* and capacitor *C3* in the collector circuit of *Q1* cause a waveform consisting of a series of positive-going peaks of about +50 volts amplitude to charge *C5* to about 30 volts. This 30 volts is then regulated to 22 volts by *D7* and is delivered on demand to the EPROM plugged into the programmer.

When the Programmer needs the programming voltage, *Q2* conducts and energizes *K1*, whose contacts then close and deliver the 22 volts to the EPROM. At all other times, the pin that receives the programming voltage must be held high. This condition is satisfied by *D6*, which delivers +5 volts as shown.

As shown in Fig. 2, the digital section of the Programmer must supply 25 input and output lines. However, the C-64's User Port has only nine pins for I/O (see Fig. 3 and the accompanying Table). The remaining I/O bits are obtained with serial-to-parallel converter *IC2*, which creates a new 8-bit I/O port without sacrificing any of the I/O capabilities of the existing port.

There are two serial ports on the C-64's User Port for 8-bit synchronous data. By using one of these as



C-64 User Port Contacts Used in EPROM Programmer

1 Ground	11 9 volts ac	E Data 2	K Data 6
2 +5 volts	12 Ground	F Data 3	L Data 7
4 Serial port clock	A Ground	H Data 4	M Latch enable
5 Serial port data	C Data O	J Data 5	N Ground
10 9 volts ac	D Data 1		

Fig. 3. Pinout diagram for the C-64 User Port.

an output and *IC2* as a shift register, eight bits of I/O are obtained. The data outputs of *IC2* are latched by *IC3* so that the I/O pins do not change as new data is sent through the shift register. Latching the data with *IC3* requires one bit of actual I/O on the C-64's User Port.

Two of the outputs from the new 8-bit I/O port, available at pins 5 and 6, control counter *IC3*. This 12-bit counter provides the lower 12 bits of the address of the EPROM being programmed. The output at pin 5 of *IC3* provides the reset that clears counter *IC4* to all 0s, while the output at pin 6 of *IC3* increments the count in *IC4*. Likewise, the outputs at pins 2, 9, 12 and 15 of *IC3* provide address 12, chip enable, output enable and program signals to the EPROM plugged into zero-insertion-force (ZIF) socket *SO1* at pins 2, 20, 22 and 27, respectively.

Programming relay *K1* in Fig. 1 is controlled by the output at pin 7 of *IC3*. The last bit is unused. The remaining I/O pins of the C-64's User Port are connected to Data pins C through L that are, in turn, connected to pins 11, 12, 13, 15, 16, 17, 18 and 19, respectively, of *SO1*.

Reading and programming a 2764 EPROM with the Programmer consists of issuing commands via the computer's serial port to the new I/O port in the Programmer, latching the new commands with *IC3*, and using the User Port I/O pins to either provide the data to be programmed into the EPROM or read the output data from the EPROM.

Construction

Though the 2764 EPROM Programmer can certainly be assembled on perforated board with the aid of suitable soldering or Wire Wrap hardware, a printed-circuit board is recommended. Also recommended is the use of sockets for all ICs. A zero-insertion-force socket is almost a must for *SO1*, since repeated insertions and removals of EPROMs from an ordinary socket can rapidly fatigue the socket pins and, more importantly, damage the EPROMs.

You can fabricate the pc board using the actual-size etching-and-drilling guide given in Fig. 4 or purchase a ready-to-wire board from the source given in the Note at the end of the Parts List. Before you begin wiring *any* components to this double-

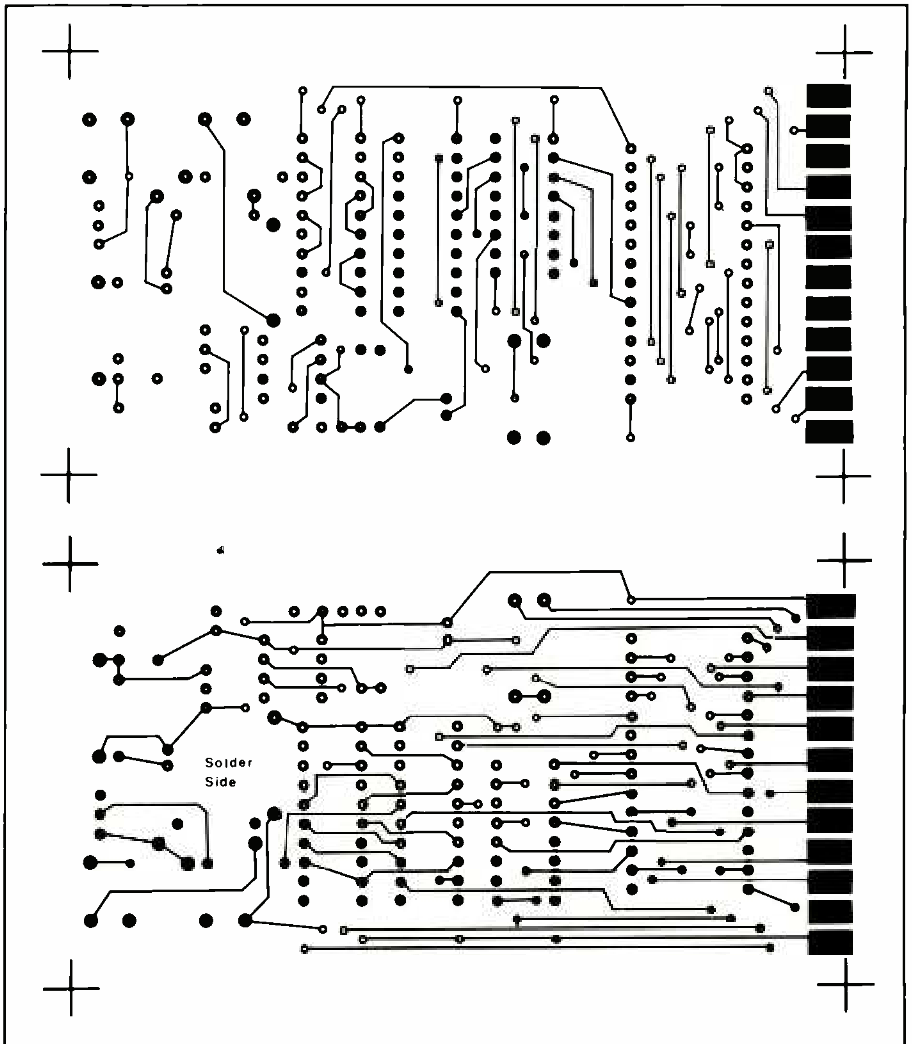


Fig. 4. Actual-size etching-and-drilling guide for the double-sided pc board.

sided board, install and solder into place the tiny wires that bridge the conductors on both sides of the board. These are all shown circled in Fig. 5. There are 60 such jumpers, making this the most tedious part of assembly.

Use bare 22-gauge solid hookup wire for the jumpers. Feed one end of a 12" or longer wire into a hole from the component side of the board and solder it to its copper pad on the noncomponent ("solder") side, leaving about 1/16" stub protruding from the solder. Flip over the board and solder the wire to the pad on the component side. Hold the wire steady until the solder solidifies. Then clip the wire close to the solder on both sides of the board. Repeat this procedure for the remaining jumpers. Make sure that all soldered connections are smooth and shiny.

After you have installed all jumpers, mount the relay so that about 1/8" of each pin is visible between it and the top of the board. Solder the relay pins to the pads on both sides of the board. Solder the relay pins to the pads on both sides of the board. (Note: from here on, except for the card edge connector "solder" refers to connections on *both* sides of the board.) Wire the board exactly as shown in Fig. 5, paying careful attention to the orientations and polarization of the electrolytic capacitors, transistors and diodes.

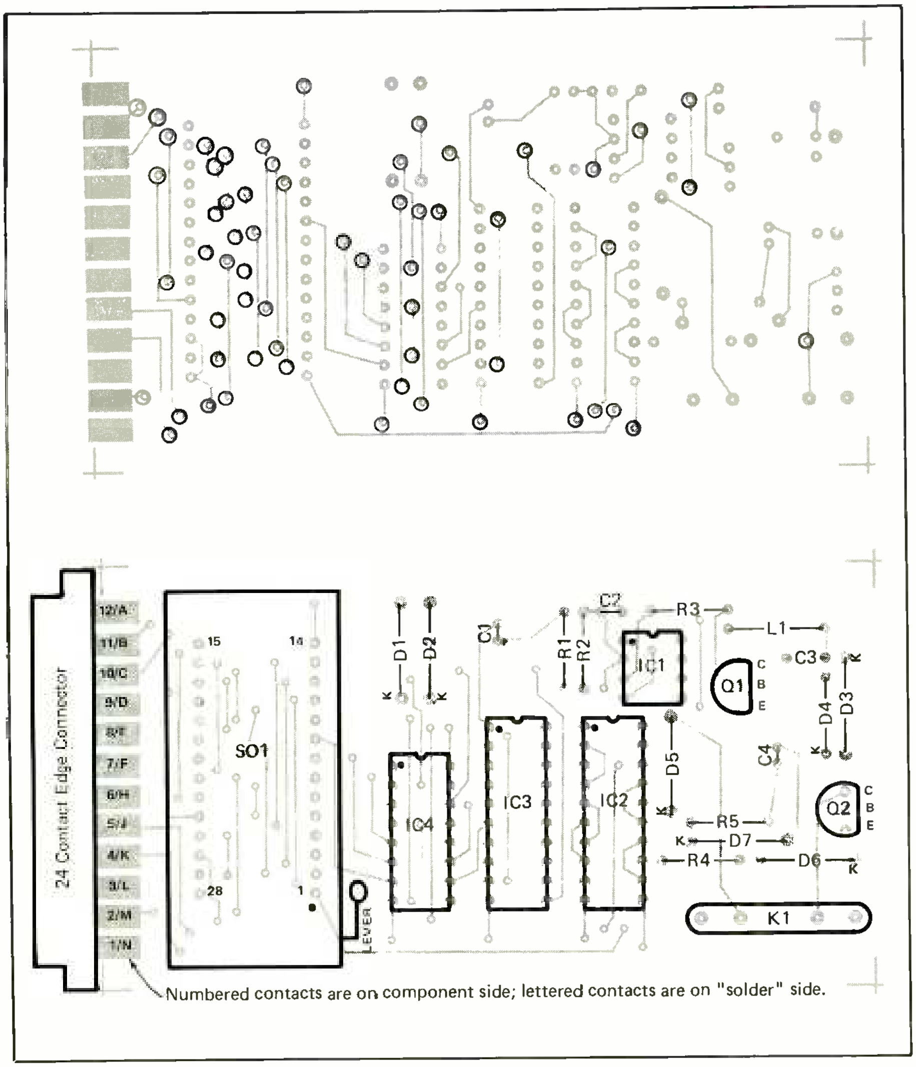


Fig. 5. Wiring guide for the pc board.

Mount the transistors so that 1/4" of each lead is visible between them and the top of the board and solder them into place. Then mount a long-pin ZIF socket in the *SO1* location, spacing it about 3/16" above the surface of the board so that you have access for soldering it into place. Do the same for the relay.

Unless a double-sided pc board has plated-through holes, you can not use standard IC sockets for *IC1* through *IC4*. You can, of course, install the ICs directly on the board and solder their pins to the pads. However, if you wish to socket your ICs, you can do so with the aid of Molex Soldercons, which do give soldering access on both sides of the board. If you are socketing the ICs, install only the "sockets"—not the ICs themselves—at this time.

Once the above components have been soldered into place you can install the diodes, resistors, capacitor and coil. (It is not necessary to solder any lead to a copper pad on the top of the board that has no trace leading from it.) When this has been done, carefully inspect the board for poor soldered connections and solder bridges, the latter especially between the closely spaced pads around the IC (or socket) pins.

Finish construction by soldering the edge connector to the board. To do this, line up the connector's solder lugs with the copper lands at the edge of the board and tack solder one lug at either end to the land on the component side of the board. Make sure the back of the connector is flush against the edge of the board, and solder the remaining lugs to the lands on the component side. Then flip over the board and carefully bend the connector lugs so that they touch the copper lands on the bottom side of the board. Solder all lug/pad connections.

Setup and Use

Plug the Programmer into the User

Program 1. BASIC Loader for 2764 EPROM Burner

```
5 REM BASIC LOADER FOR 2764 EPROM BURNER
10 FORX=49152 TO 49767
20 READ A :POKE X,A
30 Q=Q+A
40 NEXT
50 IF Q<>81167 THEN PRINT"ERROR IN DATA STATEMENTS" :END
55 SYS49152
60 END
100 DATA 76, 12, 192, 76, 81, 192, 76, 215, 192, 76
110 DATA 6, 194, 169, 186, 141, 239, 193, 32, 22, 192
120 DATA 88, 96, 120, 169, 10 , 141, 4, 220, 169, 0
130 DATA 141, 5, 220, 169, 81, 141, 14, 220, 173, 239
140 DATA 193, 141, 12, 220, 162, 50, 202, 208, 253, 173
150 DATA 0, 221, 9, 4, 141, 0, 221, 173, 0, 221
160 DATA 41, 251, 141, 0, 221, 169, 104, 141, 4,220
170 DATA 169, 66, 141, 5, 220, 169, 17, 141, 14, 220
180 DATA 96, 120, 169, 186, 141, 239, 193, 32, 22, 192
190 DATA 169, 184, 141, 239, 193, 32, 22, 192, 169, 0
200 DATA 133, 38, 169, 96, 133, 39, 169, 0, 141, 3
210 DATA 221, 169, 160, 141, 239, 193, 32, 22, 192, 173
220 DATA  1, 221, 160, 0, 145 ,38, 169, 188 ,141, 239
230 DATA 193, 32, 22, 192, 169, 184, 141, 239, 193, 32
240 DATA 22, 192, 230, 38, 208, 2, 230, 39, 165, 39
250 DATA  201, 112, 208, 213, 169, 161, 141, 239, 193, 32
260 DATA 22, 192, 173, 1, 221, 160, 0, 145, 38, 169
270 DATA 189, 141, 239, 193, 32, 22, 192, 169, 185, 141
280 DATA  239, 193, 32, 22, 192, 230, 38, 208 ,2, 230
290 DATA  39, 165 ,39, 201, 128, 208, 213, 169, 186 ,141
300 DATA 239, 193, 32, 22, 192 ,169, 184, 141, 239, 193
310 DATA  32, 22, 192, 88, 96, 32, 230, 192, 173, 237
320 DATA 193, 208, 1 ,96, 162, 28, 32, 139, 227 ,96
330 DATA 120, 169, 186, 141, 239, 193, 32 ,22, 192, 169
340 DATA  184, 141, 239, 193, 32, 22 ,192, 169 ,0, 133
350 DATA  38, 169, 96 ,133, 39 ,169 ,0, 141, 238, 193
360 DATA 169, 255 ,141, 3 ,221, 160, 0, 177, 38 ,141
370 DATA  1, 221, 169, 240, 141, 239, 193, 32, 22, 192
380 DATA  169, 208, 141, 239, 193, 32, 22, 192, 32, 240
390 DATA 193, 169, 240, 141, 239, 193, 32, 22, 192, 169
400 DATA  0, 141, 3, 221, 169, 224, 141, 239, 193, 32
410 DATA 22, 192, 160, 0, 173, 1, 221, 209, 38, 240
420 DATA 13, 238, 238, 193, 173, 238, 193, 201, 16, 208
430 DATA 185, 169, 1, 141, 237, 193, 76, 197, 192, 169
440 DATA 252, 141, 239, 193, 32, 22, 192, 169, 248, 141
450 DATA 239, 193, 32, 22, 192, 230, 38, 208 ,2, 230
460 DATA  39, 165, 39, 201, 112, 240, 3, 76, 255, 192
470 DATA  169, 0, 141, 238, 193, 169, 255, 141, 3, 221
480 DATA 160, 0, 177, 38, 141, 1, 221, 169, 241, 141
490 DATA 239, 193, 32, 22, 192, 169, 209, 141, 239, 193
500 DATA 32, 22, 192, 32, 240, 193, 169, 241, 141, 239
510 DATA 193, 32, 22, 192, 169, 0, 141, 3, 221, 169
520 DATA 225, 141, 239, 193, 32, 22, 192, 160, 0, 173
530 DATA 1, 221, 209, 38, 240, 18, 238, 238, 193, 173
540 DATA 238, 193, 201, 16, 208, 185, 169, 1, 141, 237
550 DATA 193, 76, 197, 192, 169, 252, 141, 239, 193, 32
560 DATA  22, 192, 169, 248, 141 ,239, 193, 32, 22, 192
570 DATA  230, 38, 208, 2, 230, 39, 165, 39, 201, 128
580 DATA 240, 3, 76, 114, 193, 169, 0, 141, 237, 193
590 DATA 76, 197, 192, 0, 0, 0, 173, 238, 193, 201
600 DATA 15, 208, 9, 162, 50, 32, 0, 194, 202, 208
610 DATA  250, 96, 160, 208, 136, 208, 253, 96, 162, 0
620 DATA 189, 26, 194, 240, 41, 142, 103, 194, 32, 22
630 DATA  231, 174, 103, 194, 232, 76, 8, 194, 147, 17
640 DATA 17, 70, 73, 76, 69, 78, 65, 77, 69, 32
650 DATA 84, 79, 32, 83, 65, 86, 69, 32, 65, 83
660 DATA 32, 63, 32, 32, 32, 0, 32, 96, 165, 169
670 DATA 5, 162, 3, 160, 5, 32, 186, 255, 162, 0
680 DATA 189, 0, 2, 240, 4, 232, 76, 68, 194, 138
690 DATA  162, 0, 160, 2, 32, 189, 255, 169, 0, 133
700 DATA 38, 169, 96, 133, 39, 169, 38, 162, 0, 160
710 DATA 128, 32, 216, 255, 96, 0

READY.
```

Port slot on the C-64, power up your computer and key in Program 1. Save a copy of this program on disk, and then run the program. This program creates a machine-language program that resides in the machine-language space of memory locations 49152 through 57344.

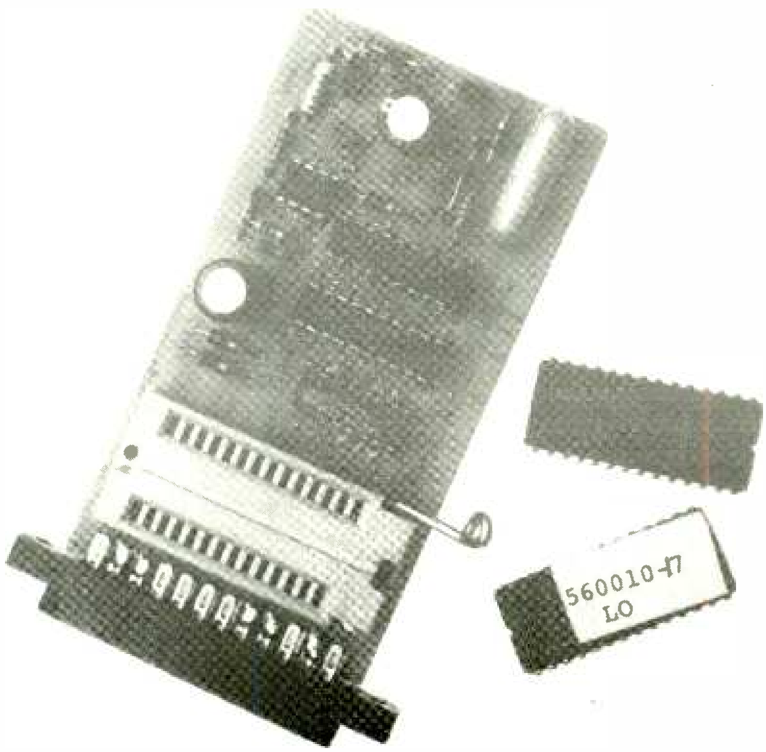
After running Program 1, key in Program 2, which creates an all-machine-language version of the program that can be directly loaded into the correct memory space by typing LOAD"EPROM",8,1. (When using Program 2, be sure to add the ,1 to your LOAD command.

You operate the Programmer with the SYS command, which calls a machine-language routine. The first command to use is SYS49152, which initializes the programming hardware. This must be done *before* you insert an EPROM in *SO1*.

To read an EPROM, load in the software and type SYS49152. The Programmer will then be ready to program or read an EPROM. Now insert an EPROM into *SO1* (make sure it is oriented so that pin 1 is near the socket's lever) and type SYS49155. The contents of the EPROM will then be read from the EPROM and be moved into the computer's memory. This takes about 10 to 15 seconds. Memory space used for this data begins at location 24576 and extends to location 32767 ($6000 to $7FFF in hexidecimal). You can examine the contents of the EPROM by PEEKing these locations.

To save data loaded into the computer from a 2764 EPROM, type SYS49161. You will be asked for a filename for the program. Data saved this way can be loaded by typing LOAD "<filename>",8,1. It will load back into the computer in the same memory space (that is, 24576 through 32767).

Before programming a 2764, the EPROM must be erased to set all memory location bits to logic 1. You do this by exposing the EPROM to ultraviolet light. Once erased, the



The finished project.

Program 2. Creates Machine-Language Version of Program 1

```
10 REM MAKEML - MAKES ML FOR EPROM/BAS
20 OPEN 5,8,5,"0:EPROM,P,W"
30 PRINT#5,CHR$(0)CHR$(192);
40 FORT=49152 TO 49768
50 PRINT#5,CHR$(PEEK(T));
60 NEXT
70 CLOSE5

READY.
```

EPROM is ready for programming.

To program an EPROM, first place the data that is to be transferred to it in memory in your computer, with the first byte at location 24576 and each successive byte in consecutive memory locations counting up from there. When this is done, type SYS49158 to have the software begin programming the EPROM, verifying each byte programmed as it attempts to program it.

Programming a 2764 usually takes 30 seconds to 2 minutes to accomplish. If there is an error, the programming will halt and the message ?VERIFY ERROR will appear on the computer's screen to indicate that the computer could not verify that a byte was properly programmed. This is usually due to incomplete erasure of the EPROM.

Upon successful completion of programming, no message is displayed other than the usual READY. The EPROM can now be removed from the ZIF socket.

Keep in mind that EPROMs have transparent windows in their cases to provide access for erasing programmed data. If this window is not covered over so that no light can get through, accidental erasure of programmed data can result. (It is estimated that a one-week exposure to direct sunlight will begin the erasure process.) To eliminate the possibility of accidental erasure from occurring, it is important that you cover the window of all your programmed EPROMs with some opaque material. An excellent choice for this are floppy-disk write-protect tabs.

A couple of precautions should be taken when using the EPROM Programmer. One is never insert and EPROM in the ZIF socket until the software is loaded into your computer and you have typed SYS49152. If you do, when the hardware powers up (it will be in an uncertain state), the programming voltage from the Programmer might be applied to pin 1 at *SO1*, damaging the EPROM.

The second precaution to observe is never remove an EPROM from the programming socket once programming has begun and has not run its course. Wait until the programming cycle has run to completion before removing the EPROM.

The 2764 EPROM Programmer described here provides a low-cost alternative to dedicated stand-alone programmers. If you are like many C-64 owners and users who have progressed beyond simple running or prepackaged programs and games to writing your own, you will find this Programmer well worth the time, effort and cost to build and use. **ME**

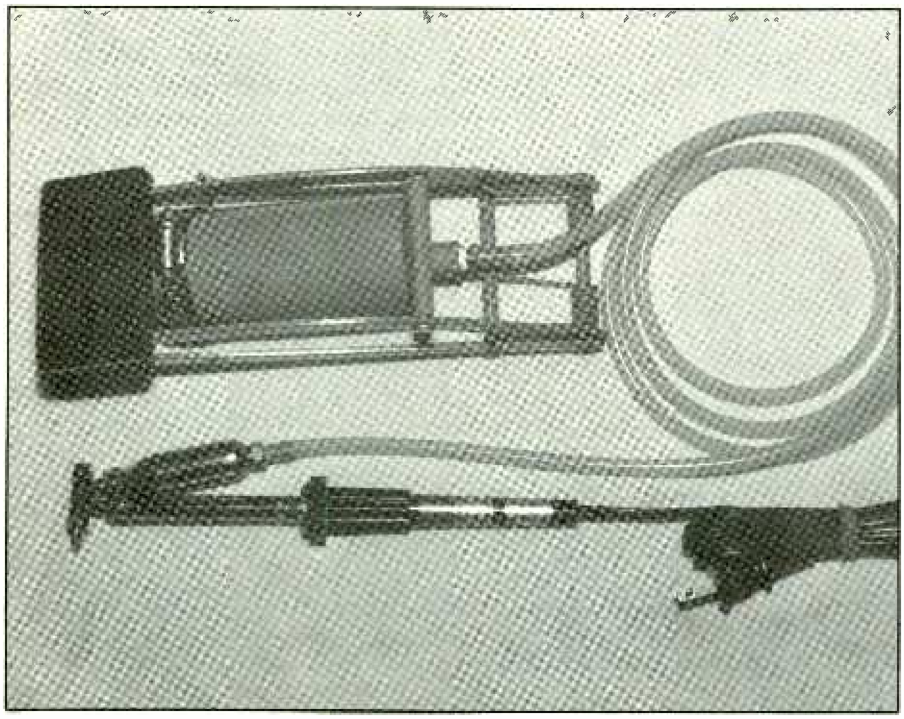
Super Solder Sucker Desoldering Tool

Built around an inexpensive bicycle tire pump, this vacuum-type desoldering tool emulates costly commercial desoldering workstations at a fraction of their cost

By Brian O'Toole

How many times have you attempted to desolder a component from a printed-circuit board only to damage the component or/and the board? If you're like most of us, this is not an uncommon occurrence. Inexpensive desoldering vacuum bulbs, plungers, etc. are compromises that allow this type of problem to happen at one time or another. The better, safe way to desolder components from a pc board is with an electric vacuum-type desoldering workstation. Unfortunately, this more sophisticated tool usually sells for $250 or more, which puts it beyond the budgets of most home experimenters and many small repair facilities. Enter the Super Solder Sucker, a tool that sacrifices all-electric vacuum action, but otherwise operates like the professional workstation at a cost of $20 to $25 for the basic version.

Building the Super Solder Sucker around an inexpensive bicycle tire foot pump gives up the convenience of electric action, but at the same time saves you $225 or more on the cost of the tool. What you get, however, is super sucking action with very little pumping effort. And like the professional tools, the Super Solder Sucker's valve action eliminates liquid solder blow-back on the return stroke. You get fast sucking



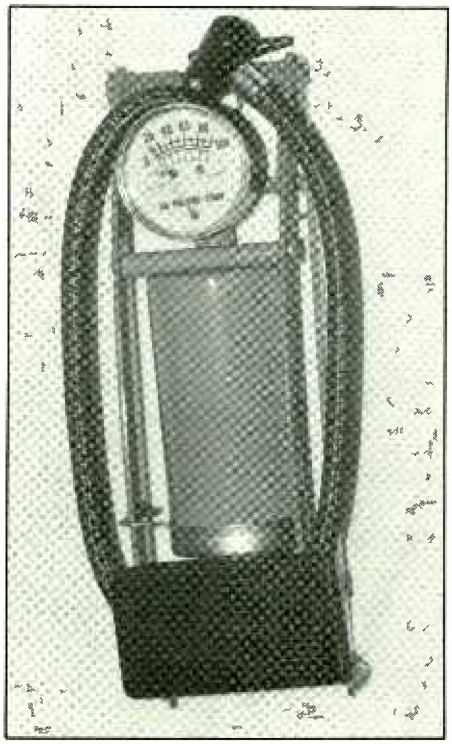


Fig. 1. A typical bicycle tire pump that can be used in this project. This is the one illustrated in all photos in this article; any similar one can be used if you can not find this one.

action that reduces the time a soldered joint must be heated and, therefore, less chance of damage to components or the pc board.

In this article, we describe two versions of the Super Solder Sucker. The basic tool consists simply of the vacuum pump, which you use with your present soldering iron or pencil. The deluxe version adds a desoldering iron that makes the Super Solder Sucker a dedicated desoldering tool that can be operated with a one hand.

Modifying the Pump: The Basic Tool

Before modifying the bicycle tire pump around which the Super Solder Sucker is built, read the "Precautionary Notes" box. The bicycle tire pump used for the photos throughout this article is shown in Fig. 1. If you can't find this particular pump, any similar one can be used. Start your modification by unscrewing and discarding the hose and pressure gauge from the end of the pump's cylinder. Remove the nut from the end of the pushrod. The cap that holds the piston in the cylinder may be secured differently than for the pump shown in the photos, which is crimped on tightly. You want to remove that cap without distorting it or the cylinder. To do this, first try by gently tapping around the edge of the cap with a small hammer and punch. It may be necessary to carefully cut a slot in the edge of the cap with a hacksaw, making sure not to cut into the cylinder.

Remove the piston fro the cylinder (Fig. 1) and slide the cap off the pushrod. Then remove the rubber O-ring from the piston and set it aside in a safe place so it won't be damaged. Notice that the simple valving arrangement consists of the two cutouts on the O-ring groove. To give the pump its vacuum action, you have to reverse the piston on its rod.

On the pump shown in the photos in this article, the plastic piston was molded onto the end of the rod. It is possible, though, to remove it without damage. Drill into the center of the top of the piston with a bit the same size as the pushrod. Drill *only* through the plastic. Stop when the bit contacts the metal rod. Now, supporting the piston in a vise without

Precautionary Notes

Whenever you do a machining operation, it is important that you observe certain safety precautions. This is particularly so when machining metal. The description of the machining process outlined in this article facilitates building the project without requiring special taps, dies, drill bits, etc.

Be sure to wear suitable eye protection when drilling any metal parts. When drilling holes larger than ¼", always start with a small pilot bit and work up with successively larger bits until the hole is the appropriate size.

It is important that you use protective soft plastic jaws or blocks of wood when holding the work in a vise. Note, too, that the word "carefully" is used a number of times in the text. By this, we mean that you should work slowly and gently to prevent damaging the parts being modified.

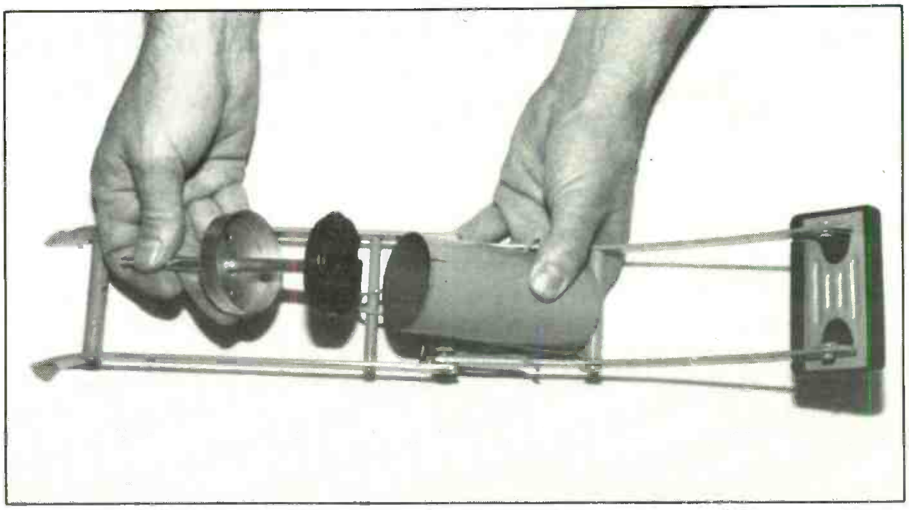


Fig. 2. Removing the piston from the bicycle tire pump's cylinder.

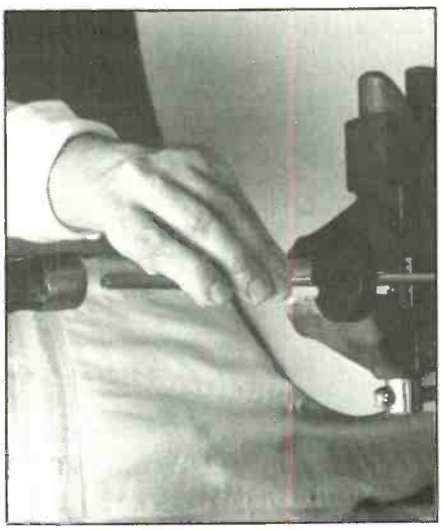


Fig. 3. Carefully drive the pushrod down using a hammer and punch.

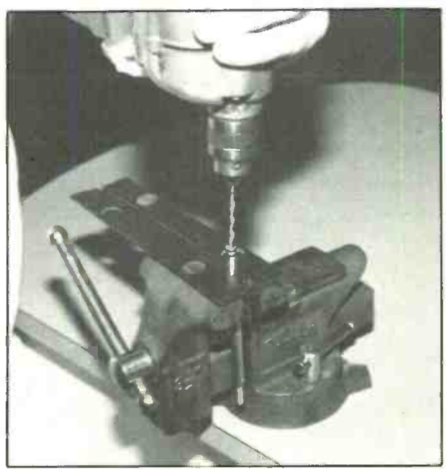


Fig. 4. Center punch the pushrod before drilling the hole for the screw that holds the cylinder in place.

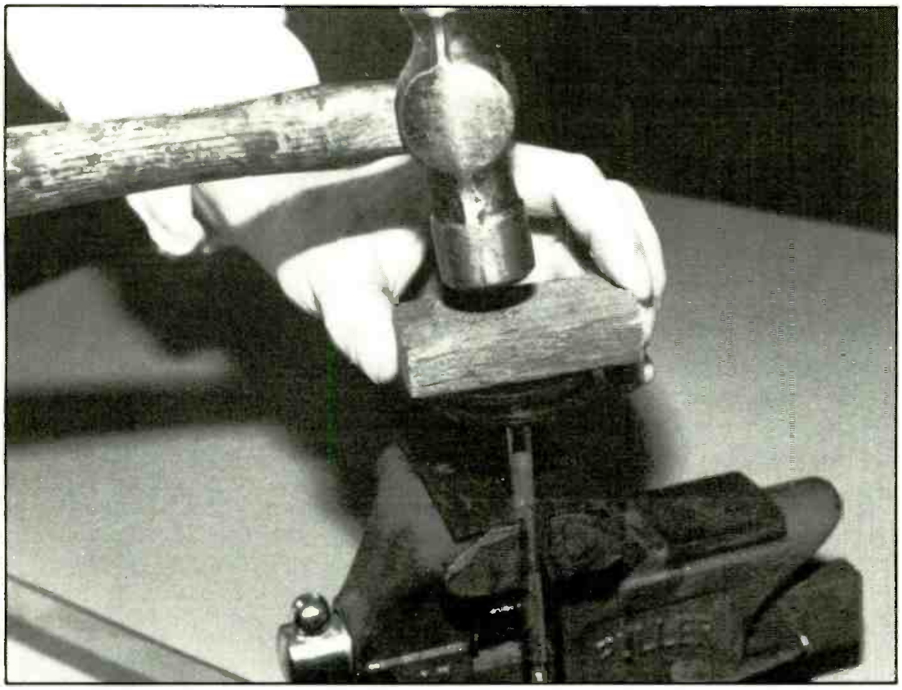


Fig. 5. Using a hammer and block of wood, gently tap the piston onto the pushrod until it is flush with the end of the rod.

gripping the pushrod, *carefully*, drive the rod down using a hammer and punch or metal rod (Fig. 3). It is not necessary to hammer hard; the plastic will shear where the piston meets the rod.

Next, holding the piston in the vise with the aid of rubber jaw faces or blocks of wood, drill through its center using a bit the same size as or, preferably, a little smaller than the pushrod. You want a press fit when remounting the piston.

The end of the rod must be drilled for the screw that will hold the piston on it. If you have a tap, an 8-32 screw is the right size. If not, a #8 × 1/4" or 3/8" sheet metal screw will work fine. If you use the tap, drill the hole with a #29 drill or 9/64" drill. The #8 sheet metal screw also takes a 9/64" bit, and definitely center punch the rod before drilling (Fig. 4).

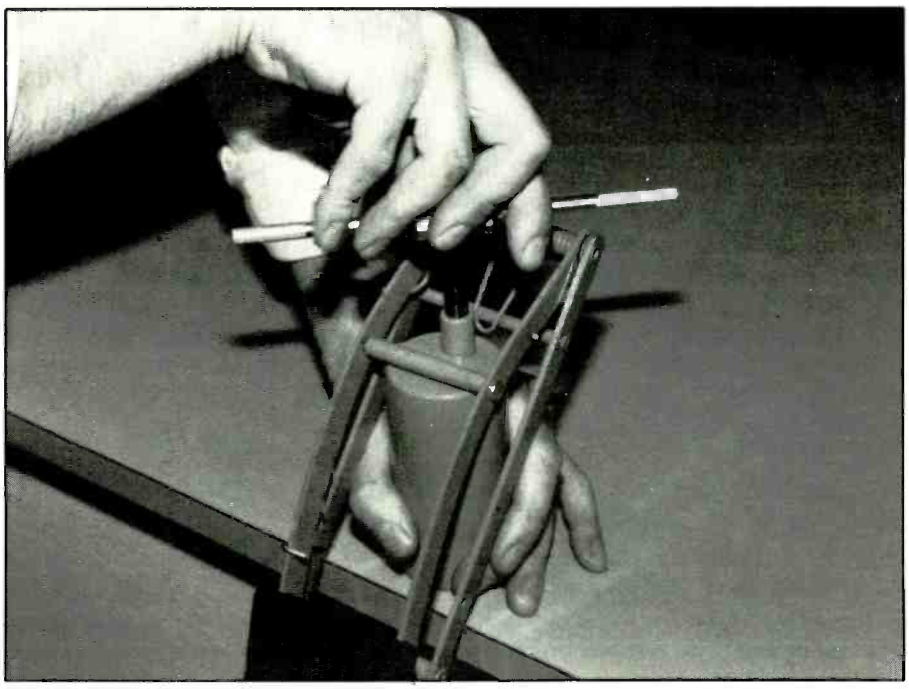
Holding the rod vertically in the vise, keep the top on-axis with the piston and carefully cut the threads in the rod. Make sure to keep the valve cutout side down during this operation. Work slowly and carefully to avoid distorting the plastic, and tap the piston until it is flush with the end of the rod (Fig. 5). If the piston slides onto the rod freely, you need secure only the bottom side by drilling a 3/32" hole crosswise through the rod and pushing a 3/32" roll pin (available at automotive suppliers) through it. Alternately, you can use a cotter pin or a piece of finishing nail. Make sure that the hole is located high enough so that the screw will tighten the piston onto the pin without any play.

Use a flat washer of sufficient size with the screw to clamp the piston onto the rod. Clean all metal chips and debris from the piston assembly, reinstall the rubber O-ring and set the assembly aside.

The threads in the coupling of the cylinder of the pump shown being modified here were of a different size than the standard American pipe thread (N.P.T.). However, it is very close to 1/8" × 27 N.P.T. (1/8" N.P.T. is a nominal size; the actual size is closer to 3/8" diameter).

Hold the cylinder by hand squarely on the workbench (gripping it in a vise can distort it). Run a 1/8" × 27 N.P.T. tap into the coupling, without drilling it, and cut enough thread to screw in the hose barb (Fig. 6). In lieu of a pipe tap, a 1/8" cast-iron or

Fig. 6. Cutting the threads into which the hose barb screws.



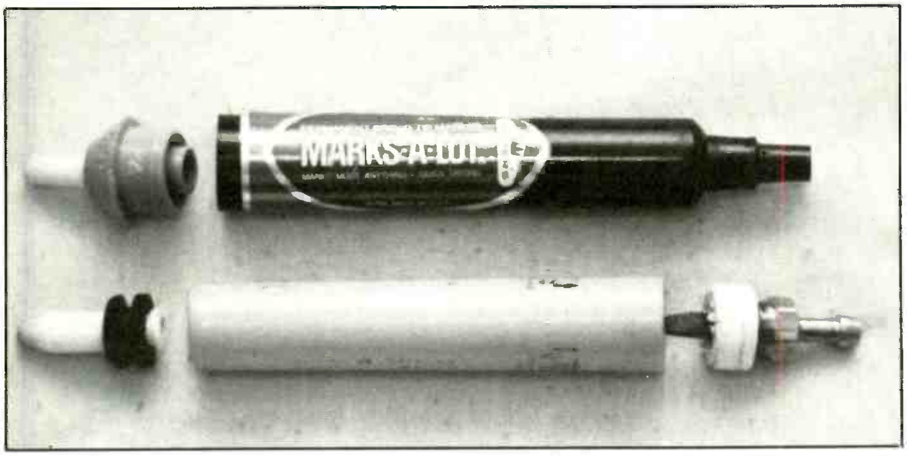


Fig. 7. Many types of marking pens and Teflon tips can be adapted for use in the basic Super Solder Sucker. Two examples are shown here.

steel pipe plug (available at any hardware store) can be run into the coupling to cut enough thread to get the hose barb started. It's not elegant, but it works.

Next, screw in the 3/16" × 1/8" N.P.T. hose barb (available from automotive suppliers) using a sealant like RTV, Permatex, or Teflon tape on the thread. The hose barb is made of soft brass so even if it's cross threaded it will conform to the new threads. Don't over tighten! Tighten only enough to hold the barb securely.

Now thoroughly clean the bore of the cylinder of all metal chips and other debris. You don't want to damage the rubber O-ring. Smear a petroleum jelly around the circumference of the piston and slide it into the cylinder. Slide the end cap over the piston rod and tap it gently onto the cylinder, using a block of wood to protect it from the hammer. If you cut a slot in the cap to remove it, use an automotive-type hose clamp of appropriate size to secure the cap. Replace the pushrod end in its anchoring hole and the securing nut. The pump is now finished.

Adding the Frills: The Deluxe Version

There are two ways to go with the business end of the tool. A solder collecting chamber with a Teflon tip, using your present soldering iron as the heat source, is the simple and inexpensive approach. The deluxe version uses a Radio Shack desoldering iron modified for use with the pump.

The basic device is simply the barrel of a marking pen with a Teflon Tip on one end and an internal filter screen. I used a Marksalot® marker, that has a writing end that was the perfect size for the tubing connection and the Teflon tip from my retired Sold-a-vac® snapped into the other end (a perfect fit). Many other types of marking pens and Teflon tips can be adapted for the application as you can see in Fig. 7.

It is a little messy dismantling the pen, even if it is dried out. So before you begin, put some newspaper down. Pull the felt tip out with pliers. Usually, there is a snap-fit cap in the other end. Pry this out without damaging it. The ink wicking should now slide right out. When assembling your unit be sure to push a piece of metal screening into the barrel of the pen to prevent pices of solder from getting into the pump. Small circular pieces of copper screen are available at tobacco stores.

Depending on the Teflon tip used, make sure the orifice in the tip is at least 3/32" in diameter to take advantage of the extra suction power. Drill it out if necessary. A stand can be made by driving an appropriately sized nail through a piece of ½" plywood. It also acts as a cleaning tool.

There are two types of tubing that

(Continued on page 90)

BILL OF MATERIALS

1—foot-operated bicycle tire pump
2—3/16" × 1/8" hose barbs (for 3/16" tubing with 1/8" × 27 N.P.T. threads)
1—2½" hose clamp with worm gear
1—¾" hose clamp with worm gear
6-ft.—silicone rubber tubing (Aerotrend extra large or similar; see text)
1—Desoldering iron (Radio Shack Cat. No. 64-2060 or similar; see text)
1—Small-size CO_2 cartridge (see text)
1—Felt-tip marking pen (see text)
1—Teflon tip (From Sold-a-vac)
1—No. 8 × ¼" sheet metal screw and flat washer

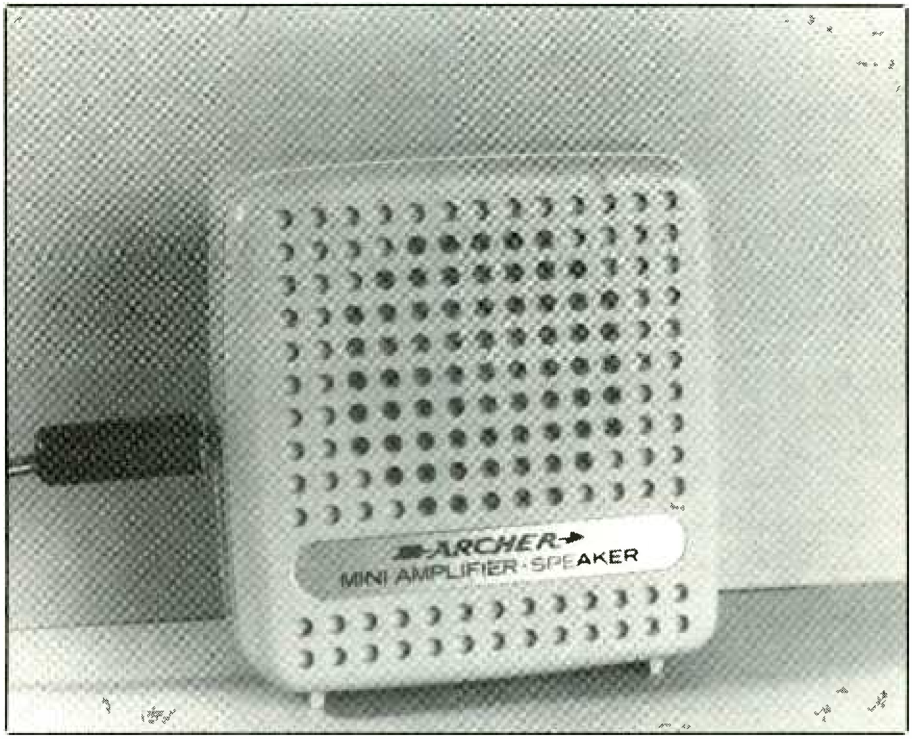
Misc.—Teflon pipe tape or RTV sealer; petroleum jelly; 3/32" roll or cotter pin (see text); ¼" flat washer; 1/8" pipe plug; copper screening; nail and 4" × 4" × ½" plywood for stand.

Note: The following items are available from O/H Electronics, P.O. Box 564, Windsor, CA 95492-0564: Unmachined: foot-operated tire pump for $6.50; discharged CO_2 cartridge for $1.00; two hose barbs for $2.00; 6 feet of silicone rubber tubing $6.00 (or $1.00 per foot); large hose clamp for $1.00; small hose clamp for 75¢; 2" copper screening for $1.25; and screw and washers for piston, split pin and Teflon tape for $1.00; complete kit of above parts for $19.50. Also available are: foot pump kit with all machining done (includes pump, one hose barb, large hose clamp and miscellaneous hardware but no silicone tubing) for $19.50; machined desoldering iron kit (includes Radio Shack desoldering iron, CO_2 cartridge, hose barb and copper screening but no silicone rubber tubing) for $19.75; complete machined kit with all items to assemble Deluxe Super Solder Sucker, including tubing, for $32.95. Pay by check or money order. Add $4.50 P&H for each kit. California residents, please add state sales tax.

Sound For Video Monitors

Modified external audio amplifier restores sound when using a video monitor with a home computer

By Ralph Tenny



Many Atari, Commodore, Radio Shack, and other home computer owners have upgraded their displays from TV receivers to video monitors to improve video quality for word processing and other applications. If an economy monitor has no built-in audio circuit, the sound portion of programs is lost, of course, hamstringing certain programs.

Fortunately, it is possible to use the computer's audio output to drive a separate amplifer/speaker system to restore the sound. The inexpensive battery powered mini-amplifier from Radio Shack shown in the lead photo can solve the sound problem with some easy modifications.

The mini-amplifier cited can be used as-is if you wish. However, its combination power switch/volume control requires that sound level be set every time you turn on the amplifier's power. Also, forgetting to turn off the switch when you are finished computing, can use up batteries at an alarming rate. The simple modification described here neatly solves both potential problems.

Modification Circuit

Shown in Fig. 1 is the modifying circuitry needed to automatically control the mini-amplifier, which connects in series with the amplifier's positive battery supply line. Once connected as shown, the amplifier's power switch is always left in the "on" position and the volume control is adjusted to a desired listening level. Thereafter, all that need be done is to apply and remove power from the circuit. This is accomplished with relay *K1*.

Power to energize *K1* comes from any convenient +5-volt dc point available at any of the computer's ports. This +5-volt line is available at pin 5 of the joystick ports and pin 9 of the cartridge port on the Radio Shack Color Computer and at pin 7 of the joystick ports, pin 2 of the User Port and pins 2 and B of the cassette port of the Commodore-64 computer.

Whenever the computer is turned on, this 5 volts dc is automatically delivered to *K1*'s coil through the *P1/J1* mini-phone plug/jack pair. Closing *K1*'s contacts completes the battery's positive line to the amplifier circuit board. Thereafter, any audio signal that the computer generates, delivered to the input of the mini-amplifier through a separate INPUT jack, will be heard through the speaker.

Powering down the computer removes the 5 volts dc from the com-

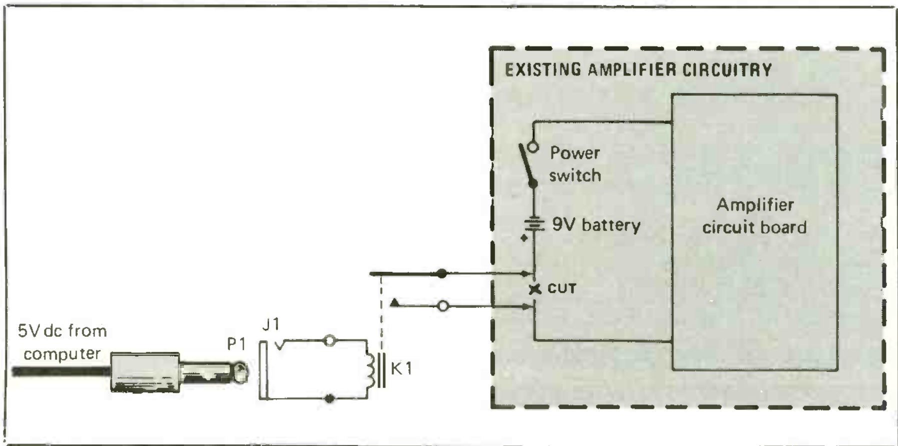


Fig. 1. Modification circuit consists of relay, miniature phone jack/plug and length of cable to computer's 5-volt dc power supply. Relay's contacts wire in series with amplifier's positive battery supply line.

PARTS LIST

J1—Miniature phone jack
K1—5-volt spst relay (Radio Shack Cat. No. 275-232 or 275-004—see text)
P1—Miniature phone plug
Misc.—Radio Shack or similar battery-powered mini-audio amplifier; two-conductor cable; hookup wire; solder; etc.

puter's ports. With no power coming to *K1*'s coil, the relay deenergizes. This causes the contacts to open and break the positive battery line, automatically disabling the mini-amplifier's circuit board.

To avoid overloading and possibly damaging the computer's power supply, a low-power relay must be used. The relay specified in the Parts List requires less than 20 mA of energizing current from the computer's + 5-volt supply.

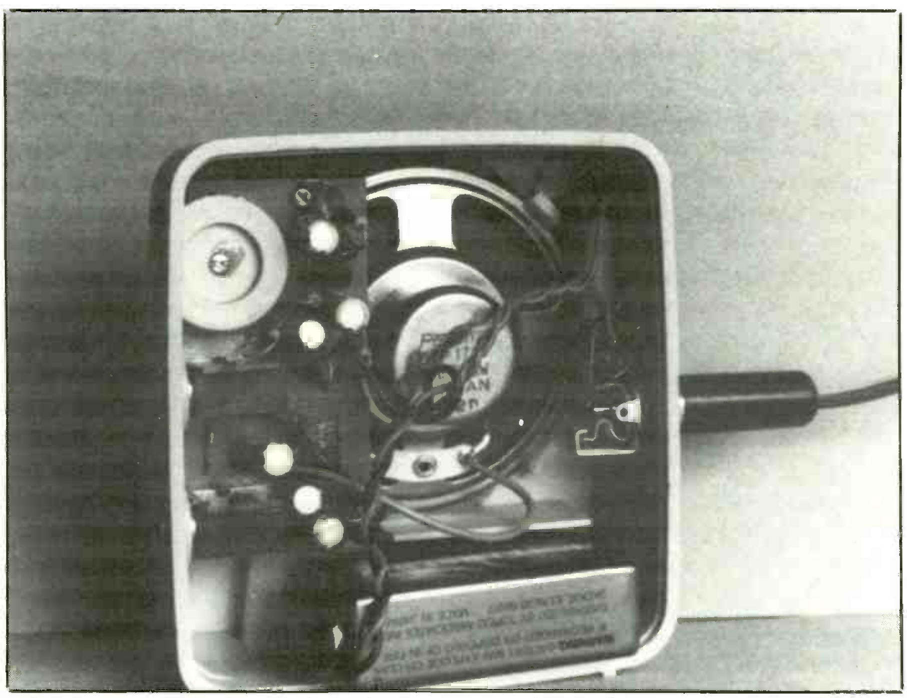


Fig. 2. Mounting details for relay and jack. General-purpose cement anchors reed-type relay in place.

Mechanical Details

Opening the mini-amplifier's enclosure, you'll observe the 9-volt battery compartment at the bottom.

There is sufficient room inside the enclosure to accommodate the relay and miniature phone jack for the 5-volt line from the computer on the right wall, as shown in Fig. 2.

The first step is to test-fit the relay inside the enclosure at the upper right and place the miniature phone jack far enough below it to ensure that there will be no interference between the two and the speaker. Mark the location of the jack on the enclosure and then remove the relay and jack. Carefully drill an appropriately sized hole at the marked location. Make sure you do not damage the speaker or the amplifier circuit.

After mounting the jack in the hole, examine the relay. If you are using the reed type shown, note that it has four wire "pins" that all point in the same direction, identifying the front of the relay. With the pins facing upward and the end with the three pins facing toward you, liberally coat the right side of the plastic end pieces with general-purpose cement and press into place on the wall of the enclosure as shown.

When the cement has fully set, interrupt the red wire between the battery connector and amplifier circuit board. You can cut through the existing wire and add a short length of hookup wire to each cut end, insulating the connections when you are finished. Alternatively, you can dismount the circuit board by removing the threaded rings from the attached jacks, a single board screw, and desolder the wire from its pad. The latter is preferable because you will then need to add only one wire—in the hole from which the wire was just desoldered.

Make the power wires long enough to reach the relay. Connect and solder them to the *contact* posts on the relay. Connect and solder appropriate lengths of wire from the lugs on the newly installed POWER jack to the coil pins on the relay.

Cut a two-conductor cable for the relay's 5-volt dc line to the length needed to go from the computer port you plan on using to the location where the amplifier will normally be. Terminate one end of the cable with the connector required for the computer port you are using and connect and solder a miniature phone plug at the other end.

Plug the 5-volt power cable into the amplifier and computer. Similarly, plug an audio cable from the computer's audio output to the amplifier's input. Turn on the amplifier by rotating the thumbwheel VOLUME control on its right side past the click and adjust volume for about half way up.

Connect a dc voltmeter set to read 5 or 10 volts across the relay's coil. Now turn on your computer; you should hear at least some electrical noise from the amplifier's speaker and the meter should read between 3.5 and 5 volts dc. If you have a program that generates sound, use a demonstration program from the computer user's manual to generate sounds. You should hear the sound clearly from the amplifier's speaker. Adjust sound level as desired.

If everything is okay, power down your computer and disconnect the cables from the amplifier. Reassemble the amplifier's enclosure and plug the cables coming from the computer back into the appropriate jacks.

The system is now ready to be put into service. Now sit back and enjoy the sound you have been missing. **ME**

Engineer's Mini-Notebook: Optoelectronics Circuits by Forrest M. Mims III. (Radio Shack. Soft cover. 48 pages. $1.49)

Modern Electronics columnist, Forrest Mims, has generated another fine little volume for experimenters. This one focuses on working with optoelectronic devices. Its informal format, consisting of hand-printed text with hand-drawn illustrations and schematics, is logically arranged according to category. These include light sensors, lightwave communications, optoelectronic logic and source/sensor pairs. This arrangement makes it easy for the user to quickly look up needed information.

Text is kept to a minimum, with emphasis on easy-to-understand and use drawings. Hence, the book is meant to be used by readers ranging from neophytes to old hands. The inside front and rear covers contain circuit symbols and the resistor color code, respectively. Within the body of the book itself are almost 50 ready-to-wire circuits, all of which have been tested by the author prior to publication. These circuits range from flashers to light meters to light- and dark-activated relays to simple lightwave transmitters and receivers and more. All are low in cost and all can be breadboarded or wired in minutes.

NEW LITERATURE

VCR Users Guides. Maxell has two new guides that can help consumers make intelligent selections of videocassettes to suit specific needs. The 48-page "Maxell Video Tape Handbook" tells how videocassettes capture audio/video images, diagrams the differences between standard and Hi-Fi Beta and VHS systems and describes the company's line of videocassettes. It details the qualities to look for in tapes, tells what Maxell videocassette to use for various applications, and offers tips on recording TV programs. The other guide, "Videocassette Selector," is a colorful leaflet that describes the unique features and recommended uses of the company's four videocassette categories. For free copies of these guides, write to: Maxell Corp. of America, Video Products Div., 60 Oxford Dr., Moonachie, NJ 07074.

LED Lamp Catalog. Dialight has a 12-page catalog that describes the company's complete range of LED lamps. It gives information on T-1¾, T-1 and T-¾ LEDs and rectangular and special-shape LED lamps. Charts list peak wavelength, typical forward voltage, luminosity, test conditions and LED color/lens for each device. Dimensioned drawings and a list of Dialight representatives in the U.S. and Canada are included. For a free copy, write to: Dialight Corp., 203 Harrison Pl., Brooklyn, NY 11237.

Aluminum Enclosures Brochure. Now available from Formax is a colorful 4-page brochure that discusses the company's complete line of aluminum instrument and control enclosures. It details design features and contains a selection table that lists model numbers and enclosure dimensions. For a free copy, write to: Formax, 1120 Federal Rd., Brookfield, CT 06804.

Equipment Protection Catalog. "Hi-Tech Equipment Protection & Interference Control" from Electronic Specialists contains 40 pages that describe uninterruptible power supplies, line conditioners, modem protectors, equipment isolators, spike suppressor/filter devices and ac power interrupters. Included are tutorials that describe various problems and the corrective action that can be taken. Catalog 861 is available free by writing to: Electronic Specialists, Inc., 171 S. Main St., Natick, MA 01760.

Wireless Selection Guide. A booklet that attempts to demystify wireless for sound contractors and end users is available from Nady Systems. The "User's Guide to Selecting a Wireless System" sets forth a series of objective and subjective tests for evaluating wireless systems on the market. Some tests are technical, others are not, but taken together they can provide a practical guide for selecting the correct wireless system for a given application. For a free copy, write to: Nady Systems, Inc., 1145 65 St., Oakland, CA 94608.

Capacitor Guide. A new "Quick-Guide to Paper and Film Capacitors" from Sprague provides an easy reference to more than 100 different Sprague commercial and military paper and film capacitor lines. It contains tables and graphs that reflect changes and upgrades; tables of performance characteristics and applications information; and graphs that show operating characteristics for various dielectric materials. Guide No. ASP-420K is available from: Sprague Electric Co., P.O. Box 9102, Mansfield, MA 02048-9012.

TI Filter Brochure. Microwave Filters has a new brochure that describes filters that suppress terrestrial interference in more than 400 satellite TV receivers. Focusing on three filter lines, the brochure contains a list of receivers and compatible filters. If a particular receiver is not listed, a form can be completed and returned for a filter recommendation. Information on how to identify inteference and select and install filters is also provided. For a free copy, write to: Microwave Filter Co., Inc., 6743 Kinne St., E. Syracuse, NY 13057.

Temperature Measurement Brochure. A brochure that explains the theory behind thermometers, focusing on how thermocouples can be used and how to reduce measurement error, is available from Fluke. A section on refrigerator work and the types of temperature measurements that can pinpoint trouble spots is included. Also included are: a glossary of terms commonly used in thermometry; a thermocouple guide; and a listing of Fluke digital thermometers; a thermocouple adapter for DMMs and a high-accuracy semiconductor probe for use with DMMs. For a free copy of "The ABCs of Thermometers," write to: John Fluke Mfg. Co., Inc., P.O. Box C9090, Dept. ME, Everett, WA 98206.

Custom Timer Circuits

By Forrest M. Mims III

Not long ago, my son and I accompanied my father on a fishing trip. The bait well of my father's boat was well stocked with small fish he had caught with a cast net, and out on the lake it was necessary to periodically switch on a small air pump to oxygenate the water in the bait well. After a few rounds of this, my father asked if it might be possible to design a solid-state timer that would switch the pump on for a few minutes every 10 minutes or so. After I offered to equip the air pump with such a system, it occurred to me that there are few circuits that command as wide a range of applications as timers.

In developed countries virtually every home is equipped with so many electromechanical and solid-state electronic timers that we take them for granted. Try to imagine appliances like washing machines, dryers and stoves without built-in timers. Stand-alone timers are often used to switch on lamps or radios at night, especially when the occupants are absent. Then there are clock radios, alarm clocks and watches, miniature countdown timers, darkroom timers, and telephone timers. Finally, personal computers can be used in a variety of timing modes.

Despite the wide range of commercially available timers, there remain many applications for which a custom timer must be designed. A good example is the one suggested by my father. Then there are applications for which a commercial digital timer would be ideally suited if only the device were equipped with a suitable output port such as a relay driver. I'll describe examples of both custom timer circuits and modified commercial digital timers here. Perhaps these circuits will find use in or suggest possible solutions for specific timer applications you might have.

A Bait Well Aeration Timer

Though the circuit described here was designed specifically to aerate a bait well in a fishing boat, it has many other applications. For example, it can control a drip irrigation system, a flashing light, a motor, and any other system or device designed to automatically cycle through a programmable, repetitious off/on sequence.

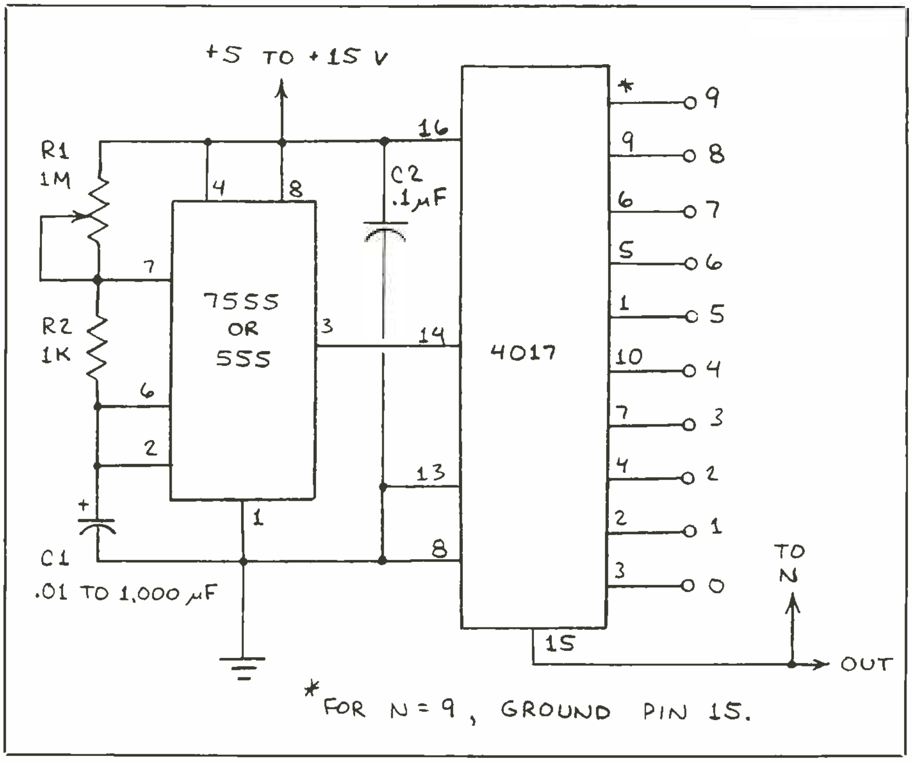


Fig. 1. A simple programmable timer.

As for the aeration system, recall that a bait well should be aerated for a few minutes every 10 minutes or so. One possible solution might be two cascaded 555 timers. The first 555 would determine the intervals between aeration; the second would control the duration of the aeration periods. While this approach seems workable, 555 timers work best at maximum timing intervals of several minutes. A 10- or 15-minute 555 timer can be designed by using large RC values, but its operation might not be reliable.

Figure 1 shows a better solution. Here the output of a 555 or 7555 (CMOS) timer is connected to the count input of a 4017 divide-by-10 counter. The 4017 contains a binary counter and a built-in 1-of-10 decoder. The 555 is connected in its astable mode with a timing cycle governed by *R1* and *C1*. Each count pulse from the 555 advances the count from the 4017 so that active outputs go high in sequence while inactive outputs remain low. By connecting the reset input of the 4017 to one of the outputs, the counter will reset itself to 0 after the respective number of count pulses. In short, the 4017 permits the timing period of the 555 to be multiplied by from 1 to 10.

This circuit permits a variety of on/off cycles of the pump to be selected. The pulse interval from the 555 determines how long the aeration pump will remain on per cycle. The 4017 output to which the reset input is connected determines the time between aeration cycles. For example, if *R1* is adjusted so that the 555 emits a pulse every two minutes and the reset input is connected to pin 5 (output 6), the pump will switch on for 2 minutes every 14 minutes (output 6 is the seventh count state; 2 × 7 = 14).

Incidentally, though the Fig. 1 circuit includes provisions for counts of 0 and 9, in practice these outputs are not usable when the circuit is connected as shown. The 0 output never becomes high and the 9 output always remains low. Fortunately, as revealed below, a practical version of the circuit salvages the 9 output.

The circuit in Fig. 1 doesn't include a means for switching a bait well pump on and off. The circuit in Fig. 2 is a simple relay driver that easily controls the aerator. To use this circuit with the timer in Fig. 1 requires a slight modification to the timer. When the output is taken from the reset pin, as in Fig. 1, the output changes state for only an instant before the 4017 is reset. Therefore, for the circuit to drive a relay, it's necessary to reset the 4017 when the count advances to the first level after the desired level. For example, assume you want the circuit to close the relay once for every four clock pulses from the 555. The input of the relay driver in Fig. 2 would then be connected to pin 7 of the 4017 and the reset input (pin 15) to pin 10, the next output.

Figure 3 is a timing diagram that summarizes the operation of the circuit in Fig. 1 when operated in this fashion. Note that the reset input can be connected to ground to give a count of nine clock intervals. This is possible because the output and reset are not tied together as in Fig. 1. Therefore, depending on the connections selected from the timing diagram, the clock interval can be multiplied by from 1 to 9. In each case, the relay will remain actuated for only a single 555 timing cycle.

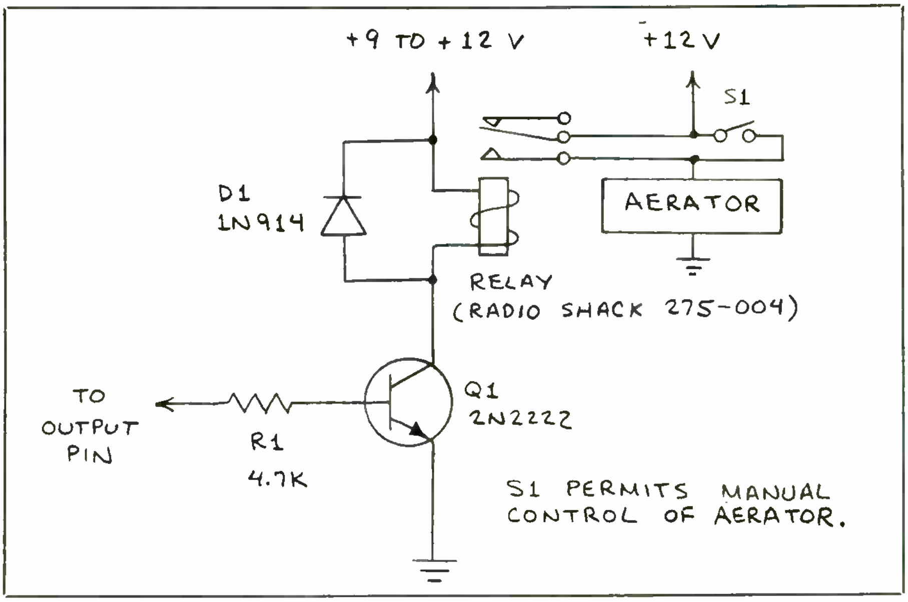


Fig. 2. A bait well aerator timer driver.

All that's required to use this circuit to control a bait well aerator is to connect the normally open relay terminals between the aerator and the boat battery. The timer itself can also be powered by the boat battery. Of course, the timer should be installed in a weatherproof housing. It should also be equipped with a delay controller in the form of a potentiometer (*R1*) and a power switch. A selector switch can be included to permit various dealy intervals to be conveniently selected. Alternatively, the output and reset pins can be hard wired to give a fixed on/off cycle. For instance, connecting the reset (pin 15) to pin 9 and the input of the relay driver to pin 6 will close the relay one clock interval for each eight

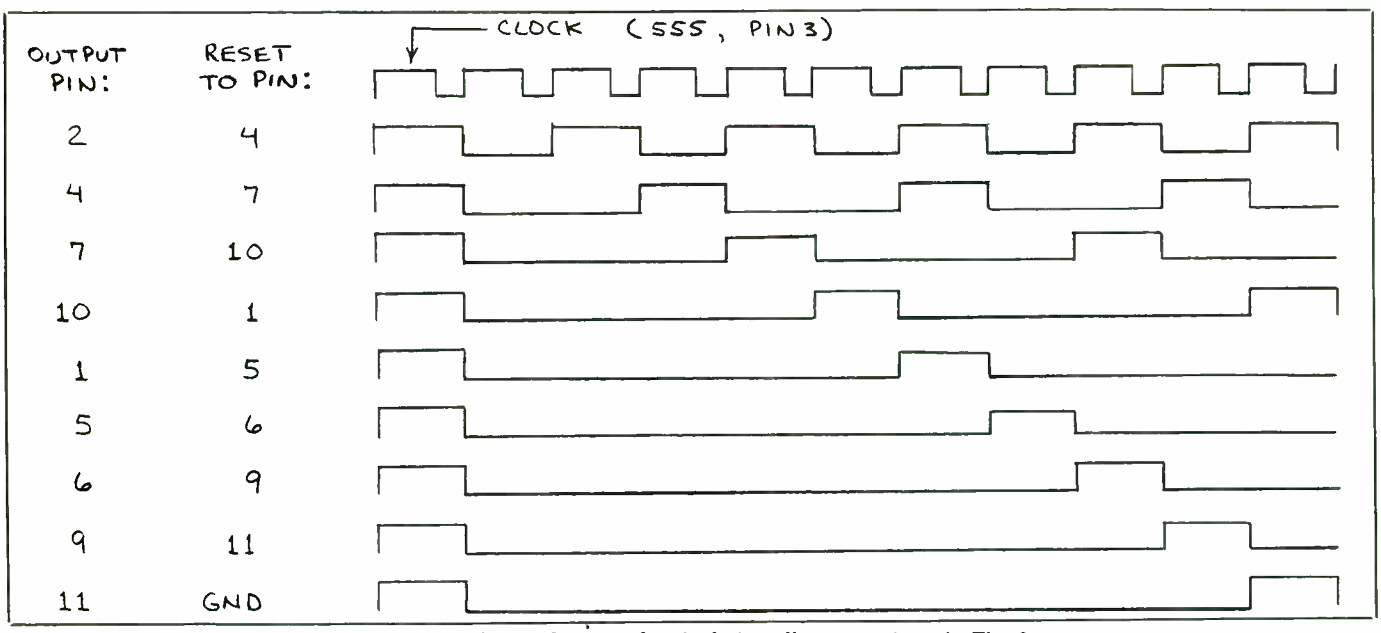


Fig. 3. The timing diagram for the bait well aerator timer in Fig. 2.

clock pulses (see the timing diagram in Fig. 3 for details).

Incidentally, be sure to connect a 0.1-μF capacitor across the supply leads of this circuit (*C2*) in Fig. 1. The capacitor should be placed close to the circuit. Otherwise, the circuit may fail to function properly without this capacitor, especially if the leads to the battery are more than a foot or so long. Also, be sure to include *S1* so that the aerator can be controlled manually should the timer circuit malfunction.

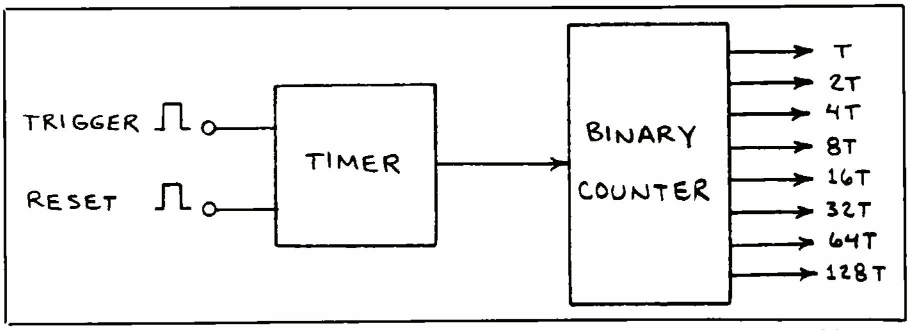


Fig. 4. Internal details of Exar's XR-2240 programmable timer/counter chip.

XR-2240 Programmable Timer

The timer-counter concept in Fig. 1 has been integrated onto a single chip by Exar Integrated Systems, Inc. (750 Palomar Ave., Sunnyvale, CA 94088). One such chip is the XR-2240 Programmable Timer/Counter. This chip provides much more programmability than the 555-4017 pair used in the previous circuit. Depending on the values of the external timing capacitor and resistor, this chip can provide delays of from microseconds to several days. Exar claims two XR-2240s can be cascaded to provide a time delay of up to three years.

Figure 4 is a simplified block diagram of the XR-2240. The timer portion of the chip is functionally equivalent to a standard 555 timer. The output from the timer is fed directly into the input of an 8-bit binary counter. The eight counter outputs provide these escalating power-of-2 multiples of the timer frequency: T, 2T, 4T, 8T, 16T, 32T, 64T and 128T. The output is normally high. After *S1* is closed, the output goes low and remains low during the programmed time delay. It then returns to the high state.

Since the counter outputs are open collectors, they can be connected to a common pull-up resistor in any desired combination in a wired-OR output configuration. The output will then be low so long as any of the selected outputs is low. This makes possible any multiple of the timer frequency up to 255T. For example, wiring together outputs 3, 6 and 7 would give an output of 100T (4T + 32T + 64T = 100T).

Figure 5 shows how to use the XR-2240 in its monostable (single cycle) mode. The time constant of the timer portion of the chip is determined by *R1* and *C1*. Momentarily closing *S1* begins the timing cycle. The binary counter then counts the pulses from the timer. A particular timing interval is selected by connecting the timer's reset input to one (or more) of the outputs via *R4*. When the programmed count is reached, the timer automatically resets.

The XR-2240 can be reset at any time during a timing cycle. Once a timing cycle has begun, any subsequent trigger pulses or closures of *S1* are ignored. To operate the timer in its astable (repetitive cycle) mode, the reset input is disconnected.

Though the circuit in Fig. 4 uses a switch to initiate a timing cycle, an external control signal can also be used. The external trigger signal should have an amplitude of at least 1.5 volts and a duration of at least several microseconds.

Figure 6 shows one way to cascade two XR-2240 timers to achieve ultra-long de-

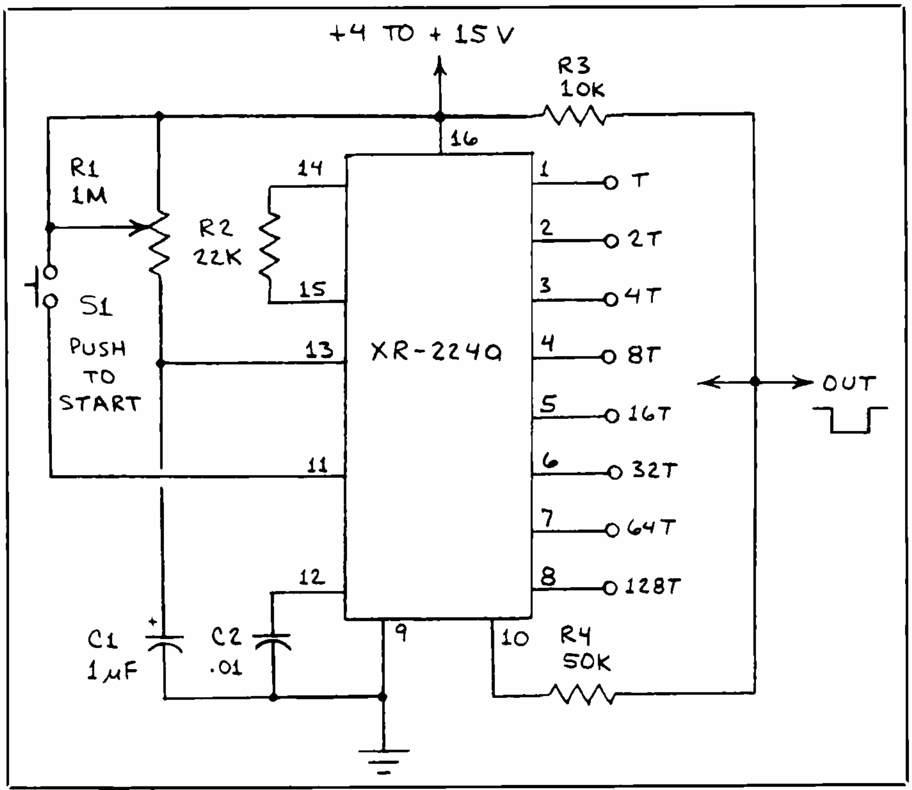


Fig. 5. A programmable timer circuit built around the XR-2240 chip.

lays. When all the outputs of the second XR-2240 are connected to the output bus, the delay becomes 65,536T. Therefore, if T is 5 minutes, at 65,546T the delay is 327,680 minutes (5,461.3 hours or 227.6 days).

Referring to Fig. 6, note that the timer section of the second XR-2240 is not connected; only the binary counter portion of the chip is used. The timer section of the first XR-2240 is connected in the astable mode so that the timer is automatically reset after a timing cycle is complete. These repetitious timing pulses are then applied to the binary counter in the second XR-2240.

The circuit in Fig. 6 is based on one given in Exar's application literature. I added *R4* and configured the circuit for astable operation. For additional information on using this versatile chip, see Exar's XR-2240 application note.

Commercial Digital Timers

A crystal-controlled timebase having a digital readout is required for ultra-precision timing applications. Of course, many such devices are available as commercial devices. While it is possible for the experimenter to design and build such a timebase, it's usually much more convenient and considerably less expensive to use a commercial unit.

Most commercial digital timers actuate a piezoelectric buzzer at completion of their timing cycle. It's possible for the timer to drive an external relay by using the buzzer signal to switch the gate of an SCR. I'll explain how this is done shortly, but first I want to review some specific digital timers.

The simplest and most common digital timer is a digital watch or clock operated in its alarm mode. Since both watches and clocks can be opened, it should be possible to connect an external device to the terminals of their piezoelectric buzzers. However, successfully connecting leads to the tiny circuits of digital watches and some digital clocks may prove to be very difficult.

The best stand-alone digital timers include a front panel keyboard for programming. One such unit is the Westbend™ Electronic Timer. This countdown timer has a liquid-crystal display and sounds an alarm after a user-programmed interval of from 1 second to 99 minutes and 99 seconds. The unit is programmed by keying in the desired delay and pressing a start button. When the count reaches 00M 00S on the display, the timer emits a series of chirps. The alarm can be silenced by pressing a stop/reset key.

Another widely available timer is the KMC Handy Timer. This unit, which doubles as a digital clock, has a 24 hour maximum countdown time. Though the display indicates seconds, the desired time delay can be programmed only in hours and minutes. Instead of the 10-dig-

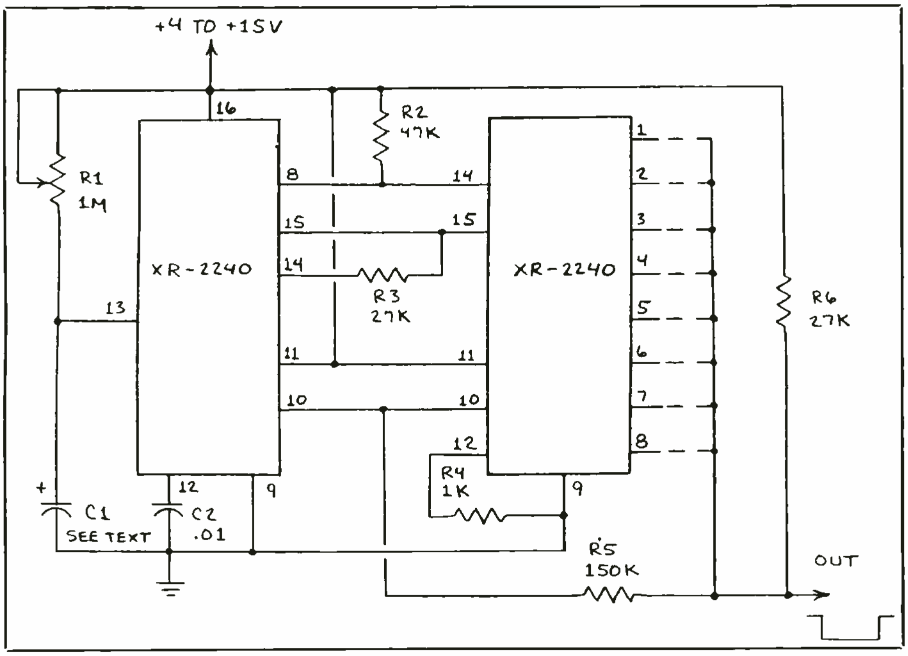


Fig. 6. Cascaded XR-2240s give extra-long time delays.

it keyboard of the previous timer, this unit has single hour and minute keys that must be repetitively pressed to set the desired interval.

Miniature countdown timers identical or similar to the two described above are available at department and discount stores and Radio Shack. Some apparently identical timers have different markings or even names. Prices for digital timers can vary widely, so be sure to shop around for the best deal.

Figure 7 shows a simple SCR output interface that I have used with the two digital countdown timers described above. The circuit closes a relay after the countdown is completed. Momentarily pressing the reset switch interrupts the SCR/relay circuit, thereby switching off the SCR. The circuit works even though the signal applied to the SCR's gate is a series of pulses since the SCR switches on in response to the first pulse.

The timers with which I have used the circuit in Fig. 7 were fairly easy to open for connection of output leads. Keep in mind, though, that opening and modifying a commercial device may void the manufacturer's warranty. You should also use care when opening and modifying a timer to avoid damaging its plastic case or circuits. Since such devices use CMOS circuits, you must follow standard CMOS handling and soldering safety precautions.

Both timers that I modified for use with the circuit in Fig. 7 were equipped with a standard, circular piezoelectric sound source or alerter. The alerter in the Westbend unit was attached to the inside of the unit's back panel and connected to the circuit board by means of a pair of color-coded wire leads. I used a battery-powered soldering iron to remove the leads from the circuit board. I then wrapped the bare ends of two lengths of wrapping wire around each buzzer lead and carefully resoldered them to their respective terminals on the circuit board. After threading the leads through a small hole bored in the back panel of the timer, I replaced the panel.

The alerter disk in the KMC timer was also attached to the inside of the back panel, but electrical connection to the alerter was made by means of two small springs soldered to the circuit board and pressed against the alerter when the back panel was in place. A printed circuit land led from one of the springs to one of the battery terminals. I soldered one length of wrapping wire to that terminal and a second wire to the second spring terminal. I then threaded both wires around an indentation in the circuit board adjacent to the clock/timer slide switch and out through a hole bored in the back panel.

Be sure to use as little heat and solder as necessary when making these connections. Too much solder may cause solder bridges to adjacent pc lands. Too much heat will cause the lands to separate from the board. The spring terminals are espe-

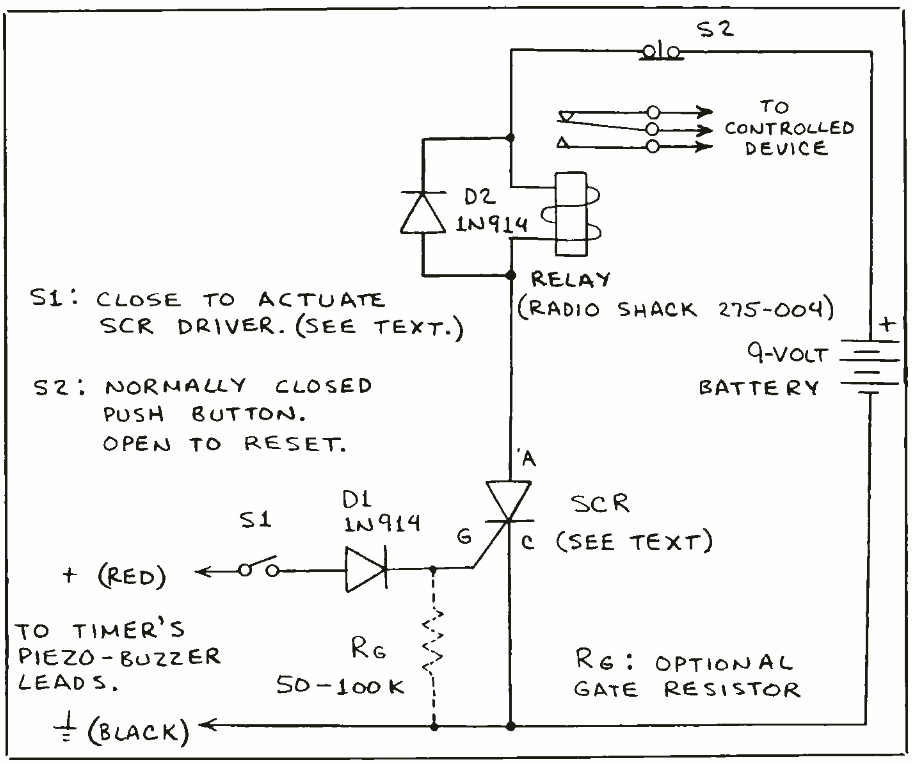


Fig. 7. An SCR/relay output interface for digital timers.

cially delicate since too much heat will cause them to become desoldered. Finally, be sure to observe proper polarity when you connect the timer output leads to the SCR circuit. Otherwise, the SCR will not trigger properly.

You can use a digital timer modified as described here to control indoor and outdoor lights, a darkroom enlarger, various appliances, and radios and televisions. For best results the interface circuit should be installed in an appropriate enclosure equipped with an output jack or a pair of binding posts connected to the relay's terminals. The timer can be attached to the enclosure with self-adhesive hook-and-loop fabric strips. This will permit you to remove the timer to change the battery or to use it for some other application.

Warning: You *must* follow safe wiring procedures if you use this or any of the other circuits described above to control devices controlled by the ac line. Insulate *all* exposed connections. Do *not* exceed the contact rating of the relay. Of course, these timer circuits should not be used in any application in which a circuit malfunction or power interruption might cause injury to people or property.

Going Further

The best known analog timer chip is the venerable 555. If you would like to find out more about this versatile chip, you might wish to see *Engineer's Mini-Notebook: 555 Timer Circuits*, one of a series of inexpensive (99¢ to $1.49) books I have written for Radio Shack.

If digital timers appeal to you and portability is not an issue, try dusting off your home computer and writing custom timer programs. The best thing about do-it-yourself computer timers is that you can dress them up with all kinds of alarms, graphics and special functions that would be extremely difficult to incorporate in a hard-wired timer circuit. Best of all, you can modify a computerized timer simply by changing a few lines of the program. **ME**

The Apple II GS; solar pumps; low-cost EPROM erasing; D/A conversion . . . more

By Don Lancaster

Be sure to get yourself a copy of the August 8, 1986 issue of *Science* magazine. You'll find a major paper here on neuron computing by J.J. Hopefield and D.W. Tank. This is bound to become one of the key "horses mouth" source documents of this exciting new field that we looked at a few columns back.

Speaking of other publications, it seems I got the phone number wrong twice for *Speleonics*. Hopefully, it is correct in this month's Names and Numbers box.

Quite a few of you have asked for more information on the "other" underground radio, the one that involves piracy broadcasts, satellite unscrambling, and such. This is one area I just haven't gotten into very much, but I hear there is a magazine called. *A.C.E.* that is published by the *Association of Clandestine Radio Enthusiasts.*

There's also our sister publication, *Popular Communications*, that gives lots more details on this sort of thing. Finally, there apparently is a satellite descrambling hotline available at (305) 771-0575.

And now for this month's feature attractions . . . .

What's the word on the new Apple II GS?

In a word—fantastic!

Publishing deadlines being what they are, I have only had a limited amount of hands-on time on this machine so far. What you have here is a drop-it-in board swap for an Apple IIe that instantly up grades the computer to full 16-bit, 65C816-based computing power, while maintaining nearly full compatability with most existing Apple software. You still have lots of slots like in a IIe. Like in a IIc, all of the stuff that used to need slots is now on-board, including two serial interfaces, a real-time clock, video firmware, the mouse interface, *Apple talk*, and support for as many as 128 disk drives, each of which can potentially handle media up to 4 gigabytes (!) in size.

You'll find three operating modes. There's the "slow" emulation mode that

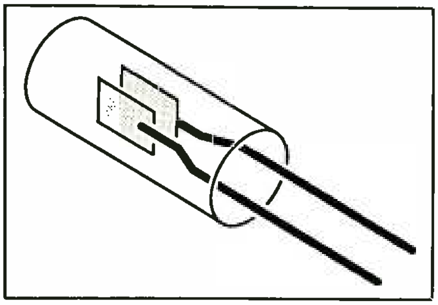


Fig. 1. JKL's new BF727 ultraviolet lamp for inexpensive EPROM erasing.

tries to behave *exactly* like the earlier II + or IIc. There's a "fast" emulation mode that speeds up Applesoft programs by a factor of 2.5 times. Finally, there is the new "native" mode that gives full 16-bit computing power, complete with desk tops, toolboxes, windows, *Quickdraw* graphics tools, and more.

There are major improvements in the existing graphics, plus two new full color graphics modes that are every bit as good as anything available elsewhere. An optional sound card instantly converts the II GS into an absolutely stunning studio-quality music, speech, or special sound effects synthesizer. Up to 32 fully poly phonic oscillators can be combined in as many as eight stereo channels, all with their own private 64K RAM memory.

While there is "only" 256K of main RAM on-board, a plug-in socket lets you easily and cheaply expand to 4 mega bytes of directly addressable RAM. You can also add another 4 megabytes per slot of slot-based RAM, to bring memory total beyond 32 megabytes. The expansion socket just needs RAM chips, since all of the refresh and address multiplexing is handled by the main board in the computer.

ROM is also expandable.

There are lots of new features, too. The new monitor does full 65C816 assembly, disassembly, tracing, and debugging. It also includes the SANE floating-point numerics set, with up to 80-bit precision.

A new front desk bus is supported by a second microprocessor. This is sort of a party line for input mice, keyboards, keypads, trackballs, graphics tablets, whatever. The keyboard itself is configurable into nearly two dozen different languages and layouts, including Dvorak. Internal character sets are available for most major languages everywhere in the world.

Things are a mite hectic around here just now, but as soon as I get some real hands-on time with my machine, I'll give you a full report. In the meantime, you can use our Hardware Hacker help line as a II GS hotline.

I need a very cheap EPROM eraser

How does $6 sound? Read on.

EPROMs, short for erasable and programmable read only memories, are ideal hacker components in that you can reprogram them over and over again. To

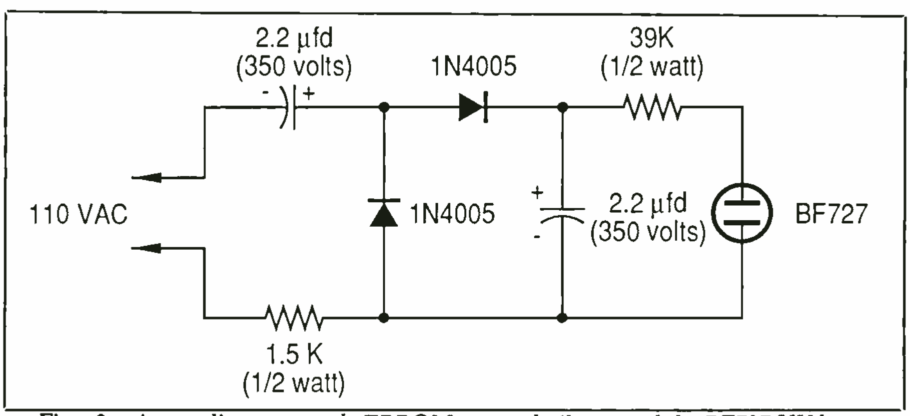


Fig. 2. An ac-line-operated EPROM eraser built around the BF727 UV lamp.

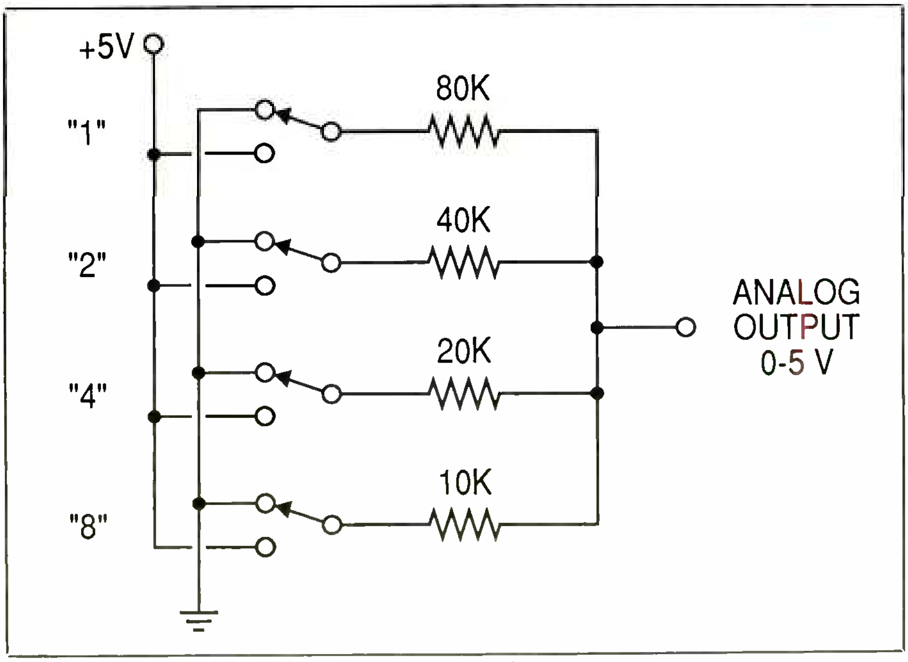


Fig. 3. A "manual" D/A converter.

erase an EPROM, you have to expose it to very strong ultraviolet light that has a very short wavelength of 2532 Angstroms. This wavelength is far shorter than most UV "poster" lamps, rockhound lamps, or germicidal types; so a very special lamp is needed.

Up to now, you had two ways to erase an EPROM. You could leave it out in strong sunlight for a week, or you could buy a special high-intensity, short-wavelength EPROM eraser at a cost of $80 or more. Many hackers felt this was too high a price to pay for just an occasional erasure.

JKL components has just introduced a brand new BF727-UV2 miniature ultraviolet lamp that sells for only $5. Its spectrum has been optomized specifically for erasing EPROMs. A drawing of this lamp is shown in Fig. 1, its simple 110-volt ac drive circuit in Fig. 2. Ultraviolet light comes out the side of the lamp, between the two parallel plates.

The Fig. 2 driver circuit is basically a voltage doubler and current limiter. The lamp fires at 300 volts and runs at an *externally* limited operating current of 1 milliampere. Be sure to use very high quality 350-volt capacitors if you build this circuit.

There are some gotchas. The intensity of the BF727-UV2 is far lower than the $80 erasers. The good news is that you don't have to be quite as careful with your visual interlocks as you did with the higher-intensity lamps. Keep in mind that high intensity UV light can easily cause permanent blindness. For this reason I still would not recommend looking directly at the JKL lamp, except for the briefest possible time.

The bad news is that it takes overnight to erase an EPROM. And that's running at higher-than-normal current with a concentrating reflector. Still, you can easily build a small "snap-on" eraser and actually erase an EPROM while it is still in the original circuit. This is something the larger erasers cannot handle at all.

Let us know the best design you come up with for a clip-on eraser.

Any new breakthroughs in solar energy?

Jim Allen of the *Solarjack* company has come up with a genuine breakthrough in solar energy economics. And he has done so with a product that has been thoroughly field tested.

Windmills have traditionally been used in remote areas of the arid southwest for pumping water for livestock and game. But windmills are costly to service, and they perform poorly because of erratic winds and dropping water tables. On the other hand, solar-powered pumps have simply been too expensive to use in these locations. Why? Because each solar array had to drive a costly inverter and a bank of expensive and hard-to-maintain batteries. Worse yet, the efficiency of the inversion and storage processes gets so low that you lose all the way around.

Jim got to thinking that solar energy would make a lot more sense if you could throw away the inverter and the batteries, getting rid of both their cost and their inefficiency. Now, in a water pumping operation, you have one goal and one goal only. You want to put as much water into the tank as you can, and do so as efficiently as possible.

So, Jim reasoned that he would design the pump to fit the sunshine, rather than using inverters and batteries to make the sunshine fit the pump. What he came up with is a new variable displacement pump mechanism. When the sun is shining brightly, the pump makes long strokes and lifts lots of water. When the sun shines a little, the pump makes short strokes and lifts less water. At night the pump makes zero strokes and does not lift anything.

What about clouds? Jim put a hefty flywheel on the pump so it can coast through brief cloudy periods. A small, simple, and very efficient CMOS microcontroller monitors flywheel speed, and, every now and then, adjusts pump displacement to exactly match the available energy coming in from up there.

A small secondary motor with a worm screw drive is used to adjust the stroke.

Thanks to the flywheel, the pump runs at an optimum and nearly constant speed, so long as any power at all is coming out of the panel.

I am particularly proud of all this, because Jim is one of my students. And he is successfully doing some extremely high-tech things in a distinctly low-tech part of the country.

Give him a call if you want any more details.

How do D/A converters work?

D/A, or digital-to-analog, converters convert digital numbers into nearly continuously varying output signals. In general, D/A converters are a lot simpler and cheaper than the A/D converters we looked at last month.

The three most important parameters of a D/A converter are its cost, its resolution, and its settling time. The resolution of a D/A converter is the number of output steps you get. In turn, this is related to the number of input bits the converter can handle. For instance, an 8-bit converter will give 256 output levels, a 12-bit converter will give 4096 levels, and a 16-bit converter will give 65,536 different output levels. Settling time is the time it takes for a change in the input digital code to produce an output that is very near the final desired analog level.

Let's look at some circuits.

Figure 3 is a very simple 4-bit manual D/A converter. The 1, 2, 4 and 8 switches are respectively summed with their 80K, 40K, 20K and 10K resistance values, producing an output voltage with 16 discrete steps. Note that the larger resistance values provide lower current increments.

As the switches are flipped, the output will go to the level set by the switch combinations. Since there are four switches, this is a 4-bit converter. There are 16 possible combinations for the four switches, so we get 16 possible output levels from 0 to 5 volts. Intermediate levels will be 0.333 volt each. Thus, level 1 will be a third of a volt, level 2 will be two-thirds and so on.

Let's add some improvements in our "neuron-like" D/A converter shown in Fig. 4. Those 1-2-4-8 resistor ratios and currents can cause problems when lots of accuracy is needed. Instead, we've shown an R/2R network that needs only two resistor values and lets each switch always handle the same current. We have also summed the analog current to the *virtual ground* of a CMOS inverter connected as an op amp, rather than trying to sum output voltage. This gives a faster settling time and a lower output impedance.

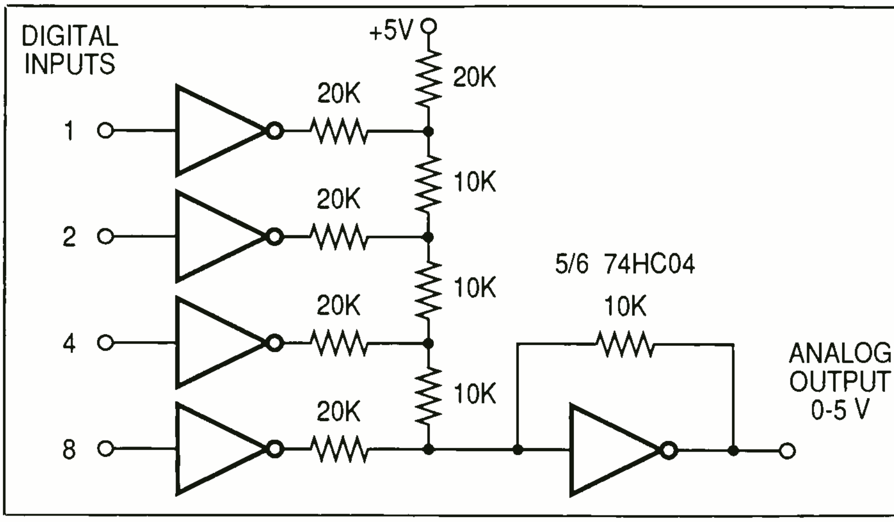


Fig. 4. A "neuron-like" D/A converter that uses R/2R summing.

In real-world D/A converters, you usually use input latches, and clock them at a specified rate.

Let's throw some more terms at you. A "monotonic" D/A converter guarantees that each successive digital value will produce a progressively higher output voltage. This can become sticky in high-resolution converters that must work over a wide temperature range.

A De-glitched converter has some steps taken to make sure that there are no unacceptable output spikes following a change of digital input. This becomes

NAMES AND NUMBERS

A.C.E. Box 46199 Baton Rouge, LA 70895 (504) 291-3449	**Marlin P. Jones** Box 12685 Lake Park, FL 33403 (305) 848-8236	**SGS** 1000 East Bell Road Phoenix, AZ 85022 (602) 867-6100
Analog Devices 2 Technology Way Norwood, MA 02062 (617) 329-4700	**Mouser Electronics** 11433 Woodside Avenue Santee, CA 92701 (619) 449-4422	**Solarjack** 102 West Eighth Street Saford, AZ 85546 (602) 428-1092
AESAR Box 1087 Seabrook, NH 03874 (800) 343-1990	**Newark Electronics** 4801 N. Ravenswood Chicago, IL 60640 (312) 784-5100	**Speleonics** Box 5283 Bloomington, IN 47402 (812) 339-7305
Intersil 10600 Ridgeview Court Cupertino, CA 95014 (408) 996-5000	**Popular Communications** 76 North Broadway Hicksville, NY 11801 (516) 681-2922	**Texas Instruments** Box 22502 Dallas, TX 75265 (800) 232-3200
JKL Components 13343 Paxton Street Pacoima, CA 91331 (800) 421-7244		

very important in video applications, where any glitches at all will produce horrible screen results. An essential first step at de-glitching a high-speed D/A converter is to make sure the turn-on and turn-off times of the input latches are identical. This is not trivial. A second method of de-glitching is to catch the analog output only at known "data-valid" times, and hold this result until the next known data-valid time.

Normally, a D/A converter is driven from a precision voltage reference, rather than from the power supply. This prevents any glitches in the supply from getting into the output. In general, Schottky TTL circuits make very poor D/A converters since they sit there "muttering" to themselves, rather than saturating to ground or the positive supply as does CMOS.

Some D/A converters will let you input any voltage you want, and then will output the product of that input and the digital word. These are called "multiplying" D/A converters. One important use is as digitally controlled attenuators for audio and video applications.

If you are allowed to input only a positive voltage to a multiplying converter, you have a one-quadrant circuit. If you can input either positive or negative analog values, you have a "two-quadrant" converter. Finally, if you can input either positive or negative analog values, as well as negative or positive digital values (by using a suitable code), you end up with a "four-quadrant" multiplying converter.

Multi-quadrant converters are considerably more expensive and complex than the one-quadrant versions. Pricing of D/A converters starts from under a dollar each.

Figure 5 shows a simple circuit of an older low-cost microprocessor-compatible D/A converter. Important suppliers of sanely priced D/A converters include *Analog Devices* and *Texas Instruments*.

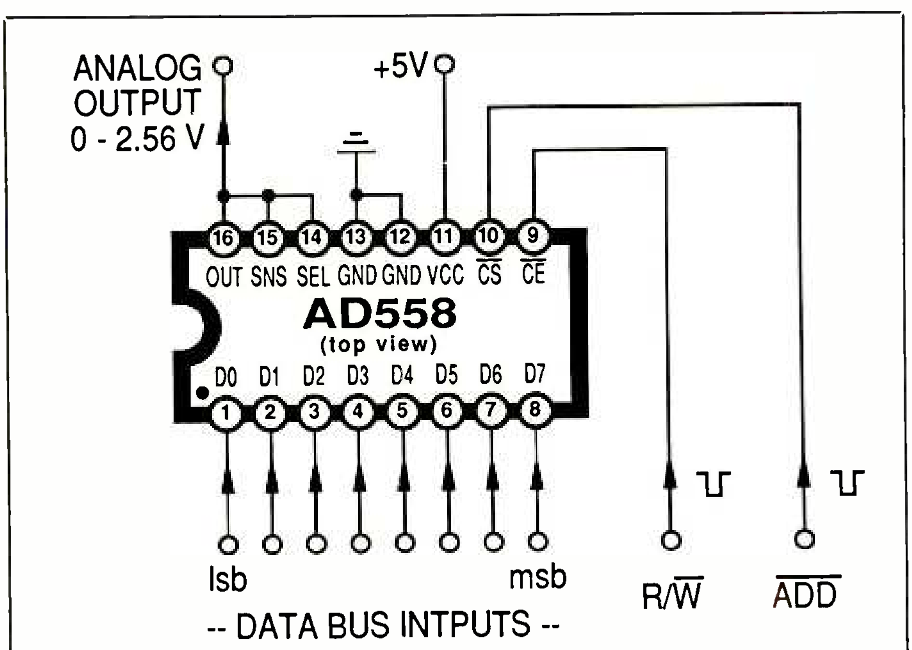


Fig. 5. A simple microprocessor-driven D/A converter circuit.

What's new in tech lit?

Lots of good technical stuff has shown up in the mail lately. The *Intersil Application Handbook* has lots of goodies on data acquisition and A/D conversion in it. From *SGS* came an L-296 switching regulator evaluation kit that's free if you send a request on letterhead. The kit includes the circuit board and two chips needed for a 4-amp, 5- to 40-volt dc step-down switching regulator. You still have to wind your own coil, though.

Two distributor catalogs came from *Newark*, a complete "old-line" electronics distributor, and from *Mouser*, with mostly foreign components at outstanding prices. A surplus catalog that came from *Marlin Jones* offers super-cheap pricing on ultrasonics, lasers, digital displays, robotics, steppers, and such.

From *Texas Instruments* came a new LSI Logic Data Book. Intriguing new devices include a memory mapper, barrel shifter, read-back latches, shaft encoder interfaces, and nearly 200 pages of application notes.

Finally, from *AESAR* came another catalog of exotic metals and elements at exotic prices. For some strange reason, none of these exotic metals houses offer 6-inch plutonium spheres. I guess it's because this particular product would give you an unfair advantage in lawn bowling.

Where can I learn the fundamentals of machine-language programming?

Check into my *Micro Cookbook* Volumes I and II. While they are particularly useful for the 6502 microprocessor, things are presented in such a way as to apply to any 8- or 16-bit microprocessor of your choice. I have a few copies in stock if you want one of them.

I also have expanded and revised my "free stuff" list, so be sure to get a copy. As always, this is your column, and you can get technical help by calling or writing per the Need Help? box. We are way behind on answering letters right now, so you'll get the best response with a telephone call. **ME**

NEED HELP?

Phone or write your **Hardware Hacker** questions directly to:

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

First Impressions: Student WordPerfect, Multifunction Modem, Le Menu

By Eric Grevstad

```
          Dear Mom and Dad,

                    I know you've heard this before, but please send money.
          There's this new student named Denise in my history class and we

send=(v)                        dispatch=(v)
 1    ·direct                    1 A ·address                    ·expedition
      ·guide                       B ·forward                     haste
      ·refer                       C ·issue                      ·speed
      ·route                       D ·route                       swiftness
                                   E ·send
 2     mail                        F ·transmit              5    ·bulletin
       ship                                                      ·item
                                 2 G  hasten                     ·news
 3    ·dispatch                    H  quicken                    ·publication
      ·issue                       I ·speed

 4    ·broadcast                 3 J ·achieve
       relay                       K ·conclude
      ·transmit                    L ·finish

                                dispatch-(n)
                                 4 M  alacrity
                                   N  celerity
1 Replace Word; 2 View Doc; 3 Look Up Word; 4 Clear Column: 0
```

Student WordPerfect includes a good, fine, first-rate thesaurus.

I was about to write a column about doldrums, dog days (it's August as I write), and the computer industry being in a slump: lots of me-too products, endless Enhanced Graphics Adapters, IBM with nothing to show lately but modest price cuts and the portless PC Convertible. But it looks like things are perking up for fall, with at least three nice trends worth talking about.

Trend One: There are rumors about IBM's finally using its manufacturing might to teach the low-cost clones a lesson—in other words, doing what Tandy did July 30 by introducing the 1000 EX at $799, ignoring Epson and Leading Edge to take on the discount houses like PC's Limited. (Have you seen the EX? It's a one-piece unit like a Color Computer with the keyboard of a Tandy 1000 and the side-mounted drive and limited expansion room of an Apple IIc; it has 256K RAM, runs at either the usual 4.77 or 7.16 MHz, and should hit the education market like a hurricane. The regular 1000 becomes the SX, with the faster CPU, five instead of three 10-inch slots, and space for 640K on the motherboard.) Between Radio Shack and Asian imports, the day of the corner-store clone has dawned. Looks like you've had it, Commodore.

Trend Two: While 8088-based PCs plunge toward $500 and the high-end market looks to 80386 dream machines, the 80286 is finding its place in the middle: the $1,500 AT compatible, just as the 286's multi-tasking, memory-addressing DOS 5.0 begins to look like more than a rumor. Tandy calls its trim new 3000 HL ($1,699) an XT compatible mainly for the sake of keeping the original 3000 HD the titular head of the line; smaller firms are selling 8-MHz machines cheap to make way for 10- and 12-MHz speedsters. It's cruel to those of us who are still making payments on two-year-old XT clones, but you can't stop progress.

Trend Three: Come to think of it, all my trends add up to products being built more efficiently and sold at lower prices. You can see it happening with staple items like modems and multifunction boards. You can find good software at a fraction of list price (although for a limited audience). You can spot a transition from introductory paragraphs to product reviews.

Student Financial Aid

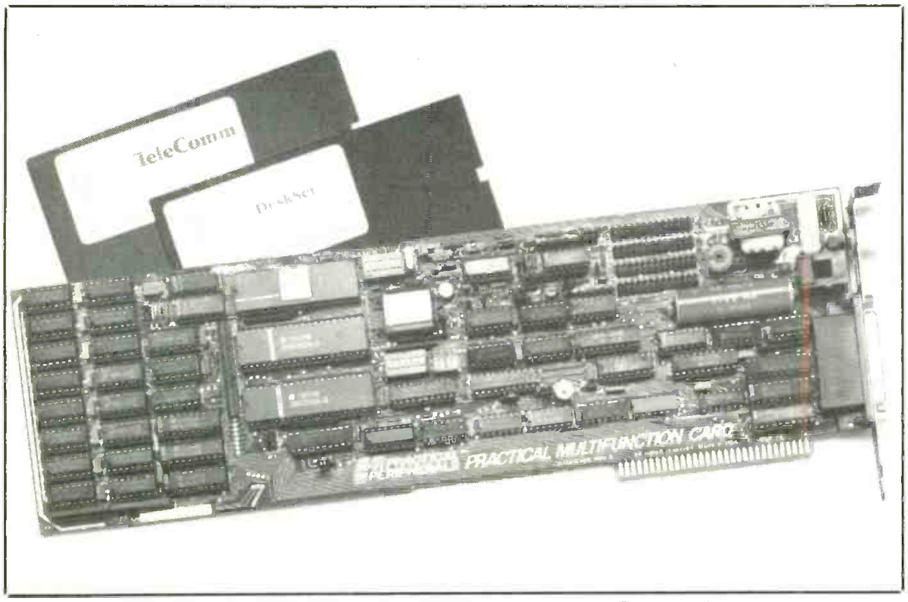
If you're not a college student (or parent or pal of one), you can skip this section; the product must be purchased from a college bookstore or ordered with a photocopy of student ID or a professor's or registrar's letter. If you qualify, however, Chambers International Corp. has a great weapon against the onslaught of campus Macintoshes: Student WordPerfect, a version of Satellite Software's $495 word processor for just $75.

Chambers promises 85 percent of WordPerfect 4.1's power for 15 percent of its price. I'd peg it at 75 percent power; Student WordPerfect has no mail merge, macros, math and sort functions, or multiple-column or split-screen editing, and can't generate an index or table of contents. For nuisance value, it's also copy-protected, installable and uninstallable onto two floppies or (preferably) a hard disk, and has a fixed, skimpy margin of one line between headers and text.

But WordPerfect's other first-class features are all there, from footnotes and endnotes to automatic timed backups, temporary exit to DOS, password file security, and the ability to undo not just one but any of your last three deletions. Its screen display is still the cleanest in the business, with easy toggling to hide or edit formatting commands.

Compared to the world's other word processing superpower, Microsoft Word 3.0, WordPerfect uses the PC's function, Ctrl, Shift, and Alt keys instead of mnemonic menus (despite excellent documentation, the function-key template is a must). It lacks Word's fancy mixing of fonts and typestyles and can't show right justification on screen (though, unlike Word, it shows page breaks automatically). But it's an equally smooth, superb word processor, combined with the best spelling checker and thesaurus I've seen —a 115,000-word dictionary, loads of spelling or synonym suggestions, fast and intuitive to use.

Bad spelling, sloppy footnotes, and chronic poverty are endemic on America's campuses. Student WordPerfect is a laudable, affordable answer to those



The Practical Multifunction 1200: memory, modem, and more.

problems, even if it undercuts a WordPerfect Corp. executive's quip in *InfoWorld* that, if buyers think $495 is too steep for the adult program's features and support, they can console themselves with the thought that they're paying off his house.

More Than a Modem

Even before this summer's new Tandy models made mine an orphan, I was suffering from a common ailment among PC (if not XT) owners—the five-slot blues. With expansion slots stuffed with my video board, 384K multifunction board, and disk controllers, I couldn't reconcile my need for a modem with my dreams of other add-ons. What to do? Buy Practical Peripherals' Multifunction 1200—a 13-inch board that combines a memory and interface card with a 300/1200-baud modem.

The Practical 1200 bristles with features, jumpers, and DIP switches, adequately explained by decent documentation. There's a clock/calendar (you have to change a DIP switch after setting it), a serial port switchable for communications or printer use, and a parallel port that dangles from an auxiliary cable and helpfully changes from LPT1 to LPT2 if you already have a parallel port on your video card.

As for the modem, it's Hayes-compatible (I made text and Xmodem transfers with several auto-dial, auto-answer programs and bulletin boards), squawks and beeps just as loudly as other internal modems, and generally works like a charm. I'm pleased with Practical's five-year warranty, too.

Carrying 512K memory, the board expands a 256K computer to 640K plus 128K for the supplied print spooler (whose software takes 17K of DOS memory). The spooler is a cute pop-up program that creates up to three print queues (serial printers require redirection of LPT output with the DOS MODE command); other Practical software includes an effective autodialer, a crummy little communications program, and the smallest (752-byte) driver I've found to create a 360K RAM disk.

The Multifunction 1200's slot saving is its main attraction, but Popular Programs' Pop-Up DeskSet and TeleComm (regularly $129.95) are a bundled bonus. TeleComm, though limited to dinky phone directories (three voice and three data numbers), hides behind your favorite application to dial other numbers from the screen or keyboard, giving surprisingly full-powered communications except for the lack of an answer mode.

DeskSet usually takes more memory than Borland's SideKick, but provides your choice of separately loaded accessories—and the accessories are of superior quality, such as a sophisticated financial calculator and a notepad that's a full-fledged word processor. Pop-Up DOS offers internal commands like Delete and Rename from within an application; Pop-Up Anything lets you temporarily leave an application to run an external command or another program.

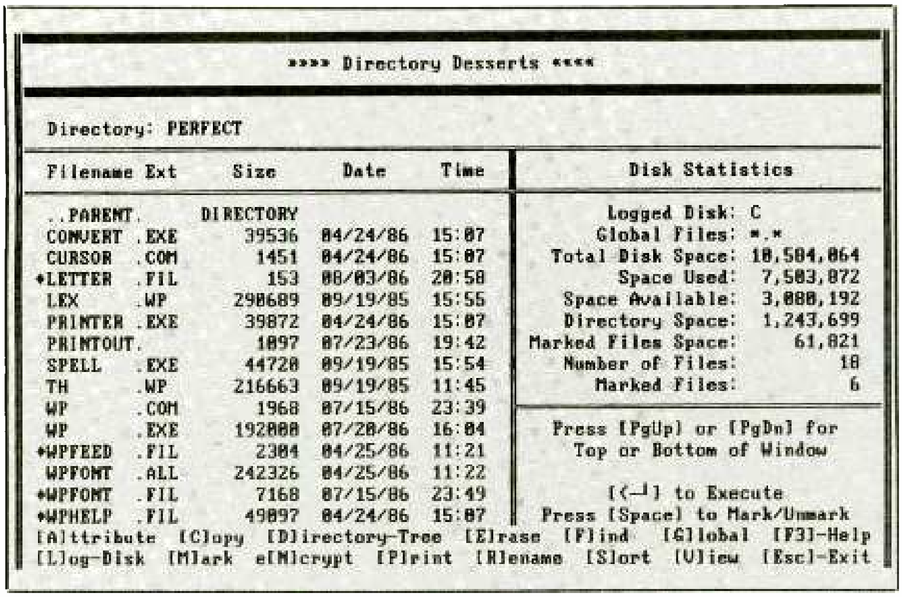
My only complaint about the Practical board is its price: $395 with no memory. That's not too bad considering its bundled software and the cost (and need for two slots) of, say, an AST SixPak and Hayes Smartmodem 1200B, but Practical's $154 fee for adding 512K memory is definitely greedy. You can buy the RAM chips yourself for under $60.

Waiter, I'll Have DOS

I was all set to ridicule Bartel Software's Le Menu. It's the only hard-disk organizer named for a frozen dinner, the manual has photos of disks on china plates, and Bartel's press kit is a howler: it follows the common practice of reprinting a review of an earlier version, but with everything negative (over half the review) blacked out with Magic Marker.

But once I tested the current version (2.5), I found Le Menu isn't so laughable. It may not be the greatest DOS shell around, but it does a good job of integrating two functions, many programs for either one of which cost more than its $59.95. If you have a crowded hard disk or manage an office XT or AT for inexperienced users, Le Menu is worth a look.

Le Menu's first function, as its name implies, is to set up a program selection system (similar to that of Delta Technology's Direct Access). Started from an AUTOEXEC.BAT file, it presents users with a custom menu of 26 choices, such as "Lotus-1-2-3" or "Database Program"; pressing one key (the desired let-



```
**** Directory Desserts ****

Directory: PERFECT

Filename Ext    Size     Date     Time  |        Disk Statistics
                                        |
..PARENT.     DIRECTORY                 |        Logged Disk: C
CONVERT .EXE    39536  04/24/86  15:07  |       Global Files: *.*
CURSOR  .COM     1451  04/24/86  15:07  |   Total Disk Space: 10,584,064
*LETTER .FIL      153  08/03/86  20:58  |         Space Used: 7,503,872
LEX     .WP    290689  09/19/85  15:55  |    Space Available: 3,080,192
PRINTER .EXE    39872  04/24/86  15:07  |    Directory Space: 1,243,699
PRINTOUT.        1097  07/23/86  19:42  | Marked Files Space:     61,821
SPELL   .EXE    44720  09/19/85  15:54  |    Number of Files:         18
TH      .WP    216663  09/19/85  11:45  |       Marked Files:          6
WP      .COM     1968  07/15/86  23:39  |
WP      .EXE   192000  07/20/86  16:04  |  Press [PgUp] or [PgDn] for
*WPFEED .FIL     2304  04/25/86  11:21  |  Top or Bottom of Window
WPFONT  .ALL   242326  04/25/86  11:22  |
*WPFONT .FIL     7168  07/15/86  23:49  |      [<—┘] to Execute
*WPHELP .FIL    49097  04/24/86  15:07  |  Press [Space] to Mark/Unmark
[A]ttribute  [C]opy  [D]irectory-Tree  [E]rase  [F]ind  [G]lobal  [F3]-Help
[L]og-Disk  [M]ark  e[N]crypt  [P]rint  [R]ename  [S]ort  [V]iew  [Esc]-Exit
```

Besides providing menus for rookies, Le Menu knows its way around DOS directories.

ter) automatically logs onto the proper subdirectory and starts the program or batch file.

A menu choice can call a submenu and so on, going five levels deep for over 11 million theoretical choices; menu entries can pause for parameter input or use default responses. Each menu entry can have an access password, with a master password required for Le Menu's other functions or exit to DOS; computer usage can be tracked and printed for nosy supervisors.

That's nice enough, but press F2 for "Directory Desserts" and Le Menu becomes a powerful directory manager like Bourbaki's 1Dir (March 1986, p. 70). Leafing through directories (sorted lists or an overall tree diagram), you can run programs or copy, delete, rename, type, or change attributes of files marked individually or with wildcards; where Le Menu requires a correct filename, as in the menu setup procedure (is it 123.COM or 123.EXE?), it will quickly search all directories to help you find it. You can't jump directly from one subdirectory to another without going from list to tree and back, but Le Menu makes up for that with a valuable bonus—it can encrypt and decrypt files with a password of your choice.

Another main menu choice, "DOS Appetizers," brings a dedicated menu of DOS functions from making directories to running BACKUP, DISKCOPY, or EDLIN, or executing a program or a short batch file typed on the spot. It's here that Le Menu strikes me (and the crossed-out magazine reviewer) as stupid: Rather than asking where it can find the DOS files, whether in your root directory or elsewhere, the installation program copies your entire DOS master disk into the Le Menu subdirectory. For a program that boasts that it saves disk space by creating a master menu rather than many batch files, this is space-wasting silliness. You can edit your PATH statement to undo Le Menu's damage, then delete the duplicated files, but it's a chore caused by poor design.

Otherwise, Le Menu works well, is priced right, and packs some likable features such as file encryption. Minus the cutesy names, I'd recommend it for most office environments. **ME**

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305-997-9444

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Popular Programs Inc.
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Kirkland, WA 98033

Bartel Software
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Midvale, UT 84047
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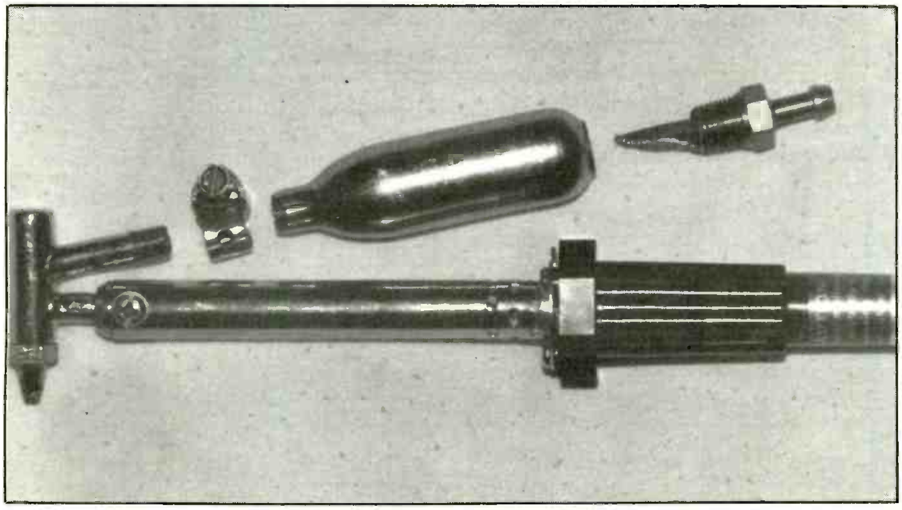


Fig. 8. Add-on elements for the desoldering tool include a small pipe clamp, a modified CO_2 cylinder and a hose barb, left to right above desoldering iron.

can be used for the Super Solder Sucker. PVC tubing, is available at most hardware stores. It is inexpensive, but is not heat resistant and is not as flexible as rubber. It can only be used with the basic version. Preferable for this project is silicone rubber tubing, such as the kind used as fuel line on model aircraft engines. I used Aerotrend "extra large" (no inch size is given), which is sold by the foot at most hobby shops. It is extremely flexible and won't melt if you touch it with the hot tip of a soldering iron.

Radio Shack's catalog no. 64-2060 desoldering iron can be easily converted for use with the foot pump. You can, of course, use a similar desoldering iron from another source if you wish.

To convert the soldering iron for desoldering purposes, you must first, fabricate a solder collecting chamber using a spent CO_2 cartridge. *Caution:* Use *only* a CO_2 cartridge—*not* a butane, propane, or N_2O (nitrous oxide) cartridge. Any other cartridge, although discharged, could contain enough residual gas to explode during the machining process. Also, do *not* release the CO_2 gas by puncturing the seal with a nail. If you do, the cartridge could become a dangerous missile. Ask the dealer from whom you purchase the CO_2 cartridge to discharge it for you.

CO_2 cartridges come in two sizes. Get the smaller, 2½"-long size that is used in soda-water makers and CO_2-powered models. These are available at hobby shops and hardware stores. The larger 3¼"-long cylinders used in BB guns are too long.

There are several ways to attach the neck of the cartridge to the iron. Brazing, silver solder and threading will all work if you have the necessary equipment. I used a ¼"-28 tap and die, but a small hose clamp makes a very satisfactory connection.

Drill out the neck of the cartridge to the same diameter as the tube on the iron, (Radio Shack's is ¼"). With a hacksaw, cut two ¼"-deep slots down the neck of the cartridge.

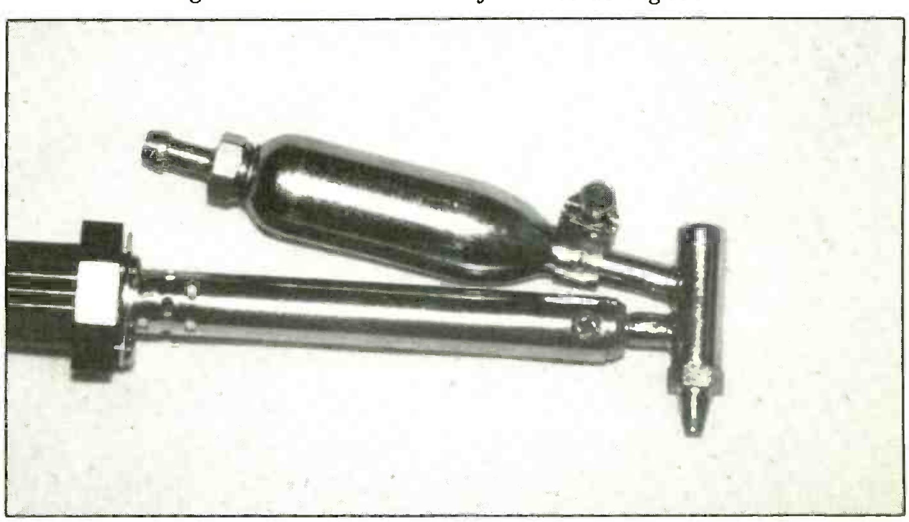
Center punch the opposite end of the cylinder and using pilot bits, drill a ⅜" hole. Thread the hole using your ⅛" pipe plug or ⅛"-27 N.P.T. pipe tap. Remove all burrs and sharp edges from both ends of the cartridge with a file.

Make a filter for the hose barb by rolling a 1" × ¾" piece of copper window screen into a cylinder and insert it into the hose barb. Close the end of the screen by folding it over and soldering the end. Using as little solder as possible, seal the seam, and put a small daub of solder to hold the filter in the fitting.

Next, remove the tip assembly from the iron by loosening the larger setscrew. Cut the tube off about ¾" from the head. Clean up any burrs or sharp edges with a file. Install the assembly back in the iron. The elements that make up the deluxe desoldering iron are shown in Fig. 8.

Put the small hose clamp around the neck of the CO_2 cartridge and slide this over the tube as far as possi-

Fig. 9. The assembled modified desoldering tool.



ble without contacting the barrel of the iron. You want the tube to extend into the cylinder a bit to prevent solder from getting back onto the tip. Tighten the hose clamp just enough to secure the connection. Clip off the extra bit of the clamp with a pair of diagonal cutters, as close to the worm gear as possible. The assembled modified desoldering iron is shown in Fig. 9.

If you don't have the facilities to perform the maching operations described here, are having difficulty obtaining the required parts, or just prefer assembling the Super Solder Sucker from a kit, see the note at the end of the Bill of Materials. You will find listed there a number of kits and individual parts that are available to suit any need.

To take full advantage of the increased suction power, remove the replaceable tip and drill it out to 5/64". Remove any burrs with a file and reassemble.

Finally, connect the pump to the iron with the silicone rubber hose (about 6 feet is a good length).

In using the Super Solder Sucker put the iron's office right over the lead protruding through the circuit board. Allow the solder to liquify, and then pump. Remember, the suction is on the up stroke.

You will find that you can control the speed of the flow with your foot, while simply lifting your foot from the pump gives a nice smooth *wooosh*.

In Closing

The Super Solder Sucker described here offers an inexpensive alternative to the $250 and more commercial vacuum desoldering tools. It may not have the elegance of a variable-speed, electrically operated vacuum pump, but manual foot pumping is a small price to pay when you consider that the Super Solder Sucker costs less than a tenth of the commercial desoldering workstation.

Analog Acquisition Unit

(from page 26)

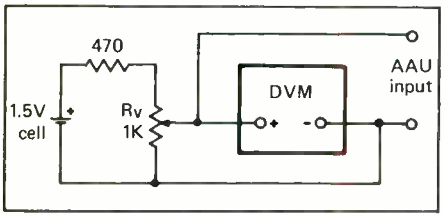


Fig. 8. Calibrating circuit for AAU.

tal A, followed by a carriage return, from computer to AAU. This should cause *LED1* to flash. After a delay of 240 ms, the AAU should return 00 (HEX) followed by a carriage return to the computer.

Only the capital letters A through H are recognized by the AAU. The letters A through D instruct the AAU to sample INPUT 1 through INPUT 4 in that order. The ASCII string returned to the computer will be a two-digit hex number between 00 and FF.

If the letters A through H are received by the AAU, INPUT 1 through INPUT 4 will be sampled as before, only now the value returned to the computer will be in the form of a three-digit decimal number between 000 and 255. The actual value returned depends on the voltage on the sampled AAU input. In this project, 1 volt is full-scale, which is equal to 255 in decimal or FF in hex.

Use the circuit shown in Fig. 8 to calibrate the Analog Acquisition Unit. With the calibration circuit connected to the INPUT 1 of the AAU, adjust *RV* for a meter indication of 0.5 volt. Then adjust *R2* until the AAU returns a 127 when a capital E is transmitted by the host computer. Repeat for INPUTS 2, 3 and 4, adjusting *R6, R10* and *R14*, respectively, as you did *R2* for INPUT 1.

You are now ready to input analog data directly into your computer. Since the parameters of temperature, humidity, force, pressure, position and many others can easily be converted to an analog voltage, the uses to which you can put your computer with the aid of the Analog Acquisition Unit are limited by only your ingenuity. ME

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TIP122	1 01	9 45	81 00	742 50
TIP127	1 05	9 80	84 00	770.00
TIP135	1 35	9 80	84 00	770 00
TIP29C	.78	7 35	63 00	577 50
TIP30C	78	7 35	63 00	577 50
TIP32C	75	7 00	60 00	550 00
TIP61C	75	7 00	60.00	550 00
TIP62C	75	7 00	60 00	550 00

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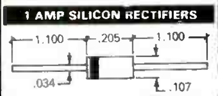

Part No	Description	Pkg.	10	100	1,000	10,000
1N4001	50 PIV	DO-41	80	7 00	60 00	515.00
1N4002	100 PIV	DO-41	80	7.00	60 00	540 00
1N4003	200 PIV	DO 41	80	7 50	64 00	563 00
1N4004	400 PIV	DO 41	80	7 90	68 00	588 00
1N4005	600 PIV	DO 41	1 00	9 00	74.00	625 00
1N4006	800 PIV	DO 41	1 00	9 00	80 00	661 00
1N4007	1000 PIV	DO-41	1 50	12 00	100 00	710 00
1N4148	Ultra Fast Switching Diode	DO 41	60	5 00	29 58	211 25

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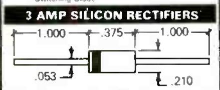

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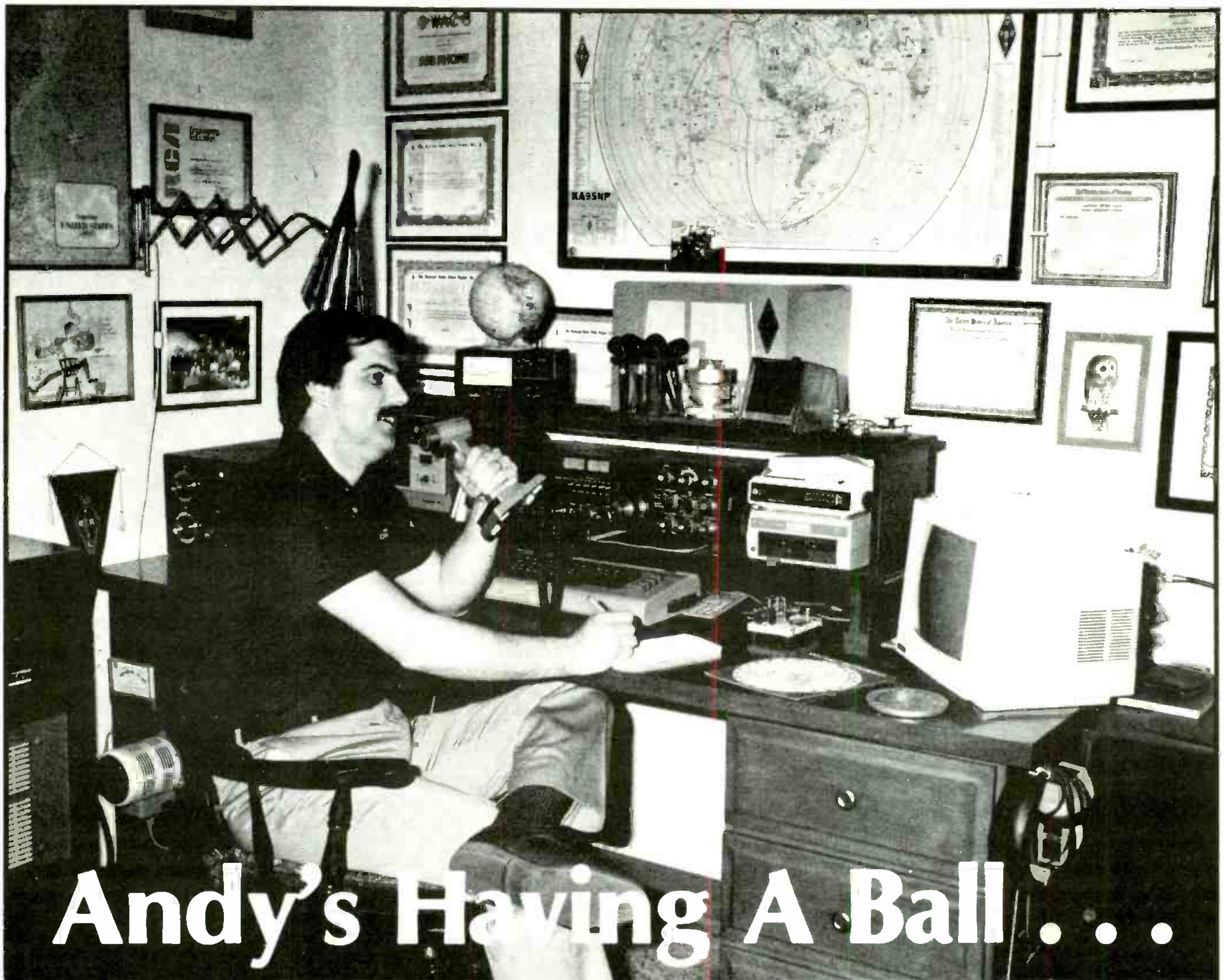

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PRODUCT EVALUATIONS . . .

The Multibotics Workshop *(from page 18)*

We then quickly snapped together plastic devices to make a sort of vehicle with a moving propeller and proceeded to control its movement across a carpeted floor. Each motor requires use of a color-coded pair of leads: Red for Motor 1, White for Motor 2 and Blue for Motor 3 (an expanded Model MB330 has three motors in the kit instead of two and nearly twice the components and projects for $199.95). The sensors, too, are attached in pairs for both transmitter and receiver use. The interface's LEDs illustrated the action of pulses during a motor-speed experiment.

After switching the interface to Scope/Meter, we loaded the oscilloscope program. A color scope appeared on-screen, graticule and all. Good use is made of the computer's function keys for toggling data, increasing and decreasing graticule divisions, etc. There's easy toggling for Time/Div, Volts/Div, real-time and stored display, Triggering, ± Slope, for instance. Moreover, trace and border colors can be changed, and the trace can be moved for centering purposes.

One shouldn't expect hi-fi sound from the digitally recorded and played-back sound. It's noisy, but turning down the tone control takes care of this. It's learning the principles and observing the rough results that counts here. According to the Manual, a 1-bit sample is taken at about every 72 microseconds and there's some quantization noise.

A knowledge of programming isn't required to quickly learn about electronics and how mechanical contrivances are controlled by a computer. With a knowledge of BASIC, however, you can modify or create your own control programs. For those who are advanced in this area, there's a programmer's reference section with technical specifications, advanced commands and a memory map at the back of the manual. Free information on interfacing, component data sheets and a schematic are offered, too, to purchasers.

We were favorably impressed by the Workshop. It fulfilled its promise of providing an educational tour of electronics and mechanics in an animated fun way. According to the distributor, there are enhancement modules that include two Robotics modules, a scope enhancement module, a thermodynamics module, a switching and relay module, and a speech digitization enhancement module, among others. ME

—Art Salsberg

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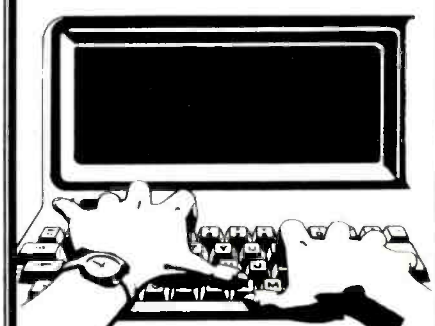

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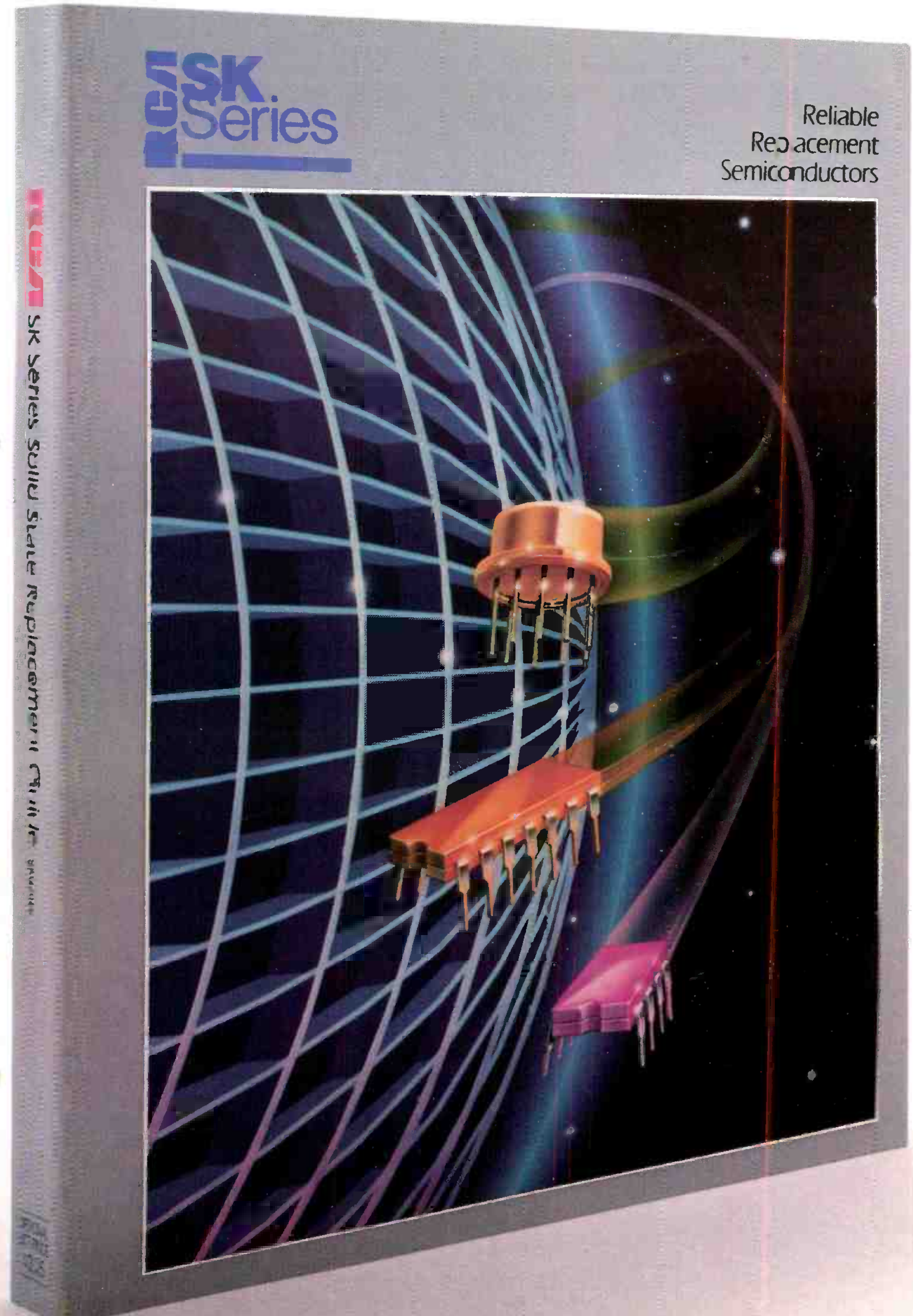

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