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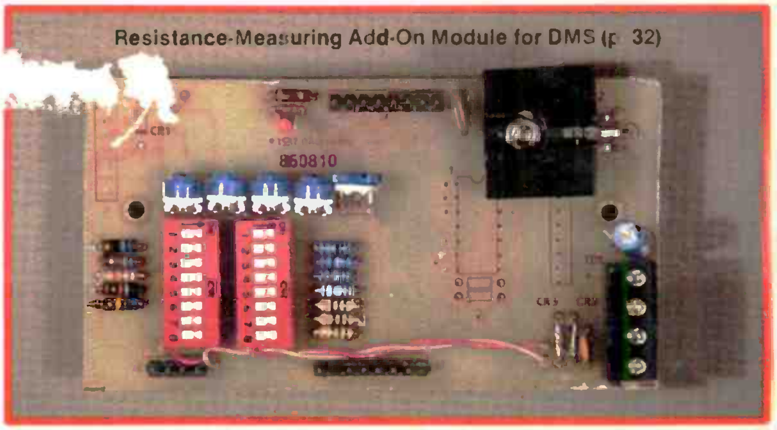
THE MAGAZINE FOR ELECTRONICS & COMPUTER ENTHUSIASTS

Vocal-Warning Burglar/Car Alarm

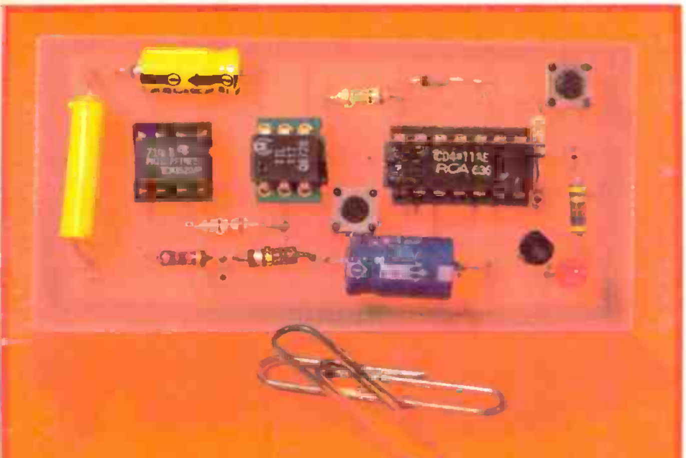
How To Install Cellular Phones



Resistance-Measuring Add-On Module for DMS (p. 32)

Plus:

- Electronic Heat Control
- Computer-Aided Circuit Troubleshooting
- An Absentee Phone Call Indicator
- Adding Computer Control to a General-Coverage Receiver
- A Resistance-Measuring Module



Absentee Phone Call Indicator (p. 46)

IC Technologies' Troubleshooting Aids (p. 82)

Also: Using TV/VCR Remote Controls in a Cable-TV Setup • Mathematical Variations of Ohm's Law • Evaluating the Logimouse C7, IQ Technologies' RS-232 Troubleshooting Aids & Bitstream's "Fontware" • Forrest Mims on Using LED's as Detectors • Latest Technical Books & Literature • Electronic & Computer News

MODERN ELECTRONICS

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FEBRUARY 1988 **VOLUME 5, NUMBER 2**

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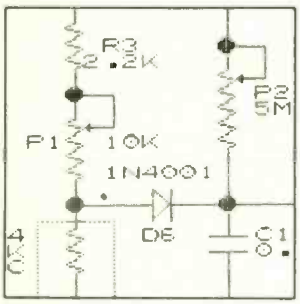

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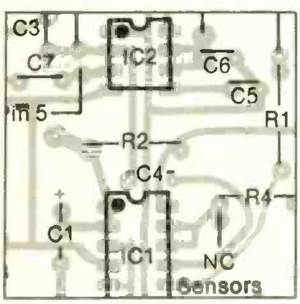

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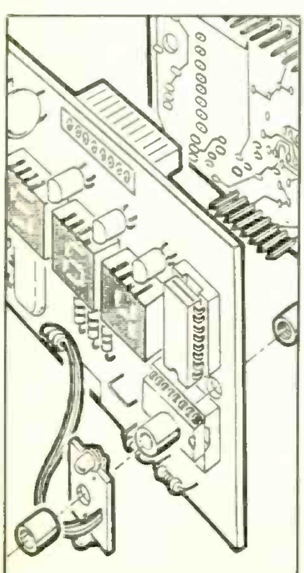

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DECLARATION OF AUTHORIZED USE — I, the undersigned, do hereby declare under penalty of perjury that all products purchased, now and in the future, will only be used on cable TV systems with proper authorization from local officials or cable company officials in accordance with all applicable federal and state laws. **FEDERAL AND VARIOUS STATE LAWS PROVIDE FOR SUBSTANTIAL CRIMINAL AND CIVIL PENALTIES FOR UNAUTHORIZED USE.**

Dated: ____________ Signed: ____________________

EDITORIAL

D Day

Near the end of last year, I extolled the virtues of analog recordings and high-end audio equipment—and reaped a bevy of letters that mostly praised digital discs and players and maligned analog counterparts. One of our erudite authors, J. Daniel Gifford, in fact, kindly sent me a two-page letter concerning this earlier Editorial piece.

The tack he took was that he seriously doubted that the pickiest high-ender could detect a difference between a very costly music system ($25,000 to $30,000) and a good standard system ($2,000) even 80% of the time. Moreover, he doubted that the high-end system, which costs more than ten times as much, sounds even twice as good.

I agree with the latter. But the value is in the ears of the listener who's willing to pay more to squeeze out small improvements in quality. I don't agree with the former, though; at least for serious, experienced music-reproduction listeners.

Mr. Gifford conceded that audiophile pressings on an excellent sound system will beat out CD in warmth and presence. He observes, however, that LP technology is at its dead end while CD technology has barely begun, and that the improved circuitry of some costlier CD players is drifting down to under-$400 CD players. Further, he emphasizes the durability of CD pressings for repeated playings, fingerprints and dust, etc.

There's no doubt that digital compact discs have the foregoing attributes going for them. Nonetheless, many people are reluctant to dump a large, irreplaceable library of LP records. The way to go is to add a CD player so that the old and new can coexist. There's also no doubt that CD's fidelity potential and convenient size make it the way to go now.

Everyone should keep in mind, though, that to realize the full benefits of CD often requires upgrading other links in the audio chain. If you play an LP at an average of 1 watt output, for example, you need at least a clean 10 watts of output power to handle just a 10-dB music peak. Since CD provides substantially greater dynamic range, you'd need 100 watts/channel to cleanly reproduce a 10-dB music peak . . . and CD's dynamic range is typically much more than 10 dB greater than an LP's! A speaker's power-handling capacity is strained, too, when a switch to CD is made, as is its handling of the extended frequency range generated by the new source (20 kHz vs. 17 kHz bandwidth).

As far as availability of source material, CD has a long way to go to match the LP archives. This is especially true if one wants the best audio quality (all digital, from recording format to finished product). You'll find that many CDs now have a code that indicates how digital the digital disc is. Three letters are used to represent recording, editing and final product. An A indicates it was done analog, while a D represents digital. Best audio fidelity quality is DDD, assuming that the recording engineers did it all right (which they often do not).

Also, the artistic quality of the program must be considered. And recording artists who passed away many years ago cannot ever have a compact disc with three Ds. Many of these recordings will never be transferred to CD, naturally, for economic reasons. So analog players will hang on for a long time for fewer and fewer people. Keep in mind that there is still a very small, hard core of audiophiles that play 78-rpm records with phono cartridges that use cactus stylus. Now *that's* flaky.

"D (for Digital) Day" is swiftly approaching. From improvements to audio CD recordings and players to interactive audio/video CDs (called CD-I) to CD-ROMs that hold a few hundred thousand pages of informational text that can be quickly searched and displayed, everything's coming up digital . . . until neuron technology bursts upon the scene, that is.

Art Salsberg

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

Add Picture-Within-Picture On Any TV Screen

Double-Play from Rabbit Systems, Inc. (Santa Monica, CA) is a new electronic device that allows users to view two pictures on the same TV screen. The unit generates a picture within a picture. The second picture, which can be positioned in any corner of the TV screen, is one-eighth the size of the main picture.

Double-Play comes with its own wireless remote-control system. With the remote transmitter, you can auto-scan through TV channels on

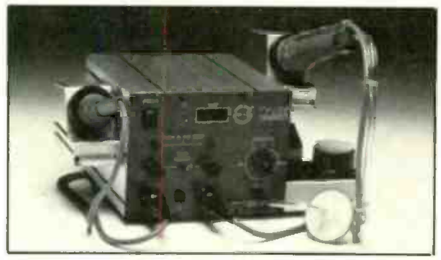
the mini-screen to make selections without interrupting viewing the channel on the main screen; freeze the image on the mini-screen so that you can jot down a fleeting telephone number or address; switch programs back and forth between the primary and mini-screen; monitor a video tape while viewing a live broadcast on either the primary or mini-screen; move the mini-screen to any desired corner; and display station identification in the mini-screen.

Housed in a metallic black cabinet, Double-Play measures 11.75"W × 8.25"D × 2.5"H. $249.

CIRCLE 15 ON FREE INFORMATION CARD

Digital Desoldering Tool

Claimed to be the most advanced tool of its kind, Pace Inc.'s (Laurel, MD) Model MBT-120 vacuum desoldering tool utilizes an electronic load-sensitive turbo-heat boost that responds on demand. For multiple-lead/pin components, especially



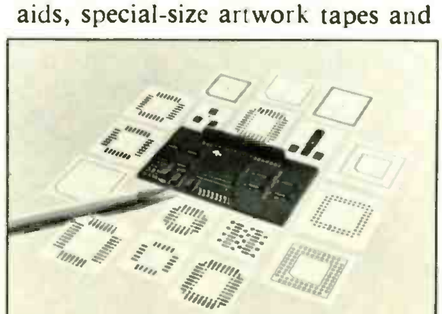
when mounted on multi-layer boards, solder is said to be reflowed instantaneously, with the heat-boost circuit compensating for any temperature drop resulting from heat sinking. A digital display indicates both temperature selection and actual tip temperature in either °C or °F. Tip temperature is settable to within 1 °F. In addition, all tip temperature controls can easily be calibrated.

A new "Snap-Vac" vacuum system is built into the MBT-210. Vacuum rise time is said to be 300 percent faster than with previous electrically operated systems. With Snap-Vac's consistent high flow, lead resweat problems are virtually eliminated. The tool also has a static-dissipative desoldering handpiece. $875.

CIRCLE 16 ON FREE INFORMATION CARD

SMT Artwork System

New from Bishop Graphics, Inc. (Westlake Village, CA) is a surface-mount technology (SMT) artwork system designed to help circuit designers lay out and create highly accurate artwork. The new artwork system consists of a special 30-line/inch resolution layout grid, component land patterns that conform to IPC-SM-72 design guidelines, corresponding silkscreen symbols that also serve as component placement aids, special-size artwork tapes and



an SMT design layout template in both 2× and 4× scales.

New surface-mount component land patterns have via pads connected to each land area to simplify integrating designs into a through-hole environment. Patterns are designed to fit on a 0.050" grid to facilitate bare board testing and permit maximum component density and trace routing. Traces can be routed between 0.025" pads on 0.050" centers. The grid permits accurate placement of tape traces when using the standard 4× scale of high-density DIP designs.

Component centers on the land patterns are marked so that the patterns can be accurately positioned on the grid, even when land pattern edges do not fall on the layout grid.

Silkscreen component marking symbols are designed to function as a design rule to placement aid. Since the silkscreen symbol represents the minimum spacing required between components, the symbols can be used to establish proper minimum spacing layout.

CIRCLE 17 ON FREE INFORMATION CARD

Digital Effects VHS Camcorder

Panasonic's Model PV-330 VHS camcorder features digital special-effects circuitry and a unique light sensitivity capability that approaches 1 lux. Combination effects make it possible to place a still image in a choice of locations on the playback screen. Three digital modes remove the still frame picture from the screen. Wipe mode scans from right to left across the screen, replacing the freeze frame image with a live image; box wipe mode expands the live picture outward from the center of the screen; and overlap allows the moving image to automatically overlap the still frame.

CCD imaging and digital circuitry that provide a light sensitivity that approaches 1 lux give the camcorder the ability to record under extremely

low light conditions. A flying erase head mounted on the rotating video head cylinder, provides exceptionally clean cuts between scenes. A high-speed shutter mode is included for excellent fast-action recordings that, when played back on Panasonic three- and four-head VCRs, are designed to provide outstanding field-slow clarity.

An Index/Address Search system permits quick location of any segment on a video tape. Index Search places a signal on the control track of the tape at the beginning of every recorded segment, while Address Search places a signal on the control track at 1-minute intervals. During playback on compatible Panasonic VCRs, these signals can be used to quickly locate specific scenes.

Other features include: a power-driven 8:1 zoom lens; audio/video dubbing; full automatic white balance; automatic iris; instant playback; and an edit switch. $2,000.

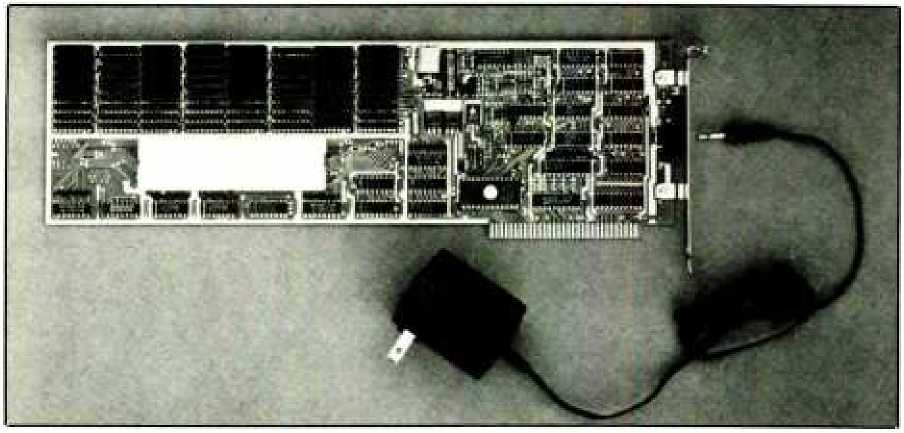
CIRCLE 18 ON FREE INFORMATION CARD

Battery Analyzer

A new six-unit battery analyzer has been introduced by Alexander Batteries (Mason City, IA). During operation, the Model TA6500-11 Tri-Analyzer first fully charges the bat-

tery utilizing a unique microprocessor to detect the exact full-charge point. It then reads and stores the full-charge data. Then the analyzer fully discharges the battery, at which point the microprocessor calculates the difference in capacity (in mAh) and displays this number. The analyzer then returns the battery to the full-charge point.

Rate of charge is regulated at 600 mAh, rate of discharge at a regulated 429-mAh, both of which will accommodate most radio batteries currently on the market. (Charge and discharge rates can be changed at the factory to accommodate other larger batteries.) This charge/discharge cycle occurs with each of the six batteries simultaneously. A battery with a 500-mAh capacity can be completely cycled in approximately 3 hours.



RAM-Based "Disk" Drive

Novo Drive 2000 for IBM PC, XT, AT and compatible computers from Kapak Design (Saratoga, CA) is a RAM-based "disk" drive implemented with semiconductor memory on a single bus card. Capacity of a single drive is 2 megabytes, and multiple units, used with installable device driver, provide 4-, 6- and 8-megabyte configurations. Because data is transferred via DMA (direct memory access), every memory cycle, Novo Drive 2000 is claimed to be many times faster than mechanical drives and twice as fast as a virtual drive implemented in main memory.

Formatting itself during initial power-up, Novo Drive 2000 is easy to install and is immediately ready to use, without requiring special drivers or software. Separate from main memory, it is claimed to be compatible with all types of add-on memory, and all of memory address space is available for programs and data.

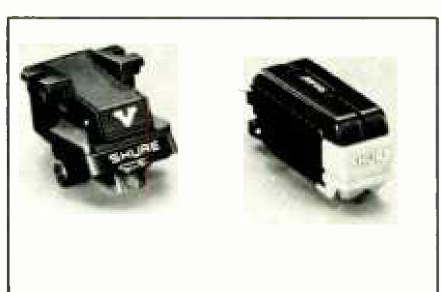
Boot firmware is built in, making it possible to boot directly from Novo Drive 2000 instead of first going to the floppy-disk drive. System boot files, part of DOS, can be installed with standard SYS and COPY commands.

Data is nonvolatile, supported in two levels. An ac power adapter, separate from the computer, maintains data when the computer is powered down. If ac power should fail, an on-board battery supplies power for at least 90 minutes, allowing Novo Drive 2000 to be physically transferred to another system without loss of data. $570, including 2M of RAM, battery and accessories.

CIRCLE 19 ON FREE INFORMATION CARD

Stereo Phono Cartridges

Shure Brothers Inc. has unveiled a new line of stereo phono cartridges, the VST Special Edition Series, that incorporate design features from the company's V15 cartridges. Topping the series is the VST V, which is designed to provide performance the equivalent of the V15 Type V-MR. It features a Micro-Ridge tip geometry for exceptional high-frequency reproduction and an exclusive Dynamic Stabilizer that acts as a shock absorber to help make warped records playable by reducing arm/cartridge resonance and eliminating static.



A pair of sister cartridges, the VST III and VST III-P, feature distortion-reducing hyperelliptical stylus tips. The VST III is designed for standard 0.5-inch headshell mounting and shares the Dynamic Stabilizer design of the VST V, while the VST III-P is optimized for P-mount applications.

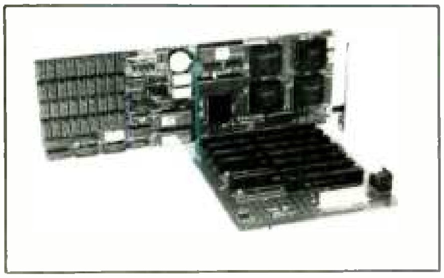
All three VST cartridges have a Microwall/Be™ stylus shank, a telescoped beryllium tube whose ultrathin walls combine rigidity with extremely low mass. Dura-Body encapsulated construction permanently locks all internal cartridge components securely in place to eliminate spurious resonances and loss of channel separation. Also included is Shure's Side-Glide stylus protection system that prevents collapse of the shank tube in case of accidental side thrusts imposed by the user. About $200 for VST V, $100 for VST III/III-P.

CIRCLE 20 ON FREE INFORMATION CARD

16-MHz 286-Based Computer Card

An AT-compatible computer-on-a-card system that operates at both 8 MHz and the buyer's choice of 10, 12, 14, 15 or 16 MHz has been announced by Professional Computer Systems (Sunnyvale, CA). Operation is with 0 wait state at 8 MHz and 1 wait state at the optionally selected higher speed. The PCS-2800 system consists of a computer board and a backplane. The computer board is the size of a conventional full-slot IBM-AT-style I/O board and contains the 80286 microprocessor, system RAM, a socket for an optional 80287 math coprocessor, Award BIOS ROM, Zymos AT chip set, clock/calendar and keyboard chip. The amount of user RAM on-board depends on the configuration selected. Minimum is 512K and maximum is 1M bytes. RAM speed is matched to that of the processor and math coprocessor specified when the system is ordered.

Speed selection can be either by setting a hardware jumper clip or through a keyboard entry. A socket is provided for an 80287 coprocessor, whose speed is matched to that of the 80286 processor ordered. Battery backup is provided for the real-time clock/calendar. A power-on



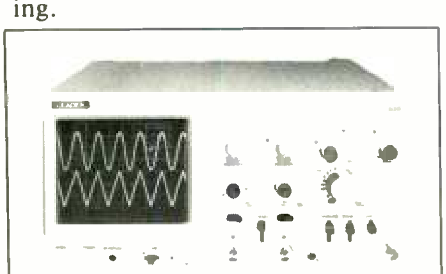
LED and a jumper for an external reset switch are also provided on the computer board. Power requirements for the computer board are +5 volts at 2 amperes maximum.

A 12-pin male connector on the backplane mates with standard AT/XT-style power-supply cables for power distribution. Included on the backplane board are the keyboard connector, a 5-pin female connector that mates with standard AT/XT-style keyboard cable connectors. Optionally available is a keyboard connector for the computer board. $395 for 8/10 MHz with 512K RAM to $995 for 8/16 MHz with 1M RAM.

CIRCLE 21 ON FREE INFORMATION CARD

Low-Cost 20-MHz Scope

New from Leader Instruments Corp. is the Model 1020 20-MHz dual-trace oscilloscope priced at $595. Its ergonomic front panel is said to simplify operation. The scope offers a comprehensive line-up of triggering controls that include alternate-channel triggering, variable trigger hold-off, TV sync separators and line triggering.

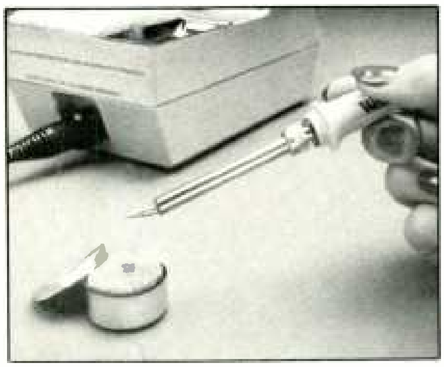


Sensitivity is rated at 0.5 mV so that very-low-level signals can be observed on the large 8 × 10-cm rectangular CRT screen. An internal graticule, automatic focus and scale illumination are among the instrument's standard features.

CIRCLE 22 ON FREE INFORMATION CARD

Soldering Iron Tip Tinner/Cleaner

Multicore (Westbury, NY) has a new soldering iron tip tinner/cleaner. The TTC1 tinner/cleaner consists of a small block of electronics-grade solder powder and chemicals com-



pacted into the shape of a disc. The disc is packaged in a metal container that has a self-adhering pad on its bottom for easy attachment to a workbench top.

A single wipe of a hot soldering iron tip across the TTC1 block cleans, "wets" and tins the tip. It is claimed that the block will remove even the stubborn tin/iron intermetallic layer that forms on plated iron tips and resist rosin-based fluxes. The chemicals it contains are noncorrosive and have a low evaporation point to assure that nothing remains on the soldering tip after tinning. $3.95.

CIRCLE 23 ON FREE INFORMATION CARD

Low-Profile MobileTV Antenna

A new low-profile "Boomrang" TV antenna for motor vehicles and powered boats has been announced by Wintenna, Inc. (Anderson, SC). It is less than 2″ high and is designed to give the same performance as the company's Classic Boomerang antenna. Constructed of high-impact ABS plastic, the new antenna is claimed to have a long range and

CIRCLE 28 ON FREE INFORMATION CARD

provide improved picture performance without roll or flutter even while the vehicle on which it is installed is in motion.

The Boomerang antenna can be mounted on the roof or trunk of a car, truck, van, RV or boat. It does not cause problems in car washes. Four versions of the new antenna are available: Model 790 standard/permanent mount; Model 790A standard/trunk mount; Model 791 amplified/permanent mount; and Model 791A amplified/trunk mount.

CIRCLE 24 ON FREE INFORMATION CARD

Remote-Control Dimmer Uses VCR/TV IR Controller

Honeywell has a new remote-controlled tabletop lamp dimmer that can control any incandescent lamp with up to a 150-watt load. In addition to turning the lamp on and off, the device can be used to dim the lighting from high to low, providing a means for full lighting control.

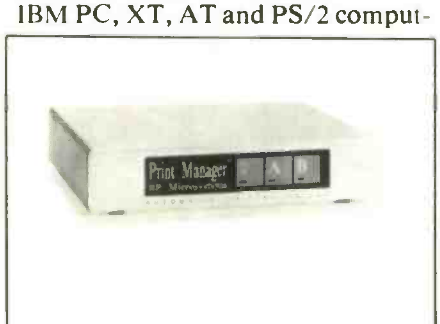
Because the dimmer works with infrared remote-control transmitters for any TV receiver, VCR or audio/video equipment, there is no need for its own remote transmitter. The dimmer contains a tabletop IR receiver that measures 4.5″ × 2.5″ × 1″, which is small enough to locate where it will be inconspicuous. The receiver has a 6-ft. power cord with an ac adapter on the end. You simply plug the lamp into the adapter and the adapter into any convenient ac receptacle.

In addition to IR remote control, the lamp can be turned on an off manually from the receiver. You simply touch a metal band that wraps around two sides and the top of the receiver's housing to turn on and off the lamp being controlled. To use the remote control transmitter for dimming action, you hold down any button with a steady pressure until the lamp gradually dims to the level you want. $39.95.

CIRCLE 25 ON FREE INFORMATION CARD

Automatic Printer Switch

Print Manager™ from BP Microsystems (Houston, TX) allows two computers to share one printer with fully automatic switching. The device is designed to work with any standard Centronics parallel printer interface and is compatible with IBM PC, XT, AT and PS/2 computers, peripherals and compatibles. It does not require software, switching ports by sensing a print request from either computer. If the second computer attempts to print while the printer is running, it puts it on "hold" until the current print operation is completed.



Maximum data transfer rate is 100K bytes per second, and maximum cable length is 30 feet. Two red LEDs indicate which computer is sending print data to the printer, and a green LED signifies when switch power is on. On the rear panel are two male DB-25 connectors for the computers and one female DB-25 connector for the printer. Power is supplied by a plug-in ac adapter. Two or more Print Managers can be connected together to allow up to eight users to share one printer. The printer switch measures 8″W × 5.75″D × 1.75″H and weighs 3.5 lbs. $179.

CIRCLE 26 ON FREE INFORMATION CARD

Chip-Resistor Kits

A variety of hybrid chip-resistor engineering kits with values ranging from 10 ohms to 24 megohms and varying in tolerance spreads have been introduced by International Manufacturing Services, Inc. (Portsmouth, RI). The IMS 0-1 Engineering Kits feature gold terminations and come in nine different configurations with 40 values that overlap at ±20 percent and up to 587 values overlapping at ±1 percent. Kits with ohm, kilohm and megohm ranges and one kit that contains all ranges can be specified.

Supplied in three-ring binders, the Engineering Kits are claimed to provide every possible value resistor in a given range. Kits with solder-coated terminations and special values and/or tolerances are also available.

CIRCLE 27 ON FREE INFORMATION CARD

Installing Cellular Mobile Phones

A guide to the cellular connection in vehicles

By Art Salsberg

Cellular telephone technology has made on-the-road communication in many areas of the U.S. and Canada convenient and affordable. As a result, many people make their vehicles an extension of their office with the aid of this modern communications system, as well as use it to make personal phone calls while "on the road."

Almost one-million people are said to now avail themselves of this service, with growth to three-million anticipated by 1990.

Cellular telephone service is still very young. It started only in 1984, in Washington, DC, and spread quickly to metropolitan areas across the country . . . and is still expanding. Other mobile telephone systems existed before cellular systems were introduced, of course, and still serve well (and more expensively) in the many areas still not set up for cellular service. Aside from lower cost, you might ask what's so special about cellular systems? There are many things.

With previously developed mobile phone systems, there is a severely limited number of call channels. Consequently, there's often a waiting list just to get one of these mobile phones. They're usually supported by a single, powerful transmitting/receiving central station that extend one's communications range to, perhaps, 25 miles. The farther you get from the strong signal area, however, the weaker and noisier the signal gets. These mobile units are larger in size than cellular types, too. In contrast, cellular phones are supported by a large number of smaller transmitter/receiver centers, called "cells." Actually, they can be likened to a bevy of switching repeaters that are tied into a central station.

As one leaves a cell reception area, moving into an area where reception/transmission is weaker, an adjoining cell picks up the service in about 2/100ths of a second, thereby maintaining full signal strength. Though depicted graphically as hexagonal, so that one can see where a cellular area ends and another begins, the reception/transmission area is actually circular, with some overlap, of course. The beauty of a cellular system is that phone communications can continue when driving into another cellular system area that's serviced by a different central transmitter/receiver company. This is called "roaming." Many companies have shared agreements to service subscribers in one area when they drive into another; with others, you may have to make arrangements to be serviced. How do you know when you've left your home area? A "roam" indicator on your cellular phone lights up, thereby alerting you.

Cellular phone systems aren't the perfect answer to mobile communications, naturally. Firstly, they don't come cheap, costing at least a thousand dollars with installation in most instances. You can save $100 or so, though, by installing the phone by yourself; maybe more, depending on the area you live in and the dealer you buy your phone from. Also, there are some areas with hills and dales that might cause pockets of reception fade-out. Further, you pay for incoming calls for the service between your phone and the cells used as well as for outgoing calls. And lastly, you incur an additional phone bill in the sense of paying a base access charge as well as connect time, which is the time you start accessing the central switching equipment, not the time you actually make a connection with the party you wish to talk to.

Nevertheless, the cellular phone system is a great convenience. Brightening the cellular mobile phone system's horizons further is the fact that each cellular service area must be set up with two systems that one can choose from. One is a local telephone company or wireline carrier, while the other competitor is a non-wireline operator which won the territory bid, thus ensuring users that connection and use prices won't get out of line.

When you buy a cellular phone, you must get a cellular phone number that's burned into a programmable ROM that's inserted into the phone. It's called a NAM, which stands for "numeric assignment number." This number, which includes your unit's serial number, identifies you to the cell site when you make or receive a phone call. It also serves as a theft deterrent if the thief knows about cellular phones.

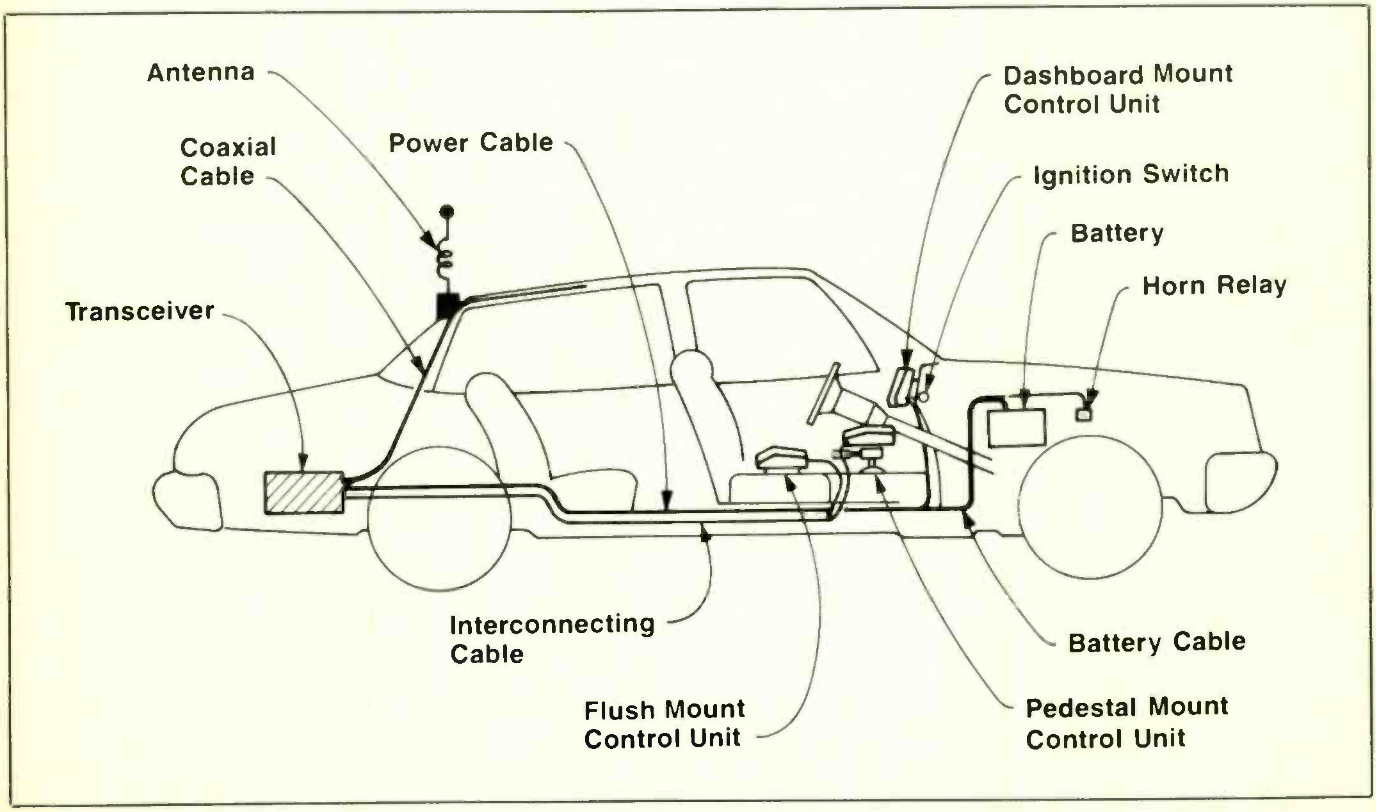
It's clear that cellular mobile phones (there are battery-powered portable models, too) are highly desirable devices—if you can afford them. You can push the initial outlay down by installing a phone yourself, making it possible to search out the best deal from sellers who don't necessarily do installation.

In typical installations, the cellular phone transceiver is installed in a car's trunk, with cable running to the control head that's located near the driver on the console or dashboard. Power is derived from the car battery and an antenna, usually mounted on the rear fender or the trunk completes the setup. Window-mounted antennas are available, too.

You can usually identify a vehicle that has a cellular phone by the shape of the antenna, which is short and has a helix winding about two-thirds down the antenna rod. The photographs and captions that follow show you how to install a system yourself. A Diamond-Tel cellular phone from Mitsubishi Electric Sales America was used as an example for installation in a GMC Safari van.

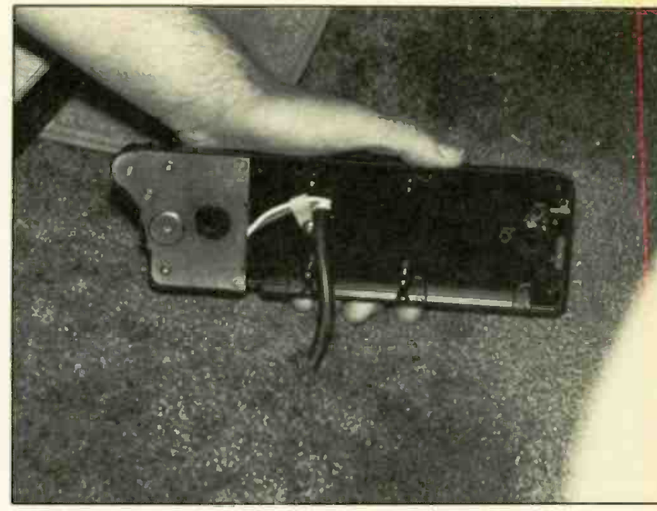
(Photographs by Ron Cogan.)

Do-It-Yourself Installation



1. This particular Diamond-Tel phone can either be mounted as a single unit with both transceiver and handset located near the driver's seat or with the transceiver mounted remotely in a vehicle's trunk. A typical remote-mounted installation is illustrated here.

2. The first step in planning a cellular telephone installation is to find a suitable mounting site for the phone. The floor area between the seats in this GMC Safari van was chosen for this Mitsubishi Diamond-Tel unit. Popular phone locations in automobiles are on the transmission hump, on the floor or under the dashboard.

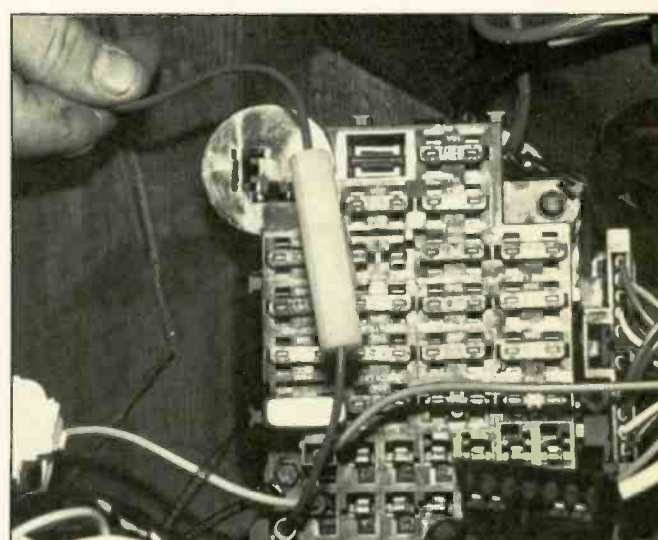


3. Like many of the new breed of transportable phones, Mitsubishi's Mesa-55 model uses a separate mounting base that bolts to the floor. Cabling containing power wiring, as well as the system's antenna coax, is routed here beneath the vehicle's carpeting from this site to other areas where the wires will be connected. It could also be brought to a door side and routed under the trim strip that covers the carpeting there.

4. The system's brown lead is routed to the vehicle's fuse block, where it is attached to a power source that is hot only when the ignition key is turned to "on" or "accessory." This wire utilizes an in-line 4-ampere fuse.

Since several wires are routed from the interior to the engine compartment, they must pass through the metal firewall. Be sure to route these through a rubber grommet to prevent the possibility of insulation fraying on sharp metal edges; this could save you from a short circuit later.

Pull the red and black leads toward the vehicle's battery and cut them to appropriate length. Secure these wires to other wires or cables with plastic wire ties; this will keep them securely in place as they route from the firewall to the battery area.



5. The red lead, with its 10-ampere in-line fuse, joins to the positive battery terminal; the black lead secures to the ground terminal. Special battery-post extenders like those used here are available from many auto parts suppliers and some electronics stores. These allow auxiliary wires to be joined to both top- and side-post style of batteries.

Join the yellow lead to your horn relay so you can set the phone to signal an incoming call when you're out of the vehicle. Be sure to use a diode to suppress potential arcing that could occur in the relay. All connections can be made by soldering or using crimp-on connectors. If you choose to solder, we recommend the use of heat-shrinkable tubing to protect the exposed wire.

(Continued on page 90)

NEW! CB Radios & Scanners

Communications Electronics,™ the world's largest distributor of radio™ scanners, introduces new models of CB & marine radios and scanners.

NEW! Regency‡ TS2-RA

Allow 30-90 days for delivery after receipt of order due to the high demand for this product.

List price $499.95/CE price $339.95

12-Band, 75 Channel • Crystalless • AC/DC

Frequency range: 29-54, 118-175, 406-512, 806-950 MHz.

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Regency® Z60-RA

List price $299.95/CE price $148.95/SPECIAL

8-Band, 60 Channel • No-crystal scanner

Bands: 30-50, 88-108, 118-136, 144-174, 440-512 MHz.

The *Regency* Z60 covers all the public service bands plus aircraft and FM music for a total of eight bands. The Z60 also features an alarm clock and priority control as well as AC/DC operation. Order today.

Regency® Z45-RA

List price $259.95/CE price $139.95/SPECIAL

7-Band, 45 Channel • No-crystal scanner

Bands: 30-50, 118-136, 144-174, 440-512 MHz.

The *Regency* Z45 is very similar to the Z60 model listed above however it does not have the commercial FM broadcast band. The Z45, now at a special price from Communications Electronics.

Regency® RH256B-RA

List price $799.95/CE price $329.95/SPECIAL

16 Channel • 25 Watt Transceiver • Priority

The *Regency* RH256B is a sixteen-channel VHF land mobile transceiver designed to cover any frequency between 150 to 162 MHz. Since this radio is synthesized, no expensive crystals are needed to store up to 16 frequencies without battery backup. All radios come with CTCSS tone and scanning capabilities. A monitor and night/day switch is also standard. This transceiver even has a priority function. The RH256 makes an ideal radio for any police or fire department volunteer because of its low cost and high performance. A *60 Watt* VHF 150-162 MHz. version called the **RH606B-RA** is available for $459.95. A UHF 15 watt, 10 channel version of this radio called the **RU150B-RA** is also available and covers 450-482 MHz. but the cost is $439.95.

Bearcat® 50XL-RA

List price $199.95/CE price $114.95/SPECIAL

10-Band, 10 Channel • Handheld scanner

Bands: 29.7-54, 136-174, 406-512 MHz.

The *Uniden Bearcat* 50XL is an economical, handheld scanner with 10 channels covering ten frequency bands. It features a keyboard lock switch to prevent accidental entry and more. Also order the new double-long life rechargeable battery pack part # **BP55** for $29.95, a plug-in wall charger, part # **AD100** for $14.95, a carrying case part # **VC001** for $14.95 and also order optional cigarette lighter cable part # **PS001** for $14.95.

PC 22

NEW! Scanner Frequency Listings

The new Fox scanner frequency directories will help you find all the action your scanner can listen to. These new listings include police, fire, ambulances & rescue squads, local government, private police agencies, hospitals, emergency medical channels, news media, forestry radio service, railroads, weather stations, radio common carriers, AT&T mobile telephone, utility companies, general mobile radio service, marine radio service, taxi cab companies, tow truck companies, trucking companies, business repeaters, business radio (simplex) federal government, funeral directors, veterinarians, buses, aircraft, space satellites, amateur radio, broadcasters and more. Fox frequency listings feature call letter cross reference as well as alphabetical listing by licensee name, police codes and signals. All Fox directories are $14.95 each plus $3.00 shipping. State of Alaska–**RL019-1**; Baltimore, MD/Washington, DC–**RL024-1**; Chicago, IL–**RL014-1**; Cleveland, OH–**RL017-1**; Columbus, OH–**RL003-2**; Dallas/Ft. Worth, TX–**RL013-1**; Denver/Colorado Springs, CO–**RL027-1**; Detroit, MI/ Windsor, ON–**RL008-2**; Fort Wayne, IN /Lima, OH- **RL001-1**; Houston, TX–**RL023-1**; Indianapolis, IN–**RL022-1**; Kansas City, MO/ KS–**RL011-2**; Los Angeles, CA–**RL016-1**; Louisville/Lexington, KY–**RL007-1**; Milwaukee, WI/Waukegan, IL–**RL021-1**; Minneapolis/St. Paul, MN–**RL010-2**; Nevada/E. Central CA–**RL028-1**; Oklahoma City/Lawton, OK–**RL005-2**; Pittsburgh, PA/Wheeling, WV–**RL029-1**; Rochester/ Syracuse, NY–**RL020-1**; Tampa/St. Petersburg, FL–**RL004-2**; Toledo, OH–**RL002-3**. A regional directory which covers police, fire ambulance & rescue squads, local government, forestry, marine radio, mobile phone, aircraft and NOAA weather is available for $19.95 each. **RD001-1** covers AL, AR, FL, GA, LA, MS, NC, PR, SC, TN & VI. For an area not shown above call Fox at 800-543-7892 or in Ohio 800-621-2513.

Regency® Informant™ Scanners

Frequency coverage: 35-54, 136-174 406-512 MHz.

The new *Regency* Informant scanners cover virtually all the standard police, fire, emergency and weather frequencies. These special scanners are preprogrammed by state in the units memory. Just pick a state and a category. The Informant does the rest. All Informant radios have a feature called *Turbo Scan™* to scan up to 40 channels per second. The **INF1-RA** is ideal for truckers and is only $249.95. The new **INF2-RA** is a deluxe model and has ham radio, a weather alert and other exciting features built in for only $324.95. For base station use, the **INF5-RA** is only $199.95 and for those who can afford the best, the **INF3-RA** at $249.95, is a state-of-the-art, receiver that spells out what service you're listining to such as Military, Airphone, Paging, State Police, Coast Guard or Press.

Regency® HX1500-RA

List price $369.95/CE price $218.95

11-Band, 55 Channel • Handheld/Portable
Search • Lockout • Priority • Bank Select
Sidelit liquid crystal display • EAROM Memory
Direct Channel Access Feature • Scan delay

Bands: 29-54, 118-136, 144-174, 406-420, 440-512 MHz.

The new handheld *Regency* HX1500 scanner is fully keyboard programmable for the ultimate in versatility. You can scan up to 55 channels at the same time including the AM aircraft band. The LCD display is even sidelit for night use. Includes belt clip, flexible antenna and earphone. Operates on 8 1.2 Volt rechargeable Ni-cad batteries (not included). Be sure to order batteries and battery charger from the accessory list in this ad.

Bearcat® 100XL-RA

List price $349.95/CE price $178.95/SPECIAL

9-Band, 16 Channel • Priority • Scan Delay
Search • Limit • Hold • Lockout • AC/DC

Frequency range: 30-50, 118-174, 406-512 MHz.

Included in our low CE price is a sturdy carrying case, earphone, battery charger/AC adapter, six AA ni-cad batteries and flexible antenna. Order your scanner now.

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The *Uniden* line of Citizens Band Radio transceivers is styled to compliment other mobile audio equipment. Uniden CB radios are so reliable that they have a two year limited warranty. From the feature packed PRO 540e to the 310e handheld, there is no better Citizens Band radio of the market today.

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PC55-RA *Uniden* mobile mount CB transceiver	$59.95

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Now the finest marine electronics are available through CEI. The *Unimetrics* **SH66-RA** has 50 transmit and 60 receive frequencies with 25 or 1 watt power output. Only $169.95. The *Unimetrics* **SH 88-RA** is a deluxe full function marine radiotelephone featuring 55 transmit and 90 receive channels and scanning capability for only $259.95. The *Unimetrics* **SH3000-RA** is an excellent digital depth sounder, good for 300 feet. It has an LCD continuously backlit with red light display and a 5 ft. or 10 ft. alarm. Only $189.95. Order today.

Bearcat® 800XLT-RA

List price $499.95/CE price $289.95/SPECIAL

12-Band, 40 Channel • No-crystal scanner
Priority control • Search/Scan • AC/DC

Bands: 29-54, 118-174, 406-512, 806-912 MHz.

The Uniden 800XLT receives 40 channels in two banks. Scans 15 channels per second. Size 9¼" x 4½" x 12½."

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RD55-RA *Uniden* Visor mount Radar Detector	$98.95
RD9-RA *Uniden* "Passport" size Radar Detector	$169.95
NEW! **BC 70XLT-RA** *Bearcat* 20 channel scanner	$168.95
BC 140-RA *Bearcat* 10 channel scanner	$92.95
BC 145XL-RA *Bearcat* 16 channel scanner	$98.95
BC 175XL-RA *Bearcat* 16 channel scanner	$156.95
BC 210XLT-RA *Bearcat* 40 channel scanner	$196.95
BC-WA-RA *Bearcat* Weather Alert™	$35.95
R1080-RA *Regency* 30 channel scanner	$118.95
R1090-RA *Regency* 45 channel scanner	$148.95
UC102-RA *Regency* VHF 2 ch. 1 Watt transceiver	$117.95
P1412-RA *Regency* 12 amp reg. power supply	$189.95
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A60-RA Magnet mount mobile scanner antenna	$35.95
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Add $3.00 shipping for all *accessories* ordered at the same time.
Add $12.00 shipping per shortwave receiver.
Add $7.00 shipping per radio and $3.00 per antenna.

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CIRCLE NO. 151 ON FREE INFORMATION CARD

Electronic Heat Control

How electronics provides more efficient utilization of available energy resources and some controller circuit examples

By Fernando Garcia Viesca

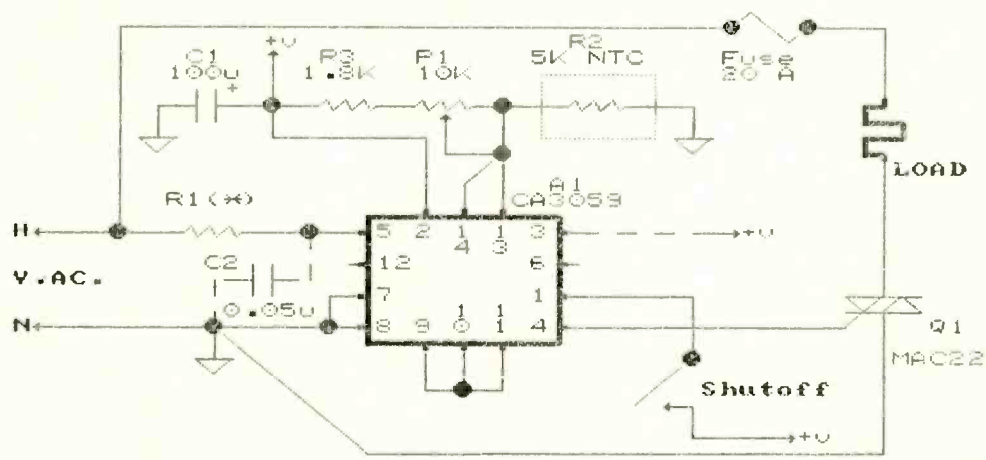
Electronic "intelligence" is frequently used to manage energy resources. With electronic management, control of all types of heating, particularly electrically generated, can maximize efficiency. Electronic energy management can be put to effective use in business/commercial and residential heating, maintaining a specific water temperature range in tropical fish aquariums, even fractionating crude oil into gasoline and other petroleum products.

Our discussion will be limited to electronic management of electrical heating systems in which temperature control up to 150° C (302° F) is required. This range is easily handled with low-cost thermistors, which provide a large "gain" without the need for amplification. Coupled with the thermistor's small heating constant, an accurate controlling system can be built with only simple circuitry.

Accompanying our discussion will be schematic diagrams for three different types of electronic controllers you can build and experiment with or use in specific applications. Before we begin, however, a word of caution is in order: When working with these circuits, exercise extreme care, since you will be dealing with potentially lethal 117 or 220 volts ac.

Basic Controllers

In a typical electromechanical thermostat arrangement, the heating load is energized through a power relay or "contactor." The main disadvantage of this setup is that arcing between the contacts of the relay or contactor eventually leads to system failure, due to erosion of the metal that makes up the contacts. To minimize on/off cycles, thermostats have built-in hysteresis, meaning that the temperature must drop two degrees or so below the setpoint before the relay energizes.



RESISTOR R1	INPUT VOLTS	WATT RATING
2K	24	0.5
10K	120	2.0
20K	220	4.0

Fig. 1. This simple high-performance on/off electronic controller can be matched to the ac input voltage by selecting an appropriate value for R1.

A couple of degrees by itself would be of little consequence if it were not for the fact that objects, including ambient air, do not cool or heat instantaneously. (Each type of material has its own thermal constant.) Hence, large temperature excursions above and below the setpoint are a common phenomenon. So the first use of electronic controllers was as electronic thermostats or on/off controllers.

By replacing the bulky power relay with a thyristor and the thermostat with a solid-state sensor, hysteresis can be set to a minimum, while at the same time eliminating contact arcing and its contribution to system failure. With this type of arrangement, heating elements can be switched faster.

Shown in Fig. 1 is a typical electronic thermostat circuit built around a CA3059 zero-voltage integrated-circuit switch. The CA3059 has an internal rectifier and voltage regulator that are supplied from the ac power line, a circuit that detects the zero crossing of the ac waveform, a current-limiting triac driving circuit, and a protection network that monitors the sensor for an open or shorted condition.

A basic controller circuit is very simple in terms of both component count and complexity. Though it can be built with only a few discrete components and a single integrated circuit, this type of circuit provides a high-performance on/off controlling device.

By firing the triac inside the IC at the zero crossing point of the ac waveform, noise pulses produced by random turn-on are avoided and triac stresses that become more meaningful with larger loads are decreased.

Operation of the Fig. 1 circuit is as follows. Ac line voltage is dropped by *R1*, which feeds the IC's internal limiting circuit. By selecting the proper resistor value, any ac supply potential from 24 to 250 volts can be used to power the circuit. This limiting circuit feeds the internal supply and zero-crossing networks.

A regulated 6.5 volts is available at pin 2 of the CA3059, which is filtered by *C1*. An internal comparator is driven at its noninverting input by the voltage from the divider network made up of potentiometer *P1* and temperature-sensing thermistor *R2*. The pin 9 inverting input is fed by the internal biasing resistors and is available at pins 10 and 11.

Because a negative temperature coefficient (NTC) resistor is used in the Fig. 1 circuit, a rise in temperature will decrease the voltage applied to pin 13 of the CA3059. This turns off the internal comparator that supplies a signal to an internal AND

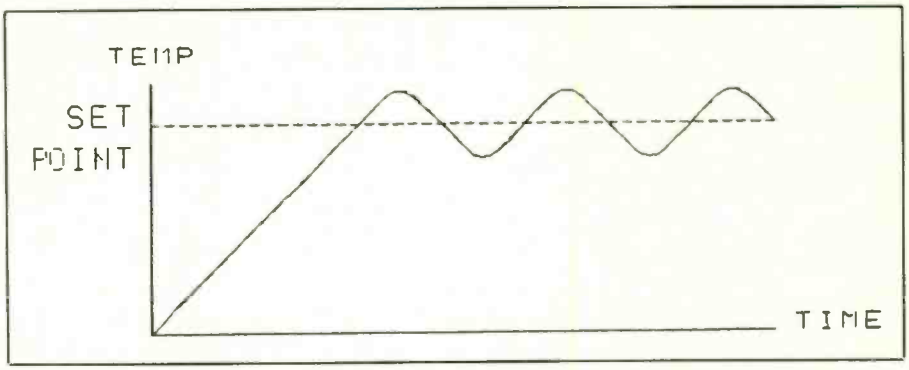


Fig. 2. The electronic on/off controller suffers from large temperature fluctuations above and below the setpoint.

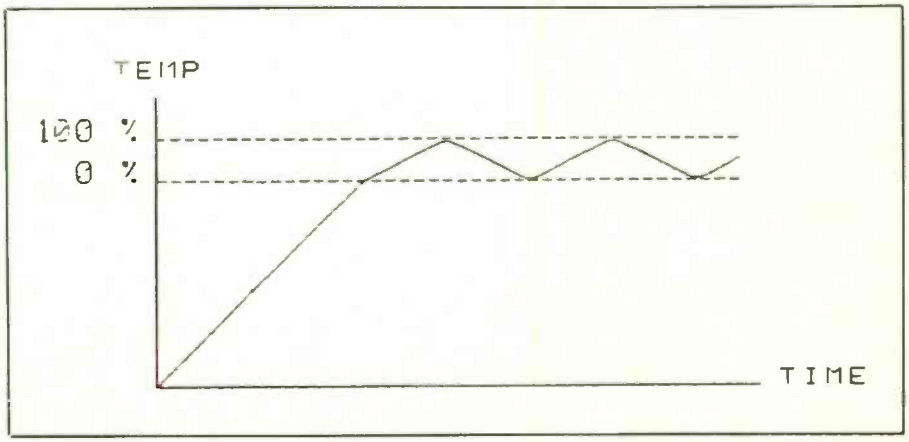


Fig. 3. Tighter control is achieved in the proportional band, between the 0 and 100-percent power levels, when power is gradually decreased.

PARTS LIST

Semiconductors
A1—CA3059 zero-voltage switch
Q1—MAC2236 or similar 400-volt, 20-ampere triac specified for four-quadrant triggering (see text)

Capacitors
C1—100-µF, 10-volt aluminum electrolytic
C2—0.05-µF, 200-volt Mylar

Resistors
R1—See text
R3—1,800 ohms, ½ watt, 5% tolerance
R2—5,000-ohm NTC thermistor
P1—10,000-ohm, linear-taper potentiometer

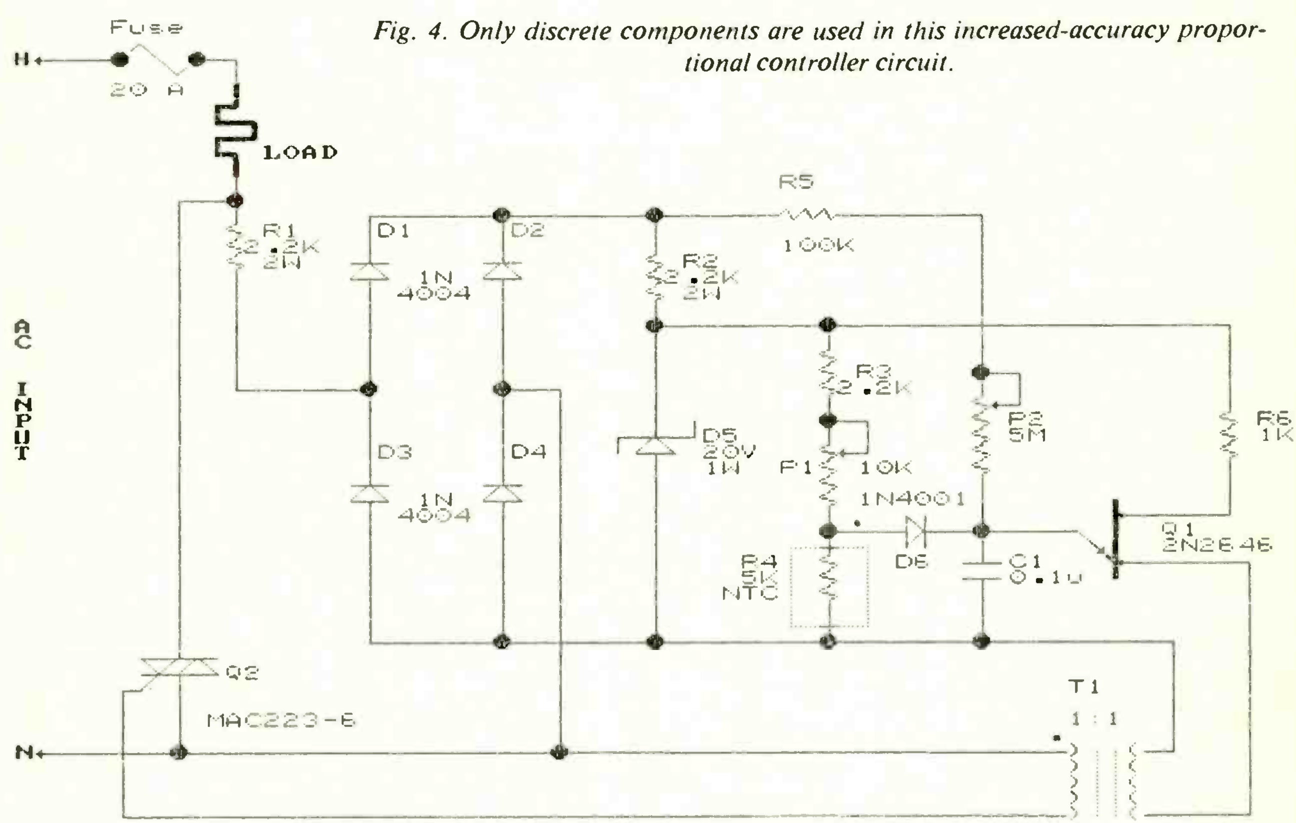
gate. The AND gate delivers a pulse to the triac driving circuit only if all its signals are enabled: that the temperature is lower than setpoint, inhibiting input pin 1 of the IC is open, the ac voltage waveform is near its zero-crossing point, and the thermistor has not failed (as sensed by the protection network).

The last attribute is extremely valuable in preventing an overheating condition in case of thermistor failure. Without it, an open device would appear to the circuit as a "low-temperature" condition, causing the system to generate continuous out-of-control heating, with probable harmful effects.

Take note that since the triac is supplied with only positive gating current, it must be selected with this parameter in mind. (Many triacs are triggered with negative gating current or with the gating current inphase with the supply voltage.) Available drive is typically 84 milliamperes, but the CA3059 has provisions to increase the current to about 124 milliamperes by shorting together pins 2 and 3. Also, the width of the output pulse can be lengthened by including *C2* in the circuit, which may be necessary if the triac fails to latch with light loads.

For the protection circuit to function properly, the ratio of the thermistor and potentiometer resistances should be greater than 0.33 and less than 3. Select a thermistor whose resistance is between 2,000 and 100,000 ohms at 25 degrees C (77 degrees F). If desired, protection can be disabled

Fig. 4. Only discrete components are used in this increased-accuracy proportional controller circuit.



PARTS LIST

Semiconductors
D1 thru D4—1N4004 rectifier diode
D5—20-volt, 1-watt zener diode
D6—1N4001 rectifier diode
Q1—2N2646 or equivalent unijunction transistor
Q2—MAC223-6 or similar 400-volt, 20-ampere triac

Capacitors
C1—0.1-μF, 200-volt Mylar

Resistors (½-watt, 10% tolerance)
R1,R2—2,200 ohms
R3—2,200 ohms
R5—100,000 ohms
R6—1,000 ohms
R4—5,000-ohm NTC thermistor
P1—10,000-ohm, linear-taper potentiometer
P2—5-megohm, linear-taper potentiometer

Miscellaneous
T1—1:1 pulse transformer (see text)

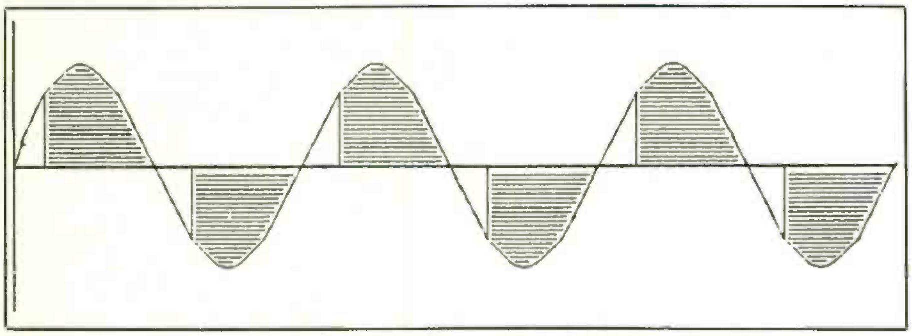


Fig. 5. Adding phase control allows the conventional proportional controller to behave like a lamp dimmer, chopping the sine wave of the power line to control power delivery.

by disconnecting pin 1 of the CA-3059 from the circuit.

Up to 4 kilowatts of power can be controlled with the specified triac at 220 volts, provided the triac is adequately heat sinked. Use sufficiently heavy gauge wire when wiring this circuit, and practice extreme caution working around ac line potentials. If a lower power level is needed, you can substitute a smaller (and less expensive) triac, but make sure that the one you select is rated to handle at least 20 percent more current than it will normally encounter in your particular application.

Proportional Controller

So far, we have discussed heat control in terms of simple on/off conditions, for replacement of a conventional electromechanical thermostat. The on/off controller has a major disadvantage in that, as shown in Fig. 2, it suffers from large temperature fluctuations above and below the setpoint. This effect is lessened if the power is gradually decreased to zero as temperature approaches the setpoint, instead of abruptly turning off upon crossing the setpoint temperature threshold. Likewise, the temperature is gradually increased from zero to full power as the temperature drops. This gives tighter temperature control.

The temperature range over which the proportional controller adjusts power from 0 to 100 percent is called the "proportional band." As shown in Fig. 3, temperature fluctuations are decreased and the heating slope is smoother.

A proportional controller circuit developed by General Electric employing discrete devices only is an elegant example of how a very simple circuit can be made to perform amazingly well. The circuit is shown schematically in Fig. 4. It operates as follows. The incoming ac voltage is current limited by *R1*, rectified by the diode bridge made up of *D1* through *D4* and clamped to 20 volts by zener diode *D5*.

Note in this circuit that there is no filter capacitor. Thus, the supply voltage drops to zero twice in each 60-Hz cycle, providing a means for resetting unijunction transistor *Q1* and synchronizing it to the line voltage frequency. The clamped voltage also feeds a voltage divider made up of resistor *R3*, potentiometer *P1* and thermistor *R4*.

Whenever the thermistor heats up, its resistance decreases and a lower voltage, delivered via *D6*, is fed to *C1*. A longer time is developed to trigger UJT *Q1*. Upon triggering, *Q1* turns on triac *Q2* via pulse transformer *T1*. A heat increase delays the conduction angle of the triac and, therefore, the system delivers lower average power.

An unclamped sinusoidal voltage is used to precharge *C1*, which is the key to the circuit's extraordinary gain. Precharging is through *P2* and *R5* so that the UJT's triggering voltage "ramps" faster. Potentiometer *P2* can be replaced with a fixed 3.3-megohm resistor.

You can easily make a pulse transformer yourself from readily available parts. All you need are a 2-inch length of ⅜-inch-diameter ferrite rod, which can be from an old AM ferrite loopstick antenna or other similar pressed ferrite material and some No. 28 enameled (so-called "magnet") wire. Using a bifilar technique, wind 120 turns of the wire onto the rod. ("Bifilar" means that the primary and secondary of the transformer are wound simultaneously.)

Liberally coat the transformer with contact cement to keep it from

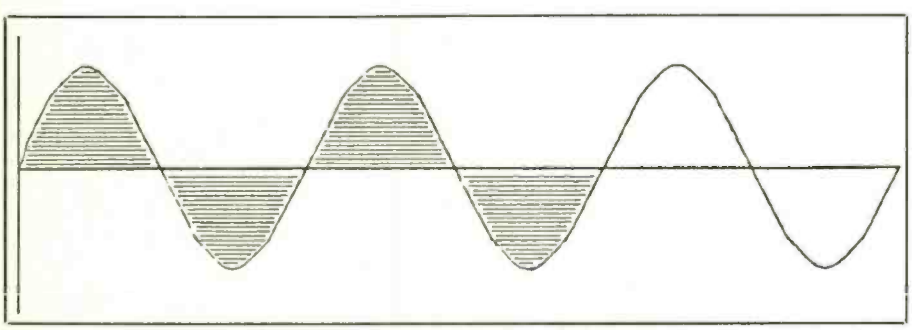


Fig. 6. In an improved proportional controller, full integral cycles are conducted. With this arrangement, power is controlled by the ratio of "on" cycles (shaded area) to "off" cycles.

unwinding. Identify the two starting wires with a dot of nail enamel or modeler's enamel paint. The dot corresponds to the dots shown near *T1* in Fig. 4. If you already have a commercial pulse transformer, so much the better.

With proportional controller circuits, an order of magnitude better heat control can be achieved than is possible with simple on/off controllers. The disadvantage of a phase control circuit, however, is that, like a lamp dimmer or the circuit just described, large amounts of r-f noise are normally generated. This noise can disturb communications and even disrupt the operation of some computers. It is a byproduct of the waveform chopping action, as illustrated in Fig. 5. R-f filters can be used to lower the level of noise, but when kilowatt loads are involved, the filter becomes too large and expensive to be practical.

Zero-Voltage-Switching Proportional Controller

Zero voltage switching, or ZVS, is a technique used to control the amount of power delivered to the load by conducting integral ac cycles within a timebase. By controlling the ratio of fully "on" cycles to fully "off" cycles, the amount of power can be adjusted, as shown in Fig. 6.

While phase control generates noise as a result of waveform chopping, ZVS conducts full cycles that are triggered at zero voltage, which results in negligible generation of rfi (radio-frequency interference). Therefore, this method of control is recommended for high-power loads and sensitive environments.

The sample waveform shown in Fig. 6 has a timebase of only three cycles. Best resolution available is in increments of 33 percent of rated power. Actual circuits have timebases of hundreds of cycles, with resolutions that can exceed 1 percent. For all practical purposes, this is considered to be continuous.

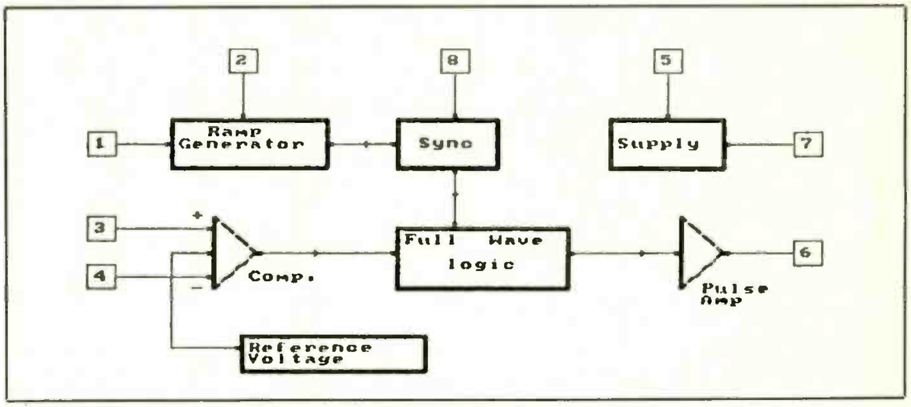


Fig. 7. Telefunken's U217B controller IC has many functions normally supplied by several ICs and discrete components.

Traditionally, ZVS circuits have been difficult to implement. Now, however, a new breed of integrated circuits from Telefunken offers a solution. These ICs have all the features of the CA3059 plus line-synchronized ramp generation, dc offset correction, an accurate reference voltage and much more. These chips represent a prime example of how semiconductor manufacturers can incorporate into a single IC complete functional blocks that heretofore required a board filled with discrete components and ICs.

Simplest of the Telefunken family of controller ICs, the U217B integral-cycle zero-voltage switch is powerful enough to handle almost any task put to it. A block diagram with pinouts of this integrated circuit is shown in Fig. 7.

In this IC, the ramp generator is the key to the proportional controller's characteristics. By superimposing a zero voltage on bias pin 3, the comparator modifies its pulse width as shown in Fig. 8. A high temperature condition is shown in (A), where the "on" periods are shorter than in a low-temperature condition, which is illustrated in (B).

Triac gating pulses are generated only if pin 3 is positive with respect to pin 4 of the IC. The ramp's period is long compared to the 60-Hz power

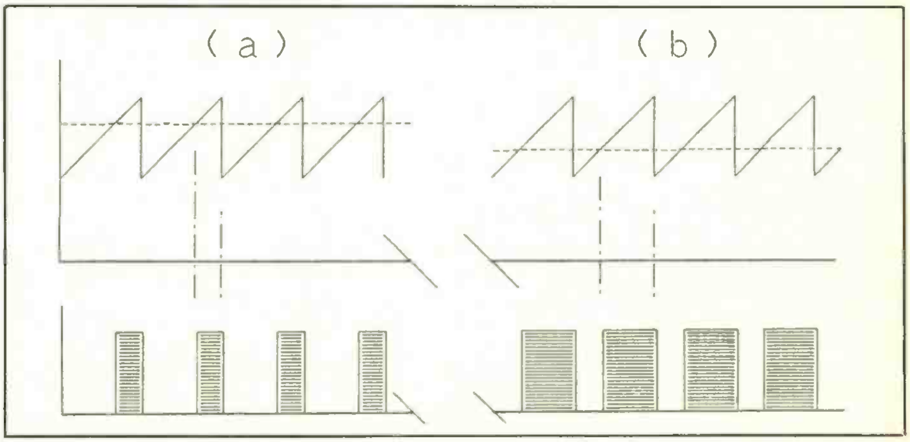
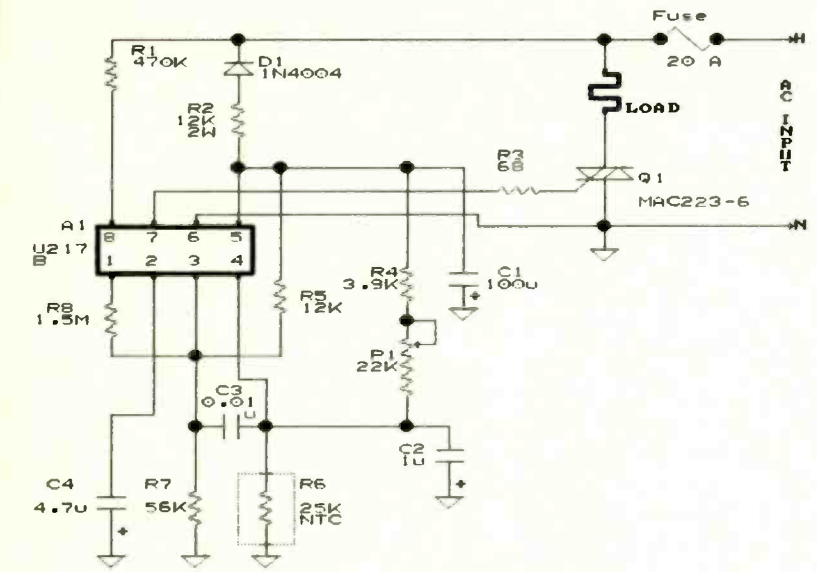


Fig. 8. In integral control generation with a U217B, the thermistor voltage at pin 4 (dashed lines) is compared with a dc-shifted ramp at pin 3. This modifies the power delivered to the load, as illustrated by the blocks at the bottom.



PARTS LIST

Semiconductors
A1—U217B zero-voltage proportional controller (Telefunken; see text)
D1—1N4004 rectifier diode
Q1—MAC223-6 or similar 400-volt, 20-ampere triac

Capacitors
C1—100-μF. 12-volt aluminum electrolytic
C2—10-μF, 25-volt aluminum electrolytic
C3—0.01-μF. 200-volt Mylar
C4—4.7-μF, 25-volt aluminum electrolytic

Resistors (½-watt, 10% tolerance)
R1—470,000 ohms
R3—68 ohms, ½ watt
R4—3,900 ohms, ½ watt
R5—12,000 ohms, ½ watt
R7—56,000 ohms, ½ watt
R8—1.5 megohms, ½ watt
R2—12,000 ohms, 2 watts
R6—25,000-ohm NTC thermistor

Fig. 9. This complete zero-voltage-switching system employs a positive ground.

line's period, with typical values ranging from 0.5 to 3 seconds. The period is adjusted with *C4* in the complete ZVS circuit shown in Fig. 9. You can see that very few components are needed in this basic circuit.

In the Fig. 9 circuit, *D1*, *C1* and *R2* provide the 9-volt regulated supply at pin 5 of integrated circuit *A1*, *R5* provides line synchronization and *C4* provides the timebase for the ramp generator and triac *Q1*. A few more components are needed for temperature sensing and setpoint adjustment. Hence, *R4*, *P1* and *R6* form a voltage-dividing network whose output voltage is modified by the temperature determined by the setting of *P1*.

The ramp is superimposed by *R8* on the bias furnished by *R5* and *R7* at the noninverting input to provide the proportional function. Though pin 1 of *A1* is current limited to about 100 milliamperes, power dissipation within the IC can be lowered by including *R3* in the circuit. Capacitor *C1* filters the rectified supply voltage, while capacitors *C2* and *C3* provide decoupling.

You may notice that this circuit operates with a positive ground, which allows negative gating pulses to be supplied to the triac, thus avoiding the need to select a special version of the latter. Values for *R1* and *R2* are for 220 volts ac. If you build a controller for a 117-volt system, simply halve the values of these resistors.

Parts Availability

Though most of the components specified in the circuits we have covered are commonly available, there are a couple you might have difficulty finding. A source for the 25,000- and 5,000-ohm NTC thermistors is Digi-Key Corp., P.O. Box 677, Thief River Falls, MN 56701. When ordering, specify Cat. No. KC007N-ND for the 25K thermistor or KC005N-ND for the 5K thermistor; both sell for $1.95 each.

You will not find the Telefunken chip specified in Fig. 9 in most traditional electronics parts outlets. For this item, you must find an AEG-Telefunken distributor in your area (check the telephone book) or purchase it directly from AEG-Telefunken Corp., Rte. 22, Orr Dr., P.O. Box 3800, Somerville, NJ 08876. ME

Computer-Aided Troubleshooting

Using a personal computer to assist in and speed up troubleshooting electronic circuits

By Robert G. Middleton

By using a personal computer and an appropriate applications program to assist you to troubleshoot electronic circuits, you can speed up the time you spend at your testbench.

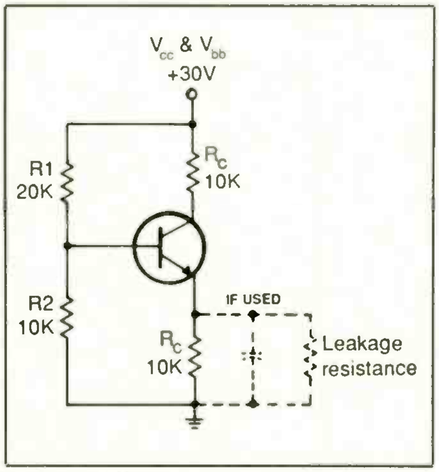
Why use computer-aided troubleshooting? Among the reasons are: Computer-aided troubleshooting, or CAT, tests circuits under normal operating conditions, based on information you feed into the computer when prompted for it. The program then calculates off-tolerance circuit characteristics and points a "finger" at any circuit parameter that is off-tolerance by a given percentage.

Given these quick clues, you can proceed to evaluate voltage measurements or scope displays with great efficiency. If you troubleshoot electronic equipment for a living, working with a CAT program/computer can enhance profitability. Besides, it is also the wave of the future.

A Practical Example

Consider a dc voltage network consisting of a widely used voltage bias configuration for a transistor stage, as shown in the schematic diagram. Key into your computer the BASIC program shown in this article and save it on-disk. Having done this, recall and RUN the program.

This program provides a means for analyzing optional emitter bypassing, with possible capacitor leakage. Observe that the resistive values, V_{cc} and V_{bb}, dc beta for the transistor, and a given tolerance percentage are keyed in as requested while the program is running.



The traditional common-emitter amplifier biasing arrangement, with emitter bypassing shown phantomed.

Once supplied with the requested data, the program will direct the computer to print out the normal emitter voltage that would be measured, then emitter voltages that would be measured with any given circuit parameter at the given high or low tolerance value. Depending upon the order of error magnitude, you might wish to select a higher or lower tolerance percentage and reRUN the program.

If the bias circuit includes an emitter bypass capacitor (shown in phantom in the schematic diagram), which is often the case, the latter portion of the program RUN prints out the emitter voltages that would be measured with various stepped values of capacitor leakage resistance. If the bias circuit does not include a bypass capacitor, you merely ignore this portion of the program RUN.

If you are familiar with Ohm's Law, the principles of circuit operation and computer programming, you can write programs for just about any troubleshooting situation you are likely to encounter. Properly written CAT programs will not only serve as an aid to a dc voltmeter, as is the case with the one given here, they can also serve as aids to oscilloscopes, signal generators and square-wave or pulse generators.

Just one word of caution. Not all personal computers have adequate processing capability to "crunch" various troubleshooting programs. An inadequate computer may RUN the program but provide incorrect results. In this instance, if you check back, you will find that the computer simply did not "remember" the originally assigned values of the variables.

Most personal computer models today do have adequate processing capability to easily handle the CAT program and other more extensive troubleshooting programs. The program listed here was written for the IBM PC (and compatibles), which is more than up to the task. ME

BASIC CAT Program for Common-Emitter Amplifier Biasing Networks

```
5 LPRINT "CE AMPLIFIER BIAS NETWORK; VOLTAGE-DIVIDER BASE RESISTORS, EMITTER RES
ISTOR, COLLECTOR RESISTOR":LPRINT:PRINT "CE AMPLIFIER BIAS NETWORK; VOLTAGE-DIVI
DER BASE RESISTORS, EMITTER RESISTOR, COLLECTOR RESISTOR":PRINT
10 LPRINT "3rd Echelon Troubleshooting Program No. 3C":LPRINT:PRINT "3rd Echelon
 Troubleshooting Program No. 3C":PRINT:A$="####.##":LPRINT "Computes Normal Emit
ter Voltage":LPRINT
15 PRINT "Computes Normal Emitter Voltage":PRINT:LPRINT "Computes Emitter Voltag
e for Individual Parameters Off-Tolerance by Given Percentage":LPRINT:PRINT "Com
putes Emitter Voltage for Individual Parameters Off-Tolerance by Given Percentag
e":PRINT
20 INPUT "Re (Ohms)=";REE
25 LPRINT "Re (Ohms)=";REE:INPUT"Rb1 (Ohms)=";RBO
30 LPRINT "Rb1 (Ohms)=";RBO:INPUT "Rb2 (Ohms)=";RBT
35 LPRINT "Rb2 (Ohms)=";RBT:INPUT "Rc (ohms)=";RC
40 LPRINT "Rc (Ohms)=";RC:INPUT "Vbb (Volts)=";VBB
45 LPRINT "Vbb (Volts)=";VBB:INPUT "Vcc (Volts)=";VCC
50 LPRINT "Vcc (Volts)=";VCC:INPUT "DC Beta=";B
55 LPRINT "DC Beta=";B:INPUT "Given % Tolerance=";T
60 LPRINT "Given % Tolerance=";T:LPRINT:PRINT:RE=REE
65 RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RE+RTH/B):VE=IE*RE
70 LPRINT:PRINT:LPRINT "** NORMAL EMITTER VOLTAGE **":LPRINT:PRINT "** NORMAL EM
ITTER VOLTAGE **":PRINT
75 LPRINT "Emitter Voltage=";USING A$;VE:LPRINT:PRINT "Emitter Voltage=";USING A
$;VE:PRINT
80 LPRINT "** EMITTER VOLTAGE WITH INDIVIDUAL PARAMETERS OFF-TOLERANCE BY GIVEN
PERCENTAGE **":LPRINT:PRINT "** EMITTER VOLTAGE WITH INDIVIDUAL PARAMETERS OFF-T
OLERANCE BY GIVEN PERCENTAGE **":PRINT
85 RE=RE+.01*T*RE
90 RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RE+RTH/B):VE=IE*RE
95 LPRINT "Emitter Voltage, Re High Tol,=";USING A$;VE:LPRINT:PRINT "Emitter Vol
tage, Re High Tol,=";USING A$;VE:PRINT
100 RE=RE/(1+.01*T):RE=RE-.01*T*RE
105 RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RE+RTH/B):VE=IE*RE
106 LPRINT "Emitter Voltage, Re Low Tol,=";USING A$;VE:LPRINT:PRINT "Emitter Vol
tage, Re Low Tol,=";USING A$;VE:PRINT
110 RE=RE/(1-.01*T):RBO=RBO+.01*T*RBO
115 RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RE+RTH/B):VE=IE*RE
120 LPRINT "Emitter Voltage, Rb1 High Tol,=";USING A$;VE:LPRINT:PRINT "Emitter V
oltage, Rb1 High Tol,=";USING A$;VE:PRINT
125 RBO=RBO/(1+.01*T):RBO=RBO-.01*T*RBO
130 RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RE+RTH/B):VE=IE*RE
135 LPRINT "Emitter Voltage, Rb1 Low Tol,=";USING A$;VE:LPRINT:PRINT "Emitter Vo
ltage, Rb1 Low Tol,=";USING A$;VE:PRINT
140 RBO=RBO/(1-.01*T):RBT=RBT+.01*T*RBT
145 RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RE+RTH/B):VE=IE*RE
150 LPRINT "Emitter Voltage, Rb2 High Tol,=";USING A$;VE:LPRINT:PRINT "Emitter V
oltage, Rb2 High Tol,=";USING A$;VE:PRINT
155 RBT=RBT/(1+.01*T):RBT=RBT-.01*T*RBT
160 RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RE+RTH/B):VE=IE*RE
165 LPRINT "Emitter Voltage, Rb2 Low Tol,=";USING A$;VE:PRINT "Emitter Voltage,
Rb2 Low Tol,=";USING A$;VE:PRINT
170 RBT=RBT/(1-.01*T):B=B+.01*T*B
175 RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RE+RTH/B):VE=IE*RE
180 LPRINT "Emitter Voltage, Beta High Tol,=";USING A$;VE:LPRINT:PRINT "Emitter
Voltage, Beta High Tol,=";USING A$;VE:PRINT
185 B=B/(1+.01*T):B=B-.01*T*B
190 RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RE+RTH/B):VE=IE*RE
195 LPRINT "Emitter Voltage, Beta Low Tol,=";USING A$;VE:LPRINT:PRINT "Emitter V
oltage, Beta Low Tol,=";USING A$;VE:PRINT
200 B=B/(1-.01*T):VBB=VBB+.01*T*VBB
205 RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RE+RTH/B):VE=IE*RE
210 LPRINT "Emitter Voltage, Vbb High Tol,=";USING A$;VE:LPRINT:PRINT "Emitter V
oltage, Vbb High Tol,=";USING A$;VE:PRINT
215 VBB=VBB/(1+.01*T):VBB=VBB-.01*T*VBB
220 RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RE+RTH/B):VE=IE*RE
225 LPRINT "Emitter Voltage, Vbb Low Tol,=";USING A$;VE:LPRINT:PRINT "Emitter Vo
ltage, Vbb Low Tol,=";USING A$;VE:PRINT
230 VBB=VBB/(1-.01*T)
235 LPRINT "* EMITTER VOLTAGE WITH EMITTER CAPACITOR LEAKAGE *":LPRINT:PRINT "*
EMITTER VOLTAGE WITH EMITTER CAPACITOR LEAKAGE *":PRINT
240 ER=.1*RE
245 RE=RE-ER:RX=RE*REE/(RE+REE):RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(
VTH-.7)/(RX+RTH/B):VE=IE*RX
250 LPRINT "Emitter Capacitor Leakage (Ohms)=";USING A$;RE:PRINT "Emitter Capaci
tor Leakage (Ohms)=";USING A$;RE
255 LPRINT "Emitter Voltage (Volts)=";USING A$;VE:PRINT "Emitter Voltage (Volts)
=";USING A$;VE:LPRINT:PRINT
260 IF RE>0 THEN 245
265 IF RE=0 THEN 267
267 LPRINT "* EMITTER VOLTAGES FOR 500, 100, AND 1 OHMS LEAKAGE RESISTANCE *":PR
INT "* EMITTER VOLTAGES FOR 500, 100, AND 1 OHMS LEAKAGE RESISTANCE *":LPRINT:PR
INT
270 RX=500*REE/(500+REE):RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)
/(RX+RTH/B):VE=IE*RX
275 LPRINT "Emitter Capacitor Leakage (Ohms)=";USING A$;500:PRINT"Emitter Capaci
tor Leakage (Ohms)=";USING A$;500
280 LPRINT "Emitter Voltage (Volts)=";USING A$;VE:PRINT "Emitter Voltage (Volts)
=";USING A$;VE:LPRINT:PRINT
285 RX=100*REE/(100+REE):RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)
/(RX+RTH/B):VE=IE*RX
290 LPRINT "Emitter Capacitor Leakage (Ohms)=";USING A$;100:PRINT"Emitter Capaci
tor Leakage (Ohms)=";USING A$;100
300 LPRINT "Emitter Voltage (Volts)=";USING A$;VE:PRINT "Emitter Voltage (Volts)
=";USING A$;VE:LPRINT:PRINT
305 RX=REE/(1+REE):RTH=RBO*RBT/(RBO+RBT):VTH=VBB*RBT/(RBO+RBT):IE=(VTH-.7)/(RX+R
TH/B):VE=IE*RX
310 LPRINT "Emitter Capacitor Leakage (Ohms)=";USING A$;1: PRINT "Emitter Capaci
tor Leakage (Ohms)=";USING A$;1
315 LPRINT "Emitter Voltage (Volts)=";USING A$;VE:PRINT "Emitter Voltage (Volts)
=";USING A$;VE:LPRINT:PRINT
320 END
```

Printout of a Sample Run of BASIC CAT Program

```
CE AMPLIFIER BIAS NETWORK;
VOLTAGE-DIVIDER BASE RESISTORS, EMITTER
RESISTOR, COLLECTOR RESISTOR

3rd Echelon Troubleshooting
Program No. 3C
Computes Normal Emitter Voltage

Computes Emitter Voltage for Individual
Parameters Off-Tolerance by Given Percen
tage

Re (Ohms)= 10000
Rb1 (Ohms)= 20000
Rb2 (Ohms)= 10000
Rc (Ohms)= 10000
Vbb (Volts)= 30
Vcc (Volts)= 30
DC Beta= 200
Given % Tolerance= 50


** NORMAL EMITTER VOLTAGE **

Emitter Voltage=    9.27

** EMITTER VOLTAGE WITH INDIVIDUAL
PARAMETERS OFF-TOLERANCE BY GIVEN
PERCENTAGE
**

Emitter Voltage, Re High Tol,=    9.28

Emitter Voltage, Re Low Tol,=    9.24

Emitter Voltage, Rb1 High Tol,=    6.77

Emitter Voltage, Rb1 Low Tol,=   14.26

Emitter Voltage, Rb2 High Tol,=   12.11

Emitter Voltage, Rb2 Low Tol,=    5.29
Emitter Voltage, Beta High Tol,=    9.28

Emitter Voltage, Beta Low Tol,=    9.24

Emitter Voltage, Vbb High Tol,=   14.25

Emitter Voltage, Vbb Low Tol,=    4.29

* EMITTER VOLTAGE WITH EMITTER CAPACITOR
LEAKAGE *

Emitter Capacitor Leakage (Ohms)=9000.00
Emitter Voltage (Volts)=    9.24

Emitter Capacitor Leakage (Ohms)=8000.00
Emitter Voltage (Volts)=    9.23

Emitter Capacitor Leakage (Ohms)=7000.00
Emitter Voltage (Volts)=    9.23

Emitter Capacitor Leakage (Ohms)=6000.00
Emitter Voltage (Volts)=    9.22

Emitter Capacitor Leakage (Ohms)=5000.00
Emitter Voltage (Volts)=    9.21

Emitter Capacitor Leakage (Ohms)=4000.00
Emitter Voltage (Volts)=    9.19

Emitter Capacitor Leakage (Ohms)=3000.00
Emitter Voltage (Volts)=    9.17

Emitter Capacitor Leakage (Ohms)=2000.00
Emitter Voltage (Volts)=    9.12

Emitter Capacitor Leakage (Ohms)=1000.00
Emitter Voltage (Volts)=    8.97

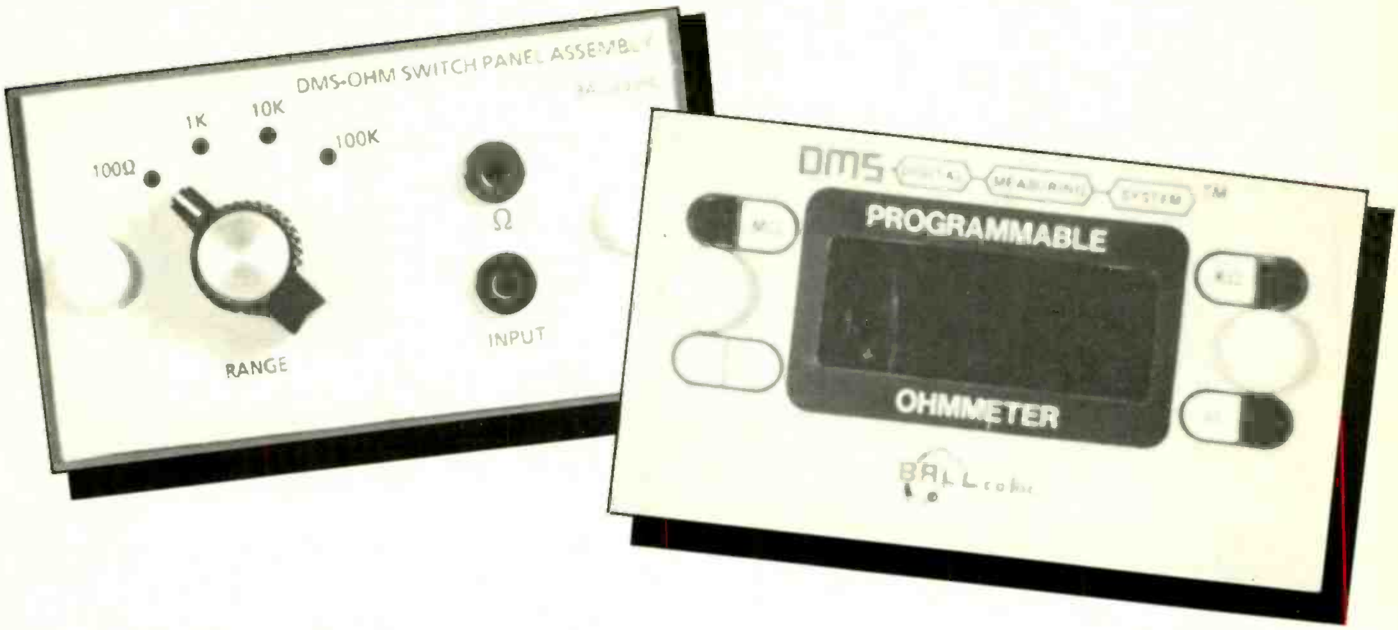
Emitter Capacitor Leakage (Ohms)=    0.00
Emitter Voltage (Volts)=    0.00

* EMITTER VOLTAGES FOR 500, 100,
AND 1 OHMS LEAKAGE RESISTANCE *

Emitter Capacitor Leakage (Ohms)=  500.00
Emitter Voltage (Volts)=    8.69

Emitter Capacitor Leakage (Ohms)=  100.00
Emitter Voltage (Volts)=    6.96

Emitter Capacitor Leakage (Ohms)=    1.00
Emitter Voltage (Volts)=    0.27
```



The Digi-Ohm Add-On Module

A low-cost add-on module that gives the Digital Measuring System display module a resistance-measuring capability

By C.R. Ball Jr.

Measuring resistance is a basic requirement in electronics. This ability lets you troubleshoot any unpowered circuit to determine if resistances meet specifications, quickly sort through a pile of unknown resistors to determine their values, match resistors pairs, etc. The Digi-Ohm module to be described provides this needed function for readers who built the "Digital Measuring System" digital display module featured in the August 1986 *Modern Electronics*.

Digi-Ohm is a locally or remotely programmable plug-on ohmmeter support module designed specifically to work with the previously presented DMS module. Connectors on the Digi-Ohm module mate directly with those on the DMS module to permit connection without wire runs. You can locally program a DIP switch for a desired dedicated range or use a socket, header, cable and rotary switch to add flexibility and versatility in mounting the project and selecting ranges. Digi-Ohm can also be made into a portable ac/dc-operated instrument by using the power-supply module featured in the August 1986 DMS article.

Digi-Ohm is capable of displaying five full-scale resistance ranges from 99.9 ohms to 999K ohms. Calibrated accuracy is better than 1.0 percent ±1 count. If a 10- or 12-volt source is used with the project to supply the current source around which the ohmmeter module is built and a precision current meter is used for calibration, greater accuracy can be achieved. You can build the Digi-Ohm module for less than $35.

About the Circuit

Digi-Ohm provides a selectable constant current from a fixed-voltage source. When passing through an unknown value of resistance (R_x), this known current produces a voltage that is proportional to the resistance. Consequently, the DMS equipped with Digi-Ohm does not display resistance but, rather, a voltage that represents the resistance. The value of the display, though, is read directly in ohms.

A basic constant-current source is shown in Fig. 1(A). In the past, constant-current sources have been complex and expensive devices in applications where a wide range of current was required. Fortunately, the LM134/234/334 series of three-terminal current sources, as illustrated by Fig. 1(B), reduces both the complexity and cost of building a constant-current device.

A drawback of the LM series of current sources is that their current is temperature-dependent (a feature that makes these devices good temperature sensors). To overcome variations with changing temperatures, thermally attached germanium diode *CR1* and compensating resistor R_T are inserted in the circuit, as shown in Fig. 1(C). The diode has a temperature coefficient that is opposite that of the LM current sources, which nulls out effects due to temperature variations.

Since the LM series of current sources are adjustable over a 10,000:1 range, these devices make ideal inexpensive current sources for the Digi-Ohm. Though all three devices in the LM series provide the same function, for best accuracy and stability, the LM134 is preferred.

The LM134-3's initial accuracy is 3 percent, while that of the LM134-6 is 6 percent. Trimmer potentiometers included for all ranges in the Digi-Ohm permit easy fine tuning during calibration so that initial accuracy is not a critical factor.

Ranges in this project are selected with either two on-board DIP switches or from a remote rotary switch on its own separate panel. One DIP switch is used to select Rset to determine the current range, the other to select the value of the temperature-compensating resistor.

As shown in the basic schematic diagram in Fig. 2, voltage regulator *U2* provides regulated +5 volts for current source *U1*. A +12- or +15-volt regulator could be used instead of the 7805 specified (with minor circuit-board modifications) to provide better linearity on the highest ranges. However, the tradeoff is likely to be temperature drift in the *U1* LM device on the lowest range as a result of increased dissipation.

Digi-Ohm is connected to the V+ and V− inputs of the DMS module as shown in Fig. 2. Since input impedance of the DMS module is greater than 80 megohms, if no resistor is connected between TP1-1 and TP1-4, the DMS module will display "EEE," indicating an overrange (infinite-resistance) condition.

Once a resistor is connected across TP1-1 and TP1-4, the current from the programmed constant-current source flows through it, producing a voltage across the unknown resistor that is proportional to the value of the resistor. This voltage is then displayed by the DMS module. Back-

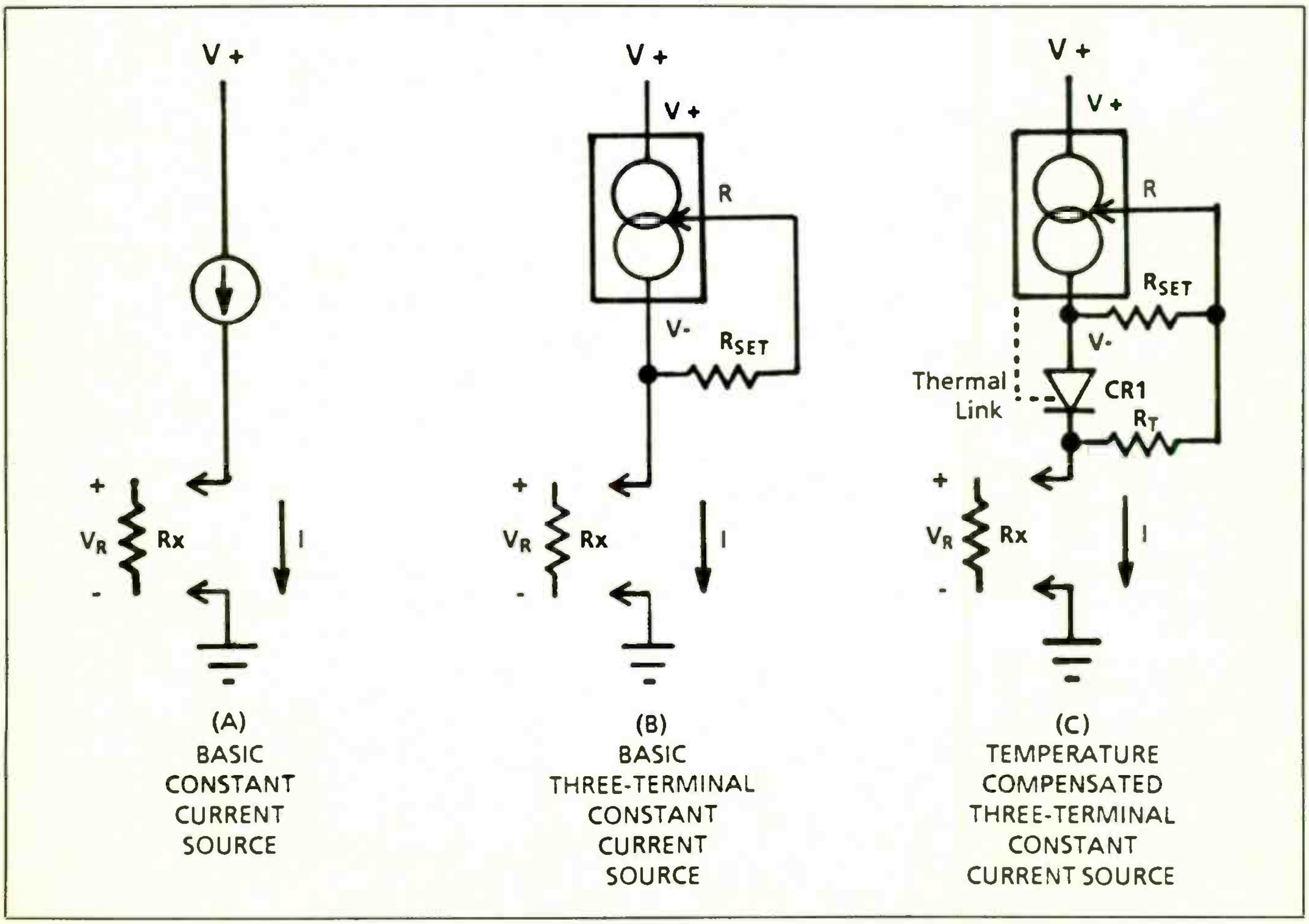
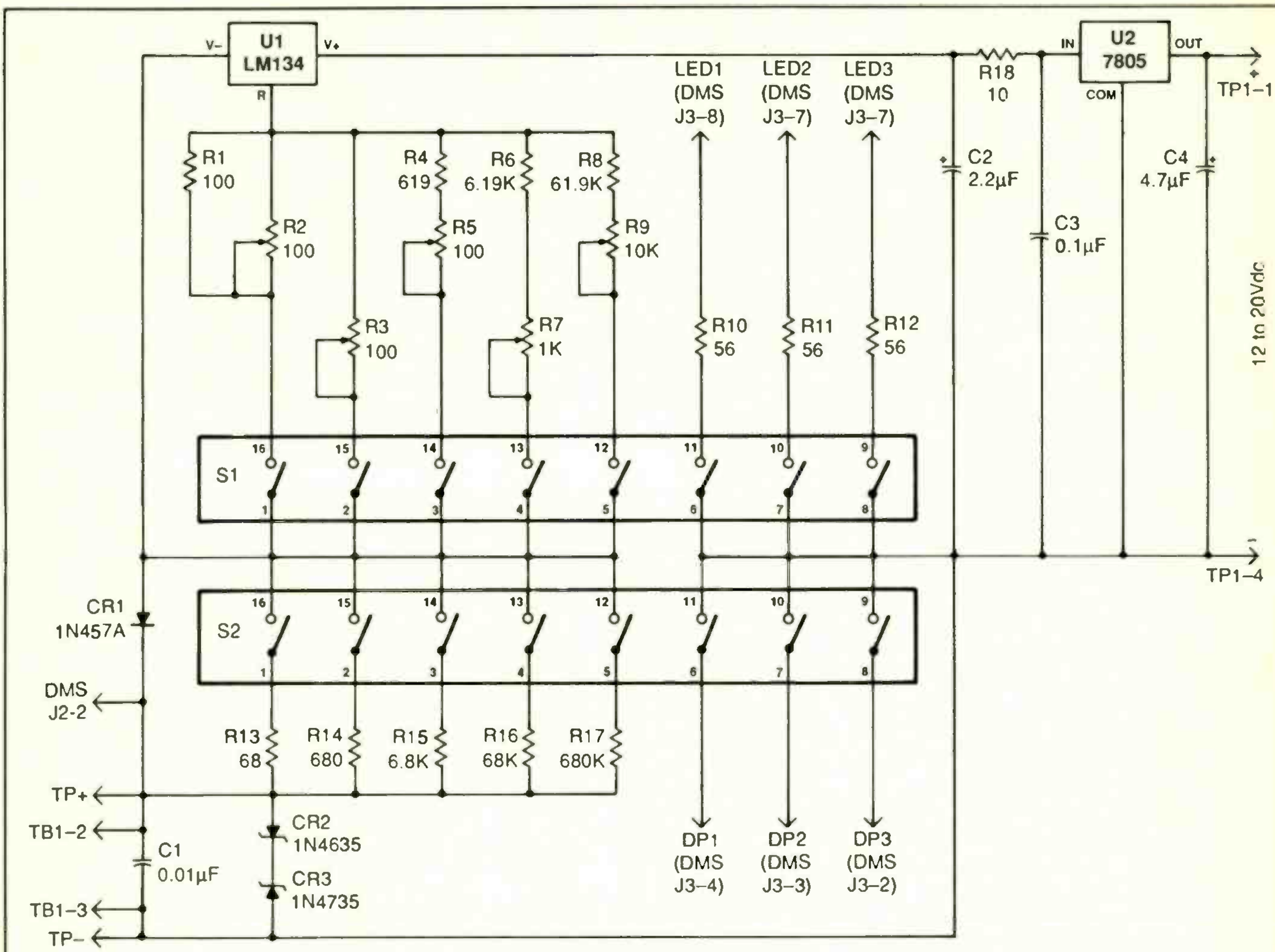


Fig. 1. Constant-current resistance-measuring circuits.



PARTS LIST

Semiconductors
CR1—1N457A diode
CR2,CR3—1N4735 zener diode
LED1,LED2—Red T-1¾ light-emitting diode
U1—LM134, LM234 or LM334 current source (see text)
U2—7805 fixed +5-volt regulator (optional; see text)

Capacitors
C1—0.01-µF, 100 volt ceramic disc
C2—2.2-µF, 16-volt tantalum
C3—0.1-µF. 25-volt ceramic
C4—220-µF. 25-volt electrolytic

Resistors
Metal-Film (¼-watt, 1% tolerance)
R1—100 ohms
R4—619 ohms
R6—6,190 ohms
R8—61,900 ohms
Carbon (¼-watt, 5% tolerance)
R10,R11,R12—56 ohms
R13—68 ohms
R14—680 ohms
R15—6,800 ohms
R16—68,000 ohms
R17—680,000 ohms
R18—10 ohms

Cermet Trimmer Potentiometers
R2,R3,R5—100 ohms
R7—1,000 ohms
R9—10,000 ohms

Miscellaneous
S1,S2—8-position DIP switch (see text)
S3—4-pole, 5-position nonshorting rotary switch (optional; see text)
Printed-circuit boards for Digi-Ohm and LED modules; DIP sockets for S1 and S2; AP Part No. 929834-04 36- or 40-pin male header strip; OK Part No. K180 4-pin terminal board; red and black banana or pin jacks or 5-way binding posts (see text); clear Lexan or Plexiglass for front panel(s), 1/32" thick; 16-pin header plugs optional; see text); pointer-type control knob for S3 (optional) suitable enclosure; ribbon cable; 6-32 machine hardware; solder; etc.

Note: The following items are available from BALLco, Inc., 148 S. Clayton St., Suite 131, Lawrenceville, GA 30245: Etched, drilled, plated and silk-screened Digi-Ohm pc board No. 860-810, $10.95 PPD; complete No. DMS-OHM kit of parts, including LM334, all headers, terminal boards, DIP switches and pc board but not including S3, cabinet, etc., $34.95 plus $2.50 P&H; LED pc board kit No. 651-032, including two pc boards, four LEDs and ribbon cable, $7.95 PPD; front-panel kit No. 651-001, including Lexan sheet, inlay and machine hardware, $8.85 PPD. Georgia residents, please add state sales tax.

Fig. 2. Schematic diagram of Digi-Ohm module.

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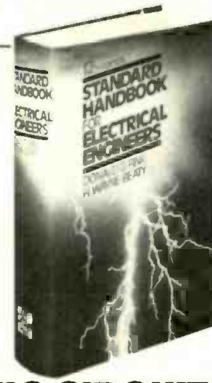

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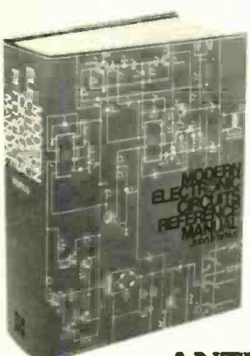

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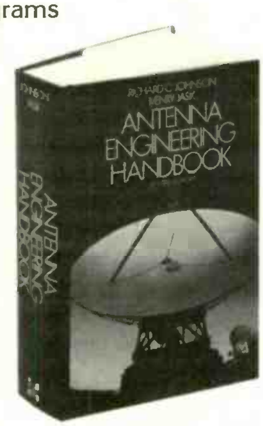

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Table 1. Ranges and Currents for Digi-Ohm Module		
RANGE	DISPLAY	CURRENT
1. 100Ω F.S.	0 - 99.9 Ohms	10 mA
2. 1KΩ F. S.	0 - 999 Ohms	1 mA
3. 10KΩ F. S.	0 - 9.99K Ohms	100 µA
4. 100KΩ F. S.	0 - 99.9K Ohms	10 µA
5. 1MΩ F. S.	0 - 999K Ohms	1 µA

to-back zener diodes *CR2* and *CR3* in Fig. 2 provide static and overvoltage protection for the A/D converter in the DMS module.

Full-scale indications that are possible with the Digi-Ohm/DMS combination are listed in Table 1, along with the display range and test current for each.

Shown in Fig. 3 is the schematic diagram of the optional remote range-select switch that can be used with Digi-Ohm.

Construction

Assembly of Digi-Ohm is essentially straightforward. However, as with the other modules in this series, printed-circuit wiring is a must, this time because the pc copper conductor pattern is required for temperature tracking between the temperature-compensating diode and current source. Hence, if you attempt to build this resistance module on perforated board, you may discover that the project does not operate as it should.

You can fabricate your own printed-circuit board for the project using the actual-size etching-and-drilling guide shown in Fig. 4(A). Alternatively, you can purchase a ready-to-wire, silk-screened board from the source given in the Note at the end of the Parts List. If you make your own boards, you can apply to the component sides self adhering clear plastic sheets on which the component locations are identified using the technique described in "Dress Up Your Projects" in the September 1985 issue of *Modern Electronics*.

When you are ready to wire your boards, refer to Fig. 4(B). Wire first the main board, starting with the sockets for *S1* and *S2*, assuming you have decided to use sockets for the DIP switches. Sockets are optional for the DIP switches, which can be soldered directly into place on he pc board. Including them in your project, however, will give you an opportunity to substitute the optional rotary-switch later if you desire. If you are building Digi-Ohm with the remote switching arrangement from the start, you must include the sockets to provide a means by which to interconnect it to the module.

Once the sockets are in place, install and solder into place the fixed resistors, capacitors and zener diodes but *not CR1*, as indicated. Take care to observe polarity for the polarized capacitors and diodes. For the fixed precision resistors, you *must* use metal-film types to ensure good temperature stability. Color-coded precision resistors have five color bands and are easy to confuse with some military-style carbon resistors that also have five bands. So exercise care when reading resistor value codes.

Install the trimmer potentiometers as shown. The pc pattern on the

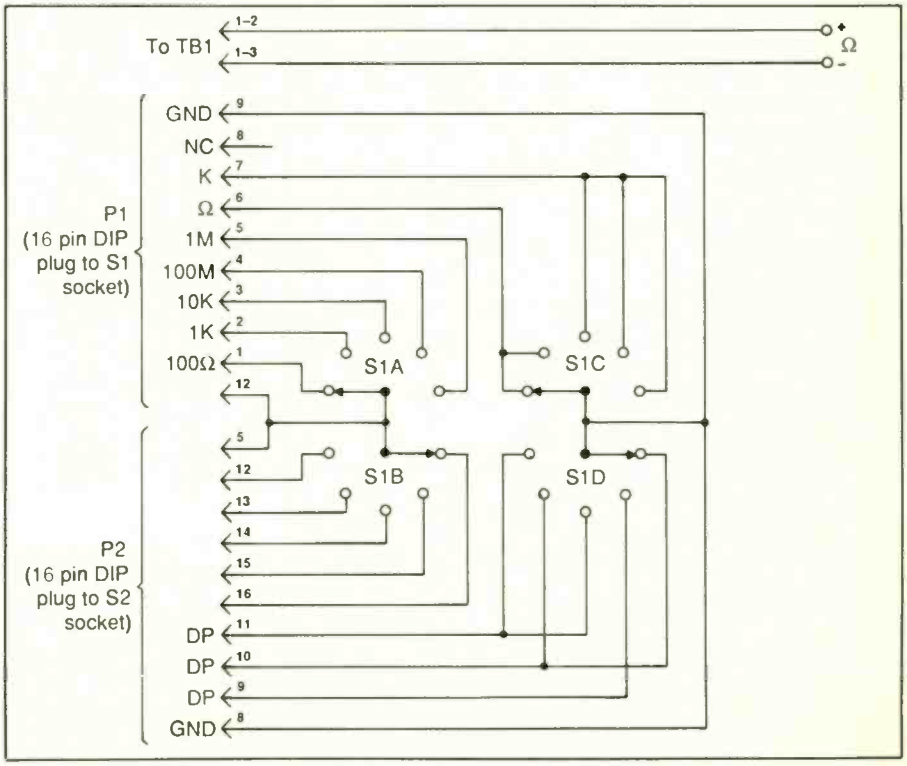


Fig. 3. Schematic/wiring diagram for optional range-selection switching arrangement.

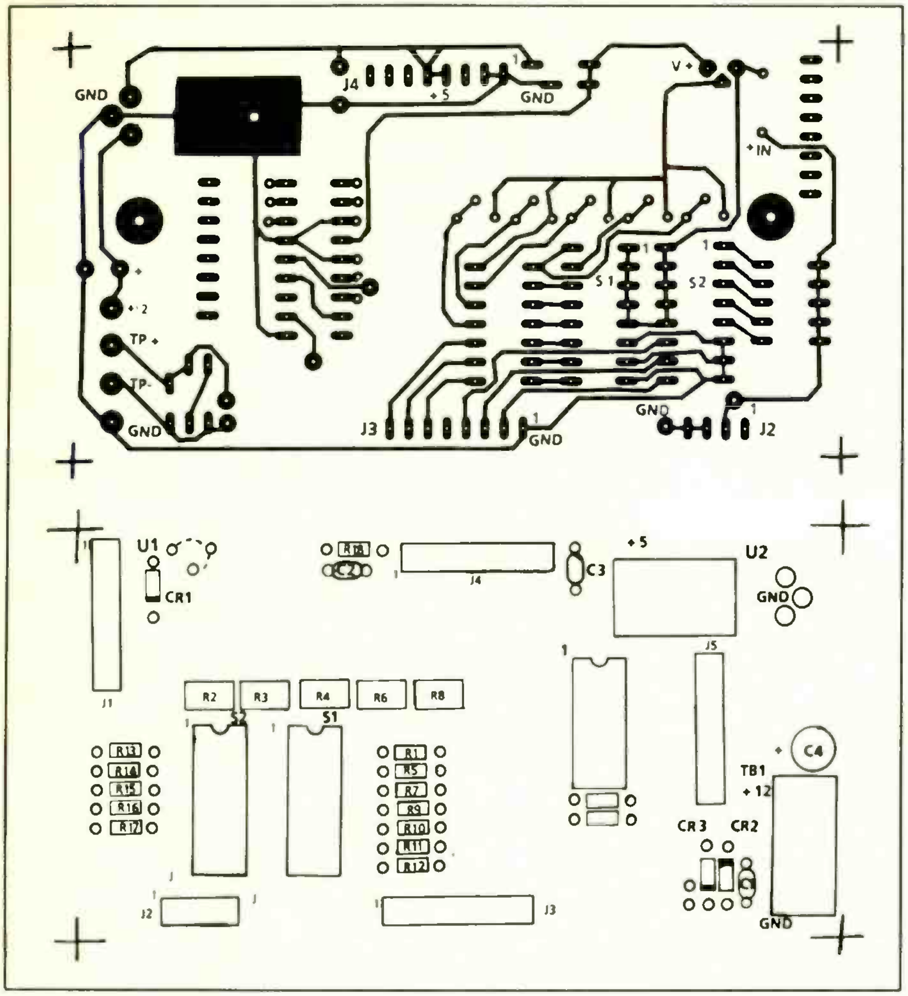


Fig. 4. Actual-size etching-and-drilling guide (A) and wiring diagram (B) for Digi-Ohm pc board.

board has been designed to accommodate either vertical- or horizontal-mount trimmers. Use only cermet or wire-wound trimmers, again to ensure temperature stability.

Next, cut the header strip into four strips of eight and one strip of four pins. From the *component* side of the main board, push the longer-pin end of the eight-pin headers through the board's holes at locations J1, J3, J4 and J5. Seat the headers so that their plastic separators sit solidly against the surface of the board. Do the same with the four-pin strip in the J2 location.

Plug the header pins into the mating header sockets on the DMS module to assure proper header alignment. Solder each pin to its associated copper pad on the Digi-Ohm board. Take care to avoid creating solder bridges between the pads on the bottom of the board.

After soldering all pins to the Digi-Ohm board, unplug the DMS module and set it aside. Then install and solder into place the four-contact terminal block at TB-1 on the Digi-Ohm board. Make sure that the holes in the terminal block face the edge of the board, as shown in Fig. 5(A).

Turn over the board and mount *CR1* in place, again making sure that it is properly oriented before soldering its leads to the copper pads. This diode must mount on the *foil* side of the board and must be in intimate contact with the copper pattern to ensure proper temperature tracking with *U1*. Hold the diode tight against the copper pattern as you solder each lead into place and until the liquid solder sets.

Install *U1* on the foil side of the board as follows. First position it so that its leads are as shown in Fig. 5(B). Then before soldering it into place, bend its leads so that the flat side of the device's case is against the foil pattern near *CR1*. Hold the diode tight against the board while soldering its leads to the copper pads and until the liquid solder has set. Later, after calibration has been performed, you will epoxy both *CR1* and *U1* to the board to ensure maximum temperature stability.

The circuit board has provisions for an on-board +5-volt regulator at U2. If you do not need this regulator, install a jumper wire in the two outside regulator holes to connect *TB1* to header *J4*.

Loosely twist together two 3¾-inch lengths of No. 24 hookup wire and strip ¼ inch of insulation from both ends of both wires. Plug one wire into the hole labeled J nearest the edge of the board to the left of *CR3* and solder into place. Plug the other end of this wire into the hole labeled J at pin 4 of *J2* and solder into place. If both wires have the same color insulation, use an ohmmeter or continuity tester to identify the other end of this wire. Then plug the ends of the other wire in the twisted pair into the remaining holes labeled J and solder into place.

As you approach final assembly, decide how you are going to use the Digi-Ohm—as a single, fixed-range device; as a DIP-switch selectable multiple-range device; or as a remotely selected multiple-range device. How you plan on using this project determines how to proceed with final assembly.

If you have decided to use Digi-Ohm as a single, fixed-range device, simply solder a jumper wire in the

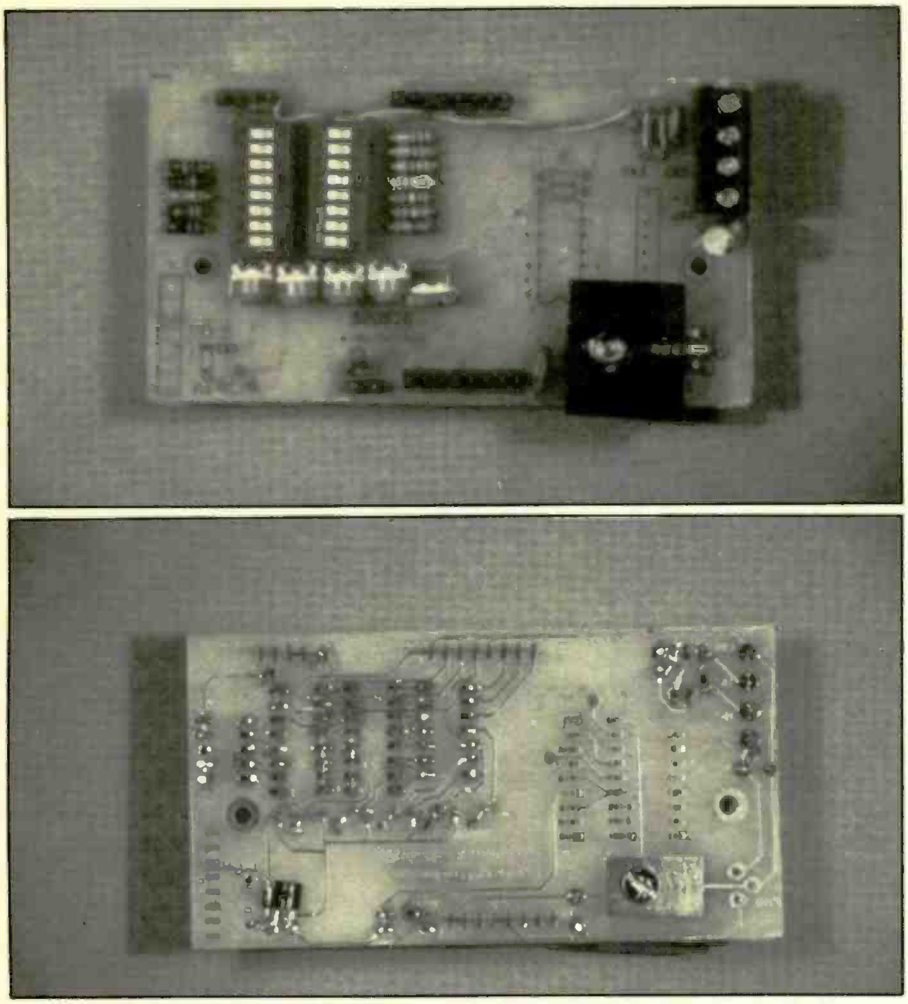


Fig. 5. Top view of wired Digi-ohm module (A) and bottom view (B) showing mounting details for CR1 and U1.

appropriate positions that correspond to the desired range where *S1* and *S2* would normally complete the circuit. To determine where to install this jumper for any given range, refer to Table 2.

Using the DIP-switch-selection option, simply plug into IC sockets a pair of eight-position DIP switches.

For remote selection, you must wire a four-pole, five-position nonshorting rotary switch to ribbon cable and plugs according to Fig. 3. Label the plugs S1 and S2 to avoid confusion when plugging them into the IC sockets on the circuit-board assembly.

Once the Digi-Ohm board has been fully wired, clean away all solder flux with a spray solvent. Bear in mind that solder flux is conductive, especially in high humidity, and can be the cause of parallel-resistance circuits that can result in measuring errors.

LED boards for the DMS are used to indicate range, function or other information not given in the numeric display and to provide enough space for mounting the front panel. Only one LED board is required for the Digi-Ohm module, to indicate range in ohms or kilohms). The other is used merely as a spacer. If you wish, you can eliminate this second board by replacing it with a ⅟₁₆-inch-thick washer.

Prepare two LED boards, using the actual-size etching-and-drilling guide shown in Fig. 6(A). When this is done, mount two light-emitting diodes on the LED board as shown in Fig. 6(B). Note that the leads of the LEDs plug into the holes from the *foil* side of the board(s). Plug the leads of the LEDs into the appropriate holes in the board. Bend the leads so that the bottoms of the plastic cases of the LEDs sit flush against the top of the board(s), with the leads wrapping around the edges of the board(s).

Separate the conductors at both ends of a 3-inch-long, three-conductor ribbon cable by about ½ inch. Strip ¼ inch of insulation from both ends of all three conductors. Tightly twist together the fine wires in each case and sparingly tin with solder. Then plug the conductors at one end of the cable into the holes labeled LED1, LED2 and COM on the LED board.

Connect and solder the wire from LED1 to pin 8 of *J3*, the wire from LED2 to pin 7 of *J3* and the wire from COM to pin 4 of *J4*. Leave the LED board dangling by the short cable until you finish calibrating Digi-Ohm.

Test & Calibration

To test and calibrate Digi-Ohm, you need a tested and calibrated DMS module. The DMS module should not have resistors installed in locations R_x and R_y. It should have a jumper wire installed in the R_z location and a 0.1-microfarad capacitor in the C_z location.

If you are using a +5-volt regulator for *U2*, before connecting Digi-Ohm to the DMS module, connect a 12- to 20-volt dc power supply to TB1-1 + and GND terminals and then check for 5 volts between pins 4 (+) and 1 (−) of J4. If you do not get a reading of 5 volts between these two points, recheck your wiring and replace *U2* if necessary.

If you are not using a regulator, or have finished the above check, plug

Table 2. DIP Switch Positions to Use for Different Ranges

SW1

Range / Position	99.9 ohms	999 ohms	9.99K ohms	99.9K ohms	999K ohms
1	ON	OFF	OFF	OFF	OFF
2	OFF	ON	OFF	OFF	OFF
3	OFF	OFF	ON	OFF	OFF
4	OFF	OFF	OFF	ON	OFF
5	OFF	OFF	OFF	OFF	ON
6	ON	ON	OFF	OFF	OFF
7	OFF	OFF	ON	ON	ON
8	OFF	OFF	OFF	OFF	OFF

SW2

Range / Position	99.9 ohms	999 ohms	9.99K ohms	99.9K ohms	999K ohms
1	ON	OFF	OFF	OFF	OFF
2	OFF	ON	OFF	OFF	OFF
3	OFF	OFF	ON	OFF	OFF
4	OFF	OFF	OFF	ON	OFF
5	OFF	OFF	OFF	OFF	ON
6	OFF	OFF	ON	OFF	OFF
7	ON	OFF	OFF	ON	OFF
8	OFF	ON	OFF	OFF	ON

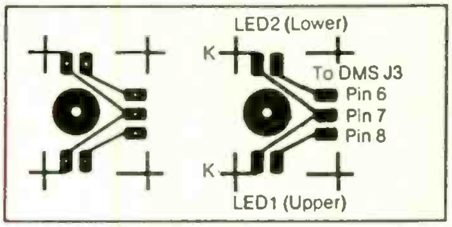


Fig. 6. Actual-size etching-and-drilling guide (A) and wiring diaram (B) for LED boards.

the Digi-Ohm module onto the rear of the DMS as shown in Fig. 7.

Connect test leads to *TB1* at TP+ and TP−. Connect an appropriate power source to TP+ and GND and turn on the power supply. At this point, your DMS module should be displaying "EEE," indicating an overrange (infinite-resistance) condition. Shorting TP+ to TP− should cause the displayed reading to drop to "000," indicating a 0-ohm (short-circuit) condition.

If you encounter any problems at this stage, *U1*, *CR1* or the headers are the probable cause.

There are two ways to calibrate the Digi-Ohm module. The first is to use several precision resistors of different values, one per range. The second, more accurate, method is to use a precision current meter.

If you use precision resistors for calibration, select resistors of known value in the middle of each range to be calibrated. If possible, the resistors should be 0.1-percent tolerance. For the second method, the current meter used should have a rated accuracy of 0.1 percent.

If you are using the DIP-switch method of range selection, refer to Table 2 and position *S1* and *S2* for the lowest range (99.9 ohms full-scale). If you are using the remote switch panel, connect the cables at *S1* and *S2* and set the selector switch to the 100-ohm range. When using the fixed-range arrangement, substitute the appropriate values (see Tables 1 and 2) for the specific fixed range you have selected.

For calibration with precision resistors, connect a 50-ohm test resistor between TP+ and TP− and adjust the setting of *R2* until the DMS displays "050." For calibration with a current meter, set the milliammeter to a range that will measure 10 mA. Adjust the setting of *R2* for a reading of 10.00 mA on the milliammeter. Repeat the procedure for each range, using the proper middle-of-the-range resistor (first method) or adjusting for the current indicated in Table 1. The appropriate decimal point and panel LED (Ω or KΩ) should light as each range is selected.

If you encounter any difficulties, check to see if the proper value of trimmer potentiometer has been installed for each range. If no current is present, check *U1*, *CR1* and the range-selection arrangement. Make any necessary repairs and then repeat the calibration procedure.

After calibrating all ranges, apply a small amount of fingernail enamel to the trimmer screws to prevent

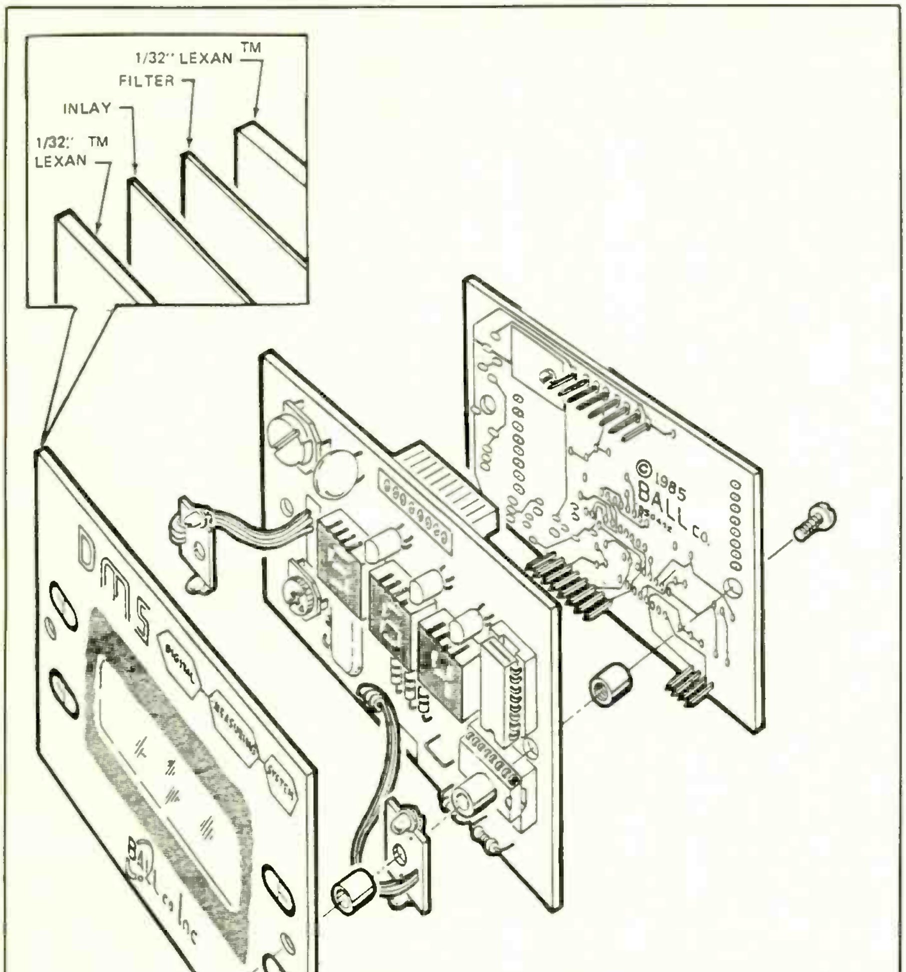


Fig. 7. Assembly details for putting together front panel, LED boards, DMS module and Digi-Ohm module. Detail at upper-left shows how front-panel assemly goes together.

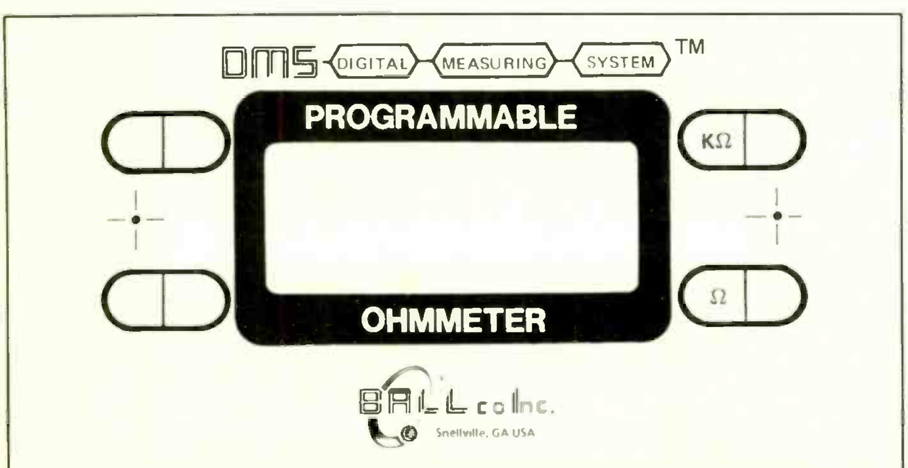


Fig. 8. Actual-size front-panel inlay artwork to use when Digi-Ohm module is attached to DMS module.

them from being accidentally rotated. Press *U1* and *CR1* together against the circuit board and secure them into place with a fast-set epoxy cement to ensure good thermal tracking between the two.

Final Assembly

Unplug the Digi-Ohm module from the DMS module. Prepare the front panel inlay (shown actual-size in Fig. 8) for the numeric display and LEDs. You can use the Fig. 8 artwork directly, backing it up with a sheet of matte black paper (to prevent the print on the opposite side of the page from "phantoming" through to the front) with appropriate cutouts for the display window area, LEDs and mounting hardware, or a same-size photocopy of it without the black paper backing. Sandwich the inlay and a red filter (red cellophane works well, or you can use piece of Rubylith, purchased from an art-supply store) between two thin, preferably $\frac{1}{32}$-inch, pieces of Lexan or Plexiglass, as shown in the detail at the upper-left in Fig. 7.

Feed two 6-32 × 1-inch machine screws through the front-panel assembly as shown and slide onto each a ¼-inch spacer. Follow with a LED circuit-board assembly (or $\frac{1}{16}$-inch-thick washer) on each screw end (the right screw *must* have a real LED board) and another ¼-inch spacer. Slide onto the screw ends the DMS circuit-board assembly and finish up with a threaded ¼-inch spacer on both screws. Make the spacers only finger tight. The ends of the screws should not protrude through the ends of the threaded spacers.

Plug the Digi-Ohm circuit-board assembly onto the rear of the DMS module and secure it in place with 6-32 × ¼-inch machine screws, driven into the open ends of the threaded spacers. Unless you have decided to use the remote range-select option, this completes assembly of the DMS with its ohmmeter function. The front-panel, LED-board, DMS-module and Digi-Ohm-module "sandwich" arrangement is illustrated in Fig. 9.

If you have decided to incorporate the remote range-select option into your project, you must assemble it in much the same way as you did the DMS, Digi-Ohm and front panel. Shown in Fig. 10 is the actual-size inlay to use for the switch panel. You can cut this out and cement it to a sheet of matte black paper or make an actual-size photocopy of it and use it directly without the black paper. Sandwich this between two thin layers of Lexan or Plexiglass, as you did for the instrument front panel. Then mount the rotary switch and input jacks in place.

Make the hex nut on the rotary switch only finger tight to start. Slide the pointer-type control knob onto the switch's shaft and, while holding the switch in place, rotate the knob fully counterclockwise and note if the pointer lines up with the 100Ω index on the panel. If it does not, remove the knob, loosen the hex nut and reposition the switch as needed. Then securely tighten the nut (do not make it so tight that it cracks the plastic of the panel) and replace the knob on the switch shaft. Now as you rotate the knob clockwise, its

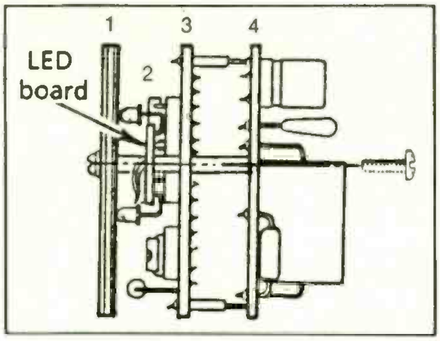


Fig. 9. Finished project consists of "sandwich" of front-panel assembly (1), LED boards (2), DMS module (3) and Digi-Ohm module (4).

pointer should stop at each panel legend index in turn.

Install a red and a black banana or pin jack or five-way binding post in the "+" and "−" INPUT jack holes, respectively, in the panel. The only thing left to do now is plug in the ribbon cables that connect the remote switch panel to the Digi-Ohm module into the appropriate *S1* and *S2* sockets.

If you wish, you can house the project in any small plastic project box that will accommodate it. If you built the remote switch option, this should be housed inside the same box, perhaps with the two modules' panels stacked one above the other or side by side. **ME**

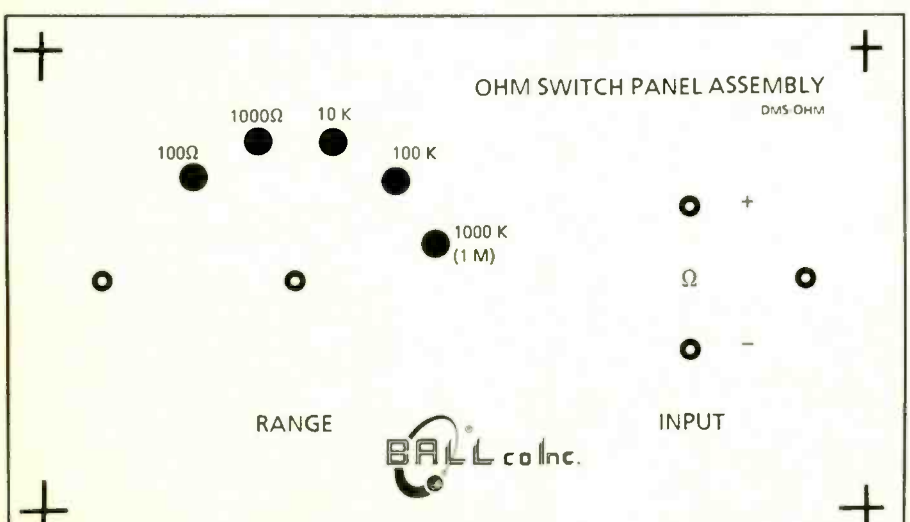
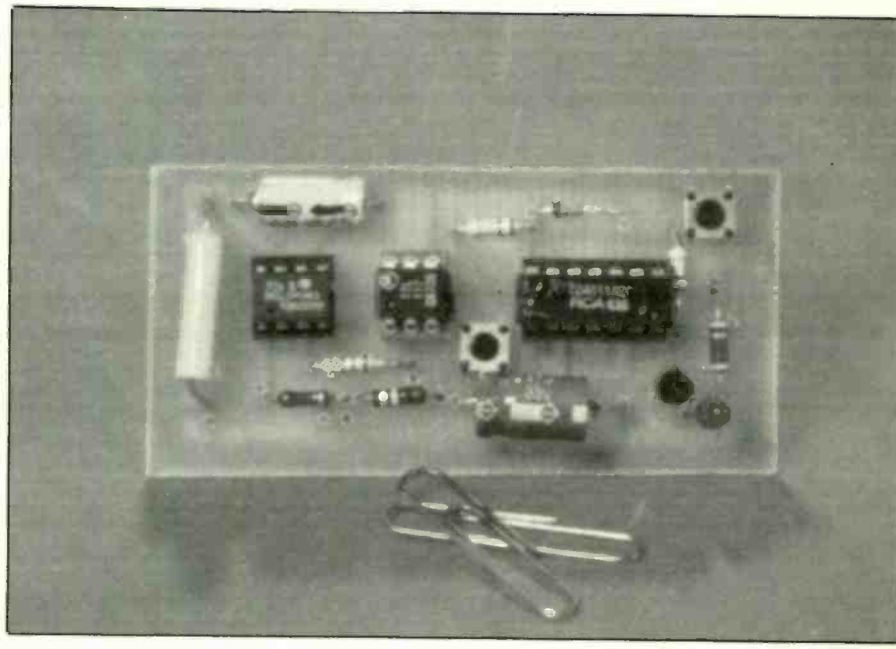


Fig. 10. Actual-size panel inlay artwork for optional remote range switch.

The Telephone Minder

This handy accessory tells you if someone tried to call you when you were not at home

By Anthony J. Caristi



Have you ever left your home and upon returning wondered if you missed a telephone call? If you have a telephone answering machine, your caller probably left a message that you can play back. Without it, all you can do is wonder.

Our Telephone Minder may be the answer to this dilemma. It monitors your telephone line for incoming calls and turns on a light-emitting diode when it detects a ring signal as someone tries to get through to you. You simply press a button to see if the LED is lit. If it is on, you know someone tried to reach you; if it is off, no one called while you were out.

Of course, the Telephone Minder has one major disadvantage: it may tell you that someone tried to contact you by phone, but you have to figure out who it was. On the plus side, since it never answers an incoming call, your caller will not be billed for a completed call, nor will you have the obligation to call back.

A very easy project to install in your telephone system, either inside an existing instrument or as a stand-alone device, the Telephone Minder gets its power from the telephone line itself. It does not interfere with normal telephone service, nor does it load down the telephone line. Its two-button operation makes it easy to use as well.

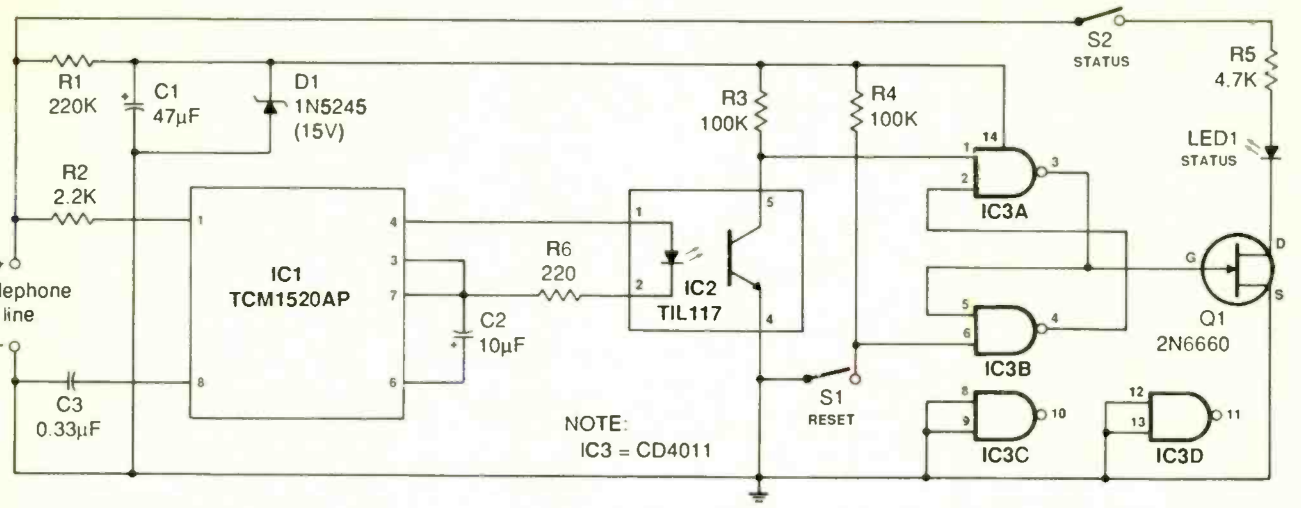
About the Circuit

As shown in Fig. 1, the Telephone Minder consists of three integrated circuits, each of which has a specific task to perform. Telephone ring detector *IC1* contains all the circuitry needed to detect the 20-Hz, 90-volt ring signal that appears across the telephone line to announce an incoming call. On-chip are a bridge rectifier, current sensor, 5-volt regulator and transient suppression circuitry to prevent damage and false operation in the event of a lightning strike or other transient voltage that might appear on the telephone line.

On standby, *IC1* presents a very high impedance across the telephone line. This obviates any interference with normal telephone operation of incoming and outgoing calls. When a ring signal appears across the telephone line, external capacitor *C2* stores the energy of the signal. This energy ultimately appears at output pin 5 as regulated 5 volts dc, which is used to turn on a light-emitting diode inside optical isolator *IC2*.

Also contained inside *IC2* is a photosensitive transistor "switch" that is turned on whenever light from the on-chip LED strikes it. During standby, this transistor is held in cutoff, with its collector potential held at 15 volts, as supplied by the telephone line and zener diode *D1*. When a call comes in, *LED1* lights and the collector potential of the transistor inside *IC2* (at pin 5) drops to zero. This transition to a logic-0 level is passed on to the pin 1 input of *IC3*.

Two of the four NAND gates inside *IC3* are wired in a flip-flop configuration and operate in a mono-



PARTS LIST

Semiconductors
D1—1N5245 or similar 15-volt zener diode
C1—TCM1520AP ring detector (Texas Instruments)
IC2—TIL117 optical isolator (Texas Instruments)
IC3—CD4011BE quad 2-input NAND gate
LED1—Red T-1¾ light-emitting diode (2 volts at 20 mA)
Q1—2N6660 or equivalent 60-volt breakdown enhancement-mode n-channel field-effect transistor (see text)

Capacitors
C1—47-μF, 25-volt electrolytic
C2—10-μF, 35-volt electrolytic
C3—0.33-μF, 250-volt Mylar or paper

Resistors (¼-watt, 10% tolerance)
R1—220,000 ohms
R2—2,200 ohms
R3,R4—100,000 ohms
R5—4,700 ohms
R6—220 ohms

Miscellaneous
S1,S2—Spst momentary-action push-button switch (preferably calculator-key type)
Printed-circuit board or perforated board with holes on 0.1-inch centers and suitable soldering or Wire Wrap hardware; DIP sockets for ICs (see text regarding IC2 socket); suitable enclosure for stand-alone unit (see text); telephone cable with modular connector at one end (see text); small-diameter heat-shrinkable tubing; at least ¼-inch thick double-sided foam tape; hookup wire; solder; etc.

Note: The following items are available from A. Caristi, 69 White Pond Rd., Waldwick, NJ 07463: Printed-circuit board, $9.95; TCM1520AP ring detector IC, $5.75; TIL117 optical isolator, $2.75; CD4011BE NAND gate IC, $1.95; 0.33-μF, 250-volt Mylar or paper capacitor, $1.00. Add $1.00 P&H per order. New Jersey residents, please add state sales tax.

Fig. 1. Complete schematic diagram of Telephone Minder. Circuit gets its power directly from telephone line with minimal loading.

stable mode. That is, the flip-flop has two stable states. Each state depends on the logic level fed to the circuit's input terminals at pins 1 and 6. When the flip-flop circuit is first energized, you set the logic state to 0 by pressing RESET switch *S1*. Grounding the pin 6 input of *IC3* by closing *S1* pulls the output of the flip-flop to logic 0, placing the circuit in the standby mode. The circuit will remain in this state until it is toggled by a 0-logic level felt at pin 1 of *IC3* from the preceding circuitry.

The ring signal detected by *IC1* and the resulting current through the transistor inside *IC2* provide the required logic-0 signal level to cause the flip-flop to assume its opposite state (logic 1 at the pin 3 output of *IC3*). When the flip-flop's output pulse does toggle to logic 1, it remains at this level (about 15 volts) until it is manually reset to logic 0 by closing *S1*. This being the case, *IC3* "remembers" if a call has been received.

No conduction occurs between the drain (D) and source (S) of n-channel enhancement-mode field-effect transistor *Q1* unless a positive bias is applied to the gate G terminal. Unless a call (ring signal) has been detected, *Q1* remains in cutoff and *LED1* remains off when STATUS switch *S2* is pressed.

If a call was detected in your absence, the resulting positive output at pin 3 of *IC3* sends *Q1* into conduction when *S2* is pressed. Since conduction is through *LED1*, the light-emitting diode will turn on to indicate that there was a call.

Since power for the circuit is derived from the telephone line, current drain is kept at an absolute minimum (about 0.15 milliamperes, or 150 microamperes). When the Telephone Minder is installed you must press *S2* to see if *LED1* is off or on. If the LED is off, no one attempted to call you; if it is on, someone did attempt to call. In the former condition, *LED1* and *Q1* would be off.

If someone had attempted to call you, *Q1* would conduct and *LED1* would be on, placing at least 20 milliamperes more load on the telephone line constantly if limiting resistor *R5* had been wired directly to the + side of the telephone line and *S2* had been eliminated. With the circuit wired as shown, the current drain when *Q1* is conducting and *LED1* is on would be for a very brief period of time, just long enough for you to see the status of the circuit.

If the telephone line had been tripped, indicated by *LED1* being on when you press *S2*, you would know that someone had attempted to call you. To restore the circuit to its standby mode, you simply press and release *S1*.

Bear in mind that the Telephone Minder does *not* answer an incoming call. It simply detects when a ring signal that announces an attempt to reach your number has come over the line. Since it does not initiate an off-hook condition, which signals the telephone company that the caller has completed the connection, the caller will not be charged for a call.

Construction

As you can see in Fig. 1, this project's circuit is very simple. You can assemble the circuit on a small printed-circuit board. Since there is nothing critical about circuit layout and wire routing, you also have the option of using a small perforated board with holes on 0.1-inch centers and soldering or Wire Wrap hardware. Whichever technique you choose, be sure to use sockets for the ICs.

If you plan on fabricating your own printed-circuit board, use the actual-size etching-and-drilling guide shown in Fig. 2. Alternatively, if you wish pc wiring but do not care to etch and drill your own board, you can purchase a ready-to-wire board from the source given in the Note at the end of the Parts List.

Wire the board exactly as shown in Fig. 3. (Use this illustration as a rough guide to component layout on perforated board if you do not use a printed-circuit board.) Start by installing and soldering into place the three DIP IC sockets. You may have difficulty finding a six-pin DIP socket to use for *IC2*. If you do, use either Molex Soldercon® socket connectors, three to each socket side, leaving vacant the left-most *IC2* holes in the upper and lower rows (with the board viewed as shown in Fig. 3), or install an eight-pin socket in this location. Do *not* install the ICs themselves at this time.

Next, install the resistors, zener diode, capacitors and transistor. Make sure *C1*, *C2* and *D1* are properly oriented and that *Q1* is properly based before soldering their leads to the copper pads on the bottom of the board.

It is very important that you use the proper type of transistor for *Q1*. This *must* be an n-channel *enhancement-mode* field-effect transistor. Ordinary FETs are depletion-mode types that will not work with this circuit. If you substitute a transistor with a different part number from that specified in the Parts List, be sure to use a FET that is electrically equivalent to it.

At this point, you can exercise either of two options, depending on the type of telephone instrument with which you plan to use the Telephone Minder. You can build the project into an existing telephone instrument, assuming it has sufficient room inside it to accommodate the circuit-board assembly and has enough panel space on which to mount the switches and light-emitting diode. Alternatively, you can build the project as a stand-alone unit. For the latter, which requires its own separate enclosure, proceed as follows.

Prepare six 4-inch lengths of

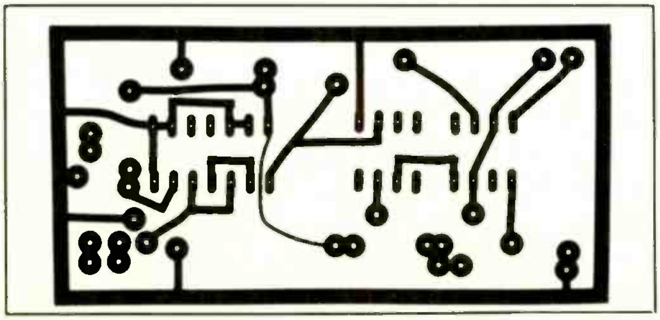


Fig. 2. This is the actual-size etching-and-drilling guide to use for home fabricating your own printed-circuit board.

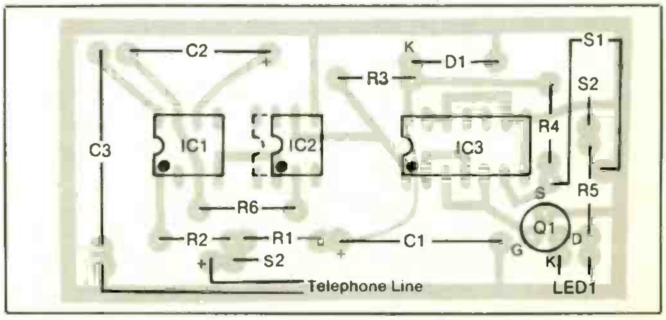


Fig. 3. Wiring guide for pc board and rough component-placement guide when using perforated board.

hookup wire by removing ½ inch of insulation from both ends. If possible, use a wire with a different color of insulation from the other five for the connection to the cathode pad for *LED1* on the board. Plug one end of the wire that has a different color of insulation into the LED1 hole identified with a K and solder it into place. Then plug one end of each of the other wires into the S1, S2 and remaining LED1 holes. When you are finished, there should be only two holes in the circuit board that are not occupied, identified as TELEPHONE LINE + and −.

Prepare a suitably sized plastic box by drilling the holes in which to mount the light-emitting diode and switches and to provide entry for the cable that will connect the project to the telephone line. Mount the switches in their respective holes. Slip a 1-inch length of small-diameter heat-shrinkable tubing over the ends of the LED1 wires on the board. Trim the LED's cathode lead to ½ inch long and solder it to the cathode wire (with different-color insulation). Do the same for the other wire and the anode lead. Then push the heat-shrinkable tubing up over the connections until both are resting against the bottom of the LED's case and shrink into place.

To connect the Telephone Minder to the telephone line, you need an appropriate length of cable terminated at one end in a standard plug. (Note that FCC Regulations require this arrangement so that the device can be quickly disconnected from the telephone line.) The length of cable needed will depend on where the project will be located with respect to the wall jack. If you purchase a telephone cable that is terminated on both ends in a plug, cut off and discard one plug. Trim off 1 inch of outer plastic jacket from this end of the cable.

Since you need only the red and green cable conductors, you can clip off the yellow and black ones. Then strip ¼ inch of insulation from the red and green conductors. Tightly twist together the fine wires in each conductor and sparingly tin with solder. Pass the free end of the cable through the entry hole into the box in which the project will be housed. Tie a knot about 4 inches from the end inside the box to serve as a strain relief for the cable.

If you prefer, you can use a chassis-mount telephone jack instead of having to hard-wire the telephone cord directly to the circuit-board assembly. In this case, connect and solder appropriately color-coded hookup wire between the jack and board and use a cord terminated at both ends in quick-disconnect plugs.

Before attempting to solder the telephone cable's conductors to the circuit-board assembly, you must determine the polarity of your telephone line. To do this, connect the "hot" probe of a voltmeter to the red conductor and the meter's common probe to the green wire. Set the meter to indicate at least 20 volts dc. Before turning on your meter, make sure that neither conductor or probe touches each other.

If there is only one jack available at the wall box, temporarily unplug the telephone instrument plugged into it and use it for this test. If there is only one telephone instrument and one wall jack in your installation, you will need a one-to-two jack adapter to accommodate both instrument and Telephone Minder for final installation.

If you obtain a positive (+) reading on your meter during checkout, tag the red cable conductor with a + label. On the other hand, if the reading is a negative voltage, tag the *green* conductor with a + label. Unplug the cable from the wall jack and disconnect the meter.

Plug the + labeled conductor into the board labeled TELEPHONE LINE + and solder it into place. Similarly, plug the unlabeled conductor into the − hole in the board and solder it into place. Referring to Figs. 1 and 3, connect and solder the free ends of the remaining wires to the lugs on the switches. Turn over the board and clip all leads as close as possible to the board.

Cut one or more pieces of double-sided *foam* tape that is at least ⅛ inch thick to a length of 3 inches. If the tape is less than 1 inch wide, cut two strips and trim them so that their combined width does not exceed 1½ inches. Lift off the protective paper backing from only one side of the tape and press the tape firmly into place in the plastic box in the exact location where the circuit-board assembly is to be mounted. Do *not* remove the protective paper from the other side of the tape until after you have performed initial checkout and have installed the ICs in their respective sockets.

Building the Telephone Minder into an existing telephone instrument simplifies matters a bit, since the housing for the project it the telephone instrument itself. Just make sure that there is sufficient room inside the telephone instrument's housing to accommodate the project and that sufficient panel space is available for mounting the LED and switches. Use the same double-sided foam tape arrangement described above for mounting the circuit-board assembly inside the telephone instrument in a location where it will not interfere with operation of the telephone instrument or touch any of its circuitry.

Checkout

Before attempting to operate the Telephone Minder, and before installing the ICs in their sockets, make a preliminary check of the power supply as follows. Plug the modular connector on the project into a telephone line receptacle and measure the potential across *C1* with a voltmeter that has at least a 1-megohm input resistance. Set the meter to

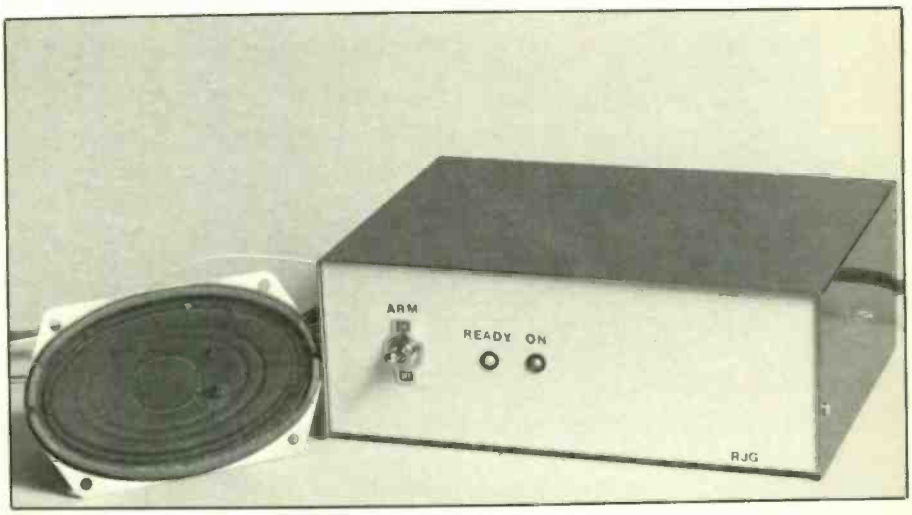
(Continued on page 98)

A Vocal Warning Burglar/Car-Theft Alarm

When tripped, this alarm vocalizes a warning message to intruders and thieves and then sounds a piercing attention-getting buzzer

By Ricardo Jiminez

Most stand-alone intruder alarms simply sound a beeper, bell, siren or other attention-getting device a certain number of seconds after they have been tripped. Anti-theft vehicle alarms do basically the same. The vocal warning alarm to be described takes advantage of modern electronic speech-synthesizer electronics to warn the trespasser of his intrusion. It does so with a message vocalized in a human-sounding voice.



In its most basic form, the vocal warning alarm is nothing more than a common hard-wired perimeter alarm system, though it can be used to work with wireless and radio modules that either open or close a pair of contacts. Its appeal is in the vocalizing package that sets the alarm apart from others of its type.

You can build this alarm at only moderate cost, from readily available components, using traditional wiring techniques. You program the message you want your alarm to vocalize by programming the appropriate data into an erasable programmable read-only memory (EPROM). The EPROM's data then "tells" a speech synthesizer chip what message to vocalize.

The speech synthesizer chip used in this project generates phonemes. Hence, you can program an unlimited vocabulary, since it is not simply word based. With a little ingenuity and the instructions provided with the speech- synthesizer chip, you can program into your alarm any message you like.

About the Circuit

The complete schematic diagram (minus a few voltage-stabilizing and bypass capacitors that are listed in the Parts List) of the vocal warning alarm is shown schematically here in two parts. Figure 1 shows the basic timing and logic/synthesizer sections, while Fig. 2 shows the audio amplification stage and the power supply for the complete project. This arrangement makes it possible for the alarm to vocalize two different messages, each depending on the condition of the alarm.

Action begins when *S1* in Fig. 2 is set to the ARM, or closed, position. Closing this switch turns on dc power to all circuits and causes POWER light-emitting diode *LED1* to turn on.

Once power has been applied to the circuit, capacitor *C1* in Fig. 1 begins to charge exponentially at a rate determined by the formula $T_1 = 0.41R2C1$. From this formula, it would take approximately 30 seconds to reach a threshold level of 6.2 volts with the component values specified. When the threshold level is reached, the output at pin 4 of *IC1* goes high and enables the resets at pin 4 of timers *IC2* and *IC3*. Consequently, you have approximately 30 seconds to vacate your premises or vehicle before the alarm sounds.

When the alarm is armed and in

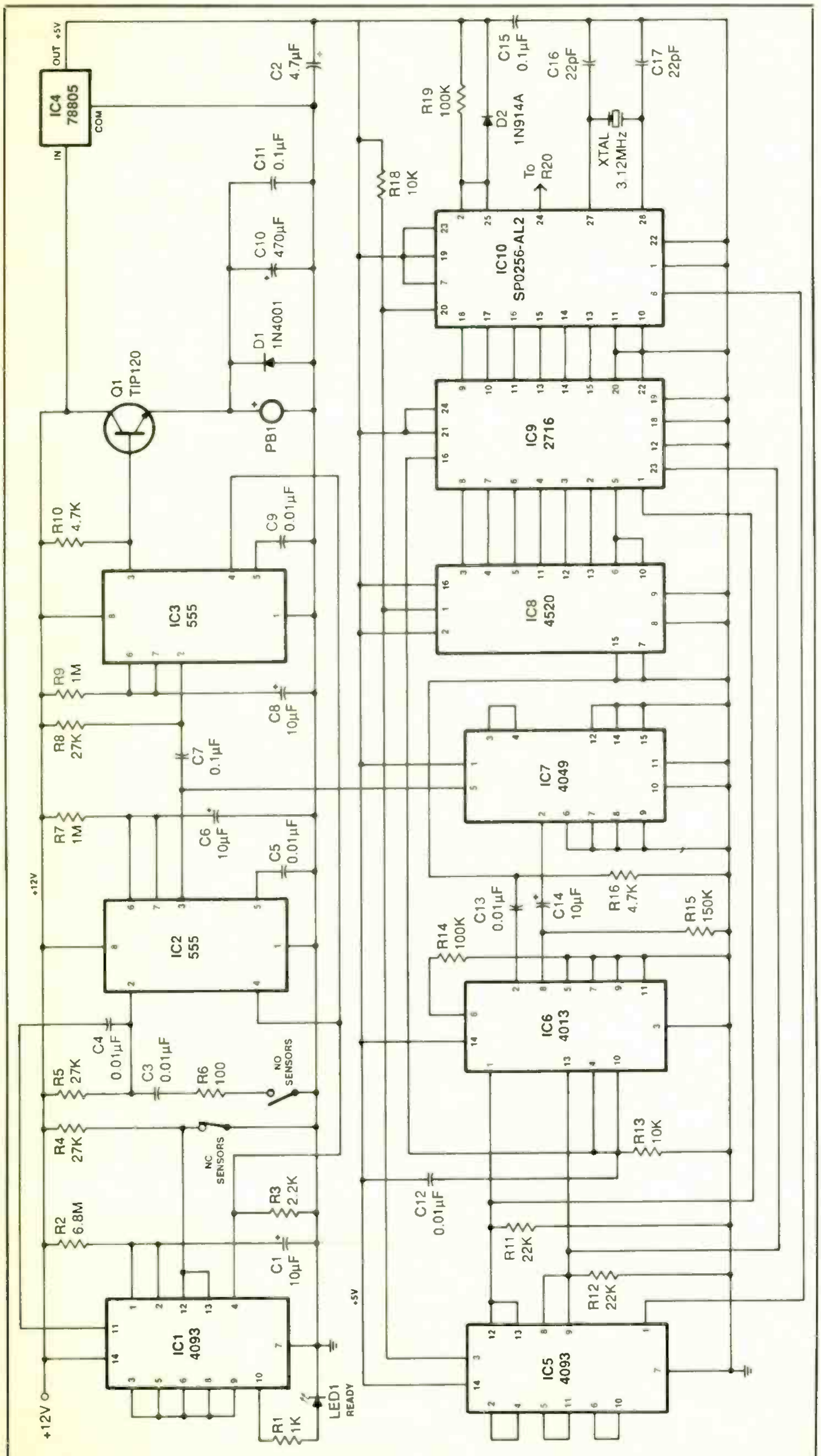


Fig. 1. Schematic diagram of timer, buzzer, logic and synthesizer portions of alarm circuit.

standby mode, if any attempt is made to gain entry by opening a door or window (or move your protected vehicle) will cause *IC2* to trigger. When this occurs, *IC2* triggers on and its output at pin 3 signals *IC3* to turn on for almost 11 seconds (given by $T_2 = 1.1R7C6$). The T_2 period is the time you have to disarm the alarm before the buzzer sounds.

During the 11-second period in which the timer is in countdown mode, the speech synthesizer will be vocalizing the countdown, starting at nine and counting down to zero. If the alarm has not been disabled before the count reaches zero, the output of *IC3* at pin 3 biases on transistor *Q1* for a period of approximately 220 seconds (given by $T_3 = 1.1R9C8$). This is how long the buzzer will sound before the alarm shuts off and resets itself. When monostable timer *IC3* shuts off, it goes into standby until the next pulse (generated again by an intrusion).

Diode *D1* and capacitors *C10* and *C11* in parallel with piezoelectric buzzer *PB1* are used to trap spikes that can disrupt operation of timers *IC2* and *IC3*.

Note in Fig. 1 that the timer and buzzer sections of the circuit are supplied from a 12-volt dc source, while the remainder of the circuitry is powered by a 5-volt dc source. The latter is obtained from the + 12-volt line by passing it through voltage regulator *IC4*. The + 12-volt line, as shown in Fig. 2, is obtained by passing the raw dc from bridge rectifier *RECT1* and filter capacitor *C26* through the *IC12* + 12-volt regulator.

The SPO256-AL2 speech processor integrated circuit specified for *IC10* is a single-chip n-channel MOS LSI device whose internal circuitry is capable of synthesizing speech and

PARTS LIST

Semiconductors
D1—1N4001 rectifier diode
D2—1N914A switching diode
IC1,IC5—CD4093 CMOS quad 2-input NAND gate
IC2,IC3—555 timer
IC4—7805 +5-volt regulator
IC6—CD4013 dual D-type flip-flop
IC7—CD4049 CMOS hex inverter
IC8—CD4520 CMOS dual binary up counter
IC9—2716 EPROM
IC10—SP0256-AL2 speech processor (Radio Shack Cat. No. 276-1784)
IC11—LM386 audio amplifier (Radio Shack Cat. No. 276-1731 or similar)
IC12—7812 +12-volt regulator
LED1—Green or yellow T-1¾ light-emitting diode
LED2—Red T-1¾ light-emitting diode
Q1—TIP120 or similar npn silicon power transistor
RECT1—50-volt, 1-ampere bridge rectifier

Capacitors
C1,C6,C14,C20,C24—10-μF, 15-volt tantalum
C2,C32,C33—4.7-μF, 15-volt tantalum
C3,C4,C5,C7,C9,C12,C13,C18,C19, C29,C31—0.01-μF Mylar
C7,C11,C15,C21,C22,C24,C27, C28,C30—0.1-μF Mylar
C8—10-μF, 25-volt electrolytic
C10—470-μF, 25-volt electrolytic
C16,C17—22-pF ceramic disc or Mylar
C25—100-μF, 35-volt tantalum
C26—2,200-μF, 25-volt electrolytic

Resistors (¼-watt, 5% tolerance)
R1,R23—1,000 ohms
R2—6.8 megohms
R3,R11,R12—2,200 ohms
R4,R5,R8—27,000 ohms
R6—100 ohms
R7,R9—1 megohm
R10,R16—4,700 ohms
R13,R18—10,000 ohms
R14,R19—100,000 ohms
R15—150,000 ohms
R17—Not assigned
R20,R21—33,000 ohms
R23—10 ohms
R22—50,000-ohm audio-taper pc-type trimmer potentiometer

Miscellaneous
PB1—Piezoelectric buzzer
S1—Spst switch (see text)
XTAL—3.12-MHz crystal (available from Radio Shack and Digi-Key)
Printed circuit boards (see text); small 8-ohm speaker; magnetic sensors (see text); 9- to 12-volt ac, 1-ampere power transformer; 6-ft. ac line cord with plug; DIP sockets for all ICs except IC4 and IC12; two small rubber small rubber grommets or panel clips for LEDs (see text); phono jack and plug for speaker (see text for alternative); three-lug terminal strip; small-diameter heat-shrinkable tubing; barrier block or screw-type terminal strip for connection of sensors (see text for alternative); suitable enclosure; lettering kit; machine hardware; speaker cable; hookup wire; solder; etc.

complex sounds. Each sound or phoneme is vocalized differently, depending on its position within a word. The SPO256-AL2 contains 59 allophones plus five pauses. Using these, you can synthesize an unlimited vocabulary by addressing specific allophones in the appropriate sequence.

When you use the allophones, you must think in terms of sounds rather than words or letters. In this project, we will program the speech processor chip to vocalize two different messages. To do this, we will use the EPROM identified in Fig. 1 as *IC9*.

One of the NAND gates in *IC5* operates as a logic oscillator. The output of this oscillator, at pin 3, is fed to the input at pin 1 of dual binary counter *IC8*. For each pulse detected at pin 1 of *IC8*, count-up from 0 to *n* occurs, where *n* is controlled by the output at pin 16 of *IC9*, which resets *IC8* via *IC6* every time the *IC10* speech processor chip's output at pin 24 ceases sending its message to be vocalized to the audio amplifying section of the circuit.

In this project, we use addresses 128 through 202 in EPROM *IC9* to store the data for the first message to be vocalized and addresses 256 through 306 to store the data for the second message to be vocalized. By connecting the outputs at pins 3 through 6 and 11 through 13 of *IC9* to the binary address inputs of *IC9* as shown, the desired sequential data programmed into the EPROM can be sent via the outputs lines at pins 9, 10, 11, 13, 14 and 15 of *IC9* to the address inputs at pins 18, 17, 16, 15, 14 and 13 of speech processor *IC10*.

Shown in Listing 1 is an example of the data program that can be fed into the EPROM to have the synthesizer section of the project vocalize the first message. This data program was taken from the "dictionary" supplied with the SPO256-AL2, which is written in decimal code. The addresses were calculated according to the binary weight of the two line A7 and A8 address inputs of *IC9* at pins 1 and 23. For example, when pin 1 of *IC9* is at a logic 1, the binary address is 128.

You program the first message so that it is stored in address locations 128 through 201 (see Listing 1), where the numbers 1 through 4 and 40 reset the speech processor chip and the binary counter, respectively. If pin 23 of *IC9* is at a logic 1, you will hear the second message (see Listing 2), starting at address 256.

When the NAND gate output at pin 3 of *IC5* is at a logic 1, the *IC8* counter advances one count. Therefore, EPROM *IC9* sends the respective data to speech processor chip *IC10*. Now, when the output at pin 3 of *IC5* goes to logic 0, a negative pulse of variable duration is sent to address load input pin 20 of *IC10*, which causes the speech processor chip to generate the desired allophone.

Referring to the upper circuit in Fig. 2, when *IC11* is amplifying and delivering the allophone signal to the speaker, the standby output at pin 8 of *IC10* goes to a logic 0. In turn, this resets the T_3 period of the timer cir-

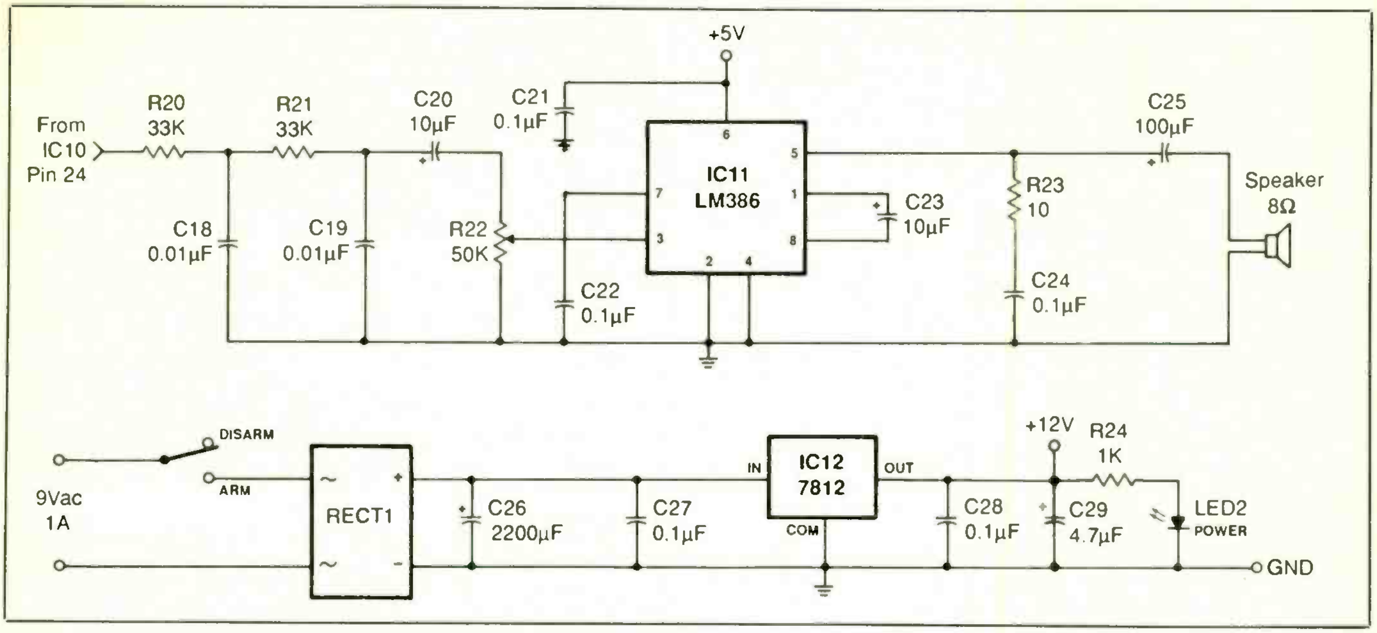


Fig. 2. Audio amplifier portion of circuit is shown at top, basic dc power supply at bottom.

cuit in Fig. 1. When *IC10* is finished generating the desired allophone, its output at pin 8 goes to a logic 1. This output, therefore, indicates to a NAND gate in *IC5* that *IC10* is ready to be triggered again. This process continues until data output from *IC9* has reached its end.

When the vocal warning alarm is first turned on, the *R1/C2* network sends a positive transient pulse, which finds its way to the set input at pin 6 of the first flip-flop in *IC6*. When the pulse arrives, the output of this flip-flop, at pin 1, goes high. Because this high is fed to an OR-gate configuration made up of NAND gates inside *IC5*, the gate's output enables the final NAND gate in the IC to send the pulses that appear at pin 3 of *IC5* to the inputs at pin 1 of *IC8* and pin 20 of *IC10*.

Since the pin 1 output of *IC6* is at a logic 1, the same high logic level is delivered to address input A7 at pin 1 of *IC9*. So the EPROM sends the data stored in it starting at address 128 to *IC10*. At this point, you will hear the first message: "I am a talking alarm. You have thirty seconds to leave the car. Please hurry." When this message ends, *IC9* sends a logic 1 via its pin 16 output back to *IC6* which resets both flip-flops and causes a logic 0 to appear at the pin 1 output of the first flip-flop.

Now let us suppose that someone attempts to open the door of the protected premises (or move your protected car, if that is where you installed the alarm). The normally open (NO) sensor would now trigger timer *IC2*, whose pin 3 output then sends, through a pair of inverters inside *IC7*, a positive transient pulse to the pin 8 set input of the second flip-flop inside *IC6*. This causes the output at pin 13 of *IC6* to go to logic 1, enabling the final gate inside *IC5*.

Because the standby output is normally at logic 1, pin 3 of *IC5* goes high and sends pin 1 of *IC8* and pin 20 of *IC10* high as well. This causes a logic 1 to appear at input pin 23 of *IC9*. When this occurs, the EPROM sends the data programmed into it to *IC10*, starting at address 256. Hence, you will now hear the second message: "nine, eight, seven, six, five, four, three, two, one, zero."

From the time this second (countdown) message starts, you have 10 seconds to disarm the alarm by setting *S1* to DISARM (open the switch). Otherwise, the piezobuzzer will sound.

You may have noticed that only two of the six inverters in *IC7* are being used in this circuit. The sole purpose of these two inverters is to transform the 12-volt pulses generated by the timing circuit into the 5-volt pulses required by the rest of the circuitry.

As you can see in Fig. 1, this project can accommodate both normally open (NO) and normally closed (NC) switch-type alarm trip sensors. If you plan on installing the alarm inside your home or office, you can use either or both types of sensors, as the need arises. Door and window sensors should be ordinary magnetic-type devices. Use glass breakage sensors for window panes as well.

If you plan on installing the alarm in your car, van or other vehicle, use a normally open sensor to detect motion should someone attempt to push or tow your vehicle.

As shown in the lower schematic in Fig. 2, this project uses a conventional ac-line-operated power supply. The power transformer's secondary should be rated to deliver at least 9

Listing 1. EPROM Program for First Message									
DECIMAL ADDRESS	DECIMAL DATA	HEX ADDRESS	HEX DATA		DECIMAL ADDRESS	DECIMAL DATA	HEX ADDRESS	HEX DATA	
128	4	80	4		166	1	A6	1	
129	24	81	18	"I"	167	3	A7	3	
130	6	82	6		168	55	A8	37	
131	1	83	1		169	55	A9	37	"seconds"
132	7	84	7		170	7	AA	7	
133	7	85	7	"am"	171	2	AB	2	
134	16	86	10		172	42	AC	2A	
135	2	87	2		173	12	AD	C	
136	24	88	18	"a"	174	11	AE	B	
137	2	89	2		175	1	AF	1	
138	13	8A	D		176	55	B0	37	
139	23	8B	17		177	3	B1	3	
140	23	8C	17	"talking"	178	13	B2	D	
141	2	8D	2		179	22	B3	16	"to"
142	42	8E	2A		180	3	B4	3	
143	12	9F	C		181	62	B5	3E	
144	44	90	2C		182	19	B6	13	"leave"
145	1	91	1		183	35	B7	23	
146	23	92	17		184	4	B8	4	
147	62	93	3E		185	18	B9	12	"the"
148	24	94	18	"alarm"	186	17	BA	1A	
149	51	95	33		187	3	BB	3	
150	16	96	10		188	8	BC	8	
151	1	97	1		189	59	BD	3B	"car"
152	4	98	4		190	BE	BE	4	
153	4	99	4		191	4	BF	4	
154	49	9A	31		192	9	C0	9	
155	31	9B	1F	"you"	193	45	C1	2D	"please"
156	2	9C	2		194	19	C2	13	
157	57	9D	39		195	55	C3	37	
158	7	9E	7	"have"	196	2	C4	2	
159	35	9F	23		197	27	C5	1B	
160	3	A0	3		198	24	C6	18	"hurry."
161	29	A1	1D		199	59	C7	3B	
162	52	A2	34		200	19	C8	13	
163	2	A3	2	"thirty"	201	4	C9	4	(resets IC3)
164	13	A4	D		202	64	CA	40	(resets IC1)
165	19	A5	13						

volts ac at 1 ampere. You can use a transformer whose secondary delivers up to 12 volts ac.

ARM/DISARM switch *S1* applies power to and removes power from the circuit as desired. The ac from the power transformer is coupled into bridge rectifier *RECT1*, where it is converted to pulsating dc and is filtered to a more pure dc by capacitor *C25*. This dc is then regulated down to +12 volts to power the timer and piezoelectric buzzer portions of the circuit.

The +5 volts dc required by the logic, speech synthesizer and audio amplifier sections is taken care of by +5-volt regulator *IC4* shown in Fig. 1.

Construction

You can fabricate your own printed-circuit boards for this project from the actual-size etching-and-drilling guides shown in Figs. 3 and 4. Note that there are two pc boards for this project. One contains all the circuitry that is powered by the 12-volt dc source, the other all the circuitry that is powered by the 5-volt dc source.

You might wish to wire your project on perforated board instead of having to fabricate pc boards. If you do, use boards that have holes on 0.1-inch centers and appropriate soldering or Wire Wrap hardware. Also, use the wiring guides shown in Figs. 5 and 6 as guides to component layout and wiring runs. Though this is not a particularly difficult project to lay out, you must keep in mind that stray capacitances must be held to a minimum.

Start wiring the project with the large logic/speech synthesizer/audio amplifier board, shown in Fig. 5. Begin by installing and soldering into place the sockets for all ICs except *IC4*. (Do *not* install the ICs in their sockets until after initial voltage checks have been performed.) Follow with the resistors and diode, making sure you properly orient the latter before soldering its leads to the pads on the bottom of the board.

Next, install and solder into place the nonpolarized capacitors. Follow up with the polarized capacitors, again making sure they are properly polarized before soldering them into place. Four capacitors (*C30* through *C33*) do not appear on either schematic diagram to avoid confusion. To determine their values, refer to the Parts List.

Plug the leads of the crystal into the board, solder them to the copper pads and clip them as short as possi-

Listing 2. EPROM Program for Second Message

DECIMAL ADDRESS	DECIMAL DATA	HEXADECIMAL ADDRESS	HEXADECIMAL DATA		DECIMAL ADDRESS	DECIMAL DATA	HEXADECIMAL ADDRESS	HEXADECIMAL DATA	
256	56	100	38		281	40	119	28	"five"
257	24	101	18	"nine"	282	6	11A	6	
258	6	102	6		283	35	11B	23	
259	11	103	B		284	3	11C	3	
260	2	104	2		285	40	11D	28	
261	20	105	14		286	40	11E	28	"four"
262	2	106	2	"eight"	287	58	11F	3A	
263	13	107	D		288	3	120	3	
264	2	108	2		289	29	121	10	
265	55	109	37		290	14	122	E	"three"
266	55	10A	37	"seven"	291	19	123	13	
267	7	10B	7		292	4	124	4	
268	7	10C	7		293	13	125	D	
269	35	10D	23		294	31	126	D	"two"
270	12	10E	C		295	4	127	4	
271	11	10F	B		296	57	128	39	
272	2	110	2		297	15	129	F	"one"
273	55	111	37		298	15	12A	F	
274	55	112	37	"six"	299	11	12B	B	
275	12	113	C		300	4	12C	4	
276	2	114	2		301	43	12D	2B	
277	41	115	29		302	60	12E	3C	"zero"
278	55	116	37		303	53	12F	35	
279	3	117	3		304	4	130	4	
280	40	118	28		305	1	131	1	(resets IC3)
					306	64	132	40	(resets IC1)

ble. Do the same with trimmer potentiometer *R22* and 5-volt regulator *IC4*. Make sure the last is properly oriented before soldering it into place.

Nine jumper wires must now be installed. These are identified simply by solid lines and the letter J. You can use short lengths of bare hookup wire (or cut-off resistor leads) for the four short jumper wires, but the remaining long jumpers should be insulated solid hookup wires.

Strip ¼ inch of insulation from both ends of five 8-inch lengths of stranded hookup wire, three with one color insulation and two with another color. Twist together the fine conductors at both ends of all wires and sparingly tin with solder.

Plug one end of the two wires that have the same color insulation into the holes labeled +12V and SPKR+ and solder into place. Then plug one end of the remaining wires into the holes labeled SPKR−, GND and IC2 PIN 3. The other ends of these wires will be connected later.

When you are finished wiring this circuit-board assembly, the only IC that should be on it is +5-volt regulator *IC4*. Temporarily set aside this circuit-board assembly.

Now proceed to wire the power supply/timer board as shown in the Fig. 6 wiring guide. Do this in the same sequence as you did for the large board. Once again, install only the sockets—*not* the ICs themselves. The only IC that should be installed on this board when you are finished wiring it is +12-volt regulator *IC12*.

Before you solder any polarized capacitor or diode leads to the copper pads on the bottom of the board, make sure these devices are properly oriented. Similarly, make sure the basings of *IC12*, *Q1* and *RECT1* are correct before soldering the pins of these components to the pads.

On this board you need only two jumper wires, one linking the base (B) of *Q1* to pin 3 of *IC3* and the other below *IC1*. The first can be a short piece of bare wire, but the other must be insulated wire. You also need 12 8-inch lengths of stranded hookup wire, each with ¼ inch of insulation stripped from both ends. Six of these wires should have red insulation, the remainder black insulation. As before, twist together the fine conductors at both ends of all wires and sparingly tin with solder.

Plug one end of the red-insulated wires into the holes labeled BUZZER +, LED1 ANODE, LED2 ANODE, NO SENSORS, NC SENSORS and +12V TO IC4 IN and solder into place. Then install the black-insulated wires into the holes labeled LED CATHODES, SENSORS, BUZZER −, and S1 and solder into place.

How you machine the project's enclosure will depend on your choice of components and whether or not you plan on installing the speaker or/and piezobuzzer inside the enclosure. If you use a key-lockable steel enclosure and solidly mount it to a wall, the system should be quite secure, especially if all incoming wiring, including the ac power cord, enters the enclosure through a large hole cut through the panel that mounts against the wall.

If the project is to be out in plain sight, the enclosure should be steel and be solidly secured to the wall. Then a key-operated ARM/ DISARM switch can mount on the enclosure's

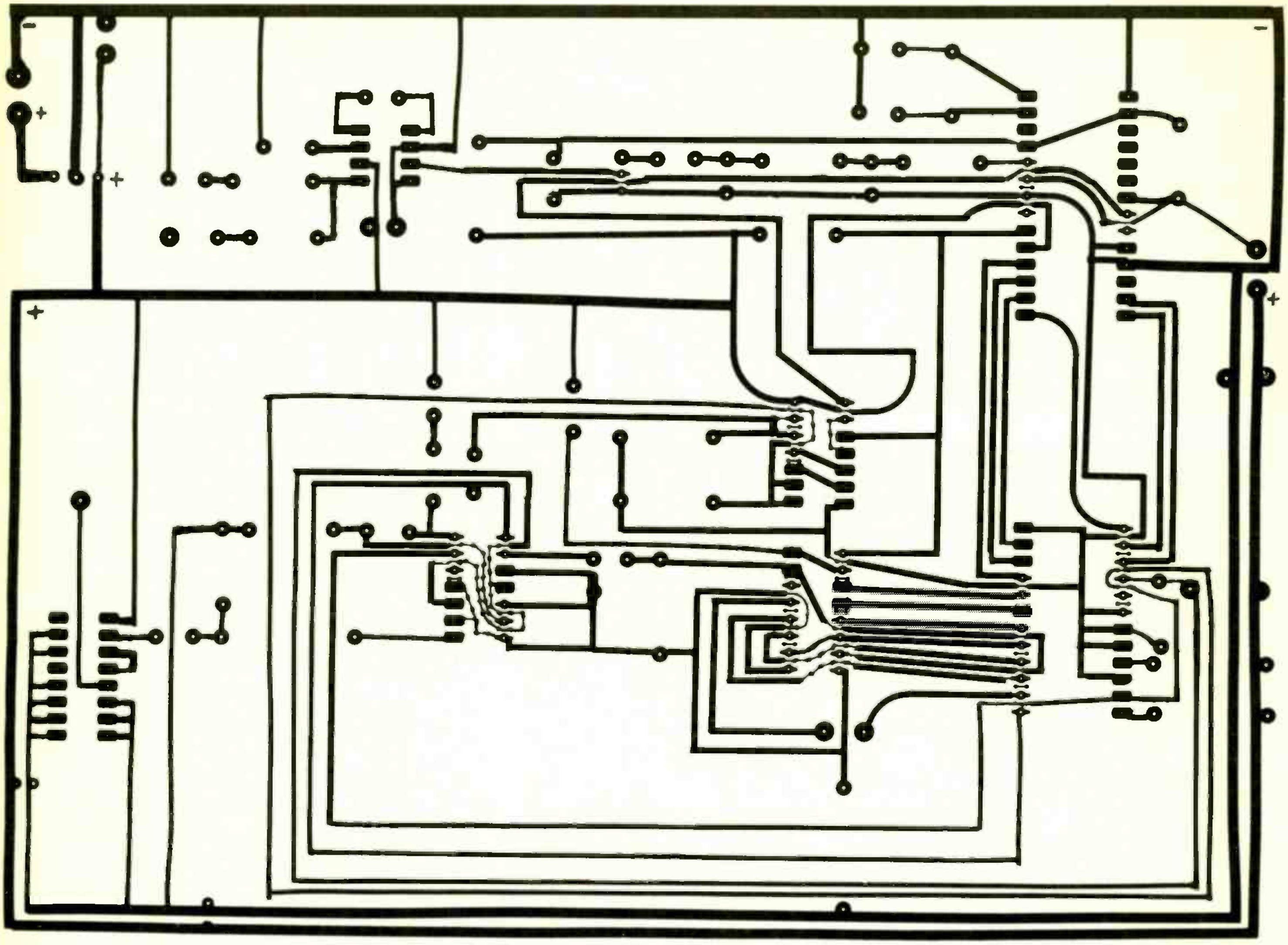


Fig. 3. Actual-size etching-and-drilling guide for logic, synthesizer and audio-amplifier sections of project.

front panel along with the LEDs. If you prefer to use an ordinary slide or toggle switch, it can be mounted on a metal subpanel, made from sheet aluminum or steel bent into an L shape, inside the enclosure. The switch will be reachable only by unlocking the enclosure. If you make the subpanel large enough, you can mount on it a barrier block at which the speaker and sensors connect into the circuit.

Drill mounting holes in the enclosure for the circuit-board assemblies, power transformer, speaker jack, LEDs piezobuzzer and ARM/DISARM switch. Make the holes for the LEDs large enough to accommodate panel mounting clips or small rubber grommets or just large enough to provide press fitting of the plastic cases of the LEDs, and drill a dozen or so holes for the sound from the buzzer and speaker to escape if you mount these items internally.

You also need holes for mounting a three-contact barrier block or three-position screw-type terminal strip for connection of the normally open and normally closed trip sensors. Alternatively, you can replace the speaker jack and separate barrier blocks or terminal strips for the speaker and sensors with a single six-position barrier block to which all external-device connections, except those for the ac power cord, can be conveniently made. Also drill the entry hole for the ac line cord and the holes for mounting the enclosure to a wall.

Mount the power transformer in the enclosure, sandwiching a three-lug terminal strip (*no* lugs connected to the mounting tab) and toothed lockwasher between the head of one of the screws and mounting tab. Place a rubber grommet in the ac line

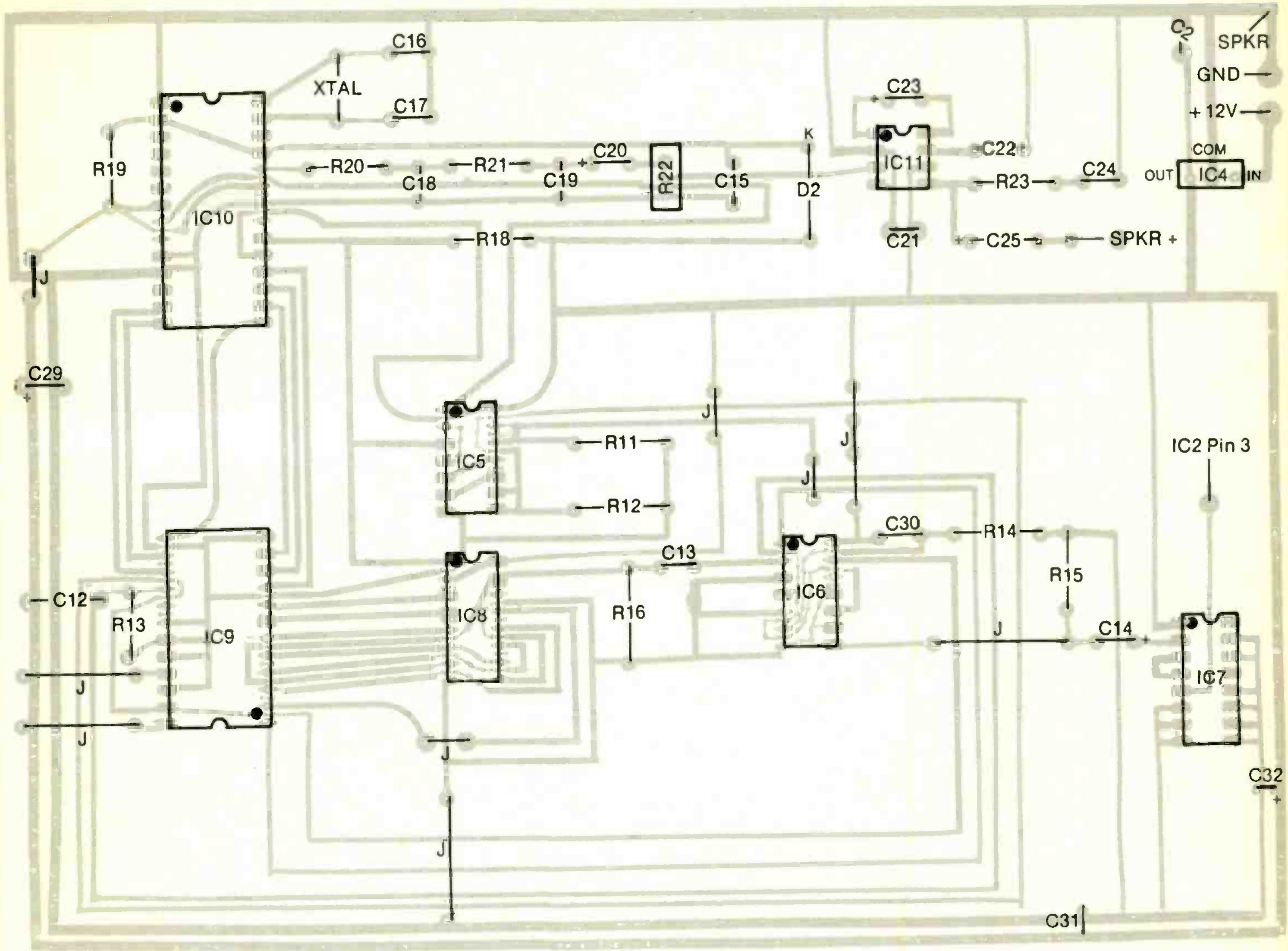


Fig. 4. Actual-size printed-circuit guide for timer and power supply sections.

cord hole. Strip ⅜ inch of insulation from both line cord conductors, tightly twist together the fine wires in each conductor and lightly tin with solder. Pass the line cord through the rubber grommet into the enclosure and tie a knot in it about 5 inches from the prepared end inside the enclosure to serve as a strain relief.

Crimp and solder one power transformer lead and one line cord conductor to each of two adjacent terminal strip lugs. Strip ¼ inch of insulation from both ends of a hookup wire long enough to reach from *S1* to the terminal strip. Connect and solder one end of this wire to one lug on the switch and the other end of this wire and one secondary lead of the power transformer to the unused lug on the terminal strip. Plug the other transformer secondary lead into the hole labeled 9VAC and solder into place. Then mount the circuit-board assembly into place with ½-inch spacers and machine hardware.

Locate the free end of the wires that are connected to the LED holes in both circuit-board assemblies and slip over each a 1-inch length of small-diameter heat-shrinkable tubing. Trim the cathode lead of the red LED to ½ inch long and crimp and solder it to the free end of one LED CATHODE wire coming from the large circuit-board assembly.

Do the same with the anode lead and the free end of the LED1 ANODE wire coming from the same board. Repeat this procedure with the green LED and the LED2 wires.

Push the heat-shrinkable tubing up over the connections and flush against the bottoms of the plastic cases of the LEDs and shrink into place. Mount the LEDs in their respective locations on the front panel of the enclosure.

Checkout & Final Assembly

With none of the DIP ICs installed in their sockets in either circuit-board assembly, plug the project's line cord into an ac outlet. Connect the common lead of a dc voltmeter, set to indicate at least 20 volts full-scale, to circuit ground at the negative (–) side of *C26*. Set *S1* to ARM (red POWER light-emitting diode *LED2* should now be on) and touch the meter's "hot" probe to the following pins of the IC sockets and compare your readings:

IC/Pin	Meter Reading
1/14	+ 12 volts
2/8	+ 12 volts
3/8	+ 12 volts
4/IN	+ 12 volts
5/14	+ 5 volts
6/14	+ 5 volts
7/1	+ 5 volts
8/2,16	+ 5 volts
9/21,24	+ 5 volts
10/1,9,23	+ 5 volts
11/6	+ 5 volts
12/OUT	+ 12 volts

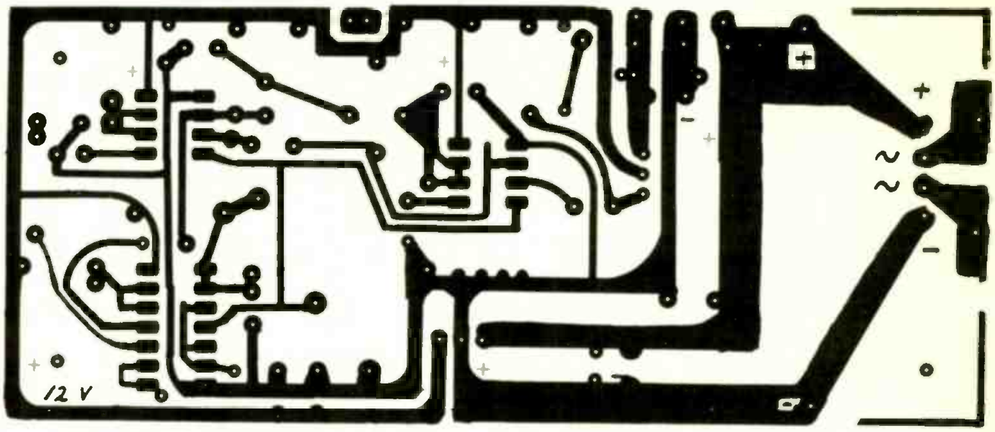


Fig. 5. Wiring guide for logic, synthesizer and audio-amplifier board.

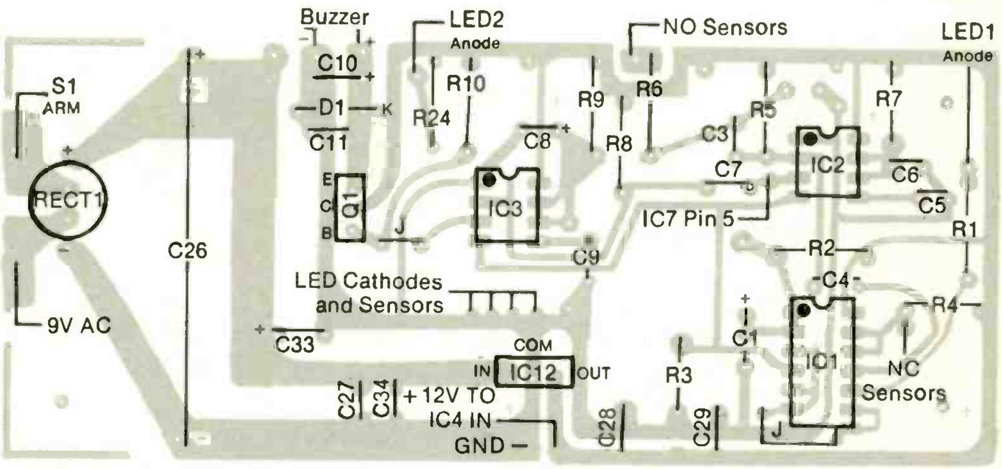


Fig. 6. Wiring guide for timer/power-supply board.

Once you know that your wiring is correct and that the voltage regulators are operating as they should, allow the charge to completely leak off the electrolytic capacitors. Then install the ICs in their respective sockets. Make sure you properly orient each IC as you install it, referring to Figs. 5 and 6. Most of these devices are CMOS devices that are sensitive to static electricity; so practice the usual precautions for MOS devices when handling them. Also, make sure that no pins overhang the sockets or fold under between the ICs and the sockets as you push the ICs home.

Mount the speaker jack and individual barrier blocks or screw-type terminal strips (or the single barrier block if you have decided to use it) in their respective locations. Then referring to Figs. 5 and 6 connect and solder the free ends of the wires coming from each circuit-board assembly to the appropriate lugs on these components to complete assembly.

With the project fully wired and ready to go, plug an 8-ohm speaker into its jack (or connect it to the barrier block), set trimmer potentiometer *R22* to about the middle of its range and short the normally closed barrier block contacts together with a jumper lead to simulate a not-tripped condition. Plug the project's line cord into an ac outlet and set *S1* to ARM. At this point, you should hear the first message. If necessary, adjust the setting of *R22* for the desired listening level. Do nothing until the 30-second timing cycle has run its course. Then opening the normally closed connection should cause the second message to be vocalized, followed by the buzzer sounding.

The buzzer should continue to sound for approximately three minutes, after which the alarm should retrigger if you have not restored the normally closed condition to the barrier-block contacts.

Reset the alarm by setting *S1* to DISARM and then back to ARM, with the normally closed contacts shorted together. Repeat the test procedure with the normally open contacts, shorting them together with a jumper lead.

When you are completely satisfied that your alarm is operating as it should, power it down and unplug it from the ac line. Label the LEDs, positions of *S1*, etc. Then install the project box in a convenient location in your home, office or car. Wire to it any switch-type sensors you wish. Keep in mind that normally open sensors all wire in parallel with each other, while normally closed sensors wire in series with each other. ME

Mathematical Variations of Ohm's Law

By C.R. Ball Jr.

German physicist Georg Simon Ohm discovered the relationship between voltage, current and resistance, circa 1854. In honor of his discovery, the relationship became known as Ohm's Law, and the "Ohm," abbreviated as Ω (the Greek letter omega), ultimately became the officially recognized MKS unit of resistance.

Several mathematical variations and definitions of Ohm's Law exist. These are mathematically summarized in the Ohm's Wheel shown here. With this Wheel, you can start at the hub and derive any variation of the Law by going to the appropriate quadrant. Traditionally, electromotive force, or voltage is represented by an "E," current by an "I" and resistance by an "R." To these three basic parameters have been added power in watts, represented by a "W."

In essence, Ohm postulated that when a potential of 1 volt is placed across a 1-ohm resistance, the current flowing through the resistance would be 1 ampere.

To use Ohm's Wheel to calculate any given parameter, you start at the hub and use the appropriate formula of the three shown in that specific quadrant. For example, if you know the voltage applied to a known value of resistance, you would start at the hub of the unknown current (lower-left) quadrant and discover that voltage (E) divided by resistance (R) will provide the unknown current. If the potential is 10 volts and the current is 1 ampere, you would solve the problem as follows:

I = E/R
I = 10 volts/1 ampere
I = 10 ohms

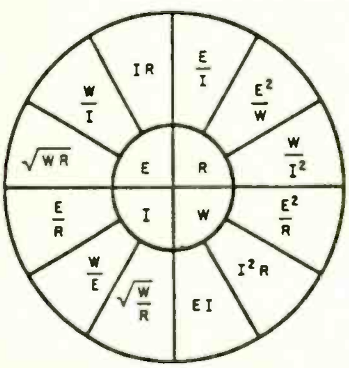
Now you can go a step further and calculate the power dissipated by the resistor. The easiest way to do this is to use any of the formulas in the power quadrant (lower-right) of the Wheel. In the simplest of these formulas, you just multiply voltage by current:

W = I × E
W = 1 ampere × 10 volts
W = 10 watts.

That's all there is to it!

Newcomers to electronics, and even old hands, will want to keep this Ohm's Wheel handy as a reference. ME

TABLE 1
MATHMATICAL VARIATIONS OF OHM'S LAW



Ohm's Wheel

WHERE E = Potential Difference in Volts
I = Current in Amperes
R = Resistance in Ohms
W = Power in Watts

Using LEDs as Detectors

By Forrest M. Mims III

Light-emitting diodes can double as both emitters and detectors of light. This dual capability makes possible several unique applications. In this column, I will describe several applications for LEDs operated as detectors. First, however, let's review the background of devices that both emit and detect light.

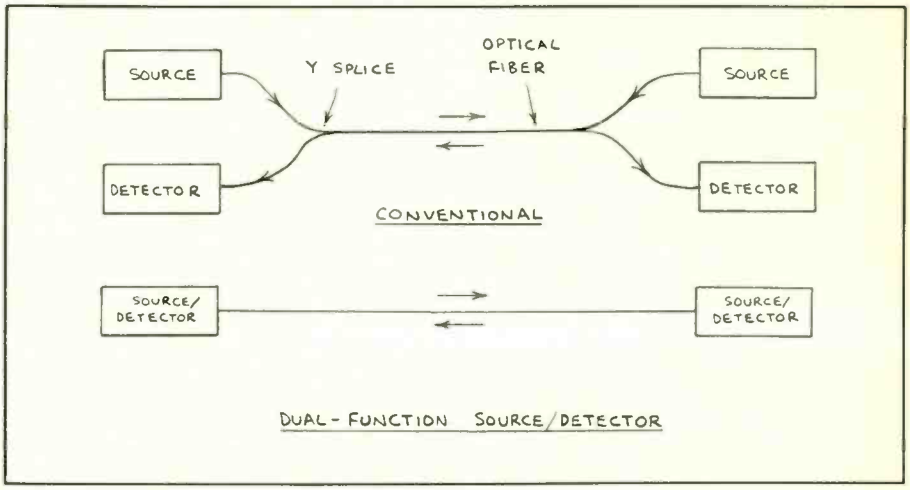


Fig. 1. Conventional and simplified bidirectional fiber links.

Detectors that Emit Light

A few months before graduating from high school in the spring of 1962, it occurred to me that semiconductors that detect light might also emit light. I decided to test this hypothesis by passing a current through a bulk semiconductor, a thin layer of cadmium-sulfide that formed the light-sensing region of a photoresistor.

When the current from a flashlight cell failed to stimulate the emission of photons, I decided more electromotive force might do the trick. Since I had been experimenting with a spark coil, I connected the CdS cell to the output leads of the spark coil and switched on the power. This time, the entire zig-zag pattern of CdS emitted a greenish glow. Of much more significance were tiny but bright spots of flickering green light.

Since CdS has a peak spectral response in the green range, I was convinced that the green emission was not merely a visual by-product of the high-voltage spark discharge but was what physicists call "recombination radiation." In other words, the green emission was the direct result of electrons within the CdS being stimulated to a higher-than-normal energy level by the high-voltage discharge. When the electrons resumed their normal levels (recombined), they emitted photons (radiation).

On November 6, 1966, I repeated this experiment with single-crystal platelets of cadmium-sulfide provided by the University of Colorado. The brittle, yellowish platelets produced green flashes that were significantly brighter than those produced in the earlier experiment, which I also repeated.

Earlier, on March 14, 1966, I conducted an experiment that eventually led to a confrontation with Bell Laboratories. In this experiment, I connected a surplus silicon solar cell to the output of a two-transistor audio-frequency oscillator. An identical cell was connected to the input of an audio amplifier. The first cell produced pulses of near-infrared radiation that were detected by the second cell.

This experiment demonstrated that half-duplex optical communications could be accomplished over a coaxial path with a single semiconductor device at either end of the link. When one solar cell was transmitting, the other would function as a receiver. Their roles would then be reversed for communication in the opposite direction.

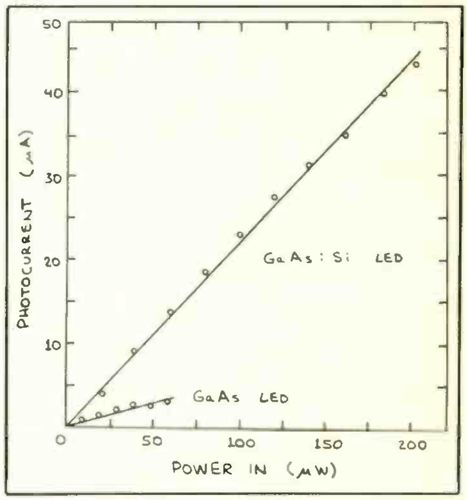


Fig. 2. Response of GaAs and GaAs:Si LEDs in detector mode.

Emitters that Detect Light

Most semiconductor pn junctions emit photons when forward biased. This is the principle that makes possible visible-light and near-infrared emitting diodes. The most efficient semiconductor light emitters are made from single-crystal alloys of gallium and arsenic (GaAs) and aluminum, gallium and arsenic (AlGaAs). But even silicon solar cells, as noted above, and both germanium and silicon diodes and transistors emit near-infrared radiation when forward biased.

The efficiency at which silicon and germanium pn junctions transform a current into an electromagnetic wave is considerably lower than that of diodes designed specifically for this purpose. Moreover, many diodes designed expressly as efficient photon generators function well as photon detectors.

In 1972, I conducted a series of experiments to determine if GaAs LEDs and lasers and GaAs:Si LEDs could double as detectors. The results of these experiments were quite successful. I also found that it is possible to transmit an information-carrying optical wave in both directions through a single optical fiber by placing a single LED at each end of the fiber. Previously proposed optical fiber communication links required an emitter and a detector at each end of a link made from either two fibers or a single fiber equipped with a "Y" splice at both ends. Figure 1 shows both methods.

In 1973, I sent Bell Laboratories a formal invention proposal that described several applications for dual-purpose emitter/detector devices. The proposal was reviewed by two scientists at Bell Labs, both of whom held the PhD. One wrote that it is not possible to design a practical device that functions as both an emitter and a detector. His supervisor concluded that, "I think it extremely unlikely that systems considerations would permit a single device to operate as both a source and detector. Certainly all of our present thinking has been along the lines of separate fibers for transmitting and receiving." My proposal was rejected.

I related some of the details of what happened next in *Siliconnections: Coming of Age in the Electronic Era* (McGraw-Hill, 1986). Briefly, after Bell Labs rejected the proposal, I developed a magazine construction project titled "Communicate Over Light Beams With the First Single-LED Transceiver" (*Popular Electronics*, March 1974). This article concluded that the device's ". . . fiber-optic mode of operation is a precursor of what telephone systems of the future are likely to resemble."

In the fall of 1979, Bell Labs announced that it had also developed a new kind of single-LED transceiver, an optical telephone that *Electronics* claimed would ". . . establish AT&T as the No. 1 provider of wideband services to home and industry" (October 25, 1979). *Business Week* described the new phone as ". . . so radically different it may eventually transform American Telephone and Telegraph Co. and the entire telephone industry with profound effects on data communications, cable television, and every phone user . . . and dramatically alter the basic nature of the phone network" (December 4, 1978).

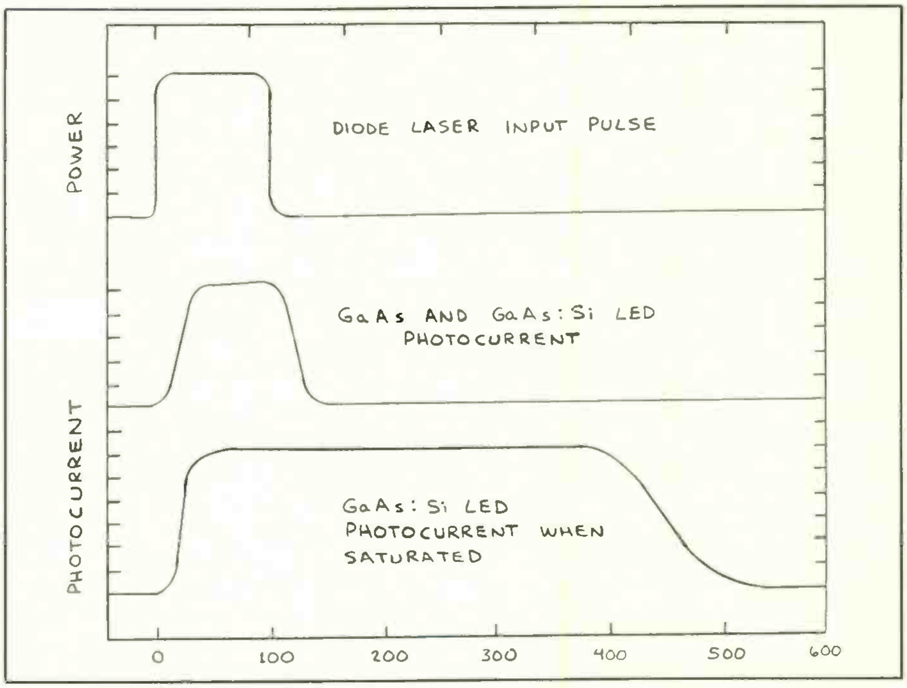


Fig. 3. Response times (nanoseconds) of LEDs in photodetector mode.

When I approached Bell Labs about its apparent use of the invention I had submitted to them, they refused to honor our 1973 agreement that, should they desire to make use of my proposal, they would first ". . . discuss the matter . . . in an effort to arrive at an agreement that is mutually satisfactory." Following six months of unsuccessful negotiations, I filed suit against Bell Labs. The matter was settled out of court in my favor in December 1980.

During this litigation, Bell Labs abandoned at least one U.S. patent application that in part claimed precisely what I had submitted to them in 1973. Furthermore, an extensive search of the prior art by Bell Labs revealed that Jean Claude Chaimowicz had applied for an English patent (No. 1,101,223) in 1965 that proposed a two-way free-space optical communications system using a single dual-function semiconductor at each end of the link. Other early work was performed at IBM from 1969 to 1972, including one-way links using fiber optics.

Some Experimental Results

It's important to realize that off-the-shelf LEDs often function well as optical transceivers. I made some measurements of the performance of commercial LEDs operated as detectors that will give you a good idea of their sensitivity.

"External quantum efficiency" is an important measure of a detector's performance. A detector generates a photocurrent when illuminated by a light source. The external quantum efficiency of the device is the ratio of the number of photocurrent electrons to the number of photons striking the detector during a given period of time. Thus, if each photon generates an electron, the quantum efficiency is 1 (or 100 percent). If two photons are required to generate an electron, the efficiency falls to 0.5 (or 50 percent), and so forth.

With the help of a calibrated silicon

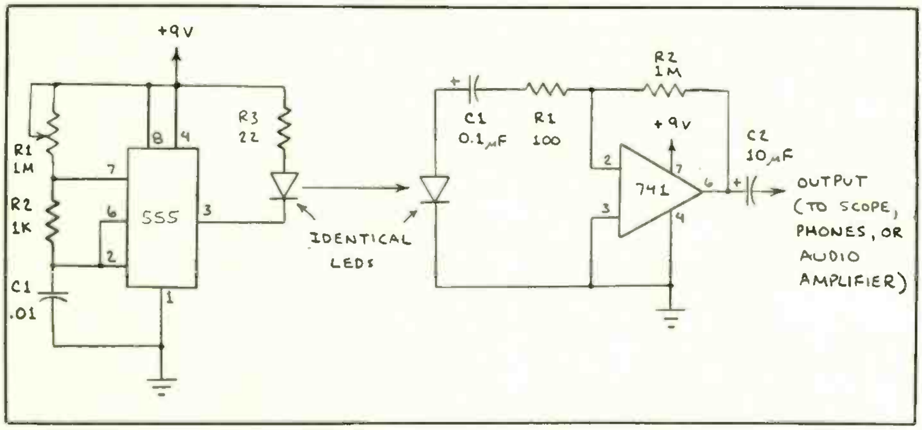


Fig. 4. A simple LED-LED demonstration circuit.

photodiode, I measured the external quantum efficiency of several GaAs and GaAs:Si LEDs. In each case, the LED connected as a detector was illuminated by radiation from an identical LED. This is because an LED operated as a detector responds best to the band of wavelengths at or slightly below the band of wavelengths it emits when operated as an emitter.

A General Electric SSL-54 GaAs LED with a peak emission wavelength of 900 nm gave a quantum efficiency of 8.8 percent when operated as a detector. A GE SSL-55 GaAs:Si LED with a peak emission wavelength of 940 nm gave a quantum efficiency of 26 percent in the detector mode. The external quantum efficiency of commercial silicon photodiodes ranges from 50 to 70 percent. Though the LEDs I measured are not nearly this efficient, their performance is more than adequate for many practical applications.

I also measured the photocurrent generated by both LEDs in response to an increasing level of illumination from similar LEDs. As can be seen in Fig. 2, both diodes exhibited a linear response over the range of applied radiant power.

Optical communications is an important application for LEDs operated as both detectors and emitters. Therefore, I measured the response of the LEDs cited above to fast-risetime (1-nanosecond) pulses from a GaAs semiconductor laser diode. Both LEDs were connected across a 50-ohm load resistor. The current through the resistor was monitored with an oscilloscope. As shown in Fig. 3, both LEDs exhibited rise and fall times of around 25 nanoseconds (10- to 90-percent points).

Note in Fig. 3 that the GaAs:Si LED exhibited a considerably increased fall time when the incoming radiation exceeded the device's saturation point, at which increasing radiation fails to generate a greater photocurrent. Well above saturation, the 100-nanosecond-wide pulse from the laser diode was stretched to 450 nanoseconds. This effect is probably related to the fact that, when operated as emitters, GaAs:Si LEDs exhibit much slower rise and fall times than do GaAs LEDs. Of course, what this means is that GaAs:Si LEDs are not as suitable for wide-bandwidth links as are GaAs LEDs.

During the past five years or so, highly efficient red and near-infrared emitting AlGaAs LEDs have become widely available. Though I have not quantified the performance of AlGaAs LEDs in the detector mode, I have had excellent results using both red and near-infrared AlGaAs LEDs as detectors. AlGaAs LEDs used as detectors should be paired with similar AlGaAs LEDs. Thus a super-bright red AlGaAs LED will detect the light emitted by a similar LED much better than the radiation emitted by a near-infrared AlGaAs LED.

Simple LED-LED Test Circuits

There are several ways to determine if a pair of similar LEDs will work in an optical transceiver application. The most straightforward is to connect one LED to a current meter and expose it to radiation emitted by the second LED. This is essentially how I made the quantum efficiency measurements mentioned above.

When performing such tests, it's helpful to compare the performance of LEDs to that of conventional detectors. For example, the receiving LED can be replaced by a silicon photodiode or solar cell. For a fair comparison, it is essential to compensate for the sensitive surface area of the detectors being compared. The simplest way to do this is to form a small hole in a sheet of aluminum foil and expose all the detectors under test through this hole.

Since LEDs have a much smaller sensitive region than a solar cell, this procedure can be simplified by making a hole in the foil so that it has the same dimensions as the LED's chip. The LEDs can then be tested without the external aperture, while large-area detectors, such as solar cells, can be tested with the aperture.

Figure 4 shows a simple arrangement that will allow you to quickly determine if a particular pair of LEDs will work in a bidirectional audio-frequency lightwave link. In operation, the transmitter LED sends a stream of pulses to the receiver LED. The photocurrent from the receiver LED is amplified, and the magnitude of the audio tone provides a rough indication of whether or not the selected pair of LEDs will function in a practical lightwave link.

The Fig. 4 transmitter is a straightforward 555 pulse generator. Potentiometer *R1* controls the pulse repetition rate. Though the simple receiver shown works well, you can connect the receiver LED directly to the input of a commercial audio amplifier.

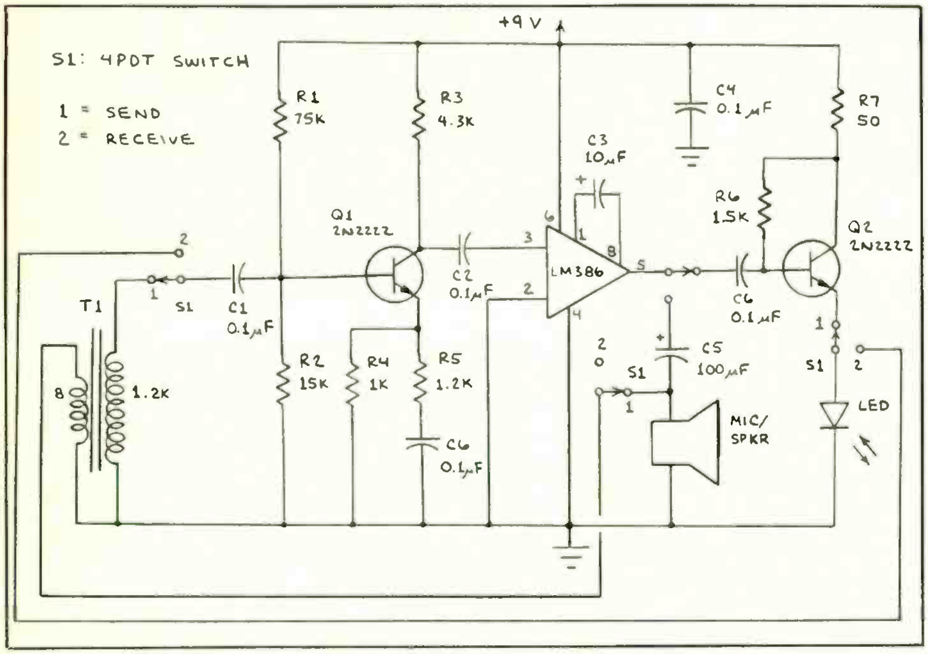


Fig. 5. Lightwave voice communicator with LED source/detector.

Remember that the Fig. 4 arrangement provides only a rough indication of an LED's performance as a detector. For more precise information, it's necessary to make measurements as described above.

A LED-LED Transceiver

Since 1973, I have built a number of working lightwave transceivers that incorporate a single LED as a dual-function source and detector of optical radiation. These transceivers have been operated through the atmosphere over ranges of hundreds of feet and through optical fibers over similar distances.

Figure 5 is the schematic diagram of one of these systems. You can use this circuit to demonstrate that the concept of a lightwave transceiver in which a single LED doubles as a source and a detector is indeed a practical proposition. Or you can adapt the circuit to a practical system.

Note in Fig. 5 that a standard 8-ohm speaker functions as both a microphone and a speaker. Setting *S1* to position 1 connects the speaker to the 8-ohm side of audio transformer *T1*. Speech directed into the cone of the speaker generates a small current that is coupled into *Q1* via *T1* and *C1*. The amplified signal is then coupled through *C2* into the LM386 audio power amplifier chip. The output from the LM386 is then coupled into LED driver *Q2*, which controls the current flowing through the LED. Hence, speech directed into the speaker's cone is transformed into an amplitude-modulated lightwave by the LED.

Setting *S1* to position 2 connects the speaker to function as a speaker instead of as a microphone, and the LED is connected to *Q1* via *C1*. Lightwaves striking the LED's junction generate a photocurrent that is amplified by *Q1* and passed through *C2* to the LM386 power amplifier. The output of the LM386 is then passed to the speaker via *C5*.

A pair of the Fig. 5 circuits can be used for half-duplex, bidirectional communication through the atmosphere or through a single optical fiber. If you have built and used lightwave communication systems designed to operate through the atmosphere, you can appreciate the advantage of having a single lens rather than two lenses at either end of the link. This greatly simplifies alignment of a pair of transceivers.

For best results, the LED should be an AlGaAs near-infrared or super-bright red device. Near-infrared LEDs will provide a covert communications link, but alignment is more difficult than when visible LEDs are used.

Various kinds of optical fiber termination devices are available for interfacing fibers and LEDs. Alternatively, you can attach a fiber directly to an LED. One way to do this is illustrated in Fig. 6. Here a small hole is bored into the end of an epoxy-encapsulated LED. You can form the hole with a small drill or a hot needle. In either case, it's important to avoid damaging the very small bonding wire that connects one of the LED's leads to the top of the chip.

After forming the hole, dip the end of the fiber into clear epoxy and insert it in the hole. The epoxy secures the fiber in place and provides refractive index matching between the end of the fiber and the roughened end of the bored hole.

You can use plastic optical fiber if the LED is a visible red emitter. Plastic fiber is easy to cut with a sharp safety knife or razor blade.

Silica and glass fibers have much lower characteristic attenuation than plastic fibers do, and they can be used with both red and near-infrared emitting LEDs. These fibers must be cleaved to provide a perfectly flat end. One way to cleave a glass or silica fiber is to lightly score it with a carbide blade. First, pull the fiber across a curved surface, such as a plastic 33-mm film container. Then lightly pull the carbide blade across the desired cleavage point. The fiber should almost immediately pop apart.

Examine the end of the fiber with a record player stylus magnifier. When light is shining through the opposite end of the fiber, a properly cleaved end will be a brightly glowing circle. A half-moon of glowing light indicates an imperfect cleave, in which case, you should try again.

Caution: You *must* wear protective glasses when cleaving glass and silica fibers since small slivers broken off during cleaving might fly into your eye. Small remnants of fiber are like invisible splinters that can cause painful injuries. Collect fiber scraps with the mastic side of a piece of masking tape and discard them in a safe place.

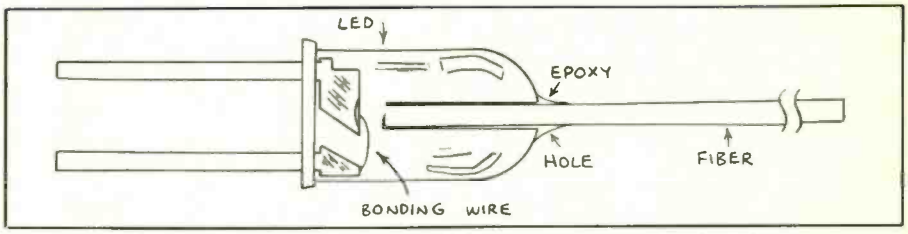


Fig. 6. How to mate an optical fiber to an encapsulated LED.

Going Further

The conclusions of the scientists at Bell Labs in 1973 notwithstanding, LEDs *can* indeed double as both emitters and detectors in practical lightwave communication links. For example, I have used a pair of circuits similar to that shown schematically in Fig. 5 and equipped with near-infrared LEDs to transmit voice in both directions through a 200-meter silica fiber. In February 1980, I demonstrated this system at the site in Washington, D.C., where Alexander Graham Bell first demonstrated voice communication over a beam of reflected sunlight exactly 100 years earlier. Besides my wife and me, present were representatives of the Smithsonian Institution, the National Geographic Society and, despite their ongoing legal battle, Bell Laboratories.

For additional information about lightwave communications and LEDs that function as both emitters and detectors, see *The Forrest Mims Circuit Scrapbook* (McGraw-Hill, 1983) and *Forrest Mims' Circuit Scrapbook II* (Howard W. Sams, 1987). In *A Practical Introduction to Lightwave Communications* (Howard W. Sams, 1982), which is out of print but still available from some libraries, I discuss lightwave communications in great detail. **ME**

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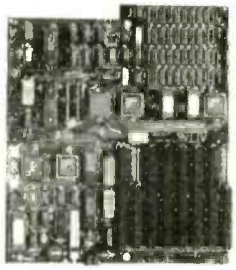

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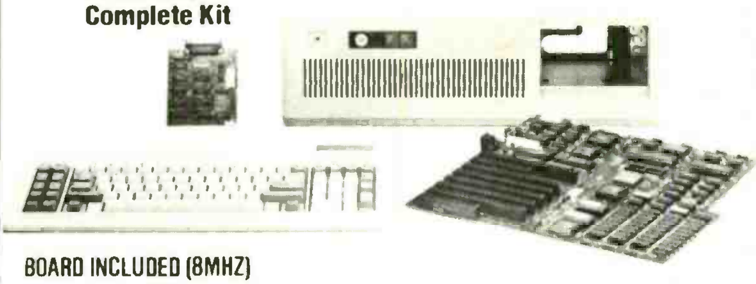

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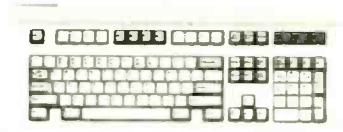

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CIRCLE 30 ON FREE INFORMATION CARD

An intriguing programmable bit rate generator; digital/linear high- and low-pass filters; late-breaking news

By Harry Helms

Deep in the heart of Texas—Austin to be precise—is Motorola's MOS semiconductor division. Over the past few years, a number of innovative CMOS ICs have been produced by the design teams in Austin. Some are now starting to enter the general semiconductor marketplace and are worth closer looks.

One that seems particularly intriguing to me is the MC14411 *bit rate generator*. Everyone who works with digital devices and circuits needs stable clock signal sources. Most such clock signal generators are fixed frequency, with the output frequency determined by a timing resistor and capacitor. Changing output frequencies, or obtaining more than one output frequency at the same time, can be a problem. The solution might well be the MC14411, which can be thought of as a logic-controlled clock oscillator. It offers 16 different clock output frequencies simultaneously, and all outputs can be digitally switched between four frequency ranges by a 2-bit "address" input! The output frequencies available from the MC14411 range from 1,843 kHz down to approximately 75 Hz.

Figure 1 shows the package and pin connections for this device. The outputs are labeled F1 through F16. The output range is selected by the Rate Select A (pin 23) and Rate Select B (pin 22) inputs. The MC14411 requires an external 1.8432-MHz crystal to control its output frequencies, and this crystal must be connected to the XTAL Input (pin 21) and XTAL Output (pin 20) pins. There is also a Reset Input at pin 10. For normal operation, the Reset Input must be held to a high logic level (V_{cc}). If pin 10 is low, outputs F1 through F14 will be low, while outputs F15 and F16 will be high.

Shown in Fig. 2 is an internal block diagram of the MC14411. The first stage is the 1.8432-MHz oscillator section, whose frequency is controlled by the external crystal connected to pins 20 and 21. The output of the oscillator is applied to output F16 and to the input of the first divider stage. This means that the output frequency at F16 will always be 1.8432 MHz, regardless of the signals at the Rate Select inputs. The first divider "predivides" the oscillator signal frequency. The output at F15 is taken from the first divider and will be a constant 921.6 kHz regardless of the Rate Select inputs. The first divider and the output dividers are both connected to the Reset Input line from pin 10.

Outputs F1 through F14 are from additional dividers controlled by a Rate Select Logic section. The outputs from the first divider are subjected to one of four possible "multiplication factors" according to the Rate Select inputs. The available multiplication factors are by 1 (×1), 8 (×8), 16 (×16), and 64 (×64). For example, the four possible output frequencies at F1 are 9.6, 76.8, 153.6, and 614.4 kHz. High (H) and low (L) logic signals at the Rate Select outputs determine the multiplication factor as followings:

Rate Select A	Rate Select B	Multiplication Factor
L	L	×1
L	H	×8
H	L	×16
H	H	×64

Motorola recommends that the oscillator crystal connected to pins 20 and 21 meet certain specifications. It should be parallel mode and be within ±0.05 percent of 1.8432 MHz at a capacitance of 13 picofarads. Additional stability can be gained by connecting a 15-megohm resistor in parallel with the crystal.

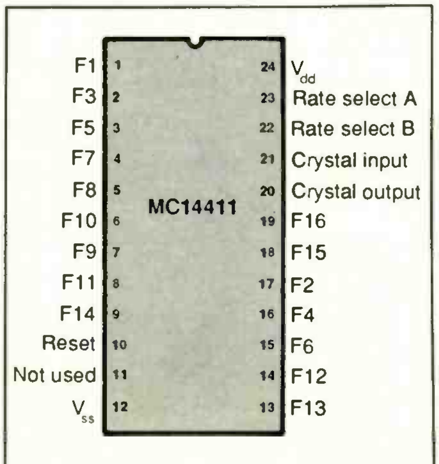

Fig. 1. MC14411 pin connections and packaging details.

Table I
MC14411 Bit Rate Generator

Supply voltages: +5 volts dc (±5%)
Output drive current (sink): 0.78 mA typical
Dc current drain per pin: 10 mA
Quiescent power dissipation: 0.015 mW
Input capacitance: 5 pF
Duty cycle: 50%
Noise immunity: 45% of V_{dd} typical
Prime vendor: Motorola

Table I gives a summary of the essential specifications of the MC14411, while Table II shows the frequencies available at the various inputs for different multiplication factors. Note that the supply voltage for this device is +5 volts, the same as for TTL, although it is a CMOS IC. The +5 volts is becoming the *de facto* "standard" logic supply voltage for these CMOS devices, too, since TTL and CMOS devices alike can be powered from it. Outputs of the MC14411 are buffered and are compatible with low-power Schottky (LS) versions of TTL. All inputs are diode protected, although the usual precautions against static discharge when working with CMOS should be followed.

A data sheet for the MC14411 is available from your local Motorola semiconductor distributor or from Motorola Semiconductor Products Inc., 3501 Ed Bluestein Blvd., Austin, TX 78721.

Digitally Programmable Filters

The MC14411 is an example of a recent push toward producing CMOS devices containing standard analog or linear functions that have previously been implemented using operational amplifiers and supporting discrete components.

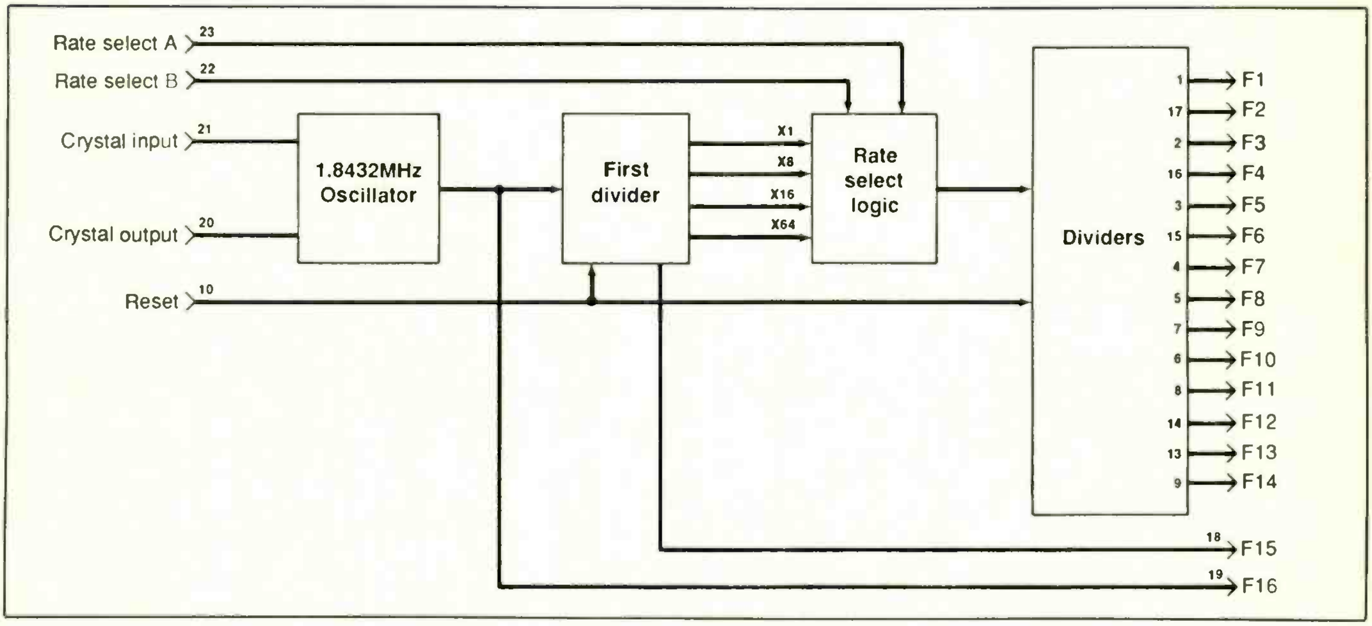

Fig. 2. Block diagram of MC14411's internal circuitry.

Two recent devices are equivalents of popular active filters: the S3528 programmable low-pass and S3529 programmable high-pass filter devices from AMI/Gould Semiconductors. Both are based on switched-capacitor techniques and permit their cutoff frequencies to be adjusted in 64 discrete steps by a 6-bit digital control input.

The S3528 has a frequency range of 40 Hz to 20 kHz, and the cutoff frequency can be set to a desired point in that range. The 64 steps to select from can be custom programmed from a universe of 2,048 possible points via an internal 64 × 11-bit ROM. An internal oscillator section uses an external 3.58-MHz "colorburst" crystal, or it can use TTL/CMOS clock signals. Attenuation at the cutoff frequency and above is better than 51 dB. The S3529 has identical specifications and performance, but it has a high-pass filter function.

There is another interesting similarity between these two devices. Both require a constant +5- and −5-volt dual-polarity power source and both have digital *and* analog ground pins. The internal circuitry of these devices is a combination of linear and digital stages, so they are neither purely digital nor purely linear devices. Do we need a new descriptive term for such ICs, such as "digilinear"?

Details on the S3528 and S3529, including cutoff frequencies for various control inputs and applications circuits, are found in data sheets for each device available from AMI/Gould. You can get these from your nearest AMI/Gould dis-

Table II—Output Frequency Multiplication Factors*

Output	×64	×16	×8	×1
F1	614.4K	153.6K	76.8K	9,600
F2	460.8K	115.2K	57.6K	7,200
F3	307.2K	76.8K	38.4K	4,800
F4	230.4K	57.6K	28.8K	3,600
F5	153.6K	38.4K	19.2K	2,400
F6	115.2K	28.8K	14.4K	1,800
F7	76.8K	19.2K	9,600	1,200
F8	38.4K	9,600	4,800	600
F9	19.2K	4,800	2,400	300
F10	12.8K	3,200	1,600	200
F11	9,600	2,400	1,200	150
F12	8,613.2	2,153.3	1,076.6	134.5
F13	7,035.5	1,758.8	879.4	109.9
F14	4,800	1,200	600	75
F15	921.6K	921.6K	921.6K	921.6K
F16	1.843M	1.843M	1.843M	1.843M

*All output rates measured in Hertz (Hz).

tributor or by writing to AMI/Gould, 3800 Homestead Rd., Santa Clara, CA 95051. A written request for data sheets should be made on company or professional letterhead.

Short Takes

How low can an op amp go? (in terms of voltage, that is). Linear Technology Inc. (P.O. Box 489, Station A, Burlington, ON, Canada L7R 3Y3) recently announced its LC810 op-amp device, which can operate from single- or dual-polarity supply voltages below 1 volt. Its output swings virtually "rail-to-rail" and it can handle typical supply currents of 200 microamperes and drive loads as low as 180 ohms.

National Semiconductor Corp. (2900 Semiconductor Dr., P.O. Box 58090, Santa Clara, CA 95052-8090) has announced publication of its *ASIC Design Manual* and *Semiconductor Master Selection Guide*. The *ASIC Design Manual* covers National's complete line of applications-specific ICs, including circuit functions available in gate arrays and standard cell libraries. Data on designing with ASICs is also included. The *Semiconductor Master Selection Guide* provides basic features and specifications for all of National's standard and ASIC devices. There is also a directory of sources for more detailed information on the various products. Copies of both of these books are available from a National sales office or its corporate literature department.

Speaking of National Semiconductor, they recently acquired Fairchild Semiconductor. Fairchild was one of the true pioneers in the linear IC field, having introduced the first monolithic IC operational amplifier (the 709) in 1965 and following up with what may be the world's most popular op amp, the 741, in 1976. At the time this column was written, National planned to keep many Fairchild devices in continued production, although the Fairchild name (and familiar "μA" part number prefix) will gradually be phased out.

See you next month! **ME**

CAT Control of a Yaesu FRG-8800 with a Commodore C-64 Computer

By Kjell W. Strom, SM6CPI

The microcomputer brought many advantages to modern electronics. Communications is one area in which its benefits can shine, especially if you have a communications receiver already equipped to "communicate" with a computer. Such a receiver is the popular Yaesu FRG-8800.

I'll show you how the Yaesu FRG-8800 general-coverage receiver can be controlled with a Commodore C-64 (or C-128 operated in the C-64 mode) computer. The problems associated with running the C-64 reliably at the undocumented 4,800-baud rate have been solved using a machine-language routine, which is loaded from a BASIC program. A very simple hardware solution for interfacing between the computer and the shortwave receiver is included here as well.

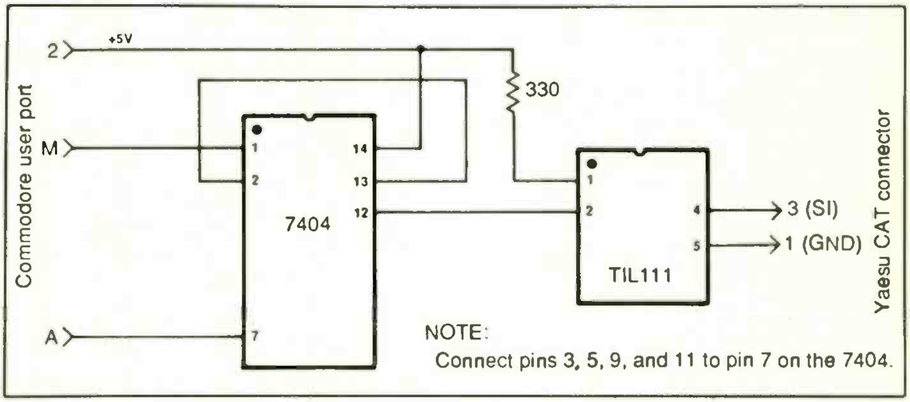

Fig. 1. Schematic diagram of interface between a Commodore C-64 computer and Yaesu FRG-8800 general-coverage shortwave receiver.

The RS-232 Mystery

Yaesu's CAT (Computer Assisted Transceiver) accepts commands sent to it in a standard RS-232C format. This format does not cause any problems. Any advanced book on the C-64 will tell you how to set up the Command and Control registers for a word length of eight bytes with two stop bits and no parity.

Though the CAT system operates at 4,800 baud, the computer's baud rate stops at 2,400 baud. Some available literature gives formulas for calculating nonstandard baud rates. If you try plugging in numbers, you will arrive at the conclusion that the maximum transfer rate is a bit over 5,000 baud. In point of fact, you can set up the C-64 for 4,800 baud with the parameters calculated from these formulas. However, the result is not reliable; sometimes characters get lost on their way to the User Port.

In the program listed here, such problems are avoided by using the aforementioned machine-language routine for handling the RS-232C procedures. There is also a routine for converting the frequency bytes from hexadecimal to decimal format. This is necessary because the frequency bytes calculated in the program are in hex format, while the BASIC interpreter treats all numbers as decimal numbers. You then get an extra decimal-to-hex conversion, which you must undo by reconverting.

Reconversion is easily accomplished in BASIC, but the machine-language routine occupies less memory space and is several times faster than the BASIC program. This can be important in, for example, scanning procedures.

The machine-language part of the program is loaded from the DATA in lines 4110 through 4114 by the command GOSUB 4000. There are four SYS-call entrances to the routines:

1.) SYS 52480 is the 4,800-baud improved version of OPEN 1,2, . . .

2.) SYS 52512 takes the five bytes that have been POKEd into temporary storage at locations 52592 through 52596, does the hex-to-decimal conversion on 52592 through 52596 and sends all five bytes, like PRINT 1.

3.) SYS 52526 sends 52592 through 52596 without conversion, since you do not want to reconvert the 2-byte commands.

4.) SYS 52578 is functionally equivalent to CLOSE 1.

Main Program

Key in and SAVE the program listed elsewhere in this column. Then type RUN 10000, followed by a RETURN to check that the machine-language routine's DATA have been entered in good order. Otherwise, you may lose the program if you try to RUN it without first saving it. (Note: If you are having difficulty in interpreting the reverse block characters in the program, they are as follows: Line 200 contains an R after the first quotation mark and QQ in quotes at the end of the line; Line 1050 also contains an R after the first quotation mark and QQQQQQQ in quotes at its end; and Line 1115 contains SQQQQQQ in quotes after the first quotation mark and has a wide cross graphics character in quotes just before the final "A" on the line.)

The program executes as follows:

Lines 100 through 500 initialize the program, open the RS-232C file and set up the first selection screen.

Lines 1120 through 1295 detect commands from the keyboard and perform them via subroutines.

Lines 1300 through 1320 check that the entered frequency is in the proper format and is within the range of the radio.

Lines 1700 through 1990 first determine the position of the decimal point and then slice up the frequency into four two-digit bytes, POKE them into temporary storage and send them to the microprocessor inside the FRG-8800.

Lines 2000 through 2030 contain the subroutine for exiting the program.

Program Listing With Machine-Language Routines

```
10 REM ==============================
20 REM CAT CONTROL FOR YAESU FRG-8800
30 REM          AND COMMODORE 64
40 REM   BY KJELL W. STROM, SM6CPI
50 REM                   MAY 17, 1987
60 REM ==============================
100 DIM M(12,2):GOSUB3000:GOSUB4000:SYS52480:REM OPEN FILE #1
200 PRINTCHR$(147)"■  YAESU FRG-3800 CAT PROGRAM BY SM6CPI   ";"■■"
210 PRINT" [ 1] CAT ON          [ 2] CAT OFF":PRINT
220 PRINT" [ 3] POWER ON        [ 4] POWER OFF":PRINT
230 PRINT" [ 5] AM WIDE         [ 6] AM NARROW":PRINT
240 PRINT" [ 7] LSB             [ 8] USB":PRINT
250 PRINT" [ 9] CW WIDE         [10] CW NARROW":PRINT
260 PRINT" [11] FM WIDE         [12] FM NARROW":PRINT
270 PRINT" [13] FREQUENCY       [14] QUIT PROGRAM":PRINT:PRINT
300 INPUT"       WHAT IS YOUR CHOICE";C
310 IF C<1 OR C>14 GOTO 300
330 IF C=13 GOTO 1000
340 IF C=14 GOTO 2000
350 GOSUB 500
360 GOTO 200
500 POKE52592,M(C,1):POKE52593,M(C,2):SYS 52526 :REM SET MODE
510 RETURN
1000 REM FREQUENCY CONTROL
1010 PRINT
1020 INPUT"FREQUENCY KHZ";A
1030 IF A<150 THEN A=150:GOTO 1010
1035 IF A>29999.975 THEN A=29999.975:GOTO 1010
1040 GOSUB 1700
1050 PRINTCHR$(147)"■  YAESU FT-757GX CAT PROGRAM BY SM6CPI   ";"■■■■■■"
1060 PRINT"NEW FREQUENCY [N]                     OTHER [O]":PRINT:PRINT
1070 PRINT:PRINT"                   FINE TUNING"
1075 PRINT"              << - <KHZ> + >>"
1080 PRINT"[1]100                               100[-]"
1090 PRINT
1100 PRINT"10   5   1  .1   <   >  .1   1   5   10"
1110 PRINT"[2] [3] [4] [5] [6] [7] [8] [9] [0] [+]"
1115 PRINT "■■■■■■■              KHZ":PRINT"■"A
1120 GET C$:IF C$="" GOTO 1120
1130 IF C$="6" THEN A=A-.025:GOTO 1300
1140 IF C$="7" THEN A=A+.025:GOTO 1300
1150 IF C$="5" THEN A=A-.1:GOTO 1300
1160 IF C$="8" THEN A=A+.1:GOTO 1300
1170 IF C$="4" THEN A=A-1:GOTO 1300
1180 IF C$="9" THEN A=A+1:GOTO 1300
1190 IF C$="3" THEN A=A-5:GOTO 1300
1200 IF C$="0" THEN A=A+5:GOTO 1300
1210 IF C$="2" THEN A=A-10:GOTO 1300
1220 IF C$="+" THEN A=A+10:GOTO 1300
1230 IF C$="1" THEN A=A-100:GOTO 1300
1240 IF C$="-" THEN A=A+100:GOTO 1300
1245 IF C$="A" THEN C=5:GOSUB 500:GOTO 1120
1250 IF C$="Z" THEN C=6:GOSUB 500:GOTO 1120
1255 IF C$="S" THEN C=8:GOSUB 500:GOTO 1120
1260 IF C$="X" THEN C=7:GOSUB 500:GOTO 1120
1265 IF C$="D" THEN C=9:GOSUB 500:GOTO 1120
1270 IF C$="C" THEN C=10:GOSUB 500:GOTO 1120
1275 IF C$="F" THEN C=11:GOSUB 500:GOTO 1120
1280 IF C$="V" THEN C=12:GOSUB 500:GOTO 1120
1285 IF C$="N" THEN PRINT"■■":GOTO 1010
1290 IF C$="O" GOTO 200
1295 GOTO 1120
1300 A=INT(A*1000+.5)*.001
1303 IF A<150 THEN A=150
1306 IF A>29999.975 THEN A=29999.975
1310 GOSUB 1700
1320 GOTO 1115
1700 REM OUTPUT
1710 A$=MID$(STR$(A),2)
1720 IF A=INT(A) THEN A$=A$+"."
1730 A$="000"+A$+"000"
1740 FOR I=1 TO LEN(A$)
1750 DP$=MID$(A$,I,1)
1760 IF DP$="." THEN DP=I:GOTO 1800
1770 NEXT
1800 A$=MID$(A$,DP-6,6)+MID$(A$,DP+1,3)
1810 F1=VAL(MID$(A$,1,2))
1820 F2=VAL(MID$(A$,3,2))
1830 F3=VAL(MID$(A$,5,2))
1840 FA=VAL(MID$(A$,7,1))
1850 FB=VAL(MID$(A$,8,2))
1860 IF FB<25 THEN FC=1:AR=0:GOTO1900
1870 IF FB<50 THEN FC=2:AR=.025:GOTO 1900
1880 IF FB<75 THEN FC=4:AR=.05:GOTO 1900
1890 FC=8:AR=.075
1900 F4=10*FA+FC
1910 A=INT(A*10)*.1+AR
1940 POKE 52593,F1
1950 POKE 52594,F2
1960 POKE 52595,F3
1970 POKE 52596,F4
1980 POKE 52592,1
1990 SYS 52512:RETURN :REM SEND SET FREQ COMMAND BYTES
2000 REM CLOSE1 AND QUIT
2010 INPUT"           ARE YOU SURE";C$
2020 IF LEFT$(C$,1)<>"Y" GOTO 200
2030 POKE52592,M(2,1):POKE52593,M(2,2):SYS52526:SYS 52578:END
3000 REM TITLE SCREEN
3010 H1$="       C A T  P R O G R A M  F O R"
3020 H2$="       Y A E S U  F R G - 8 8 0 0"
3030 H3$="                 BY KJELL W. STROM, SM6CPI"
3040 PRINTCHR$(147):PRINT:PRINT:PRINT:PRINT
3050 FOR I=1 TO LEN(H1$)
3060 PRINT MID$(H1$,I,1);
3070 NEXT
3080 PRINT:PRINT
3090 FOR I=1 TO LEN(H2$)
3100 PRINT MID$(H2$,I,1);
3110 NEXT
3120 PRINT:PRINT:PRINT
3130 FOR I=1 TO LEN(H3$)
3140 PRINT MID$(H3$,I,1);
3150 NEXT
3200 M(1,1)=0:M(1,2)=0        :REM CAT ON
3210 M(2,1)=0:M(2,2)=128      :REM CAT OFF
3220 M(3,1)=128:M(3,2)=254    :REM POWER ON
3230 M(4,1)=128:M(4,2)=255    :REM POWER OFF
3240 M(5,1)=128:M(5,2)=0      :REM AM WIDE
3250 M(6,1)=128:M(6,2)=8      :REM AM NARROW
3260 M(7,1)=128:M(7,2)=1      :REM LSB
3270 M(8,1)=128:M(8,2)=2      :REM USB
3280 M(9,1)=128:M(9,2)=3      :REM CW WIDE
3290 M(10,1)=128:M(10,2)=11:REM CW NARROW
3300 M(11,1)=128:M(11,2)=4  :REM FM WIDE
3310 M(12,1)=128:M(12,2)=12:REM FM NARROW
3320 RETURN
4000 REM LOAD ML
4010 FOR I=52480 TO 52696:READX:POKEI,X:NEXT
4020 RETURN
4100 DATA 169,1,162,2,160,3,32,186,255,169,4,162,104,160,205
4101 DATA 32,189,255,32,192,255,162,3,189,108,205,149,247,202
4102 DATA 16,248,96,162,3,188,113,205,185,117,205,157,113,205
4103 DATA 202,16,244,162,1,32,201,255,173,14,220,41,254,141
4104 DATA 14,220,162,4,189,112,205,168,173,161,2,41,1,208,249
4105 DATA 152,32,210,255,202,16,238,173,161,2,41,1,208,249
4106 DATA 32,204,255,173,14,220,9,1,141,14,220,96,169,1,32
4107 DATA 195,255,96,0,0,2,0,0,206,0,207,0,0,0,0,0,0,1,2,3
4108 DATA 4,5,6,7,8,9,16,17,18,19,20,21,22,23,24,25,32,33,34
4109 DATA 35,36,37,38,39,40,41,48,49,50,51,52,53,54,55,56,57
4110 DATA 64,65,66,67,68,69,70,71,72,73,80,81,82,83,84,85,86
4111 DATA 87,88,89,96,97,98,99,100,101,102,103,104,105,112
4112 DATA 113,114,115,116,117,118,119,120,121,128,129,130,131
4113 DATA 132,133,134,135,136,137,144,145,146,147,148,149,150
4114 DATA 151,152,153
10000 REM 'RUN 10000' FIRST TO CHECK ML DATA LINES
10010 S=0:FORI=52480TO52696:READX:S=S+X:NEXT
10020 IF S<>22004 THEN PRINT"CHECK ML DATA!":END
10030 PRINT"ML DATA OK!"

READY.
```

Lines 3000 to 3150 contain the subroutine for the title screen.

Lines 3200 through 3310 consist of the matrix that contains the decimal values of the 2-byte commands.

Lines 4000 through 4114 contain the machine-language loader and data.

Lines 10000 through 10030 contain a checksum program for the DATA lines.

Using the Program

Using this program is quite straightforward. The title screen is displayed while the machine-language routines are being loaded. After loading is complete, the selection screen appears with all available CAT commands.

Once CAT has been activated, the radio will not respond to the controls on its front panel until you type in the CAT

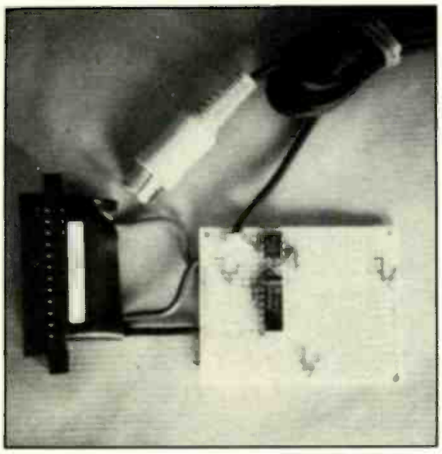

Fig. 2. Interface circuit wired on perforated board, using soldering or Wire Wrap hardware and a socket for the 7404.

OFF command at the computer. For example, if you try to leave the program with STOP/RESTORE, the FRG-8800 will remain locked up until you remove and reinsert the memory back-up battery. The Quit Program command is the safe way out, since it deactivates CAT before leaving the program.

FREQUENCY brings you to the main operating screen, where you can tune the frequency up and down in different-size steps, using the upper row on the keyboard. For example, you may find it comfortable to tune across the shortwave bands in steps of 5 kHz, which is the standard channel separation.

From the main operating screen, you can also switch mode using the following keys:

A = AM wide	Z = AM narrow
S = USB	X = LSB
C = CW narrow	D = CW wide
F = FM wide	V = FM narrow

The N key for New Frequency allows you to move to any frequency, and the O key brings you back to the selection screen.

The Hardware

If you do not like to solder, you may prefer to use the Yaesu FIF-232C external interface box for the hardware needed to interface the receiver to your computer. Just keep foremost in mind that the C-64 does not produce standard RS-232C signals, but an inverted TTL-level variant. There is a switch (*SO1*) inside the FIF-232C that takes care of this disparity. You will have to change its position before using the interface with the C-64 computer, since it is supplied set for standard RS-232C.

A simple interface circuit is shown in Fig. 1. To wire it you will need a 7404 hex inverter, a TIL111 or equivalent optical isolator, a 330-ohm (¼-watt, 10-percent tolerance) resistor, a 6-pin DIN plug for the CAT input and a small perforated board with holes on 0.1-inch centers and an edge connector to mate with the C-64's User Port (or a solderless breadboarding socket and separate edge connector to which you can run wires). You will also need hookup wire and 3 to 5 feet of shielded cable. Normal audio cable works well for the latter and is easier to handle than most r-f coaxes.

Build the interface circuit with as short connecting wires to the edge connector as possible. This will help in reducing noise from the computer. Bear in mind that Commodore's convention is to skip the letters G and I on the lower row of the User Port (positions are denoted by the letters A through N, minus these two exceptions).

The cable's shield connects to pin 4 of the optocoupler and to pin 1 of the DIN plug but *not* to any grounded point connected to the computer. This is also a way of keeping computer noise to a minimum. A completed interface circuit I assembled is shown in Fig. 2.

Before connecting the interface between your computer and receiver, double check all wiring to make sure it conforms with Fig. 1. When connecting the interface, make sure that power to both the computer and receiver are turned off. Also, since the C-64's CIA chip is sensitive to both overloading and static electricity, *never* do any soldering in the circuit while the interface is connected to the computer.

Summing Up

Though the short program shown here only serves as an illustration of what can be done with the CAT system, it contains all the basic tools needed for more elaborate designs, such as scanning stations kept in a database file, using the computer as a clock timer, etc. More detailed information on the CAT system can be found in the FRG-8800's Operating Manual. **ME**

How to recover use of your TV/VCR remote controllers in a cable setup and finding buys at electronics flea markets

By Curt Phillips

Welcome to "Electronics Omnibus." This column will cover a broad spectrum of electronics activities: audio, video, computers, communications and other general electronics topics. I'll be reviewing new equipment and developments in these areas as well as covering topics of general interest to electronics enthusiasts.

Cable Television

One of my pet peeves is the way that many cable television companies negate the utility of remote-control TV receivers and programmable VCRs by requiring that all channels come through their special converter. One of the attractions of cable TV is the premium channels and special programming they offer. Because they charge extra for these channels, almost all cable companies scramble them. When the premium channels are descrambled outside the subscriber's house, a cable-ready TV/VCR can be used directly. But very often scrambled channels require an in-the-home converter/descrambler, which can make your remote controls and programmable VCRs useless.

However, if you are fortunate to be served by one of the older-style cable systems, you can recover most of the usability from your remote control and VCR.

Midband and superband cable channels can be converted to uhf frequencies by use of "block converters" available from many sources. One use of a block converter is to make any TV receiver or VCR "cable ready," but for the purpose I am describing they are useful with equipment that already tunes cable channels.

Most of the converters supplied by the cable companies output to Channel 3 or 4, and block (filter) out all other channels. Even if your TV/VCR is cable-ready, you must use the cable company's converter to descramble the premium services (HBO, Showtime, etc.) paid for; filtering action of the cable converter prevents the tuner from receiving anything on the other channels. (Occasionally, you may receive a weak picture on a few of the other channels due to the cable wire acting as an antenna.)

By using a block converter as shown in Fig. 1, you can use the cable converter to descramble the premium channels you subscribe to, which are then tuned on the output channel (Channel 3 or 4, typically). All other cable channels will then be tuned on the uhf channels. Since a block converter also converts vhf Channels 2 through 13 to uhf, the original occupant of Channel 3 will be tunable on one of the uhf channels. The exact uhf channel will depend on the brand of converter you have, but a conversion chart is often included with it (otherwise, it can be found by trial and error).

With your TV/VCR combination wired this way, you can watch one channel and tape another, program your VCR for multiple-event taping of different channels and use your remote controls as they were originally designed to be used!

If you have *two* scrambled premium channels, it can get a little more difficult. You can use the foregoing system and choose one scrambled channel at a time for programming or simultaneous taping/viewing with the other channels. If you want maximum flexibility, however, there is another wiring option.

In this case, you will need two converter/descramblers, one tuned for output on Channel 3 and the other tuned for output on Channel 4 (it is not mandatory that they use Channels 3 and 4, but they will probably be your only choices). Usually, a second converter/descrambler is available for a nominal fee from the cable company. Be sure to specify that the output of the second unit is on a different channel than the first one. Connections for the two descramblers are shown in Fig. 2. A signal mixer, also known as a channel combiner, is widely available (MCM Electronics' Part. No. 33-255, for example).

Tune the first unit to premium channel "A" and the second to premium channel "B." Now you still have access to all the other cable channels via the uhf tuner, and the scrambled premium services are on Channels 3 and 4. If you have more than two scrambled premium services, this setup will allow you to watch any premium channel while simultaneously taping another.

As mentioned earlier, these techniques work with the older cable systems. Some cable operators use a newer addressable system that scrambles *all* channels outside the original vhf Channels 2 through 13. If you are served by a company using this type of system, the techniques described here will be of only limited use.

Electronics Flea Markets

A great source for electronic parts and other equipment that is under-utilized by general electronics hobbyists is a radio/electronics/computer show and flea market known as "hamfest."

Hamfests began as get-togethers for amateur radio operators (hams) to pro-

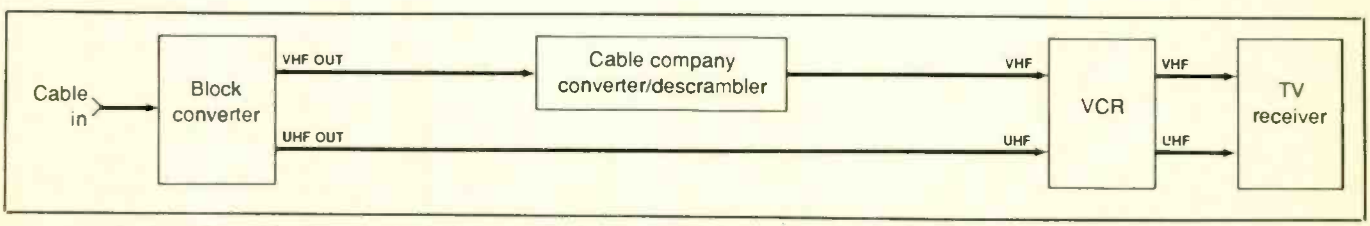

Fig. 1. Using a block converter to tune a premium pay-TV channel and any other cable channel simultaneously.

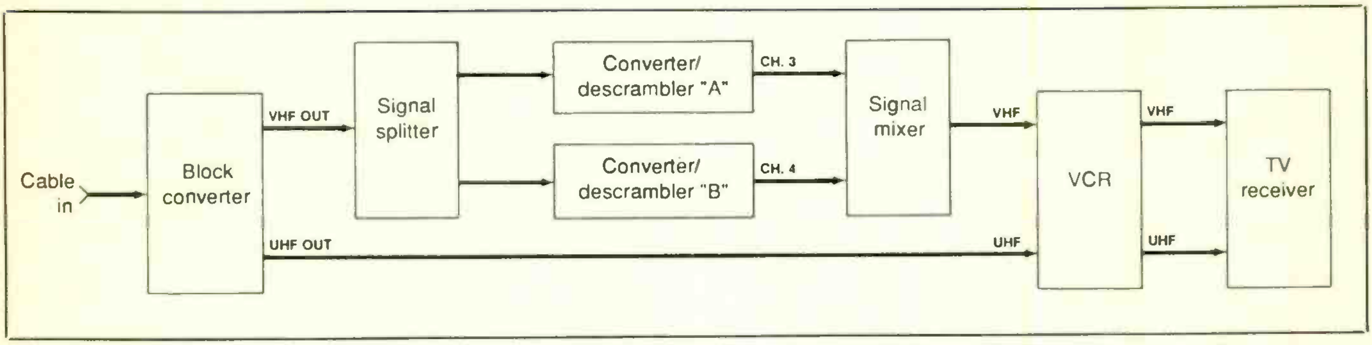

Fig. 2. Using a block converter and two converter/descramblers to tune two premium pay channels and any other cable channel simultaneously.

vide a place for them to meet people they have talked with over the air, sell and swap their used radio equipment and look at new equipment. Although they still serve that purpose, their scope has broadened considerably.

There is good support from many manufacturers and dealers who set up "booths" at these meets to sell their wares. Many hamfests now are also computerfests, and some actually bill themselves that way. The place of most interest to the general-electronics enthusiast is the flea market. Far from being limited to ham radio gear, hamfest flea markets offer bargains of all types.

Often, the flea market area contains several "semi-professional" dealers (people running part-time businesses who only sell at flea markets on weekends) who offer electronic parts and computer chips at prices far below retail. Among the offerings by private individuals are the expected ham radios and shortwave receivers, but also stereo gear, telephones, oscilloscopes and other test equipment, computers, and many items that you might find at a yard sale (my father purchased a ¾-hp motor and an electric drill at a hamfest).

The flea market is also a trip into the past. Ex-military technicians may come across electronic equipment that they worked with many years ago, and one can trace advancements in electronics by the age of the items offered for sale. Much of the older equipment is best suited for parts scavenging, nostalgia and other unconventional uses, of course. Some are real operating bargains, such as, say, a Hammarlund HQ-180A tube-type general-coverage receiver that can still run rings around some new solid-state units in certain respects.

Hamfests take place all over the country, year round. Most are held on a Saturday or a Sunday for one day only. Some of the larger ones run on both Saturday and Sunday. The country's largest hamfest is the Dayton (Ohio) Hamvention™ which is held every year the last weekend in April on Friday, Saturday and Sunday. The flea market at Dayton is so large that it can take over a full day to make one browsing pass through it. The adjacent arena contains displays by ham radio manufacturers, who use Dayton to introduce their major new pieces of equipment.

To find out when a hamfest will be held near you, check newspaper public-service announcements and/or contact a local amateur radio club. The American Radio Relay League can supply you with the names of clubs in your area and a listing of some of the hamfests scheduled. *CQ The Radio Amateur's Journal*, a *Modern Electronics* sister publication, is also a fine source of such information.

Some hamfests are held in arenas and convention halls and some are held at parks and fair grounds. The arenas are nice and provide protection against inclement weather, but some of the more interesting (offbeat) equipment can be found at the ones held outdoors because of the ease with which people can display their wares. Most outdoor hamfests allow people to drive up in their car/truck/van, find a suitable spot to park, open the trunk and start selling (tailgating). This spontaneity increases the number of people exhibiting at the flea market and expands the variety of goods offered.

Because most hamfests are sponsored by amateur radio clubs, which use them for fund raising, there is often a nominal entrance fee. Some hamfests make the fee (typically $3 to $5) optional, and at most the fee enters you in a drawing for radio equipment, antennas, technical books and the like. If you are in the market for any electronics goods at all, you will save enough on your purchases to cover the ticket price.

Your comments and suggestions for this column are welcome. You can contact me at P.O. Box 678, Garner, NC 27529, or by computer on Delphi (CURTPHIL) or The Source (BDK887). **ME**

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MCM Electronics
858 E. Congress Park Drive
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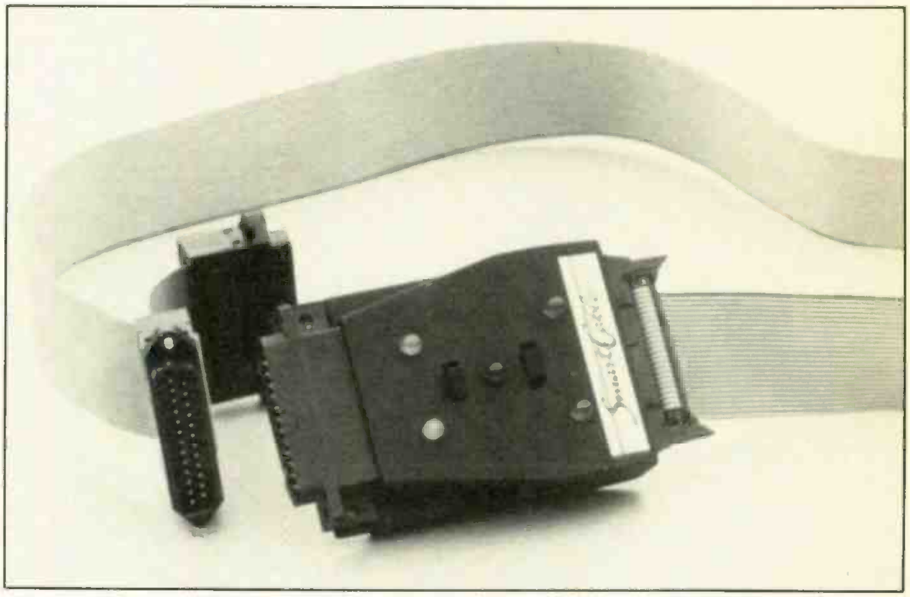
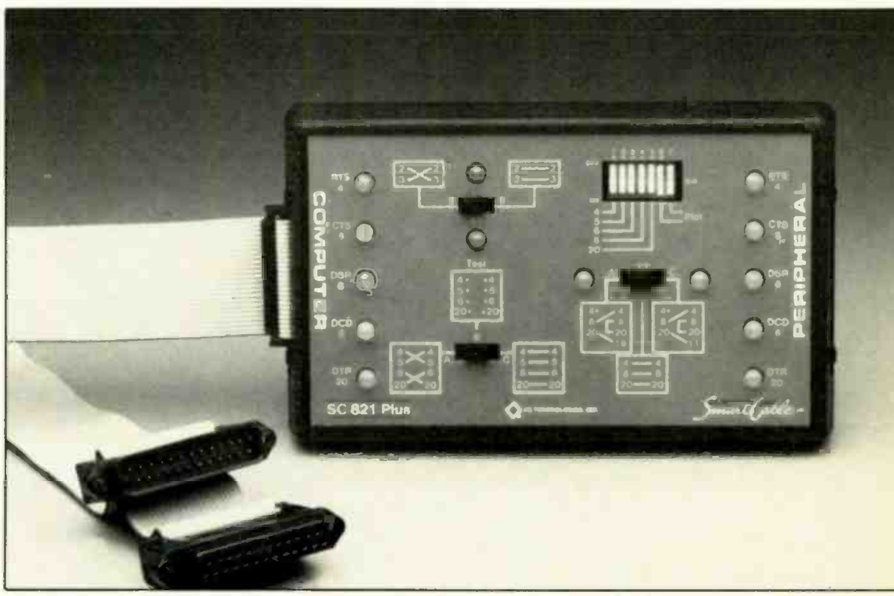
IQ Technologies simplifies RS-232 troubleshooting and making letters with Bitstream's "Fontware"

By Ted Needleman

Last month, I went through some of my trials in getting an E.I.T. pc-FAX board and scanner working. This underscored how complex it can sometimes be to troubleshoot a problem. Sadly, the system is still not working. It's in a third computer so far (this board has done more traveling than I have!) and, while the scanner now scans, the FAX refuses to talk to anyone. Diagnostics that E.I.T. includes with the package don't indicate anything wrong, but something obviously is. Furthermore, the scanner will only work with E.I.T.'s software. Publisher's Paintbrush will likely drive the scanner, too, but not without 2.5 megs of memory, a fact not mentioned in ZSOFT's documentation. In any case, I've spent enough time on this one. It goes up on the shelf for now.





IQ Technologies' Model SC817 SmartCable (above) and Model SC817Plus SmartCable Maker (below) let you breeze through RS-232C troubleshooting.

Troubleshooting Made Easier

There is at least one area where troubleshooting has gotten considerably easier over the years—serial RS-232 connections. Some of this has come about because manufacturers of equipment are actually starting to pay some attention to the "standard" instead of adding their own "improvements." Another big help, though, is the line of products from a small company called IQ Technologies. I've had one of its original SmartCables (Model SC817) for years. This is a "clever" little device consisting of a cable with male and female DB-25 connectors on one end and a small box with two slide switches, five LEDs, and another DB-25 on the other. You just plug the box into the computer's serial port, and the cable into the peripheral. Slide the switches to get the correct set of lighted LEDs and, if the baud rate and other parameters are correctly set, you should be in business. It makes it easy to hook up printers, modems, and computer to computer transfers. There are now three different models of this "low-end" SmartCable, priced of $39.95 or $49.95.

My SC817 disappeared this year. I'd be a lot more upset if I didn't have its big brother, the SC821Plus Smart CableMaker. This is a small box, about 3 by 5 inches, with three slide switches, a set of DIP switches, and numerous LEDs. There are two cables, one to the computer, the other to a peripheral, and both have male and female DB-25s. The Smart CableMaker operates in a manner similar to the Model SC817. You follow the manual's directions—flipping switches to obtain specific results on the LEDs. The difference is that when you are done, not only is your peripheral connected, but by looking up the positions of the switches in the manual, you are presented with a wiring diagram for a custom cable! At $149.95, not everyone will rush out to buy one, but if you are spending a fair amount of time perusing manuals to find pinouts so you can wire up a custom cable, this gadget will save a considerable amount of time and effort.

My only complaint with the Model SC21Plus is that there should be a DB-9 adapter available for it (or supplied with it). Ever since the IBM AT showed up with this connector on its serial port, every new 286 and 386 followed suit. These adapters are available from other sources, but it would make more sense for IQ Tech to ensure the overall applicability of their product. The company also supplies several Smart Switch Boxes which let you share printers and/or modems between two systems (and contain the same "smart" circuitry that the Smart Cables do), and an interesting tester called the Smart Data Meter.

One of the real killers in serial interfacing is determining not only that the serial port is actually outputting data, but that the parameters of this data (speed, parity, data length, and start/stop bits) actually match up with what the receiving machine expects. If any of these parameters differ between the two systems, data transfer will not take place, even though a link is established.

Just as the Smart Cable series helps solve cable mismatch problems, the Smart Data Meter 931 can help you determine whether there is a parameter mismatch. The unit can be used in either of two ways. You can hook it up to a serial output port and, by pressing a membrane switch to select various menu items from its LCD "billboard" display, read out data values being output from the port. Or, if you're not sure that the settings on a printer or other serial peripheral are correct, you can use the Model 931 as a test pattern generator, again setting various parameters with the membrane switch.

The SMD931 doesn't have the almost universal applicability of the other IQ Technologies products. And at $399, you'd have to be pretty deep into trouble-shooting to cost-justify it. But if you act as a PC coordinator for a company, do much consulting, or are a service tech for a computer store, you really should take a look at this device. Users groups might also want to purchase a unit for the use of its members. I like the equipment I've seen from IQ Technologies, and I look forward to receiving its newest product, a "smart" printer buffer/protocol converter.

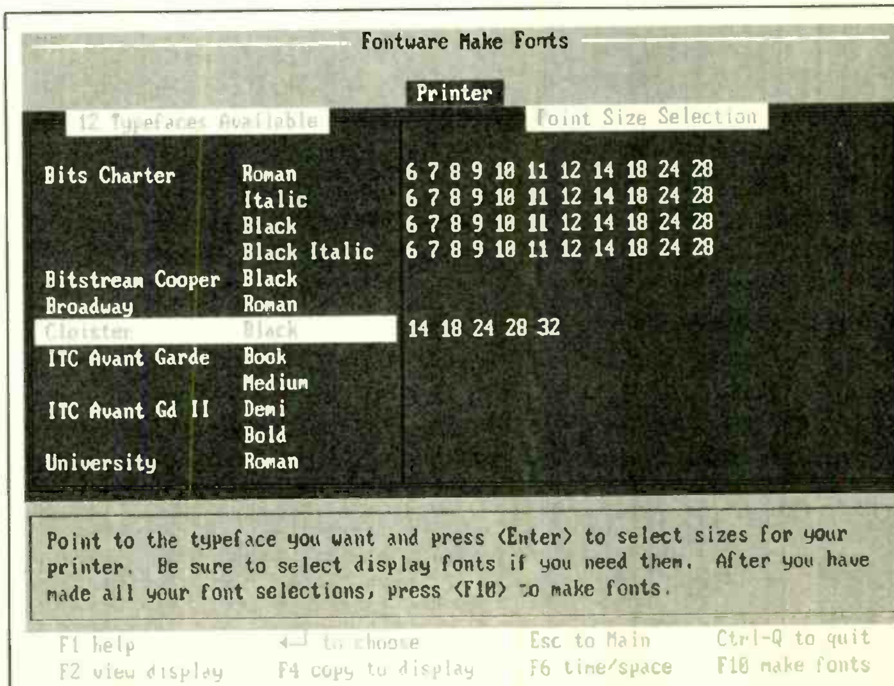
Making Letters

In the last year or so, I've really gotten into Desktop Publishing. This interest came about as a result of a private-distribution newsletter I publish. The first issue was 20 pages and was done as two separate documents on a Mac using PageMaker 1.2 (which has a 16-page length limitation). The second issue was 44 pages, and three separate documents.

Issue number three came after I upgraded to PM Version 2.0. Though it was only 36 pages (the new version of PageMaker allows 128-page documents) my 512K enhanced Mac ran out of steam at page 27, giving me a "Memory Full" message. Issue number four is going to be done on my ITT XTRA, which has 1.5 megs of RAM and an 80-meg hard disk, using the IBM version of PageMaker.

This should take care of some of the problems. In the interim, however, I've also lost use of both an Apple LaserWriter Plus and a QMS PS800+ I had been using with the Mac. Both of these are PostScript printers, and I'm going to really miss them.

PostScript, in case you've somehow missed it, is a page-description language. Its main benefit, at least as far as I'm concerned, is that once it has a (mathematical) description of a particular typeface, it can generate that typeface in any size and weight. For those of you who have been playing with Hewlett-Packard LaserJets or other laser printers, this means that you don't have to have 16 different sizes and weights of a typeface to



Selection menu from Bitstream's Fontware font-generating software from which you can select size and weight of a particular font for desktop publishing applications.

PC CAPERS . . .

experiment with various size text in a document. Not only is this approach expensive, but it also takes up a *lot* of disk space.

A better way is available, though, with Fontware from Bitstream. Fontware, available in versions which will run with MS-Windows-based applications or Xerox's Ventura Publisher, is a font generator. In theory, it's a lot like PostScript. You tell the software what size and weight of a particular typeface you want and it generates it from an outline supplied on a font disk. In practice, however, the software operates differently from Postscript.

PostScript fonts are generated at print time in a PostScript processor contained, in most instances, within the printer. Fontware fonts, on the other hand, are generated in a process completely outside of the desktop publishing application. Each separate font is saved to disk. Then the page layout program (or word processor) downloads them to the printer when needed, just like any other softfont you buy on disk. You can generate fonts in any size that your printer will support.

When setting up the Fontware Installation Kit ($99), you define both the printer you will be using, and the display you have. Fontware will not only generate a printer font, but a matching screen font as well. In addition to the installation kit, which is actually the font generator, you will need Typeface Packages, each of which contains the "outline" of a particular typeface. At the moment, Bitstream has 20 of these disks ($195 each), and supplies an attractive typeface called Bitstream Charter along with the Installation Kit.

Fontware works as claimed, requiring an IBM AT (or compatible) with at least 512K RAM, and MS-DOS 3.1 or higher. Note that when Bitstream says 512K, they *mean* 512K. When I first tried the package on my AT, it would not run (I received an error message) until I made more memory available by taking my MicroSoft Mouse driver and control panel out of memory.

The Kit displays the approximate length of time to generate the fonts you've requested before actually embarking on the task. I found this estimate to be off by quite a bit. For example, after selecting several fonts, Fontware informed me it would take 37 minutes to generate my selections. Actually, it took just about an hour.

Bitstream recommends several things to speed up the process including additional memory to 640K and a numeric coprocessor. While bumping up memory to 640K is overdue on this machine, I'd just as soon run Fontware overnight than spend an extra $300 or so for the 80287 chip. But others may feel differently.

I'm certainly impressed with Fontware and the results it generates with PC PageMaker. One last plus when using it—when the fonts are generated, they are immediately usable by Windows applications, whereas the downloadable softfonts may have to be converted before they can be used. **ME**

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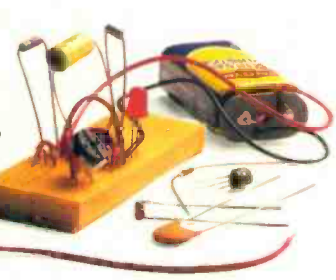

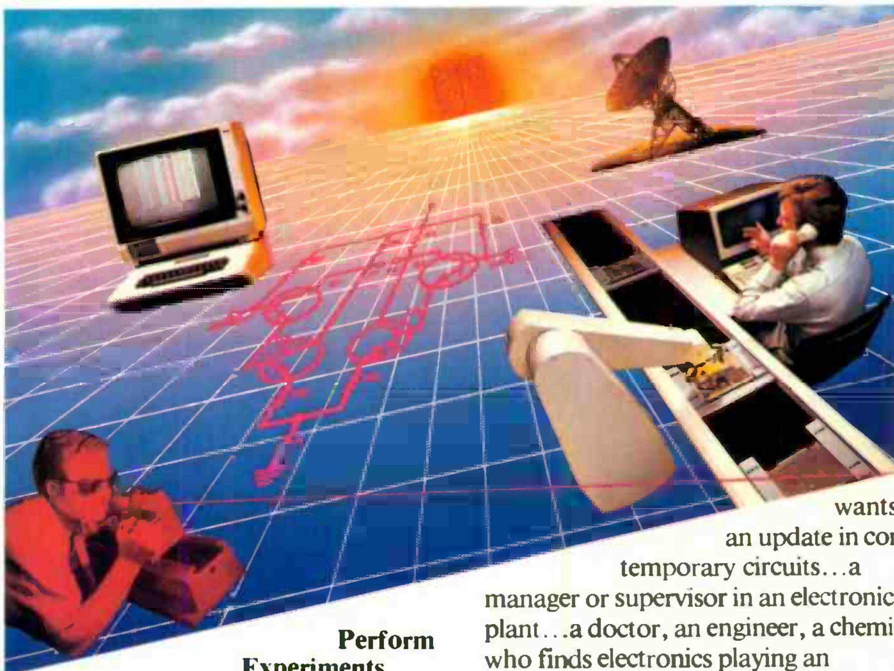

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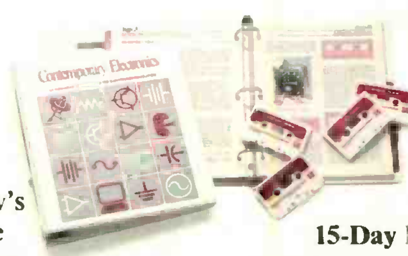

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The Logimouse C7

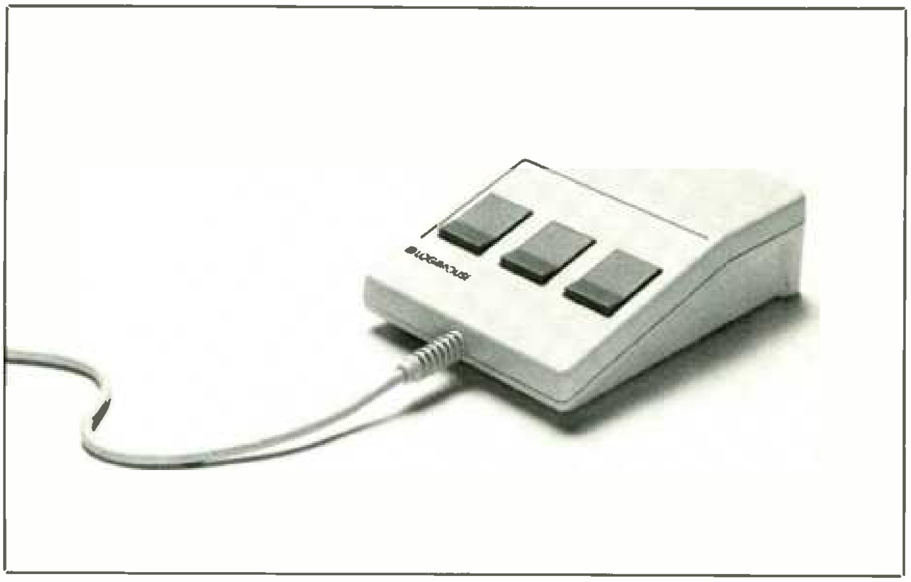
By Art Salsberg

The mouse input device gathered popularity when Apple Computer's Macintosh debuted. IBM'ers were left in the dust, it seemed. Quickly, however, mouse cursor-pointing devices were introduced for MS-DOS machines. "Point and Click" was in, though compatible software for it still hasn't caught up to that for the graphics-oriented Mac's.

A mouse has a small rotating mechanical ball or an optical sensor on the underpart of its small case to keep track of the user's movement of it and the screen cursor's position. The Logimouse C7, examined here, uses the former, which, unlike the optical type, does not require a special surface for it to move on. (Internally, Logimouse contains an optical sensor, however, so it's really an opto-mechanical device.) Any clean, flat surface will do. It has three control buttons on its top surface that are used to place data, draw, or work with text for editing, copying and selecting. Though only two buttons are generally used (and, in fact, the competitive Microsoft Mouse has only two), the third can be very useful for customizing keyboards.

Manufactured by Logitech (Redwood City, CA), a major OEM supplier of mice before it entered the retail arena, Logimouse C7 is a proven, rugged device. Moreover, its $99 retail price for a high-quality product is appealing.

Logimouse plugs into a serial port through a connecting cable on an IBM or compatible, with a programmable baud rate of up to 9600 that provides good curve-tracing accuracy. (A bus-type Logitech mouse, with a half-size board, is also available.) Its driver makes it compatible with Microsoft applications, a standard that most of the software industry uses, as well as other serial mouse devices and many digitizing tablets. An automatic memory-resident file, "Click," detects and sets up Logimouse for the proper application configuration. Resolution is 200 dots per inch, the same as Microsoft's. A variety of pop-up menus give you a speedy point-and-click choice.



In-Use Comments

Logimouse C7 comes with a nice, thick (202 pages) User's Manual that packs a lot of information. At first blush, it might seem to have too much data, in fact, as each function possibility is fully described. The mouse package includes the mouse itself, a driver disk, a Logimouse Plus Disk, and the manual. One should specify if the mouse is for an IBM PC/XT or an AT type of computer since connectors for each are different. The mouse disk contains driver enhancements such as menus, text editor, etc. Logimenu allows the user to write programs to simplify application operations.

Installing the driver and the utilities

```
A20:                                                              READY

    A        B        C        D        E        F             G
1  Monthly Mouse Sales Predictions -- 1956
2
3  Month              Units    Avg Price              Amount
4  ---------------------------------------------------------------
5
6  January              300      $350.00        $105,000.00
7  February             400      $345.00        $138,000.00
8  March                450      $250.00        $112,500.
9  April                600      $239.00        $143,400.   Retrieve
10 May                  500      $200.00        $100,000.   Graph File
11 June                 700      $199.00        $139,300.   Save
12 July                 800      $155.00        $124,000.   Sum Column
13 August             23000      $160.00      $3,680,000.   Sum Line
14 September            500      $130.00         $65,000.   Fast Quit
15 October              600      $120.00         $72,000.   Print Range
16 November             700      $110.00         $77,000.   Range Format
17 December             800      $100.00         $80,000.   Worksheet Fmt
18 ----------------------------------------------------------  Column Width
19 Total              29350    $2,358.00      $4,836,200.   Transpose
20                                                          Graph Type
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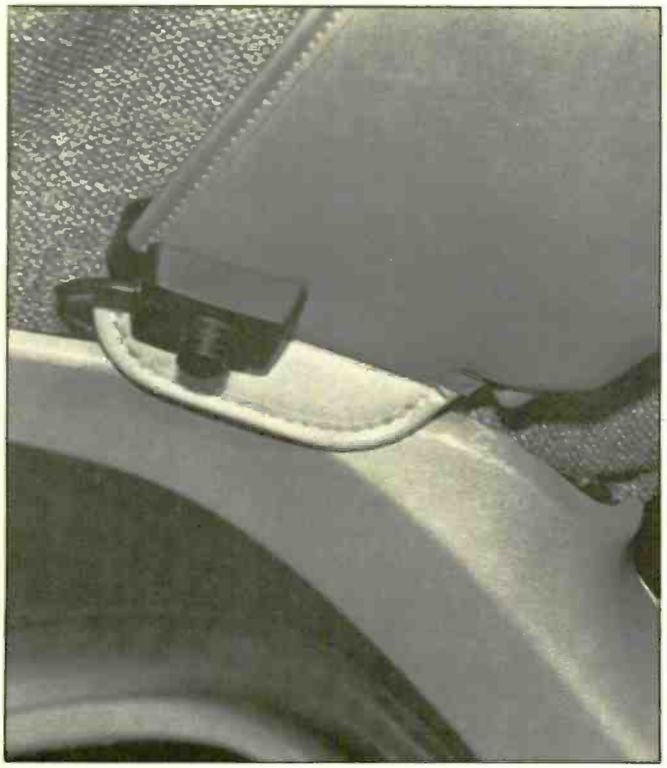
This printout illustrates Logitech C7 software's point-and-click shell pull-down menu (right) for Lotus 1-2-3.

went smoothly, even though a variety of options are offered. Using a bevy of optional, low-cost software packages underscored how quickly one can learn to use a mouse to improve productivity in many areas. LogiPaint (actually, PC Paintbrush packaged for use with LogiMouse) is an exciting package to use on a color monitor, for example. Its icon menus for graphics and text demonstrates a mouse's utility immediately. Providing 16 colors and 11 type fonts turns one into an amateur artist rather quickly. LogiCADD (a version of Generic CADD 2.0) illustrates how a micro is used for computer-aided design and drafting purposes. (A minimum of 512K of RAM is needed here.) Together with the included DotPlot, your dot-matrix printer can be made to perform like a plotter. There's a point-and-click shell for the ever-popular Lotus 1-2-3, too, which is surprising since the applications software does not have mouse-use provisions. Using only 5K of RAM, it can be added to the program so that the interface loads automatically together with 1-2-3. All three buttons are used: the left points and selects from a menu that is called up with the middle button, while the right button serves as Escape. It's a nice enhancement for this omnipresent application program.

The mouse's movement on its rubber-coated ball was always very quiet and smooth, operating well in a very small area. Clicks from the switches always let you know when one was depressed.

We're impressed by Logitech's C7 mouse and the optional software offered by the company. They add another dimension to computing in general, and make it possible to work with graphics on MS-DOS machines like no keyboard effort ever could. With both hardware and software prices being modest, a wide selection of compatible applications software available, and the flawless operation of the system, Logimouse C7 is deservedly a very popular device that anyone with an MS-DOS machine who has never gone the mouse route should give serious consideration. **ME**

CIRCLE 4 ON FREE INFORMATION CARD



6. Full-duplex, hands-free operation is possible with the aid of the clip-on microphone supplied with the phone. Determine a suitable location, such as on the windshield visor, and clip into place. Wiring is routed behind the dashboard, windshield pillar trim and windshield seal.

7. The end of the antenna coaxial cable is stripped and the coax connector is installed, as shown. Professional installers advise that the most common antenna problems encountered by do-it-yourselfers are due to improper crimping. Be sure to use crimpers specifically designed for this purpose.

8. This model is a compact unit that can be installed as shown with both handset and transceiver as a single unit. If desired, the transceiver can also be remotely mounted in your trunk like most standard cellular setups, with the handset secured by an optional cradle up front. If installed in this manner, cabling must be routed from the handset to the transceiver location in the trunk.

The all-in-one installation is convenient because the phone can be easily positioned on its mount, cinched down with a thumbwheel, and locked into place. It is simple for a vehicle owner to unlock and remove the phone at will, or to use it as a transportable with an optional battery pack, shoulder strap, and plug-in antenna.

Antenna coax is routed beneath carpeting or behind interior trim so that it can join phone to antenna. Since this particular installation is in a van, the coaxial cable was routed behind wall and ceiling upholstery to the van roof.

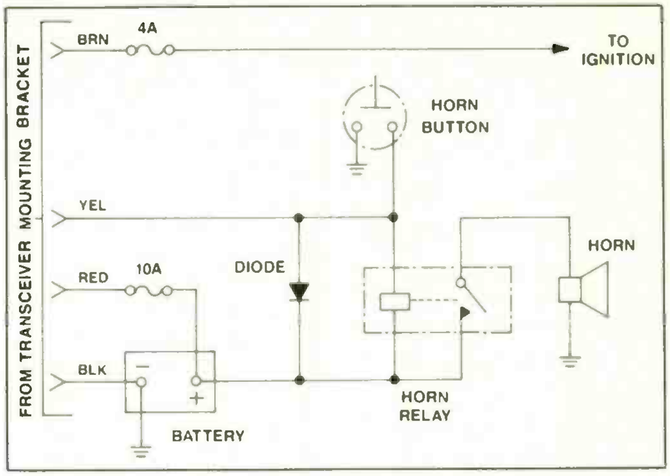
Some surface-mount antennas require a hole to be drilled into the vehicle's body, as is the case here. However, others can be simply clipped into position with readily-available brackets. Trunk-mount antennas that clip to the leading edge of a vehicle's trunk are popular models, as are windshield-mount types that need no drilling at all.

The antenna mount is fed through the hole from the underside and held temporarily in position with needle-nose pliers. The mount's trim ring is installed and its setscrew tightened to secure the assembly in place.

9. This ORA Electronics antenna simply screws onto its mount, as pictured. Many different types and styles of cellular antennas are available to suit a variety of different needs and tastes.

10. Before using any cellular telephone, it is necessary to have its NAM (Number Assignment Module) removed from the phone, programmed, and reinstalled. Many communications companies offer this service for a nominal fee, usually around $25, and can also process your application for service with your local cellular phone company.

With the NAM programmed and your new cellular telephone installed, you're ready to enjoy the convenience of clear, two-way communications on the road. Contemporary units like this Mesa-55 offer many of the same handy features as home phones, such as repertory dialing from memory, last-number recall, on-hook calling, and much more. Since cellular phones can be used in conjunction with items like mobile computer modems, their functionality for on-the-go professionals is almost limitless.



11. Connections of the unit's power cabling is straightforward, as noted here. A nice touch is that you can wire the unit so that your horn will beep intermittently when a call comes and you're out of the car. Mitsubishi recommends the use of a diode when wiring to the horn relay to prevent damage to the phone. ME

The Illustrated Handbook of Desktop Publishing and Typesetting by Michael L. Kleper. (TAB Professional and Reference Books. Soft cover; 770 pages; $29.95.)

This is an ambitious encyclopedia of desktop publishing and typesetting. In a large 8.5″ × 11″ format, and weighing almost five pounds, it's a treatise on the current state of the art in which the microcomputer has the starring role. It combines an historical chronicle of the field with software and hardware typically used today with healthy doses of how-to information. Furthermore, material is beautifully presented with crisp, clear text and is tastefully illustrated with many photographs and pleasantly rendered artwork.

The handbook opens with a discussion of type and typesetting, including measurements (point size, em, styles, etc.), then segues to the next chapter on word processing. Here, both phototypesetting and word processing on microcomputers are discussed, followed by a chapter that details popularly used microcomputer word-processing packages by phototypesetters, such as familiar WordStar and Xywrite packages and the lesser-known Gutenberg for Apple II computers, T-Word for the portable Model 100, etc. Chapter 4 digs into text creation, generation and reformatting. Included here are synonym finders, macro programs, etc.

Next, logically, is a chapter devoted to telecommunications to move data to typographic output devices and between systems. Then a data manipulation and conversion chapter discusses various software and hardware for these purposes, such as Compat to convert CP/M to MS-DOS, MCS-Transfer to generate IBM PC or Radio Shack Model III or IV data to a form that can be used by a Compugraphic phototypesetting machine (an in-house system used for setting the type you see here), ReadySetGo-MW to do the same for an Apple Macintosh (both text and graphics) and Cauzin Softstrip equipment.

Succeeding chapters present typesetting hardware tools that enhance productivity, such as special-purpose keypads and a hardware/software font-development system; professional typesetting software, such as Easy-K, which integrates software and hardware being used for publishing purposes, such as, say, WordStar software and a Kaypro computer. Others include PC-TS, which converts an IBM PC or compatible to an emulator of a Compugraphic MCS text-input station, page layout software, and a variety of others. Some descriptions go into great depth, illustrating how they work with accompanying video screen displays.

A chapter on specialized typesetting languages is particularly interesting. MicroTEX, a technical text processing system, for example, implements complex math expressions; GenCode deals with software to code a document according to content, such as type face and size for captions. Not surprisingly, a host of chapters are devoted to desktop publishing, which has become an important aspect of microcomputing. A great many software packages for this purpose are explored for the Apple LaserWriter system and IBM desktop publishing alternatives. About 200 pages, in fact, detail the workings of products used to implement such publishing methods with the two major personal computer systems, including Postscript, Xerox Ventura, and Pagemaker software. A follow-up chapter covers output devices, such as the HP laserjet, phototypesetting equipment such as Allied Linotype, and accessory products such as interfaces.

Rounding out the handbook are chapters on making typesetting decisions, business information, such as costs and billing; desktop publishing and typesetting applications, such as details on producing a newspaper, processing input for financial printing, newsletters, user profiles, etc.; and, concluding, helpful sources of information, such as vendors, user groups, and trade organizations.

For anyone interested in desktop publishing or having material set by professional typesetting equipment through data generated by a personal computer, this is a very valuable book. It's also an interesting book from an historical perspective. Like all books of this nature, the very latest products cannot be included since new products are continually debuting. Large books such as this one have a longer than normal preparation period, too, which puts them further behind. Consequently, the book does not address the most currently available products such as the HP Series II laser printer, Ventura Version 1.1, etc. But this handbook is not meant to be a buyer's guide to the latest equipment and software anyway. What it is is a trip through the varied developments that have been used to set type and computerize operations right up to and including text and graphic page layout. Anyone who thought they knew it all by reading special-interest computer magazines is in for a big surprise because people involved professionally in preparing copy and graphics for publication often use a host of products that others do not. Author Kleper, therefore, provides the reader with breadth and depth in the desktop publishing and typesetting field. Thus, this illustrated handbook is more than a source of information. It's also educational and entertaining. In all, the author and its publisher did a very commendable job.

Guide to Satellite Television Installation by John E. Traister. (Prentice-Hall. Hard cover. 148 pages. $24.95.)

This book provides a comprehensive first source on basic theory, installation and servicing of TVRO systems. Its easy-to-read and -understand text is fully supported by schematic diagrams, nicely rendered two- and three-dimensional drawings and photographs.

A brief introductory chapter contains the basic elements needed to understand satellite TV receiving systems. Written in a basically non-technical format, this chapter contains a satellite locator drawing and a blow-by-blow guide to the 14 most useful TVRO satellites. After this, the remainder of the book is devoted entirely to installation, maintenance and repair of the typical TVRO system. The aim of the book is to show the reader how to spot troubles and correct them with a minimum of time and effort.

Chapters are arranged in logical order. Antennas is followed by cable and conductors, leading to low-noise amplifiers, receivers and antenna drive systems, each discussed in a chapter of its own. Under system troubleshooting, the reader is served a short course in theory, general information and specifications and is introduced to analysis of the various subsections that make up a TVRO system. The closing chapter, Blueprint Reading, covers reading schematic diagrams, identifying components (and their functions) and reading assembly drawings. This well-rounded guide fulfills its stated purpose.

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AT RA2 AT Hard RLL Disk Controller	$185.00

Description	Price
XT slide-out case	$33.75
AT jr. style XT case w/ reset, turbo switch, keyboard lock, power LED, hard drive indicator	$41.85
XT 10 MHz Bare bones box w/ ATjr. case, 150 watt power supply, 10 MHz 8088-1 motherboard, OK RAM DTK/ERSO BIOS, 8 expansion slots.	$236.25
XT 8 MHz base unit w/ slide out case, 150 power supply, 8 MHz 8088-2 motherboard, OK RAM, AT style keyboard, Phoenix BIOS, 8 slots	$249.75
Mono graphic half card w/ printer port	$54.00
Color graphic card w/printer port	$54.00
EGA graphics adapter	$168.75
ATI autoswitch adapter	$236.25
Multi I/O half card ser/par/game/clk-cal/floppy cont.	$63.45
Mono card	$37.80
Printer card	$16.20
I/O PlusII ser/par/clk-cal/game	$49.95
Multi I/O and display ser/par/gam/clk-cal/CGA/MGA/FDC	$120.15
RAM Card 640K w/ OK	$36.45
XT speaker	$1.36
Floppy Controller - 1 port	$25.65
Floppy Controller - 2 port	$31.05
Floppy Controller - 360K/1.2 Meg	$52.65
Combination floppy/hard controller 6220	$114.75
Hard Disk controller 6210	$91.80
Clock card	$22.95
RS-232 card 2 ports	$32.40
RS-232 card 1 port	$25.65
Game I/O card	$14.85
XT turbo motherboard 10 MHz	$118.80
RLL XT Hard Disk Controller	$135.00

Description	Price
Toshiba 360K XT/AT Beige drive	$93.15
Toshiba 360K XT drive	$91.80
Toshiba 1.2 Meg drive	$122.85
Toshiba 3½″ drive	$128.25
Seagate ST225 w/W.D. Controller 20 meg	$364.50
Seagate ST251 40 meg AT drive	$553.50
Seagate ST4038 30 Meg AT drive	$648.00
Seagate ST238 w/ W.D. RLL controller 30 Meg	438.75
Citizen 120D 120/36 cps	$200.00
Seikosha SP1200AI 120/25 cps	$250.00
Seikosha SL80AI 135/54 cps	$350.00
Seikosha MP5300AI 136 column 300/50cps	$515.00
Seikosha MPI 300AI 300/50 cps	$540.00
7 color option for MPI300AI	$125.00
Star LV1215 120/140 cps + NLQ	$235.00
Star LV1215 120/140 cps 136 column	$350.00
Star LV1615 160/180 cps + NLQ	$425.00
Star LV2015 200/220 cps + NLQ	$565.00
Star NX 1000 144 cps	$225.00
Star NX 1000C 144 cps color	$245.00
Star NB24-10 24 pin 216/72 cps	$594.00
Star NB24-15 24 pin 216/72 cps 136 column	$799.00
Brother MI509 180/45 cps 136 column	$450.00
Brother MI709 240/50 cps 136 column	$525.00
Brother HR40 44 cps Daisy Wheel 136 column	$650.00
Brother MI724L 216/72 24 pin 136 column	$700.00

Software	
Paragon-integrated accounting	$940
Bravo-integrated accounting	$876
Computer Associates' Accounting	$77-$606
MS-DOS 3.21-operating system	$101
Falcon DOS 3.1-operating system	$47
Reflex 1.4- data base management	$121
dBase III + -programmable d/b mgt	$593
Paradox-semi-program.d/b/spreadsheet	$660
FrameworkII-prog.d/b/sprdsht, wrdproc	$560
MixC compiler, Mix Editor, C Trace	$17ea.
TurboGhostwriter-Pascal apps gen	$270
WordPerfect-word processing	$305
Volkswriter 3-word processing	$230
Lotus 123-spreadsheet, d/b mgt	$452
SuperCalc4-Intg'td sprdsht, d/b mgt	$380
BLAST-mini, micro and m/f connection	$201
Bookmark-saves interrupted work	$81
SuperKey-''Hot Key'', secures data	$54
EasyFlow-flow charting	$202
Harvard Total Project Management	$400
Diagnostics-disk troubleshooting	$52
HARVEY-computerized UPS'ing	$235
HowardSoft's Tax Preparer-updatable	$275
MIDI SCORE-music Interface software	$643
MIDISOFT Studio & Voice Editor	$121ea.
CCS Designer-CAD software	$80
Dratix, Dratix 3D & Design CAD	$265ea.

XT SYSTEM

Includes: 10 MHz 8088-1 motherboard with 640K RAM, 2 serial ports, 1 parallel port, game port, clock calendar, 2 360K Toshiba 5¼″ floppy drives, AT style enhanced keyboard, CTX 14″ tilt and swivel amber monitor, CGA/MONO/HERCULES graphics, 8 slots w/ 7 available, 150 watt power supply, DTK/ERSO BIOS, Microsoft MS-DOS 3.21 with GWBASIC. FCC Class B certified. Price: $1050.00

AT SYSTEM

Includes 8 MHz 0 wait motherboard with 640K RAM (expandable to 1 meg), 2 serial, 1 parallel, clock-calendar, WA2 combined hard and floppy controller, 2 Toshiba 360K 5¼″ floppy drives, CGA/MONO/HERCULES graphics, CTX 14″ amber monitor with tilt and swivel, 200 watt power supply, AT style enhanced keyboard, 8 slots with 7 available, Microsoft MS-DOS 3.21 with GW BASIC. FCC Class A certified. Price: $1450.00

Call or write for option pricing. 386 machines also available, call or write for pricing.

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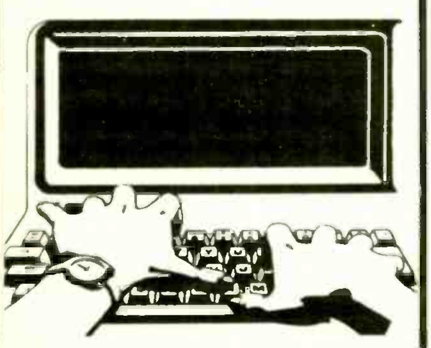

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Telephone Minder *(from page 49)*

read at least 50 volts dc, with the common probe of the meter connected to the negative (−) side and positive probe connected to the positive (+) side of *C1*. As you take a reading, check for proper polarity. Note that *all* voltage readings are referenced to the − side of *C1*, which is circuit ground.

Initially, the meter reading should climb toward 14 to 16 volts as *C1* charges. If you do not obtain this reading, check the orientation of *C1*, *D1* and the polarity of the telephone line at the TELEPHONE LINE pads on the circuit-board assembly. The potential measured at the junction of *R1* and *R2* should be +50 volts with the meter's common probe connected to the − side of *C1*.

If the power supply checks out as described, disconnect the project from the telephone line and give *C1* time to discharge. Then carefully plug only *IC3* into its socket, making certain that the IC is properly oriented (see Fig. 3) and that no pins overhang the socket or fold under between socket and IC. Handle this CMOS device with the same precautions you would use for any other MOS device. Plug the project back into the telephone line and allow *C1* to charge to 15 volts. Press and release RESET switch *S1* and measure the potential at pin 3 of *IC3*; it should register 0 volt.

Now use a piece of hookup wire to jumper from pin 1 of *IC3* and circuit ground. While measuring the potential at pin 1 of *IC3*, you should obtain a reading of 15 volts. Pressing and releasing the RESET switch should cause the reading at pin 1 of *IC3* to drop to 0 volt.

If you do not obtain the above results, power down the project by unplugging it from the wall jack and carefully check the wiring associated with *IC3* and *S1*. Check in particular for accidental short circuits between the closely spaced copper pads to which the IC's socket pins are soldered. Make absolutely certain that *IC3* is not installed backwards in its socket. If all still looks okay but the circuit does not work, the CD4011 may be bad; try replacing it with another known to be good.

When you are satisfied that the *IC3* circuit is performing as it should, disconnect the project from the telephone line and plug *IC1* and *IC2* into their respective sockets, taking the same precautions as you did when you installed *IC3*.

If you used an eight-pin socket for *IC2*, make sure you plug the optoisolator into the appropriate slots in the socket. To avoid confusion, bend a ¾-inch solid bare hookup wire into a U shape with equal-length legs and 0.3 inch bottom. Plug the legs of this wire into *IC2* socket pin slots 1 and 8. Leave this wire permanently in place.

To ascertain that your Telephone Minder is operating properly, plug its cord into the telephone wall box and press and release the RESET switch. Then press and hold the STATUS switch long enough only to see if the LED is on or off. If the circuit is operating as it should, the LED should be off.

Mount the circuit-board assembly into place inside the telephone instrument with which you are using it or in its own separate box. To do this, remove the protective paper from the double-sided foam tape mentioned above and gently press the circuit-board assembly into it. Make sure the circuit-board assembly will not interfere with the normal functioning of the mechanical elements or short to any of the electronics inside the telephone instrument.

Now ask a friend to call your telephone number. When the ringing ceases, press the STATUS switch *without* lifting the handset off the hook. The LED should be on and remain on until you press and release the RESET switch.

You can leave the Telephone Minder permanently connected to your telephone line at all times. Telephone operation will not be affected by the presence of the project on your telephone line.

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