HOBBY ELECTRONICS

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48784

Hands-on Electronics

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SEPTEMBER/OCTOBER 1986

THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!

12 One-Evening Projects
Build from duplicate parts so that you can assemble them for less dollars!

Replacing Transistors and IC's
10 easy steps to successful servicing

Tuning in the Shortwave Bands
Easy-to-snag foreign newscasts!
How your computer knows when to listen!

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PN Junction Tester
Check PN junctions in and out of circuit

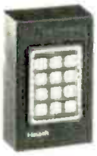
Plus—
Digital Fundamentals Course
Radio Direction Finding
Travel Burglar Alarm

A GERNSBACK PUBLICATION

Collectors: More FactCards This Issue

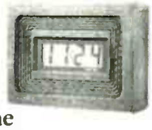
Make your home into something special!

That's exactly what your home will be when you fill it with Heathkit electronic products – products that make your life easier and more enjoyable. Within our diverse line are kit and assembled products sure to enhance each room in your home.



1. Make your entryway more secure and easy to use with the Keyless Doorlock. You'll never again be locked out because of lost or forgotten keys. All it takes is a simple fingertip entry of a four-digit code, and the Keyless Doorlock unlocks your door.

2. Add a new dimension to your living room with your own Computerized Weather Station. This Digital Weather Station displays up-to-the-minute temperature, wind, and barometric pressure readings, along with time and date.



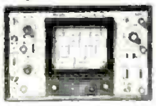
3. Give your kitchen a unique blend of style and efficiency with our Digital Wall Clock. This easy-to-build kit keeps time with quartz-crystal accuracy. And with its simulated oak wood-grain finish cabinet, you'll have a timepiece that fits into almost any decor.

4. Put your den to greater use with this IBM PC AT Compatible Computer. Do word processing, personal accounting and more when you run exciting IBM-compatible software on your fast and powerful HS-241. And you can build it yourself in just a few hours.

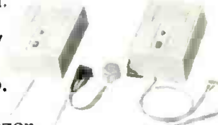
5. Bring the latest in digital technology to your bathroom. This Digital Scale lets you closely monitor your weight with electronic precision. And, it's battery operated so it's safe to use right out of the shower.

6. Add a video entertainment center to your bedroom. Our 19"-diagonal stereo TV kit gives you an extra-sharp color-corrected picture with full stereo sound, and convenient viewing that you can control from your bed. Comes in a simulated walnut cabinet that complements your room.

7. Transform your rec room into a haven for hobby fun. Put our Deluxe QRP CW Transceiver in this room and enjoy superb HAM radio operation that excells in performance and features. It offers expandable transmission and reception capabilities.



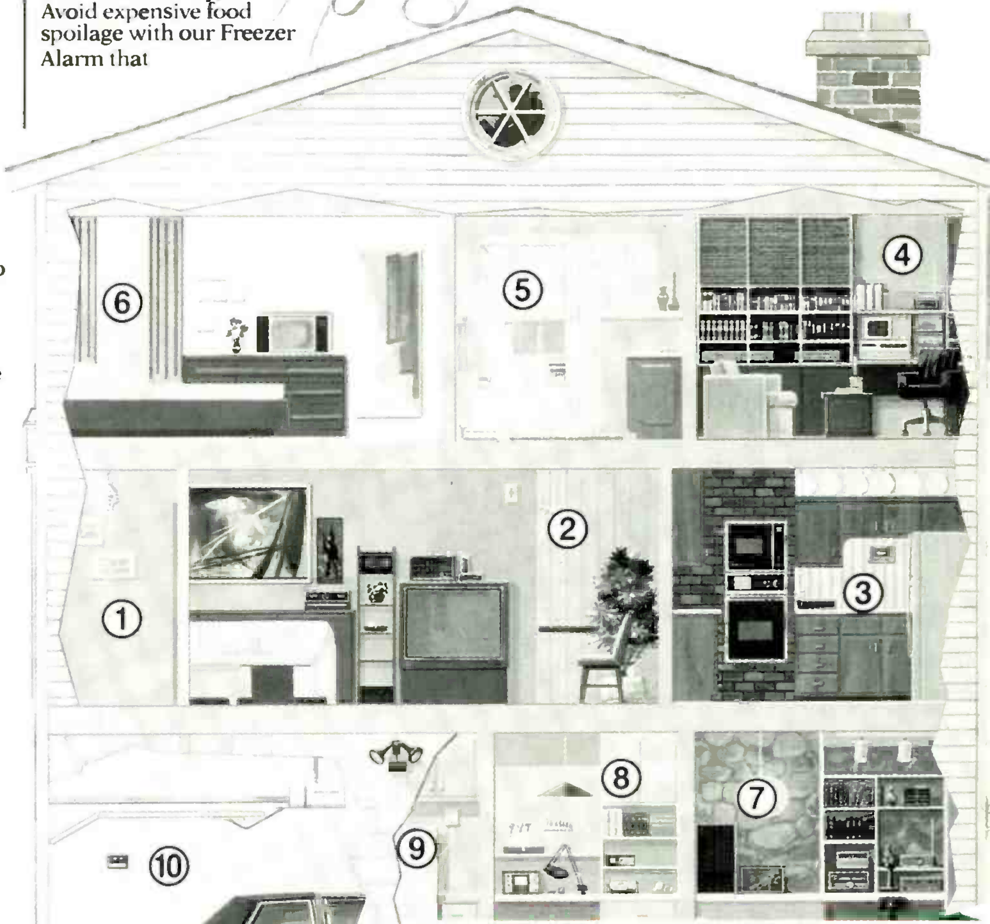
8. Give your workbench a touch of professionalism with this oscilloscope. Whether you're a service technician or a hobbyist, you'll love the wide range of measurement capability our laboratory-grade Dual Trace 10 MHz Oscilloscope gives you.



9. Add practicality to the utility room and save money, too. Avoid expensive food spoilage with our Freezer Alarm that warns you when the inside temperature of your freezer rises too high. Prevent water damage with our Food Alarm that warns you of water that's where it shouldn't be.

10. Make your coming and going easier than ever. Your garage door will open with incredible ease and dependability with our Deluxe Garage Door Opener. Easy to install, this opener is durable and includes a handy security light.

You'll find fun and excitement with every Heathkit product. Whether they're in kit form or already assembled, our products will help you enjoy your home more than you ever dreamed possible.



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Hands-on Electronics Volume 3, No. 5 September/October 1986

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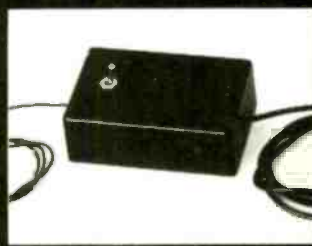
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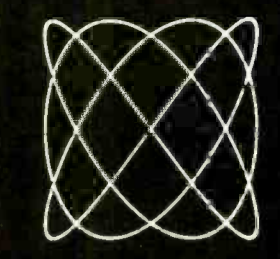
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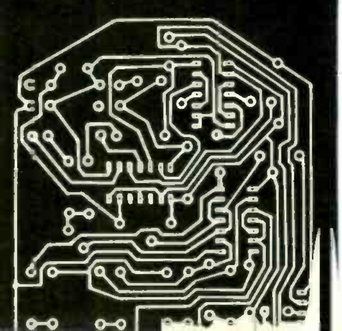

Hands-on Electronics
The Magazine for the Electronics Activist!

EDITORIAL PAGE

Volume 3, No. 5
September/October 1986

Our next big move!

It seems as if it was only a year ago that I was telling the readers that we are increasing the publishing frequency of **Hands-On Electronics** from quarterly (four times a year) to bi-monthly (six times a year). And it has been a good year: Everything we hoped for came to fruition, and now we will make the next big step—**Hands-on Electronics,** is going monthly. Newsstand buyers can visit their preferred magazine dealer the same time each month and subscribers can expect their copies via the mailbox at about the same time.

What about the problems? Well, they're all ours! The biggest one is the need to purchase twice as many manuscripts as we did this past year, or three times as many as last year. I'm afraid that we may fall short of the required amount of manuscripts unless our readers help out! You can help us. You design and build projects every few months, or more frequently. Why not let us know about them. Send us a brief letter outlining the project you have assembled, supply the hand-drawn diagrams, and a photo. Should we take a fancy to your project, you can earn some hard cash and see your name in print. Think about it!

Oh, yes, there are other problems, but those are being overcome by the addition of new staff members, new computers, a new photo lab, a photocopier that has a memory, and the desire of everyone from the publisher down to Donald in the mailroom that we succeed. Look for us when our November, 1986 (first monthly) issue hits the stands.

In the meantime, enjoy this last bi-monthly issue you have in your hands.

Julian Martin

Julian Martin, KA2GUN
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Walter Herstatt

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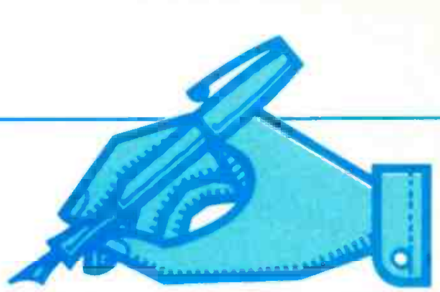


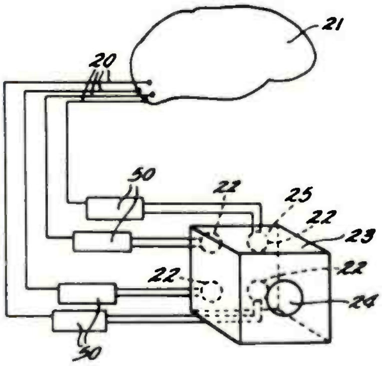
LETTER BOX

By Markus Stammum

The Originator Writes

I was very pleased to see my invention, "Methods and Means for Aiding the Blind," U.S. Pat. No. 2,721,316, mentioned in the article, "The Dawn of Artificial Vision," by Jonathan Alan Gordon in the May/June 1986 issue of **Hands-on Electronics.**

As you can see from the enclosed copy of my patent, I anticipated multiple stimuli to the visual cortex of the brain. The lens focused an image on multiple



photocells on the back wall of the camera obscura so that the stimuli to the visual cortex vary in both intensity and position corresponding to the image of the surroundings formed by this lens.

When the blind patent came out, Mr. Hugo Gernsback wrote to me asking if I would write articles for your parent magazine which is now called Radio-Electronics. That was over thirty years ago.

Development of artificial organs by electrical, electronic, and/or mechanical devices should continue although the ultimate replacement will come by means of regeneration induced by pharmacological agents.

—J. Denman Shaw, Ph. D., M.D., Columbus, OH

Stuck with Stickum

This response concerns a *Letter Box* item in March/April 1986 issue of **Hands-on Electronics** titled "Doing It My Way."

You suggested the use of Radio Shacks burglar-alarm lead foil with self-stick adhesive backing. If you use that product and live in a climate like Illinois, you will have to replace it every year.

I am a locksmith besides an electronics technician. Thus, I know that the proper method to install burglar-alarm foil is to coat the window glass with clear polyurethane varnish where you are going to attach the foil, let it dry until tacky. Then press the foil in place, let dry completely and then cover with 2 more coats of varnish.

I have burglar-alarm foil that has been installed for over 15 years in low and high humidity, with temperatures from −40° F to +110° F with no problem. The three times that I used Radio Shack window foil in the last three years, the foil had to be replaced within six months using the above method.

—Edward Dolson, Kankakee, IL

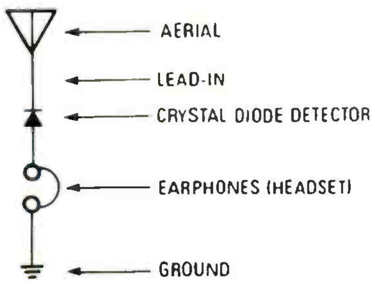
I agree! What was not mentioned was that white shellac should be put down over the tape and ⅛-inch beyond the edges of the tape on either side. That's what I learned to do many years e. That's what I learned to do many years ago.

The Ol' Fox-hole Radio

My father has been talking about a thing called a "fox-hole" radio. Do you know what he's talking about? Does he?

—R.S., Orange, NJ.

Wow! Are you bringing back memories! To make a fox-hole radio, you first steal a pair of earphones from a nearby tank or airplane. One phone is kept in-



tact, the other taken apart. Closely wind as much wire from the earphone's coil on a toilet paper core to serve as an antenna coil. Use a quench-blued razor blade as a detector or diode, touching it with the bare end of the "cat's whisker" wire. And string all the wire that's left as an antenna, as high up as you can get it. Listen with the earphone and probe the blade for a sensitive spot. G.I.'s in World War II used them all the time! My grandfather told me that he did the same thing in WW I.

Big Response

In the May/June 1986 edition of **Hands-on Electronics**, your magazine published my letter in which I requested help in obtaining a novel circuit. The circuit was for a Heartbeat Simulator to be used as a teaching aid in my CPR classes. The response was truly amazing. I would like to take this opportunity to thank you and your readers for helping me.

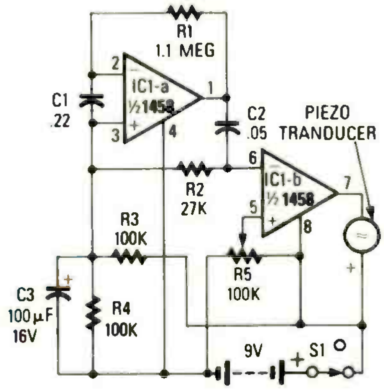
—Barry I. Kelner, DDS, Parlin, NJ

And, the editors of **Hands-on Electronics** *tip their hats to the nice guys who read this magazine.*

Fuzz Buster

Got an article or a schematic diagram kicking around on a radar detector? I just got another speeding ticket and something's GOT to be done!

—L.R., Roanoke, VA.



Try slowing down a bit and see if that doesn't help. If not, try the diagram shown here, which is fairly simple and works. Do not look to equal the performance of this simple circuit to the complex, tuned circuits in commercial units.

Spark History

I would like to correct an historical error in the Electric Fence Charger article. In 1908, while working for the Cadillac Motor Company, F. Kettering became unhappy with the vibrator and coil system in use at that time. So he invented the breaker-point system and later formed the Dayton Engineering Laboratory Company, or DELCO as we know it today.

Here are two tips. The Fence Charger could also power small He-Ne laser tubes. A 20-watt fluorescent tube connected across the Fence Charger's out-

(Continued on page 107)

NEW PRODUCTS SHOWCASE

IN THIS COLUMN, AS IN OTHER NEW-product articles and columns, mention is made to the price of an item offered by a manufacturer and/or distributor. In a free marketplace, price is not a fixed amount mandated by law, but a variable sum determined by the seller's desire to move the product and the buyer's whim to purchase it. Thus, in many newspapers and magazines you will see reference to such phrases as: "Suggested retail price is....", "made to sell for ....", and other catch clauses.

How is the price determined? Most manufacturers and distributors consider their costs and the profit they wish to make. The selected wholesale price is not arbitrary; it is determined by anticipated costs, reasonable profit considering the counteractions other competitors will take, and marketing research of the consumer marketplace.

The final ingredient is you! Purchase restraint will lower the price offered by the maker. In fact, with too much restraint, the product will disappear from the marketplace. I make it appear simple, but it is about as complicated as the asking price of a share of IBM stock on a given Thursday morning at 11 o'clock.

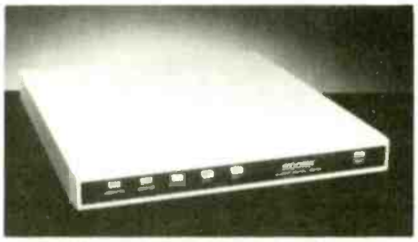
The price we state in this column is for comparative purposes only. In most instances, the price offered is the price you can expect to pay or a slightly lesser amount. Local sales taxes are not included. Some mail-order distributors slash the prices given here after a brief sales period. **Hands-on Electronics** urges our readers to be aware of the prices stated here, use them as a guide, and seek the best deal you can make with each purchase.

Now, for the *goodies* we all have been waiting to discover!

Computer Control Center

The ultra-thin Scooter Model SP5G Guard-It Control Center interfaces a personal computer or CPU with a variety of computer peripheral equipment such as modems, monitors, printers, etc. to an IBM PC/XT, PC/AT, and compatibles or clones through a choice of five protected outlet sockets. Individual pushbutton switches quickly put the correct peripheral on line.

The Guard-It Control Center protects against noise, voltage surges, and spikes common to power lines. The cabinet features an attached swivel base. LED indicators are provided for each switchable outlet and for the main power pushbutton switch. A resettable circuit-breaker completes the front panel.



CIRCLE 15 ON FREE INFORMATION CARD

Suggested retail price is $98.95. For further information on the Model SP5G Guard-It Control Center, call or write: Ohm/Electronics, 746 Vermont St., Palatine, IL 60067; 800/323-2727 (Illinois residents call 312/359-6940).

VOM WITH 100-kHz Frequency Response

The Mercer Model 9120 volt-ohmmeter has 25 ranges including a dB range, 20,000-ohms/volt DC sensitivity (5,000-ohms/volt AC), and a frequency response up to 100 kHz on the 3, 12, and 60-volt AC ranges. The VOM will measure up to 12-DC amperes and has a 3-volt AC range. DC accuracy is ±3% of full-scale.

Convenience features include a front-panel polarity-reversal switch, a single-knob range/function switch with an OFF position, an output jack for DC isolation, and a large, easy-to-read, 3.5" mirrored, color-coded scale. Also included is a high-energy fusing system along with standard fusing and diode meter-protection. The VOM's case size is 1¾ × 4 × 6

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inches; weight is 13 oz. The unit comes complete with batteries, test leads, and an operator's manual.

Mercer Electronics, a division of the Simpson Electric Company, is located at 859 Dundee Avenue, Elgin, IL 60120, or telephone 312/697-2265.

Add Digital Storage to Oscilloscopes

The two-channel Sibex Model 610 Scope Memory converts a conventional oscilloscope into a digital storage scope. By converting analog signals to digital, storing the data in RAM, and then converting the digital data back to analog, the

CIRCLE 7 ON FREE INFORMATION CARD

Model 610 makes it possible to observe waveforms long after they cease to exist.

The device features a 10-MHz maximum sampling rate and is capable of storing sinewave signals up to 1-MHz frequency in its 2K × 8 static RAM. The input sensitivity is 10 mV/div.

The Model 610 features pre- and post-triggering capabilities or the selection of a ½ pre-, ½ post-data combination. In this mode, the trigger point is always displayed midway across the oscilloscope screen. The device also incorporates a sweep function that allows the operator to sweep through the entire memory, then expand any portion of the waveform for detailed analysis.

The Model 610 is priced at $985.00. Write to Sibex Inc., 3320 U.S. 19 North, Suite 410, Clearwater, FL 33519, or call 813/786-3001.

Monitor Through The Power Lines

The PCI Sentry Model 100 is a *wireless* monitor system—consisting of one Central Receiver unit and up to 99 Remote Transmitter units—which can monitor all types of equipment by transmitting coded signals through a building's network of existing power wiring.

The system operates by detecting the closure of a sensor switch (such as a float switch, thermostat, or photoelectric control). A Remote Transmitter unit is wired to each of the sensor switches with two leads, then number-coded with a small DIP switch and plugged into a standard wall outlet. The Central Receiver can be located anywhere in the building; it is also plugged into a standard wall outlet.

When a sensor switch is tripped, its Remote Transmitter sends a coded signal through the building's power wiring to the Central Receiver, which flashes a corresponding number telling the user to correct a potentially-critical problem. The rear of the Central Receiver has a standard 117-VAC relay-closure receptacle for energizing a warning device such as a chime, alarm, flashing light, or automatic telephone dialer. A reset button on the Central Receiver clears the system, which then awaits the next signal.

There are two basic models: Central Receiver Model 100 supports up to 99 Remote Transmitters; Model 10 supports up to 9 Remote Transmitters.

Varied applications include monitoring boiler temperature, air-compressor pressure, motor overloading, solid and liquid vat-temperature levels, noise, etc. The system can also monitor safety conditions such as warehouse temperatures, bodily movement, flooding, door openings, and much more. In addition, Precision Controls (the distributor) supplies Call buttons which the user can plug into any wall outlet to page the Central Receiver.

CIRCLE 28 ON FREE INFORMATION CARD

For monitoring equipment or activities that don't already possess the sensor(s) needed to detect a problem, Precision Controls distributes a comprehensive range of 400 switches that can be installed by the user. These include pressure switches, immersion aquastats, air- and liquid-flow switches, voltage sensors, noise-activated switches, thermostats, and others.

For information, contact Walter Basedow, Product Manager, Precision Controls Inc., 14 Doty Road, Haskell, NJ 07420, or telephone 201/835-5000.

Single-Outlet Surge Protection

The Ohm/Electronics Scooter Model SP100 Guard-It Single Outlet Surge Protector line-protection device plugs into any 3-prong wall socket and glows to show that it's protecting the equipment against voltage surges. Rated at 125-VAC, 15-A, it's ideal for single-source protection of microcomputers, modems, television monitors, VCR's, microwave ovens, telecommunications equipment, stereo

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components, photocopiers, adding machines, or any other electronic equipment.

The Model SP100 sells for $9.95. For additional information on the Model SP100 Guard-It Single Outlet Surge Protector, call or write: Ohm/Electronics, 746 Vermont St., Palatine, IL 60067; telephone free 800/323-2727 (Illinois residents call 312/359-6040).

Precision Soldering Heat

Dial-Temp Soldering Iron Controller is an adjustable temperature controller that operates with any standard soldering iron rated from 15 watts to 1600 watts. Made by the M.M. Newman Corporation, the Dial-Temp Soldering Iron Controller lets the users select the temperature that is best for the soldering job at hand—and change it if necessary. Ideal for electronic assembly work, soldering iron temperatures can be adjusted from 300° F to full heat.

Compatible with any standard soldering iron from 15 watts to 1600 watts, the controller simply plugs into any 117-VAC

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outlet. Just plug the soldering iron into the controller and adjust the dial on top until the desired temperature is reached.

The Dial-Temp Soldering Iron Controller sells for $27.50. Literature is available on request from the M.M. Newman Corporation located at 7 Hawkes St., Marblehead, MA 01945, or telephone 617/631-7100.

Slender Loudspeakers

The Boston Acoustics T830 and T1000 tower speakers feature tall, slender enclosures that require only minimum floor space. The T830 is a three-way floor-standing system featuring an 8-inch woofer, 3½-inch midrange, and a 1-inch CFT dome tweeter. Frequency response is 45–25,000 Hz +3 dB. Power handling is 75 watts. At the top of the new speaker line is the T1000, a three-way, four-driver system incorporating dual 8-inch woofers, a 6½-inch midrange, and a 1-inch CFT dome tweeter. Frequency response for the T1000 is 38–25,000 Hz +3 dB. Power handling is 150 watts. The T830 sells for $450 per pair; the T1000, $1200 per pair.

The T830 is available in a rosewood vinyl veneer, while the T1000 is available in genuine walnut and oak veneers. The tall, slim space-saving profiles of the new towers take up less than one square foot of floor space.

CIRCLE 19 ON FREE INFORMATION CARD

For information see your local quality audio dealer anywhere in North America or write to Boston Acoustics, 247 Lynnfield St., Peabody, MA 01960.

Transmit Error-Free Data

The Black Box MNP Error Controller is a networking protocol device that allows data communications between similar and dissimilar personal computers, networks, or mainframes. When this device detects a transmission error, it automatically sends that data block back as often as you desire or until the data is transmitted and received accurately.

Operable in three switch-selectable modes, the device can be made to communicate only with systems that use the MNP error-checking protocol (in the Error-Free Only mode); automatically determine if the error checking standard is active at the receiving end (in the Error-Free mode); or (in the Transparent mode) enable your system to operate as though the device were not present.

Priced at $295, the Black Box MNP Error Controller can transmit at data rates of 300, 1200 or 2400 bps.

CIRCLE 13 ON FREE INFORMATION CARD

For information about this modem accessory and the more than 500 data communications and computer devices offered in the Black Box catalog, write: MNP Error Controller, Black Box Corp., P.O. Box 12800, Pittsburgh, PA 15241; or telephone 412/746-5500.

Three-Way Auto Speaker

The Boston Acoustics Model 797 three-way 6- × 9-inch speaker system is designed to reproduce the sound quality of a fine home loudspeaker system in a car or van, and offers the ruggedness and convenience of an all-in-one system to fit existing speaker cutouts.

The 797 features a 6 × 9-inch long-throw woofer. The 797 also includes a 2-inch midrange and a ¾-inch wide-dispersion tweeter. Frequency response extends from 36 to 20,000 Hz ±4 dB. Power handling is 40-watts nominal, 80-watts peak. The 4-ohm system sells for $199.95 per pair, including matte-black, perforated metal grilles.

The tweeter of the 797 uses ferrofluid to ensure smooth handling of the vigorous transients generated by compact discs and other high-quality program sources. All drivers in the 797 system use weatherproof copolymer diaphragms and are tough enough to withstand the harsh automotive environment.

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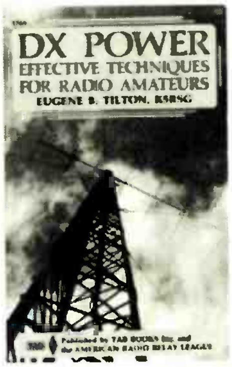
Write for information to Boston Acoustics, 247 Lynnfield St., Peabody, MA 01960. ■

By Barmard de Backus

BOOKSHELF

DX Power: Effective Techniques For Radio Amateurs By Eugene B. Tilton

This is the complete survival manual for every radio amateur entering the competitive fray of DX'ing. It's the easy way to learn all the tricks, techniques, and operating methods used by experienced DX'ers, without having to suffer the frustrations and setbacks that usually plague beginners in this aggressive amateur radio sport.



CIRCLE 9 ON FREE INFORMATION CARD

The book provides on-the-air expertise that will put you on equal footing with the big guns of DX'ing—how to successfully work the largest possible number of countries despite intense competition.

Filled with practical advice and guidance, the book is also a humorous expose of DX'ers and DX'ing that even the most experienced operator will thoroughly enjoy. It's an insider's view of all the funny, frustrating, and tricky (but legal) maneuvers practiced by DX'ers determined to work that rare or elusive DXCC country. In a lively, easy-to-read style, the author breaks Amateur Radio tradition to reveal what really does go on in the DX world...from divulging the fine art of bluffing to showing how to make your contact despite pileups and the "tricks" of other operators.

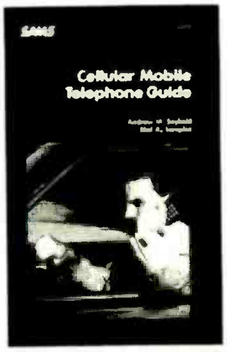
Tilton, a long-time DX enthusiast with 305 countries confirmed, focuses on actual on-the-air techniques as well as detailing the equipment and accessories needed by the successful DX'er. He shows you how to get started as a Dx'er...how to attack the DXCC countries list systematically...how to understand the different DX'ing procedures used on each amateur band (10, 15, 20, 40 and 80 meters) and avoid the DX'ing errors that proclaim to all that you're a DX greenhorn.

Chip Tilton, K5RSG (a practicing physician and an avid DX'er) includes in his book information and tips on QSL'ing, the ARRL and DXCC awards programs, instructions for making your initial DXCC applications, ARRL application and endorsement forms, the ARRL countries list...and much more. Published by Tab Books Inc., PO Box 40, Blue Ridge Summit, PA 17214, this 244-page book sell for $10.00.

Cellular Mobile Telephone Guide By Andrew M. Seybold and Mel A. Samples

The traveller's friend and valuable business tool, cellular mobile phones have become increasingly popular and have undergone many recent technological changes. This guide is designed to assist current and prospective users in purchasing, leasing, or renting the systems best suited to their needs.

This handy reference compares models, prices, dealers/suppliers, installation methods, and telephone



CIRCLE 27 ON FREE INFORMATION CARD

companies with hints on saving money and time. Diagrammed system layouts and operations provide a non-technical understanding of systems, options, and service.

(Continued on page 14)

With NRI training at home, you can...

Move up to a high paying career servicing computers

And you can start by actually building NRI's 16-bit IBM-compatible computer.

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BOOKSHELF

(Continued from page 8)

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Cellular Mobile Telephone Guide (published by Howard W. Sams & Co.) is available for $9.95 through bookstores, computer retailers, electronic distributors, or directly from Sams by calling 1-800-428-SAMS, or by writing to Howard W. Sams & Co., Dept. R23, 4300 W. 62nd St., Indianapolis, IN 46268.

Basic Electronics Theory—With Projects and Experiments—2nd Edition
By Delton T. Horn

This is a completely updated, revised and greatly expanded second edition of an electronics guide used by hobbyists, experimenters, and technicians. Heavily illustrated, the book (from Tab Books Inc., PO Box 40, Blue Ridge Summit, PA 17214) gives particular emphasis to semiconductor devices and circuits,

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including all of the most recent developments in digital electronics.

With over 25% all-new information, Delton T. Horn (a professional writer and electronics hobbyist, and a former professional electronics technician) provides information on winding coils, relays, programmable timers, ECL IC's, AM Stereo, new video program sources, computers and computer programming, and troubleshooting and servicing techniques. Basic Electronics Theory, a 665 page softbound book sells for $18.95.

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By Amanda C. Hixson

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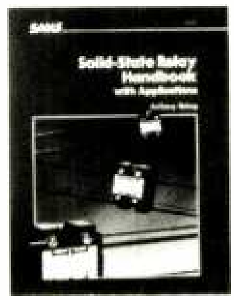
By Anthony Bishop

A comprehensive, state-of-the-art handbook giving the reader an insight into solid-state relays—what they are, how they work, and how to select, specify, test, and generally apply them. Suggested drive and protective methods are included with helpful application notes to stimulate design ideas.

Author Anthony Bishop introduces readers to SSR's through a historical profile for an increased understanding of the technological developments and functions. Currently the Manager of Applications Engineering for the



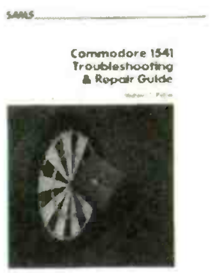
CIRCLE 23 ON FREE INFORMATION CARD

Crydon Division of International Rectifier, a leading supplier of solid-state relays, Mr. Bishop, is considered an authority in his field and has promoted the general application of the SSR.

Published by Howard W. Sams & Co., the book is available through bookstores, computer retailers, electronic distributors, or directly from Sams by calling 1-800-428-SAMS, or by writing to Howard W. Sams & Co., Dept. R22, 4300 W. 62nd St., Indianapolis, IN 46268. Softcover, 250 pages, $19.95.

Commodore 1541 Troubleshooting & Repair Guide
By Michael G. Peltier

If you own or operate a Commodore 64 or VIC 20 computer and are using the 1541 disk drive to store your programs and files, here is the comprehensive servicing guide you need to maintain your disk drive in tip-top operating condition, or repair it if problems occur. In these pages, you will find concise coverage of such topics as: Disassembly/reassembly instructions; calibration and alignment procedures; preventive maintenance guidelines; theory of operation; step-by-step troubleshooting flowcharts; and block diagrams, parts layout diagrams, and detailed schematics.



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The theory of operation and the troubleshooting flowcharts are presented at both simplified and advance levels.

Mike Peltier is an experienced electronics technician, technical writer, inventor of electronic devices, and designer of video games. The book, priced at $19.95, is available through bookstores, computer retailers, electronic distributors, or directly from Sams by calling 1-800-428-SAMS, or by writing to Howard W. Sams & Co., Dept. R23, 4300 W. 62nd St., Indianapolis, IN 46268.

(Continued on page 107)

JENSEN ON DX'ING

By Don Jensen

Time is always standard, throughout the world

BACK WHEN I STARTED LISTENING TO shortwave broadcasting stations in 1947, probably the first bit of DX'er jargon I learned was *GMT*.

GMT, of course, stands for Greenwich Mean Time; and it didn't take me much time to realize why it was so important to a listener hoping to tune in global shortwave signals.

With SWL's *over here* tuning in broadcasters *over there*, some sort of time standard is necessary to keep things from getting hopelessly confusing.

Imagine an announcer for a European SW broadcaster wishing the audience a pleasant good night when it's high-noon for listeners on the west coast of North America and early tomorrow morning for listeners in Asia.

The practical answer for international broadcasting was to adopt the existing GMT world-time standard for program schedule timings. Once listeners learned, for instance, that a certain broadcast began at 0100 GMT, half the battle was won.

Twenty-four Hours

With only a little practice I found that using GMT really took no more effort than using conventional local time. Firstly, GMT uses the 24-hour system, in which there is no AM or PM designation: the hours after midday (noon) become 1300 through 2400 hours (1 PM through midnight). Next, converting to local times takes just a bit of addition. GMT is Eastern Standard Time plus 5 hours, Central Standard plus 6 hours, Mountain Standard plus 7 hours, and Pacific Standard plus 8 hours.

Over the years, GMT became a familar old friend to this longtime shortwave DX'er, so it came as something of a jolt a few years ago when the major broadcasting stations of the world —one by one— abandoned GMT. Instead, I began finding program schedules given in something called *Coordinated Universal Time* (somewhat confusingly abbreviated as UTC, a shortening of the French name equivalent)

For all practical purposes, though, there was no difference between GMT and UTC. In time, I got used to the new, but privately, still clung stubbornly and nostalgically to the old.

So it came as yet another blow to read, not long ago, in the New York Times that the "official" end of GMT apparently was near.

The Royal Greenwich Observatory just outside London—at a geographical location designated as "0" degrees longitude—has been in the timekeeping business since 1675. Its time standard, which became GMT, was essential to Britain's maritime supremacy. Sailors could pinpoint their position at sea only by checking their chronometer, accurately set to GMT, against the local noontime sun.

In more recent times, time calculated from the movement of the stars was supplanted, at Greenwich and elsewhere in the world, by atomic clocks. It costs the British government over $100,000 a year to keep Greenwich's six atomic clocks running, and that's the rub. It has become just too darned expensive!

So over the next year or so, the Royal Observatory is being forced to simply let its atomic clocks run down and stop. When that happens, goodbye GMT.

What of UTC? Its time standard is based on readings from 150 atomic clocks at other observatories and government and university laboratories around the world, coordinated by the International Organization of Legal Metrology in Paris.

So it really won't make any difference to shortwave listeners or anyone else needing an accurate standard: we'll still calculate when to listen to our favorite SW programs in exactly the same way we've always done.

Time marches on, it's true. But for this crusty ol' traditionalist, somehow it won't be quite the same after GMT has ticked its last tock!

Time and Time Again

Speaking of time, most SWL's are aware of WWV, the standard time and frequency shortwave station at Fort Collins, Colorado, and its companion station, WWVH, at Kekaha, Hawaii. Both operate on 2,500, 5,000, 10,000 and 15,000 kHz, with WWV also on 20,000 kHz.

Mostly they tick away the hours monotonously, with time and occaisonal other announcements on the hour. WWV has a male giving the time announcements; WWVH, a woman.

The stations also offer other services to listeners, such as weather and propagational data, and standard frequency audio tones.

You may also have found the Canadian counterpart, CHU, the standard time station at Ottawa. If not, check out these frequencies: 3,330, 7,335 and 14,670 kHz. Programming consists of second pulses and time announcements in English and French each minute. Reception reports may be sent to CHU, National Research Council, Ottawa, Canada K1A 0R6.

Less well known, but not too hard to hear in North America is VNG, the Australian standard frequency and time station at Lyndhurst, Victoria. English voice announcements are given each quarter hour. VNG has three frequencies, but you're most apt to hear 4,500 or 7,500 kHz during the early morning hours.

The station replies with an attractive QSL card to reports sent to VNG, Reference Measurements Section, Telecom Australia Research Laboratories, Box 249, Clayton, Victoria 3168, Australia.

Minnesota listener Tom Gavaras recently reported hearing Argentina time station LOL2 weekly on 4,856 kHz, with time "pips" from 0056 until 0100 UTC sign off.

LOL, operated by Servicio de Hidrografica Naval, or the Argentine Naval Observatory in Buenos Aires, operates on some of the same frequencies as do WWV/WWVH, but still can be heard at times through the interference with Spanish language time announcements on 5,000, 10,000 or 15,000 kHz. It does not transmit continuously, but from 1100 to 1200, 1400 to 1500, 1700 to 1800, 2000 to 2100 and 2300 to 2400 hours UTC.

Other time-stations also share the same standard frequencies. They include ZUO, Olifantisfontein, South Africa, a service of the South African Council for Scien-

ABBREVIATIONS

BBC	British Broadcasting Corporation
CHU	Canadian standard time station
CW	Continuous wave—Morse Code
DX	long distance (over 1000 miles)
DX'er	listener to shortwave broadcasts
DX'ing	listening to shortwave broadcasts
GMT	Greenwich Mean Time
JJY	"Shortwave clock" of Japan
kHz	kiloHertz (1000 Hertz or cycles)
QSL	verification reply from broadcaster
SW	shortwave
TV	television
VNG	Australian time and standard frequency station
UTC/GMT	Universal Time Code/ Greenwich Mean Time
WWV	U.S. time and standard frequency station
WWVH	Hawaii transmitter of WWV

tific and Industrial Research, and JJY, the "shortwave clock" of the Radio Research Laboratory at Tokyo.

Both can be heard at times: the former usually on 5,000 kHz, the latter most often on 10,000 or 15,000 kHz. Those who can *read* a bit of CW will have the best opportunity to pick out their call letters, which sometimes cut through the interference of WWV/WWVH.

The Cagical Naval Observatory in Caracas, Benezuels, operates its standard time station on 6,100 kHz, in the heart of the 49-meter broadcasting band. Often, the station (YVTO) can be heard ticking away during the late evening hours when interference is not too severe.

Reception reports may be sent to YVTO, Tecnico Encargo, Observatorio Naval Cagical, Apartado 6745, Marina 69-DHN, Caracas 103, Venezuela.

New Old Reference

Back in 1947, a Dane named O. Lund Johansen edited and published a shortwave reference book which he called the *World Radio Handbook*. It contained, for its day, a wealth of information about the medium and shortwave broadcasting stations throughout the world. The book soon became known around the world as the shortwave listener's *bible*.

Some things have changed over the years, of course. O. Lund has passed on, replaced by Jens Frost, himself now nearing retirement. With the advent of television, the 1961 issue of the WRH became the WRTH—the *World Radio TV Handbook*. The current edition is about six times larger than the first publication.

But for the SWL, the WRTH remains a reference source that is a *must have*.

1986 is the WRTH's 40th anniversary year, and although the cover price has also increased over the years, this useful annual is worth the $19.95 (plus $1.50 for shipping) ticket. It is available from various dealers, including Gilfer Associates, P.O. Box 239, Park Ridge, New Jersey 07656.

Down the Dial

Here are some of the stations shortwave listeners are hearing lately. Why not join them with your own loggings. Just send them to me, in care of *Jensen on DX'ing*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, New York 11735. I'll use the most interesting in future columns. All frequencies are in kilohertz; times are in UTC:

Mexico—Not too many stations operate down on the 120 meter shortwave band, but one which is being rather widely reported is *Radio Huayacocotla*, on 2,390 from the small town of the same name in the State of Veracruz. Programming is all in Spanish. Try listening during your early evening. Greenland—3,999, *Gronlands Radio* is a nice bit of DX for most listeners. Long silent, and then later a very tough catch, the station recently has been logged with signals sometimes quite good, but suffering from ham radio interference on this shared band. Try this one around 1000 to 1200.

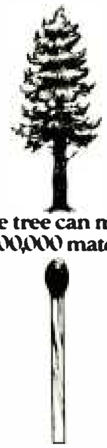
Sri Lanka—Sri Lanka Broadcasting Corp., from Colombo on this island nation, broadcasts on 9,720 during the North American Morning hours. English news is reported at 1505, followed by cricket scores and rock music.

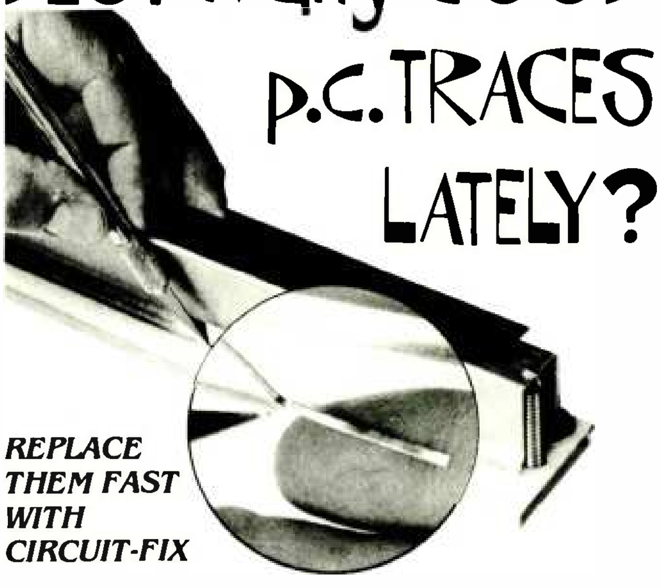
Belgium—BRT isn't the most commonly heard of the European international broadcasters, but it is one worth listening to for some interesting programming. Take a listen to its English language *Brussels Calling* program at 2200 on 5,895.

Syria—A middle East listening target is *Radio Damascus*, reported with English news at 2125 on 9,805 in the 31-meter band.

Kuwait—Same part of the world, same language, that's *Radio Kuwait* with English programming at 1830 on 11,675.

Credits—Richard D'Angelo, PA; Ann Gropper, NY; Sheryl Paszkiewicz, WI; Christos Rigas, IL; Robert Zilmer, MN; R. Nagel, PA; Robert Palmer, WA; North American SW Association, 45 Wildflower Road, Levittown, PA 19057) ■





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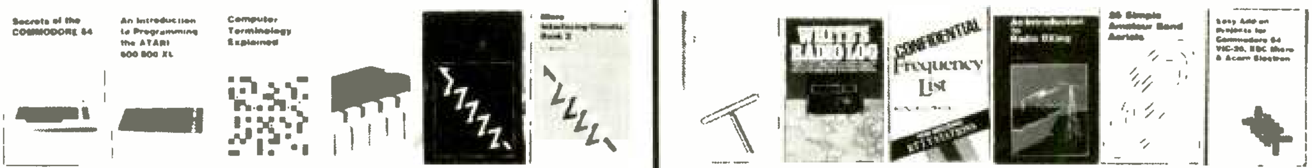

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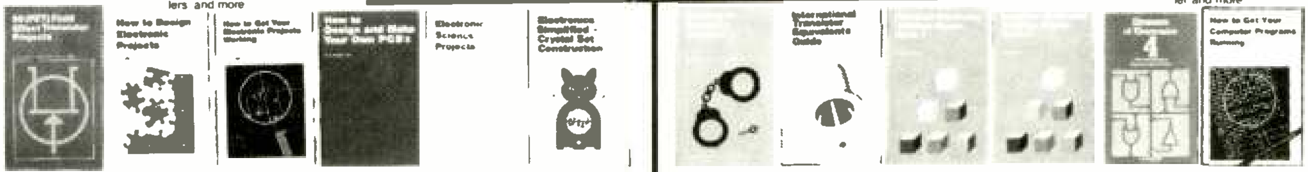

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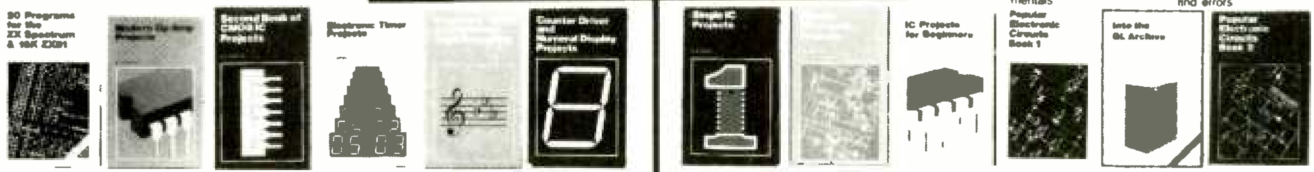

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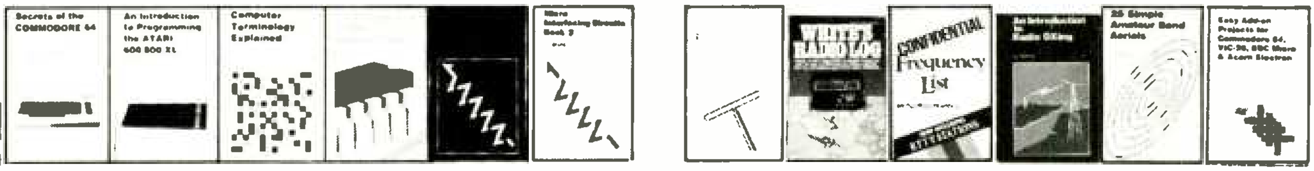

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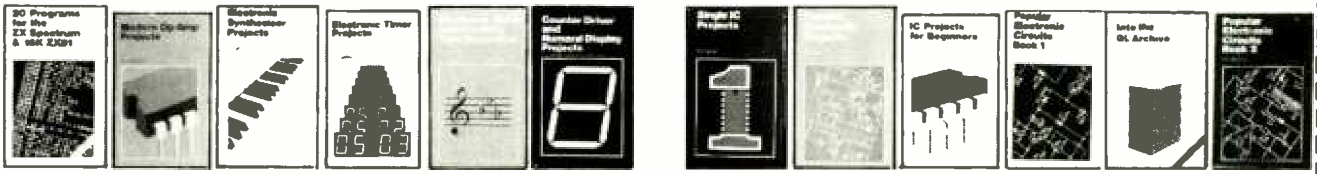

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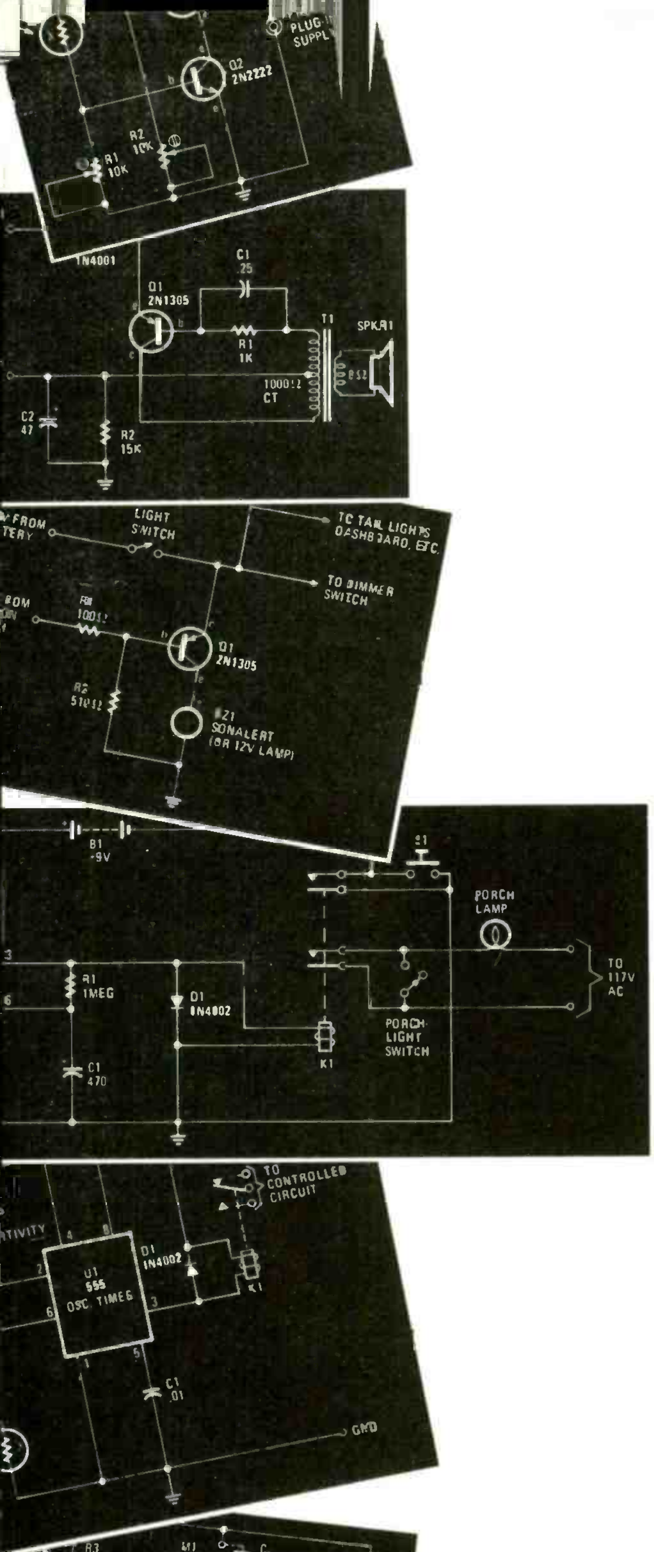


Hands-on Electronics
September/October
1986

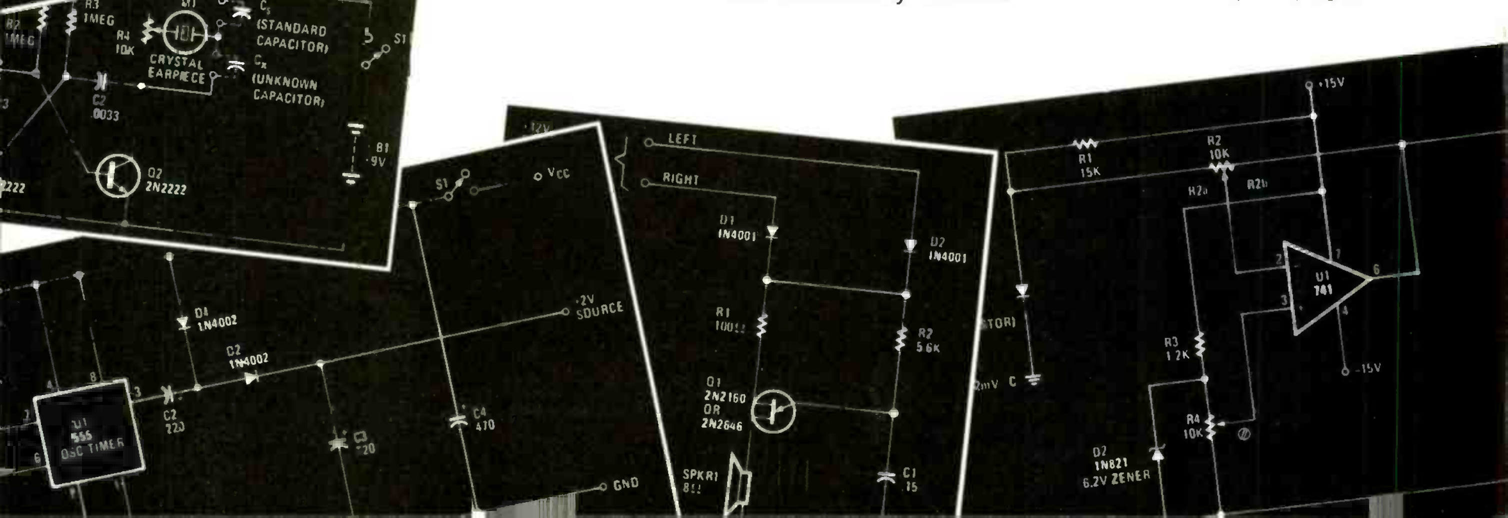
12 One-Evening Projects

Use the same set of parts for a dozen easy-to-build and useful projects

By Robert F. Scott

EVEN IF YOU'VE BEEN INTO HOME-BREW PROJects only for a few months, it's a safe bet that your junkbox is almost filled to overflowing. And if you look closely, you'll most likely find all the parts needed to build a dozen useful projects to make your evenings even more fun. As much as possible, the projects use the same pool of components; so if you don't like the way one project turns out, you can strip the parts and use them for a different project.

While we don't give step-by-step assembly instructions, the projects are easy enough so that just about anything will work. Where there is some critical assembly or adjustment, we'll spell out all the necessary details. *(turn page)*



Water-Level Sensing and Control

The water-level sensing and control circuit shown in Fig. 1 uses triac TR1 to energize a load, which might control a valve, indicator light, or audible alarm. The operation of the circuit is based on the difference in the primary impedance of a transformer when its secondary is loaded and when it is open-circuit. The impedance of the primary of T1 and resistor R1 are in series with the load. The triac's gate-control voltage is developed across parallel resistors R1 and R2.

When the water level is low, the probe is out of the water and SCR1 is triggered on. It conducts and imposes a heavy load on transformer T1's secondary winding. That load is reflected back into the primary, gating triac TR1 on, which energizes the load. If the load is an electric valve in the water-supply line, it will open and remain open until the water rises and touches the probe, which shorts SCR1's gate and cathode, thereby turning off the SCR1, which effectively open-circuits the secondary. That open-circuit condition—when reflected back to the primary winding—removes the triac's trigger signal, thereby turning the water off.

Applications of the circuit are limited only by one's imagination. The load may range from a water valve, a relay controlling a pump supplying water for irrigation, or a solenoid valve controlling the water level in a garden lily pond.

PARTS LIST FOR WATER LEVEL SENSOR

R1—10-ohm, 10-watt, power resistor
R2—100-ohm potentiometer (preferably wirewound)
R3—1-Megohm potentiometer
SCR1—Silicon-controlled rectifier, C106Y1 or equivalent (Radio Shack 276-0167)
T1—Transformer: AC-line, step down, power, 12.6-volt, 1.2-A secondary winding (Radio Shack 273-1352 or equal)
TR1—Triac, rated at 6-A and 200-PIV, 6-A (Radio Shack 276-1001)

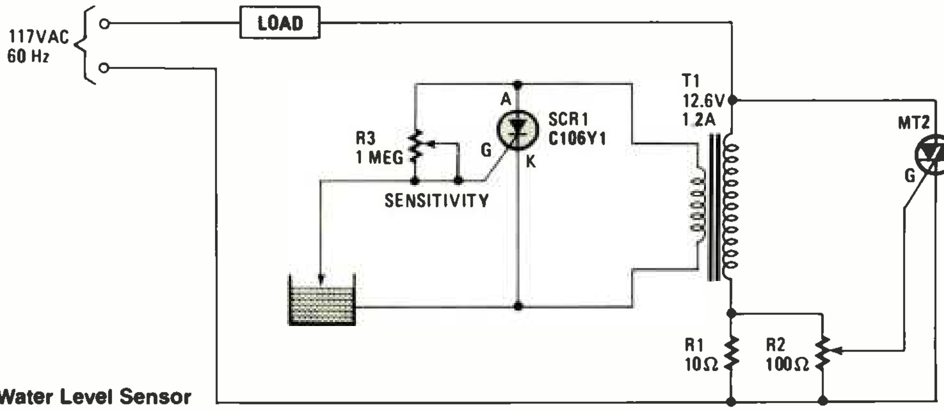


Fig. 1—Water Level Sensor

Automatic Emergency Lighting

An emergency lighting system that comes on instantly, as soon as the local power supply is interrupted, is standard equipment in many public places. Although seldom installed in residences, it can be a life-saver during storms and power outages. Figure 2 is the circuit of a simple, inexpensive emergency lighting control and power supply that can be assembled in an hour or so. It consists of a battery-powered 12-volt emergency lamp or lighting system that comes on at the instant the power line is interrupted. When line power is restored, the emergency lighting is switched off and the battery is recharged. (The system is an adaptation of one described in a G.E. application note that was published nearly 25 years ago.)

When 117-VAC is present, the battery is trickle-charged through diode D1 and current-limiting resistor R1. At the same time, C1 charges (with polarity as indicated) through D2 and R3 on one half-cycle of the supply voltage and then discharges through R2 and the battery on the next half-cycle. The discharge time-constant is about ten times longer than the charge time-constant so C1 retains a net positive charge. That keeps the SCR's gate back-biased so that it cannot be triggered into conduction. If the AC power fails, C1 discharges completely, and then begins to charge in the opposite direction from the battery. When the charge on C1 reaches SCR1's gate-triggering level (0.6 volt), the SCR conducts and turns on the emergency light. The circuit resets automatically

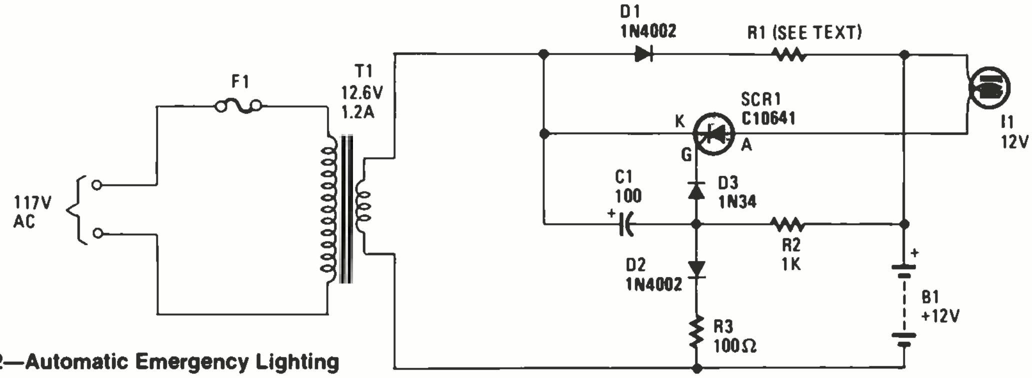


Fig. 2—Automatic Emergency Lighting

when power is restored, because the SCR's gate is again reverse-biased as D1 again conducts to charge the battery.

The current ratings of power transformer T1, SCR1, and D1, and the ampere-hour rating of the battery, all depend on the drain of the lamp or lighting system. Resistor R1 value is chosen to limit the battery-charging current to a safe level—as specified by the battery's manufacturer or supplier.

For example, a typical Ni-Cad battery can be safely trickle-charged at a rate equal to 1/100th of its ampere-hour rating; a 1-ampere-hour battery can be continuously charged at a 10-mA rate. Limiting resistor R1's value can be calculated from:

$$V_s - V_{batt}/I_c$$

where V_s is the supply voltage present at D1's cathode, V_{batt} is the rated battery voltage, and I_c is the specified charging current.

SCR1, a C106Y1, is a 2-A device, so a heatsink should be used when the lamp draws more than 1-ampere. For heavier loads, you might consider using a small, 12-volt lead-acid storage battery like those used in riding lawn mowers and garden tractors. Select an SCR that can handle the load current with a good margin of safety. Transformer T1's secondary voltage should be about 15% higher than the battery voltage. In ordinary design practice, C1 would be specified as a non-polarized type capacitor because, during emergency operation, it is reverse-charged to the SCR's gate-triggering voltage. However, that voltage rarely exceeds 0.6 volt for SCR's likely to be chosen for the application, a value that most electrolytic capacitors can handle without breakdown.

PARTS LIST FOR AUTOMATIC EMERGENCY LIGHTING

B1—Battery, 12-volt Ni-Cad or lead-acid
C1—100-µF, 35-WVDC, electrolytic capacitor
D1, D2—Silicon rectifier, 1-A, 100-PIV or higher, type 1N4002
D3—1N34 Germanium signal diode, or equivalent
R1—See text
R2—1000-ohm, ½-watt, 10% resistor
R3—100-ohm, ½-watt, 10% resistor
SCR1—Silicon-controlled rectifier, C106Y1 or equivalent
T1—Transformer: AC-line, step down, power, 12.6-volt, 1.2-A

Garage Parking Aid

If your garage entrance is a little narrow for your car, or if you must squeeze two compact cars into a single-car garage, you may often need help in guiding the car(s) in without scratching or denting a fender. You can slip the car in easily if you use the light-beam guidance shown in Fig. 3 (originally described in *Le Haut Parleur* magazine, Paris, France). Transistors Q1 and Q2 are connected as a dual-input comparator (or gate) that produces an output and lights indicator lamp I1 only when the car is correctly positioned—when both photoresistors (LDR1 and LDR2) are illuminated by the car's headlights. Figure 3B shows how the LDR's are illuminated when the car is driven though the narrow doorway with ample clearance on each side. The "Guide lamp" is on.

Figure 3C shows the car too close to one side of the doorway; the light beams miss the photocells, and the "Guide lamp" is off.

As shown in Fig. 3D, photocells are mounted in a shield tube ¾-inch long and slightly wider than the diameter of the LDR. The inside of the tube should be painted a dull black to reduce reflections. The photocells should be mounted on a support board with the distance between them equal to the center-to-center distance between the low-beam headlights. A piece of ¼-inch plywood about 5–6 feet long should do nicely. You can mount all components on the back side of the board with the LDR's protruding through. Then, with the car in the correct position, carefully pinpoint the horizontal and vertical positions for the photocells and secure them to the board. Mount the board in position on the garage's rear wall.

PARTS LIST FOR GARAGE PARKING AID

LDR1, LDR2—Photocell, Cadmium sulphide, 3 megohms or higher in darkness, 100 ohms in bright light (Radio Shack 276-116 or equal)
R1, R2—10,000-ohm, miniature trimmer potentiometer
Q1, Q2—2N2222 NPN silicon transistor
Socket for plug-in battery eliminator or terminal strip for battery connection.

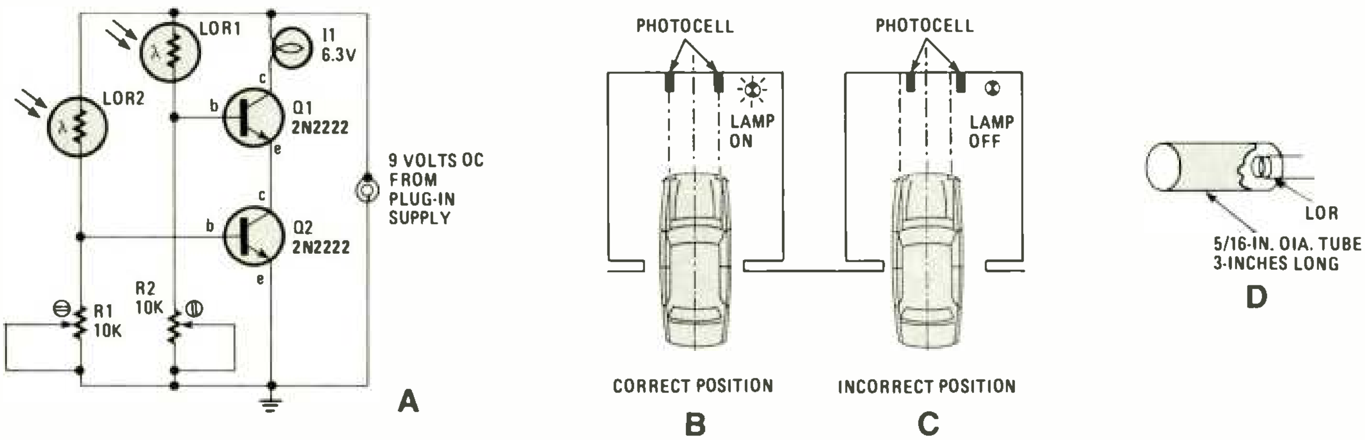


Fig. 3—Garage Parking Aid

Photo Alarm

Although the 555 integrated circuit was designed as a timer, its two internal comparators, flip-flop and switched-output stage can be adapted for many other applications. The Photo Alarm in Fig. 4 is an example of one of the non-timer applications. When the *trigger* input (pin 2) and *threshold* input (pin 6) are connected, the device can be used as a Schmitt trigger. In this circuit, the Schmitt trigger is used as a photosensitive switch to drive a relay. LDR1, a cadmium sulphide (CDS) photoresistive cell is used as the lower leg of a voltage divider between V_{cc} and ground. The timer terminals 2 and 6 are connected to the junction of the photocell and SENSITIVITY control R1.

The resistance of the photoresistive cell varies inversely as the light intensity; resistance is high when the illumination level is low; low in bright light. (The Radio Shack CDS cell suggested for this circuit has a typically wide resistance range—about 3 megohms in darkness and 100 ohms in bright light.)

When the light is interrupted or falls below a level set by SENSITIVITY control R1, the rise in LDR1's resistance causes the voltage on pins 2 and 6 to rise. If the control is set so the voltage rises above $\frac{2}{3}V_{cc}$, the relay pulls in. The relay drops out when the light level increases and the drop across the photocell falls below $\frac{1}{3}V_{cc}$. (The circuit can be modified by placing relay K1 and diode D1 between pin 3 and ground. In this case, the relay drops out when the voltage on pins 2 and 6 rises above $\frac{2}{3}V_{cc}$, and pulls in when it falls below $\frac{1}{3}V_{cc}$. This modification is valuable when the relay has single-throw contacts.)

Opening and closing of the relay contacts occurs at different illumination levels. This $\frac{1}{3}V_{cc}$ hysteresis is an advantage that prevents the circuit from *hunting* and the relay from *chattering* when there are very small changes in illumination.

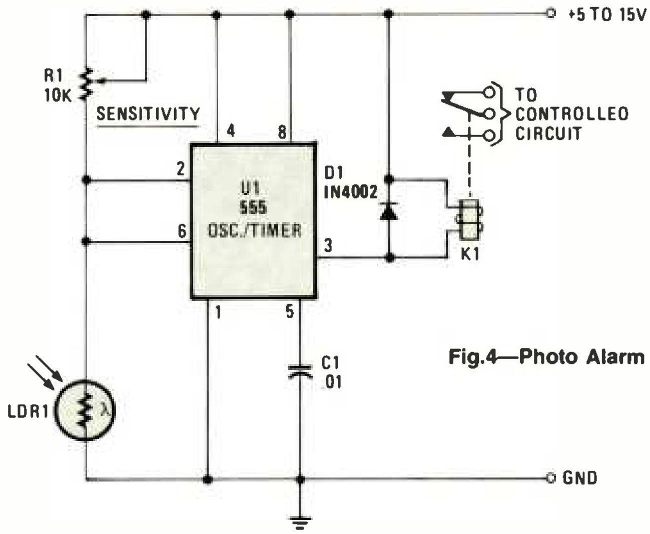


Fig.4—Photo Alarm

PARTS LIST FOR PHOTO ALARM

R1—10,000-ohm, linear-taper potentiometer
LDR1—Photocell, Cadmium sulphide, 3 megohms or higher in darkness, 100 ohms in bright light (Radio Shack 276-116 or equal)
C1—0.01-μF, 50-WVDC ceramic disc capacitor
D1—1N4002 silicon rectifier, 100-PIV, 1-A
U1—555 integrated circuit timer/oscillator
K1—Miniature relay, 6–9-VDC, 160-ohm coil, contacts as needed

Automobile Lights-on Reminder

Most modern cars are equipped with a device (sometimes an optional feature at added cost) that warns the driver that the headlights or parking lights are on if he turns off the ignition and then opens a door to leave the car. That is designed to prevent the driver from leaving the headlights on and finding a dead battery when he returns to the car.

If the lights-on warning in your car is defective, or too soft to be readily audible, you might consider adding one of the *Lights-on Reminders* shown in Figs. 5 and 6. (We're counting these two circuits as part of the twelve total.) The circuit in Fig. 5 can be used to give a visible or an audible warning that the headlights are on. It uses a 2N1305 transistor as a switch to turn on a Sonalert tone generator or a small 12-volt lamp.

Operating current for the transistor is supplied from the wire feeding the headlights. When the ignition is on, the transistor is biased off and the alarm is not activated. Turning off the ignition while the lights are on sets off the alarm.

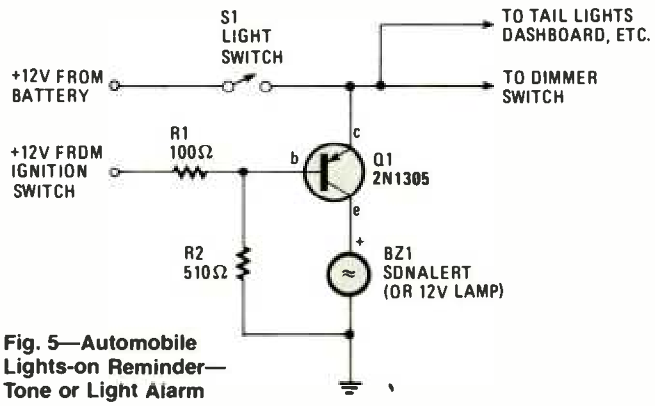


Fig. 5—Automobile Lights-on Reminder—Tone or Light Alarm

PARTS LIST FOR AUTOMOBILE LIGHTS-ON REMINDER

BZ1—SC628 Mallory Sonalert (see text)
Q1—2N1305 PNP germanium switching transistor, Radio Shack 276-2007 or equivalent
R1—100-ohm, 1-watt, 10% resistor
R2—510-ohm, 2-watt, 10% resistor

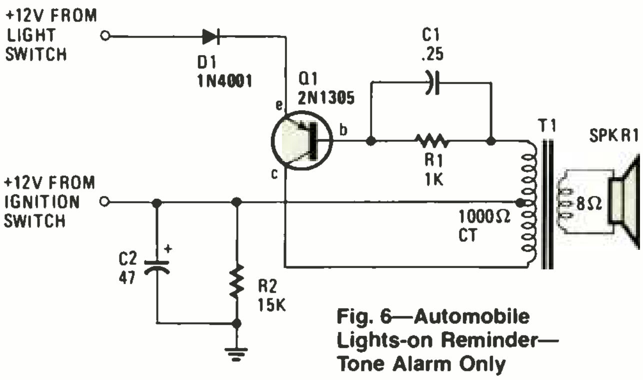


Fig. 6—Automobile Lights-on Reminder—Tone Alarm Only

The Sonalert listed in the Parts List (Mallory SC628) is the standard model. It operates over the range of 6–28-DC volts. Current requirements range from 3- to 14- mA, depending on the supply voltage. Sound-output level ranges from 68-dB at 6-VDC to 80-dB when powered by a 28-volt supply. Nominal output frequency is 2900 Hz.

In the circuit shown in Fig. 6, the alarm tone is generated by a simple Hartley oscillator. Its tapped inductor is the center-tapped primary of an audio output transformer. In this circuit, operating voltage is supplied from the lighting circuit. Voltage from the ignition circuit biases Q1 off. When the ignition is turned off, Q1 conducts and the circuit oscillates, generating an attention-getting alarm tone.

PARTS LIST FOR LIGHTS-ON REMINDER

C1—0.25-µF, 50-WVDC, ceramic disc capacitor
C2—47-µF, 35-WVDC, electrolytic capacitor
D1—1N4001, 1-A, 50-PIV silicon rectifier
Q1—2N1305 PNP switching transistor, or equivalent
R1—1000-ohm, ½-watt, 10%, resistor
R2—15,000-ohm, ½-watt, 10%, resistor
SPKR1—Speaker, 4–8-ohm
T1—Audio output transformer, 1000-ohm center-tapped primary, 4–8-ohm secondary (Radio Shack 273-1380 or equivalent)

Directional Signals Monitor

How often have you followed another car, mile-after-mile, reluctant to pass because the turn signals are blinking and you are uncertain as to what the driver may do? And, how often does one of your passengers have to remind you that, as my wife says, *You are blinking*. Most cars have some form of audible indication that the turn signals are flashing, but the tone or click isn't loud enough to be heard above the ambient noises.

You can be a safer driver, and one less likely to confuse others, if you install a turn-signal monitor on your car. A simple device for that purpose is shown in Fig. 7. Here we have a unijunction transistor audio oscillator driving a small speaker. The oscillator's frequency is determined by resistor R2 and capacitor C2.

The operating voltage is supplied from the car's turn-signal circuit(s) through D1 and D2. The diodes conduct current from the blinker circuit that is energized, and prevent stray current flow to the other blinker circuit. For example, when you signal for a right turn, D2 conducts on each flash and supplies voltage to the oscillator. That voltage cannot get into the 12-volt line to the left flashers because D1 is *blocked* by the reverse bias on its cathode. Similarly, on left turns, D1 conducts and D2 is blocked. No current is drawn by the monitor when the turn-signal *stalk* is in neutral.

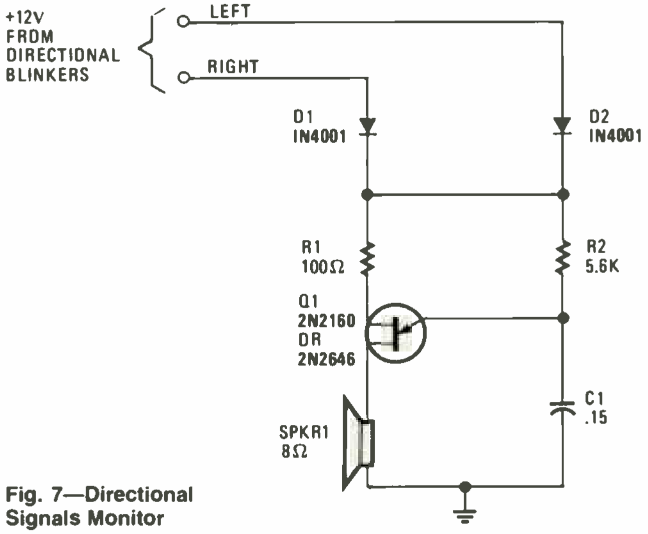


Fig. 7—Directional Signals Monitor

PARTS LIST FOR DIRECTIONAL SIGNALS MONITOR

C1—0.15-µF, 50-WVDC, film or ceramic disc capacitor
D1, D2—1N4001 1-A, 50-PIV silicon rectifier
Q1—2N2160 or 2N2646 unijunction transistor
R1—100-ohm, 1-watt, 10%, resistor
R2—5-6-ohm, ½-watt, 10%, resistor
SPKR1—Speaker, 4–8-ohm

Porch-light Timer

How often have you wished to have the porch light on as you fumble with the keys and try to fit the correct one into the keyhole? The circuit in Fig. 8 shows a solution to the problem that gives you control of the porch light; enabling you to turn it on for a preset period—long enough to select the correct key and open the door. The light remains on for approximately five minutes—a delay sufficient to supply illumination for the porch, walk, and driveway as you leave home.

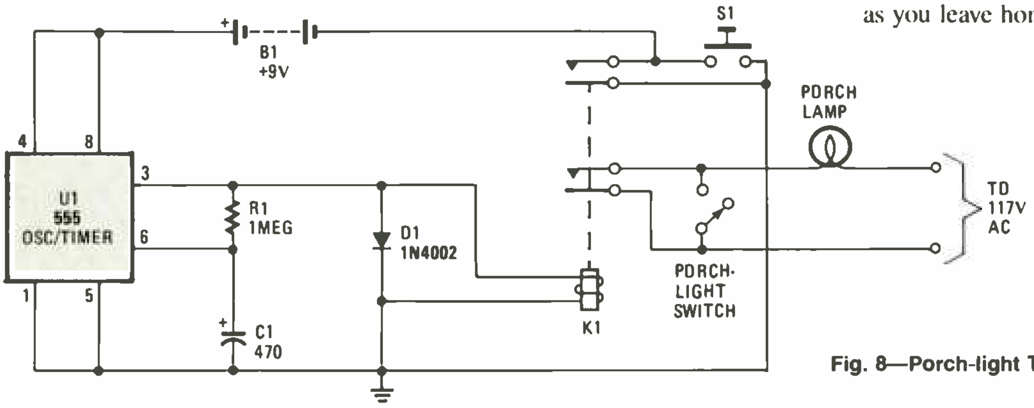


Fig. 8—Porch-light Timer

The circuit is designed around a 555 timer. When S1, a SPST normally-open push-button switch, is pressed, the 9-volt power source is connected to the timer circuit. At that time, C1 is discharged, providing a virtual short circuit between pin 6 (the threshold input terminal) and ground. Under that condition, the output at pin 3 rises to V_{cc} and energizes relay K1. One set of relay contacts shorts S1 so power is still applied to the timer circuit. The second set of relay contacts is connected across the porch-lamp switch and turns on the porch lamp.

As soon as power is applied to the timer, timing capacitor C1 begins charging through R1 until the charge, and the voltage on pin 6, reaches $\frac{2}{3}V_{cc}$. At this point, the output voltage on pin 3 drops to zero and releases the relay; turning off the porch light and breaking the 9-volt circuit to the 555.

A transformer-type 9-VDC supply can be used; however a 9-volt alkaline battery can be expected to last a year.

PARTS LIST FOR PORCH-LIGHT TIMER

- B1—Battery, 9-volts
- C1—470-µF, 35-WVDC, electrolytic capacitor
- D1—1N4002 silicon rectifier
- R1—1-Megohm, ½-watt, 10%, resistor
- K1—Miniature relay, 6–9-VDC coil rated 160 ohms or higher
- S1—Switch, SPST, normally-open push-button
- U1—555 timer integrated circuit

Dual-polarity Power Supply

Many solid-state circuits require dual power sources that deliver equal positive and negative voltages. When the current load is not too high, a single 555 timer operating as an astable multivibrator can provide up to 200-mA of negative voltage from a positive supply line. Such a power supply is shown in Fig. 9. With the values shown for R1, R2 and C1, the circuit oscillates at around 2kHz. Frequencies between 500-Hz and 4500 Hz can be used. However, the values of C2 and C3 should be increased as the frequency is lowered.

The squarewave output from pin 3 drives a diode pump consisting of C2 and D2. When the 555 output is high, C3 charges through R3, C2 and D1. Capacitors C2 and C3 form a voltage divider, with a fixed portion of the voltage appearing across C3. When the 555 output is low, C2 discharges through the output transistor in the 555 and D2. Capacitor C3 cannot discharge because D1 is now blocked (reverse-biased). When the timer output again swings high and then low on the next cycle, C2 again places a portion of the supply voltage on C3. So, at the end of each output pulse, C3's charge increases by a fixed step (smaller than the previous one) until, eventually the output voltage stabilizes at a level determined by the load current.

PARTS LIST FOR DUAL-POLARITY POWER SUPPLY

- C1—0.05-µF, 50-WVDC, disc ceramic capacitor (or other value as selected for the desired multivibrator frequency)
- C2, C3—220-µF, 35-WVDC, electrolytic capacitor
- D1, D2—1N4002 silicon rectifier
- R1—1200-ohm, ½-watt, 10%, resistor
- R2—3900-ohm, ½-watt, 10%, resistor
- R3—1000-ohm, ½-watt, 10%, resistor
- U1—555 timer/oscillator, integrated circuit

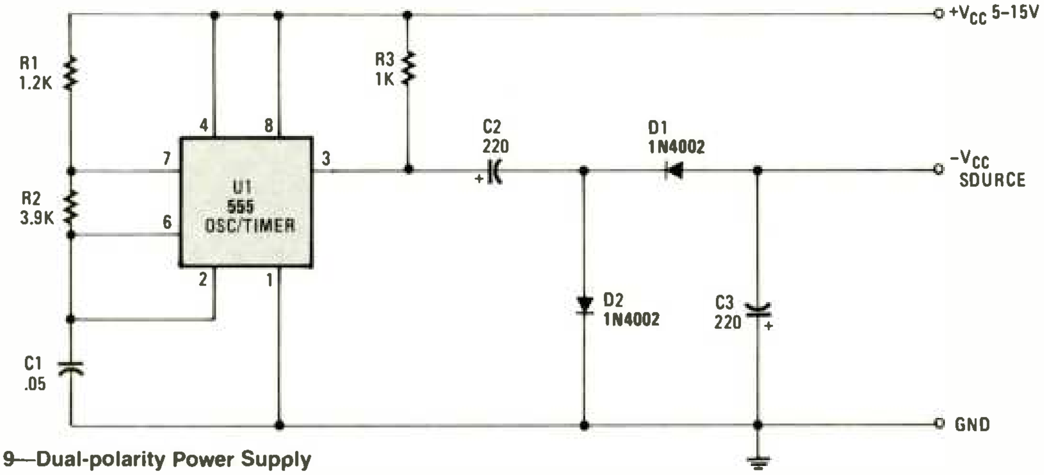


Fig. 9—Dual-polarity Power Supply

Voltage Doubler

A simple voltage doubler may be the solution to the problem when you need a voltage that is approximately twice that available from an existing source. Figure 10 shows just such a device, designed around a 555 timer integrated circuit.

The timer operates as an astable multivibrator delivering a squarewave. Frequency is controlled by R1, R2 and C1. But, when—as in this case—R2 is much larger than R1 the frequency is determined mainly by the values of R2 and C1 and the output is essentially a symmetrical squarewave. The frequency is approximately 500 Hz.

When the power is first applied to the circuit, the output pin (pin 3) is at V_{cc}. Capacitor C1 begins charging exponentially through R1 and R2 until its voltage, and the voltage on pin 6, is $\frac{2}{3}V_{cc}$. At that point, the output drops to zero and C1 discharges exponentially through R2 into pin 7 until its charge, and the voltage on pin 2, drops to $\frac{1}{3}V_{cc}$.

(Continued on page 32)

(Continued from page 28)

The device is triggered by the voltage on pin 2, the output rises to V_{cc}, and the charge-discharge cycle begins anew, producing a symmetrical squarewave output.

The voltage multiplier consists of C2/D1 and D2/C3 fed by the squarewave at pin 3. When the output is low, C2 charges through D1 and—assuming no load on the circuit—rises to V_{cc} minus the drop across D1. When pin 3 goes high, the negative terminal of C2 is V_{cc} and the voltage on its positive terminal is at a level equal to V_{cc} plus its initial charge. Capacitor C2 now dumps its charge through D2 into C3. Still assuming no output load, C3 acquires a charge voltage approximately twice the charge on C2 less the drop across D2. Thus, the no-load output of the voltage doubler is twice V_{cc} less the drop across two diode junctions.

In practice, when a load is connected to the voltage doubler output, C3 discharges into it when the timer output is low. Its charge is replenished and the DC output held relatively constant when the 555 output goes high and C2 again dumps its charge into C3.

The circuit doesn't have a high degree of regulation. Operating from a 12-volt supply, the no-load output is 22.5-volts. Output drops linearly to 17-volts at 40-mA.

PARTS LIST FOR VOLTAGE DOUBLER

C1—0.1-µF, 50-WVDC, ceramic disc capacitor
C2, C3—220-µF, 35-WVDC electrolytic capacitor
C4—470-µF, 16-WVDC electrolytic capacitor
D1, D2—1N4002 1-A, 100-PIV, silicon rectifier
R1—2200-ohm, ½-watt, 10%, resistor
R2—15,000-ohm, ½-watt, 10%, resistor
U1—555 timer integrated circuit

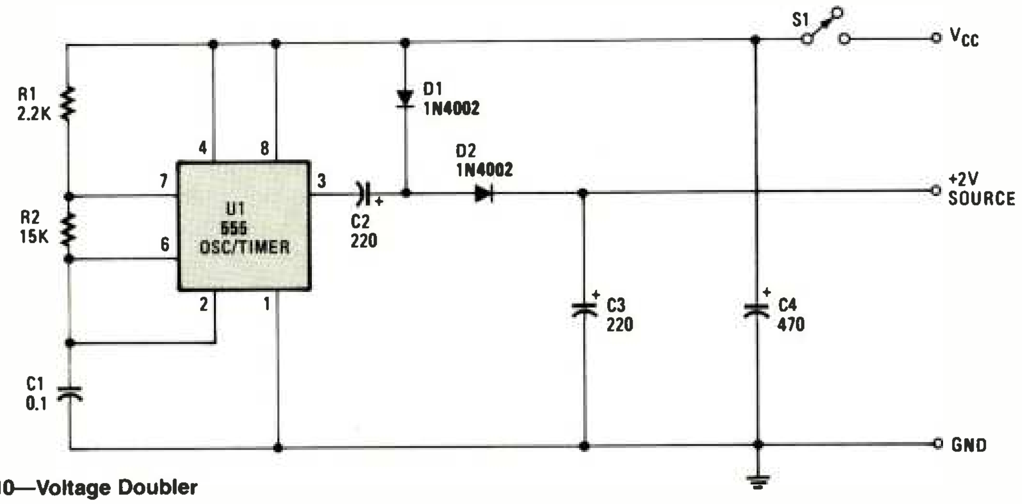


Fig. 10—Voltage Doubler

Thermometer Adapter

There are times when we want to monitor or to measure temperature from a remote point. The circuit in Fig. 11 will let you do it at a budget price. A simple op-amp and silicon diode are the heart of the temperature-to-voltage converter that will permit you to use an ordinary voltmeter—either analog or digital—to measure temperature. User-adjustments make it possible for a reading of either 10-mV or 100-mV to represent 1-degree Fahrenheit or Celsius.

Temperature sensor D1 is a 1N4148 silicon diode. It has a temperature coefficient of −2-mV/°C. U1, a 741 op-amp, is connected as a differential amplifier. A voltage divider consisting of R3 and Zener-diode D2 provides a 6.2-volt reference voltage. D2 is shunted by potentiometer R4 so the offset can be adjusted to align the output voltage with either the Celsius or Fahrenheit scale, as desired.

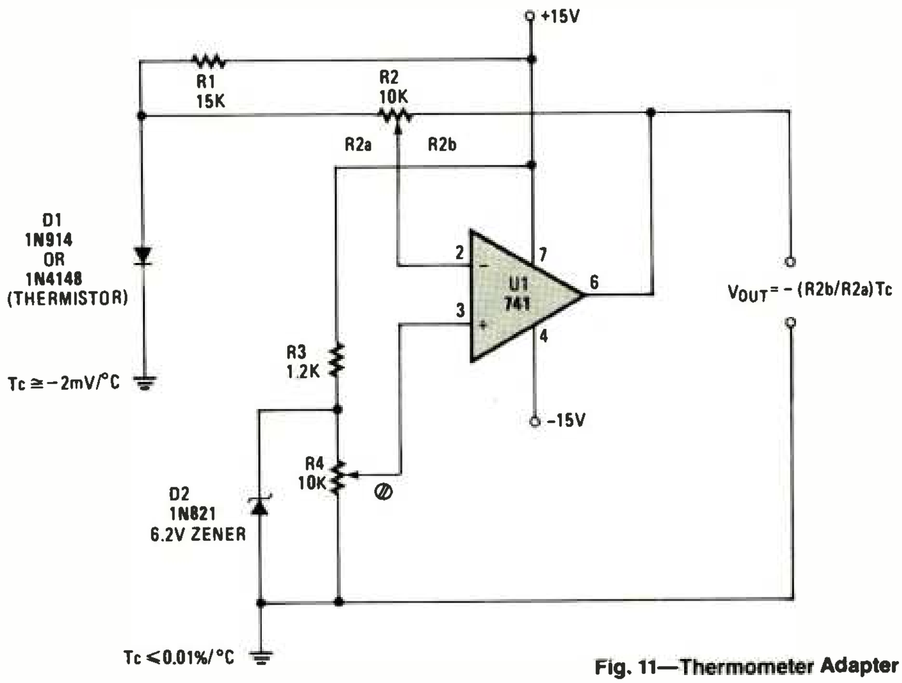


Fig. 11—Thermometer Adapter

Only a portion of R2b—the GAIN control—is in the feedback loop of the 741. Section R2a is in series with the output of the probe sensor and the inverting input of the op-amp. Gain can be adjusted so the op-amp output is linear and within the desired range of the voltmeter. The voltage output is:

$$V = -(R2b/R2a/T_c)$$

where T_c is the temperature coefficient of sensor D1.

GAIN control R2 is adjusted so the output of the op-amp is in the scale or voltage range of the meter being used. R4, the OFFSET ADJUST control, is then adjusted so the output voltage represents either degrees F or degrees C. The thermometer adapter can be calibrated by adjusting R4 while the probe sensor is at a known temperature. Boiling water and/or a mixture of water and crushed ice that has been stirred and allowed to settle to a constant temperature can be used as a temperature standard.

PARTS LIST FOR THERMOMETER ADAPTER

D1—1N4148 or 1N914 silicon diode
D2—1N821 6.2-volt Zener-diode, or equivalent
R1—15,000-ohm, ½-watt, 5%, metal film resistor
R2, R4—10,000-ohm, multi-turn trimmer potentiometer
R3—1200-ohm, ½-watt, 5%, metal film resistor
U1—741 op-amp

Metal-film resistors for R1 and R3 and wirewound trimmer potentiometers for R2 and R4 will insure good temperature stability.

Handy Capacitance Bridge

The Wheatstone Bridge is one of the earliest test instruments. It was designed for measuring resistance, but modifications for measuring capacitance and inductance soon followed. The basic bridge consists of two *ratio* arms of known value—usually with a ratio of two to one; one arm containing a fixed precision or calibrated potentiometer as the standard *reference* resistor, and the remaining arm contains the unknown resistor. The basic Wheatstone bridge for resistance measurements is in Fig. 12A.

Resistors R1 and R2 are sections of a potentiometer forming an adjustable voltage divider across excitation voltage "V." R1 and R2 form the *ratio* arms of the bridge. Resistors R3 and R4 form a second voltage divider. Lets say that R3 is the known or standard value and R4 is the unknown. The null indicator may be a sensitive meter, or an earpiece, or any means of detecting a potential difference between the points on the two voltage dividers. The values of R1 and R2 are continuously variable, but their sum is always constant.

Now, if the potentiometer is adjusted so that the bridge is balanced or nulled—as indicated by a zero reading on a meter or no sound in the earpiece—it indicates a definite relationship between the resistances in the four arms of the bridge:

$$R1/R2 = R4/R3$$

When R4 is the unknown, its relationship to the other arms of the bridge is:

$$R4 = (R2 \times R3)/R1$$

Suppose that R1 and R2 are sections of a 10,000-ohm potentiometer and the bridge voltage is 5 volts. If, when the bridge is balanced, R1 and R2 are equal, it stands to reason

(*Concluded on page 104*)

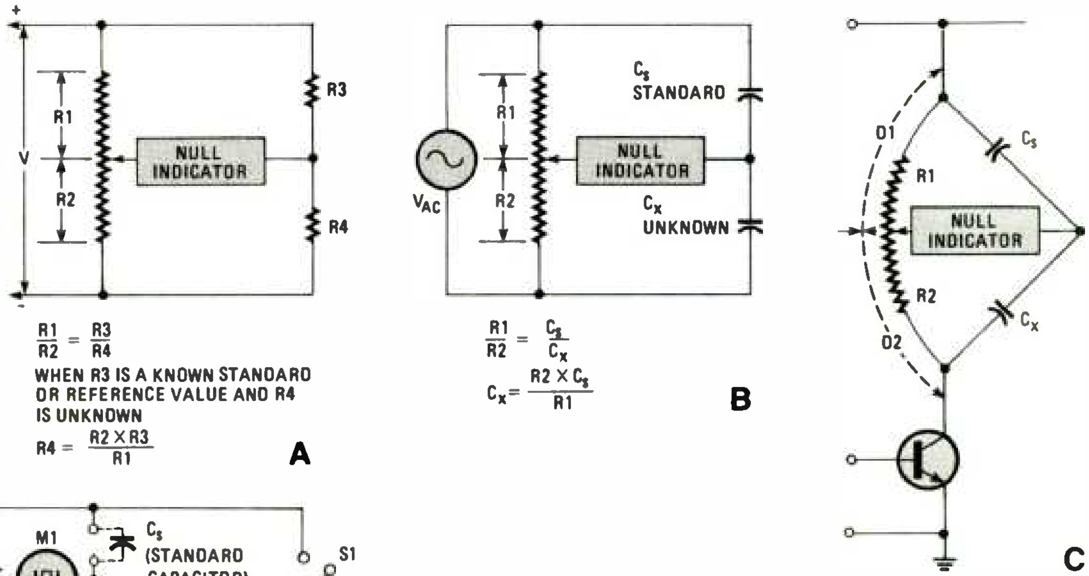


Fig.12—Basic Wheatstone Bridge diagrams showing resistance (A) and capacitance (B and C) measurements.

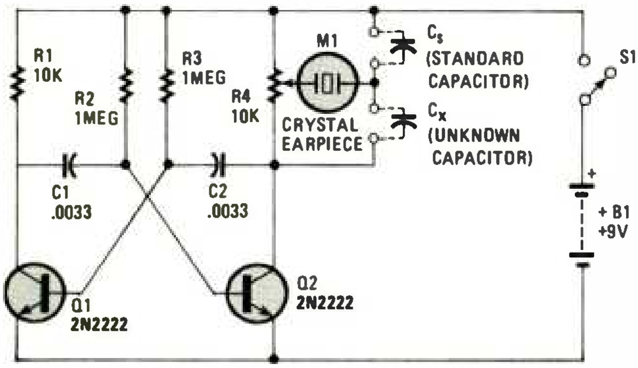


Fig. 13—Handy Capacitance Bridge

PARTS LIST FOR HANDY CAPACITANCE BRIDGE

B1—Battery, 9-volts
C1, C2—0.0033-µF, 5% ceramic capacitor
M1—Crystal earphone or earpiece
Q1, Q2—2N2222 NPN silicon transistor
R1—10,000-ohm, ½-watt, 5% resistor
R2, R3—1-Megohm, ½-watt, 5% resistor
R4—10,000-ohm, linear-taper potentiometer
S1—Single-pole, double-throw (SPST) switch

Build... SCAN-MATE

Now you can keep track of all the VHF and UHF action even when you're not at home

By Charles D. Rakes

☐IF YOU'RE CONSTANTLY MISSING OUT ON MANY OF THE exciting events going on in your area because you're too busy to stay glued to your scanner, then miss no more. Build and use our *Scan-Mate* to automatically record and store the scanner's audio until you have the time to catch up and review.

The Scan-Mate connects between your scanner and a cassette recorder. The recorder's operation is controlled by the received signal. When a signal is present at the scanner's output, the Scan-Mate starts the recorder and feeds the scanner's signal to the recorder's microphone input. The recorder is automatically turned off when the signal goes off and the muting squelches the receiver.

If the scanner is searching for an active channel, the recorder will be started whenever the scanner finds an in-use channel.

How It Works.

Inside the Scan-Mate is a solid-state switching circuit that reacts only to the audio output at the scanner's remote speaker jack. When an audio signal is present, the Scan-Mate's electronic switch instantly closes. When the audio goes off, the Scan-Mate's switch opens.

Plug P1 connects to the scanner's remote speaker-output jack. As shown in Fig. 1, when a signal is received, the scanner's audio is simultaneously routed through P1 to the 8-ohm side of T1 and through a voltage divider R1 and R2 to P2, the microphone input plug for the recorder.

The 8-ohm to 1000-ohm step-up action of T1 boosts P1's level to a usable value, which is rectified by diode D1. The resultant DC output voltage from D1 is applied to both C1 and Q1's *base*, thereby charging capacitor C1 and turning on Q1. Since the voltage across C1 is also applied to Q1's base, Q1 remains turned on as long as capacitor C1 is charged by the incoming audio. (The value of C1 sets the minimum *on* time of Q1 to keep the tape recorder from chopping off-and-on during short gaps in the audio.)

Power MOSFET Q2—which is turned on by Q1 and directly controls the tape recorder's motor—is a relatively new kid on the block in the solid-state community. Many consider it to be just about as close to a "perfect" transistor as has ever been produced. The power MOSFET offers an extremely low on-state resistance, and is free from secondary breakdown that plagues the junction transistor. Only one soft spot can be found in the good giant's armor, and that can be protected by following the handling procedures suggested by the manufacturer, to protect the device against voltage transients and static discharge.

With Q1 turned on, a positive voltage equal to the battery voltage—nine volts—is present at the collector. A voltage divider, consisting of resistors R1 and R2, steps down the full battery voltage to the level needed to turn on Q2. When Q2 conducts, its drain (D) and source (S) connections—which are connected to P3 and P4, respectively—are effectively shorted. Since either P3 or P4 is connected to the recorder's remote-control jack, the recorder will start when Q2 is turned on.

Dual Switching

Two identical subminiature phone plugs are connected to the switching output of Q2. P4 has its *tip* connected to Q2's

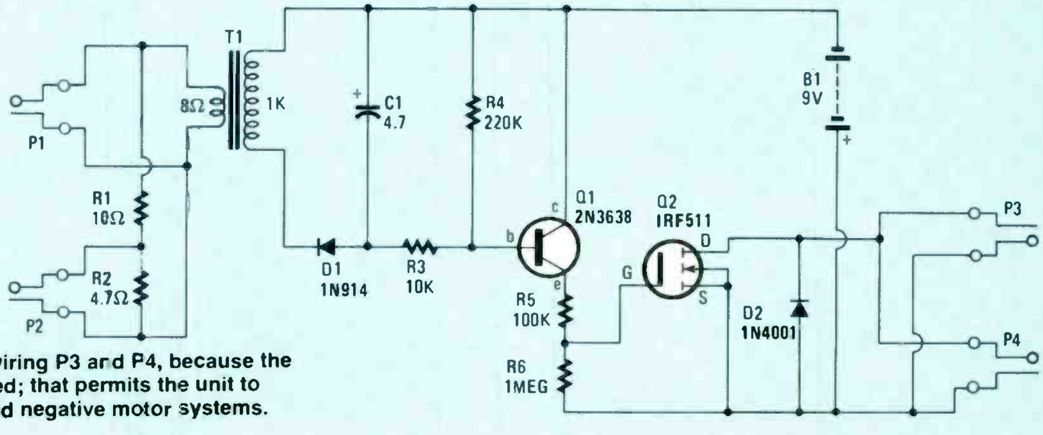


Fig.1—Take extra care when wiring P3 and P4, because the connections really are reversed; that permits the unit to function with both positive and negative motor systems.

PARTS LIST FOR THE SCAN-MATE

SEMICONDUCTORS
D1—1N914 signal silicon diode
D2—1N4001 1-A, 50-PIV, silicon rectifier diode
Q1—2N3638 PNP silicon transistor
Q2—1RF511 Power MOSFET (Radio Shack 276-2072, or equivalent)
RESISTORS
(All resistors are ¼-watt, 10% units)
R1—10-ohm
R2—4.7-ohm
R3—10,000-ohm
R4—220,000-ohm
R5—100,000-ohm
R6—1-Megohm
ADDITIONAL PARTS AND MATERIALS
B1—9-volt transistor radio battery
C1—4.7-µF, 16-WVDC, electrolytic capacitor
P1, P2—Miniature plug to match the scanner's remote output jack
P3, P4—Subminiature plug to match the recorder's remote-control jack
T1—Transformer, miniature 1000- to 8-ohm audio output
Battery snap, plastic cabinet, perfboard, wire, solder, push-in terminals

drain and that plug will turn on cassette recorders that have a positive output on the *tip* side of the remote jack. Plug P3 is connected in reverse and will activate cassette recorders that have the *tip* terminal connected to the negative voltage. That two-plug arrangement simplifies the circuit by eliminating the need for a DPDT switch to select the plug's polarity. Diode D2 provides reverse-voltage protection for Q2, and also lets you know which remote plug to use with a given cassette recorder without the need for a voltmeter. (More about that feature later.)

By now, no doubt, you have begun to wonder if we forgot to include an OFF/ON power switch for the Scan-Mate. No we did not, and here's why. With the Scan-Mate hooked up, or just placed on the shelf, the battery drain is zero as long as no audio signal is present at its input; and when a signal *is* present, the maximum current drain is less than 90-µA. A new battery should last almost as long as its shelf life; and old pooped-out batteries removed from service with a minimum terminal voltage of 6-volts or more should power the Scan-Mate for days.

Construction

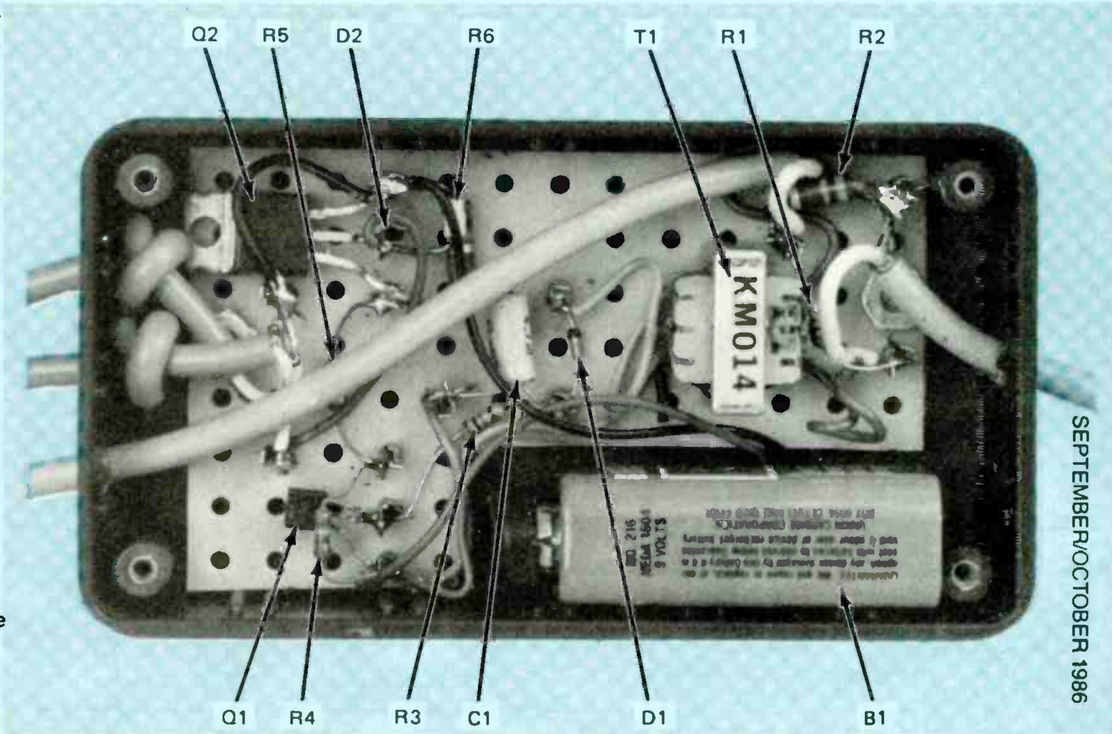
Just about any construction method will do just fine, because—as you have probably guessed by now—the circuit is straightforward, super simple, and the component layout absolutely non-critical. Simply because it's easy to do, the perfboard assembly shown in the photographs is recommended.

Cut a section of perfboard to fit the plastic cabinet you chose. Push-pins are used for *tie* points. Mount transformer T1 by pushing T1's mounting lugs through two holes in the perfboard and bend them over to secure the transformer. If you follow the layout in the photographs, assembly should not take more than an hour or two. Do take extra care when installing Q2.

Using The Scan-Mate

Connect a 9-volt battery to the Scan-Mate and set the cassette recorder to the RECORD function (the recorder should be running). Take one of the remote subminiature plugs from the Scan-Mate and plug it into the recorder's remote-control jack. If the recorder stops, that is the correct plug to use, but if the recorder continues to run, you have picked the wrong plug for that machine. Plug P2 into the recorder's microphone input and insert P1 into the scanner's external speaker jack. Set the scanner's audio to a normal level, and on the next signal received, you will be automatically recording the messages.

If you enjoy experimenting and making your own circuit changes, here are a few hints to help you travel in the right direction. Increasing the value of C1 will cause the recorder to remain on longer after the audio has stopped. The values of R1 and R2 set the level of audio going into the recorder and can be changed to increase or decrease the level. Beyond those two suggestions, you are on your own. So have fun with your Scan-Mate. ■



Except for the battery, the entire circuit can be assembled on perfboard, using push-in terminals for solder terminals.

Getting the Edge on DX'ing

Why spend your time trying to pull in those distant stations when a computer program can calculate the period for optimum DX'ing?

By Herb Friedman

☐*Where The Blue of The Night Meets The Gold of The Day* is the theme song of a legendary entertainer, Bing Crosby. It's also the place where plenty of rare DX originates. And if it's not the originating point, it often determines the kind of DX you can hear and work at your QTH.

The place where the blue of the night meets the gold of the day—where day fades into night (sunset) and night fades into day (sunrise)—is called the *Gray Line*. Actually, the Gray Line is the pattern (a curve extending around the earth) of daylight and darkness that the sun projects onto the earth. Both the shape of the Gray Line and its position change continuously. The variations are caused by both the earth's orbit around the sun and its axial rotation.

The Gray Line is important to the DX'er because very good propagation conditions can occur during sunrise and sunset periods, so it's important to know when conditions are most favorable at your QTH and any particular location you want to hear or work.

Band Conditions Vary

As you might expect, actual DX conditions vary from band to band, year to year, and hour to hour. But if you know the effect of the Gray Line on a particular band, you can more or less accurately plan the precise time and frequencies for your DX'ing. At the very least, knowing how to use the Gray Line to your advantage can save a lot of time otherwise spent tuning across empty bands.

For example, the best conditions on 10 to 15 meters normally exist between areas that are both in daylight, particularly during times of reduced sunspot activity. Around 20 meters, long path (the long way round) DX is most reliable when one QTH is going through sunrise while the other QTH is going through sunset (or vice versa). From 40 through 160 meters, the best DX conditions usually occur when it's sunset on the western side of the propagation path and sunrise on the eastern side.

And then there's the precise timing of band openings. For example, on the low bands, certain paths open when sunset at your QTH occurs and just before sunrise at the distant QTH. (Yes, it's true. Much *mumbo jumbo* and a touch of *black magic* goes into predicting DX.)

While you could calculate and draw your own Gray Line charts and graphs for every month and every hour in the year, a better way to do it is with a Commodore 64 or 128 computer and a program called "The DX Edge," a computerized Gray Line that runs under almost total user control—meaning it supplies an answer for just about any condition the user inputs. We're going to show how to understand and use the Gray Line by using "The DX Edge" just as you might do if you were into amateur radio or SWL-DX'ing.

See The World

As shown in Fig. 1, The DX Edge comes up on screen with a Miller Cylindrical projection world map, displaying the world from 90-degrees north to 90-degrees south latitude, centered on WOE meridian. The small specks seen in the various bodies of water represent the more popular islands. If you want to find a particular spot of land in an ocean, simply

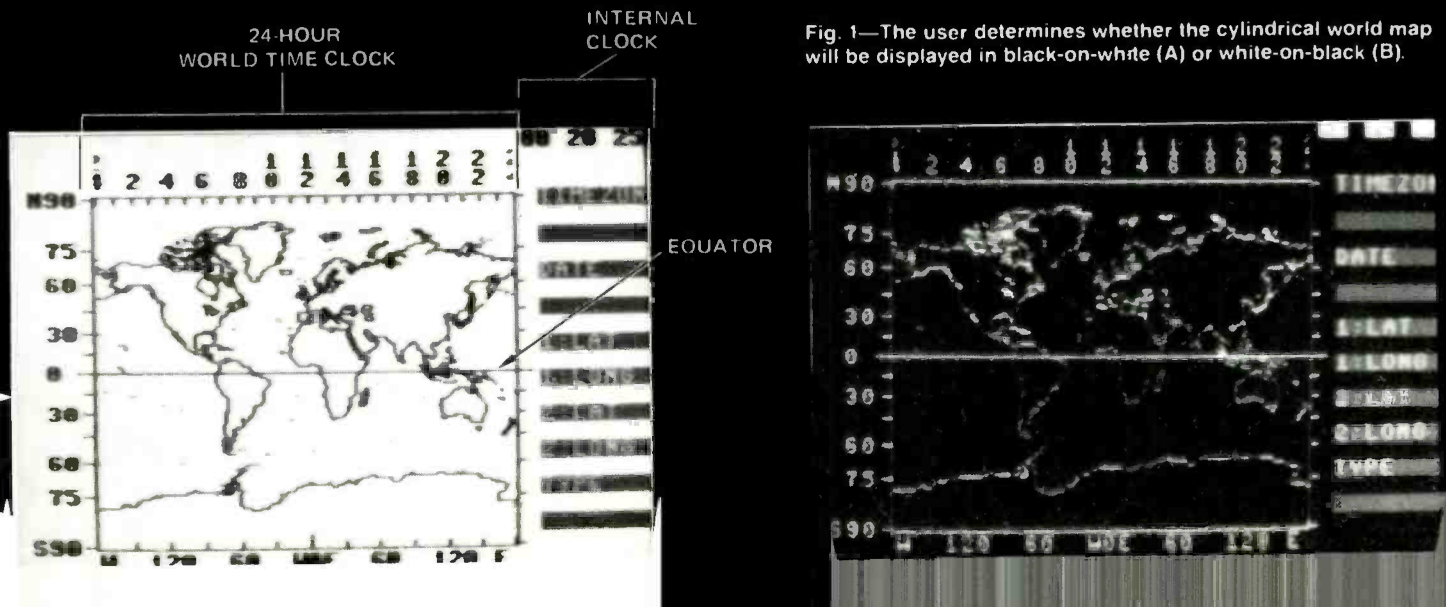
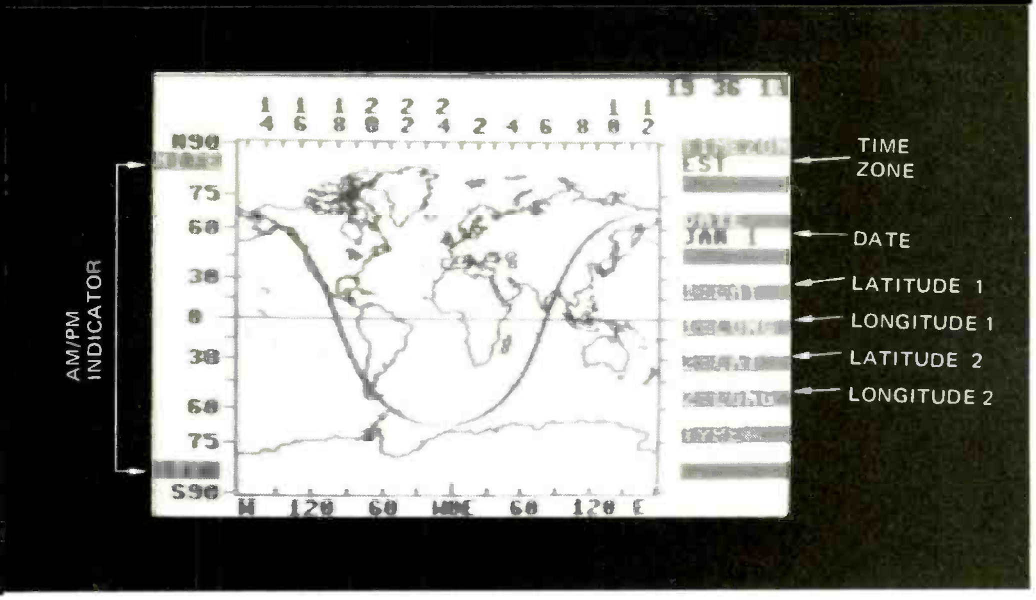


Fig. 1—The user determines whether the cylindrical world map will be displayed in black-on-white (A) or white-on-black (B).



The DX Edge program, written for the Commodore C64 and C128 computers equipped with a 1541 or 1571 disk drive, is available from The DX Edge, P.O. Box 834, Madison Square Station, New York, NY 10159. It is priced at $27.95 (US) postpaid; $31.95 (US) outside the U.S. and Canada. ■

Fig. 2—The DX Edge will trace the Gray Line (It separates day from night) for a particular date and time.

compare the computer's picture with a conventional atlas; or, as we'll show later, enter the name or *call prefix* of an island and the computer automatically draws cross-hairs through the correct location.

The horizontal line through the center of the display is the equator. Local standard times throughout the world are shown across the top of the screen on a 24-hour clock (the two-digit number is displayed vertically instead of horizontally). The upper right-hand corner shows current values of an internal clock that indicates real time, or time supplied by the program (such as sunrise or sunset).

The left side of the screen indicates night and day (see Fig 2), while the right side shows the user-selected time zone, date, and latitude and longitude of location No. 1—the local QTH (which must be entered in latitude and longitude), and location No. 2, which can be entered in the same manner; or by country, call prefix, or even zone. The program automatically converts country, call sign, and zone data to latitude and longitude.

The user can select either black-on-white display as shown in Fig. 1A, or the white-on-black shown in Fig. 1B. We'll use black-on-white because it provides a better photograph from the conventional TV set used as the computer's monitor. In actual use, the white-on-black display of Fig. 1B might prove easier on the eyes. ("Ye pays yer money and ye takes yer choice!")

Figure 2 gives the Gray Line for January 1 at 1936-hours—7:36 PM eastern standard time (EST)—as shown on the clock in the upper right corner of the display. Note that the area above the Gray Line (as shown on the left of the screen) is indicated as *night*, while the area below the line is *day*. Assume for a moment that we're interested in the Gray Line up in Alaska or Siberia; both of which are up against the "ends" of the map in Fig. 2. We can instruct the computer to rotate the earth to put anything where we want it.

In Fig. 3, we've rotated the earth 6-hours east so that all of Russia and Alaska are clearly on the map. Notice that the time scale at the top indicates the shift in hours, while the scale at the bottom of the display has automatically shifted so that the center is about 70 degrees east, instead of W0E (as in Fig. 1, A and B). The map can be rotated by inputting the change in either time (hours) or longitude (degrees). No matter which method is used, the other scale automatically corrects itself. As far as DX conditions in Fig. 2 and Fig. 3 are concerned, they're probably best in the pacific because Asia through the North American pacific coast are in daylight. (Also, keep in mind that the Gray Line moves from east to west.)

Figures 4 and 5 show the effect of the earth's orbit around the sun on the Gray Line. But first, note the cross-hair centered on New York. When we plugged in our location of 40-degrees north, 73-degrees west the program automatically

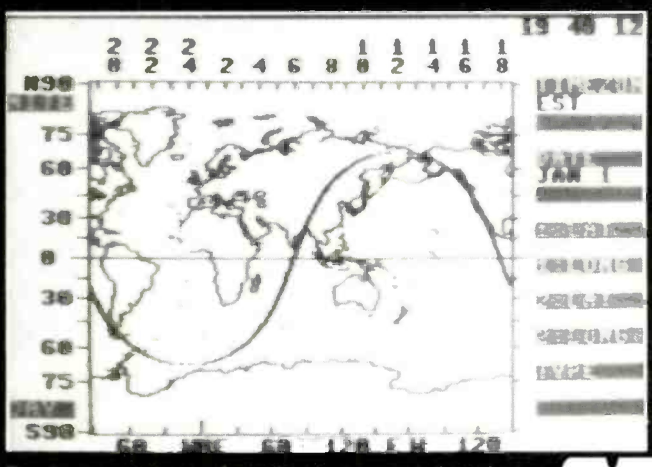


Fig. 3—If necessary, the map can be rotated so that par

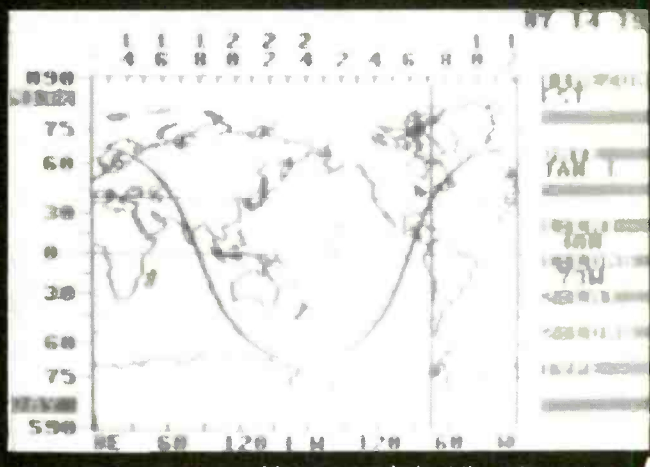


Fig. 4—The program provides a cross-hair at the primary loca-

created cross-hairs—a meridian and a parallel—so we can accurately determine the relationship of our New York QTH to the Gray Line.

When we told the computer to create the Gray Line for sunrise at our QTH on January 1, it created the Gray Line shown in Fig. 4, and programmed the local clock to indicate sunrise—0714 hours (7:14 AM). (Take particular note of the time and day on January 1.)

Figure 5 shows the Gray Line for sunrise on June 1. Note that the local clock indicates sunrise on June 1 as 0426 hours (4:26 AM), and that the Gray Line is almost 180 degrees out of phase with the Gray Line of January 1. While the New York to Hawaii path was night just prior to sunrise on January 1, the same path is in daylight on June 1.

Figure 6 shows another set of cross-hair centered on the southeastern tip of Australia. On January 1, we decided to try to "work" the VK3 district of Australia. We entered VK3 for the second location and the computer automatically calculated the latitude and longitude, and put cross-hairs right on VK3-land. As you can see, VK3 is right on the Gray Line—going through sunrise (night to day); but the Gray Line is still a little more than two hours away from New York, where it is 1402 hours (2:02 PM). For about two hours, there will be a daylight opening between VK3 and New York. It's a heck of a shot on a very long path, but that's the way "rare" DX is heard and worked; and we've got daylight on our side.

Figure 7 shows the Gray Line for January 1 if we tell the computer to plot the line for crossing at VK3 when it's early morning in New York. Note that sunset occurs at VK3 at 1925 hours (7:25 PM) local (Australian) time, when it is 0447 hours (4:47 AM) in New York, and sunrise is still almost three hours away from New York. It doesn't look too good, but keep in mind that, with cooperation from the ionosphere, good DX possibilities exist when one QTH is going from sunrise to sunset, while the other is doing just the opposite (i.e., sunset to sunrise), which is fairly close to what's indicated in Fig. 7. Three hours split between two locations is only 1.5 hours at each QTH, and although that is not optimum, it's worth a try.

Figure 8 illustrates how The Gray Line can be used for DX'ing the really rare stations. Again, it's January 1 and it's sunrise in Japan, Korea, and eastern Asia, while it's sunset in New York. Conditions are just about optimum for DX'ing between those locations on a "long path" through daylight if the maximum usable frequency (MUF) and the ionosphere permit.

Admittedly, it often takes considerable time to snag DX, and if an hour or more passes, the displayed Gray Line will have no significance if not updated. To avoid confusion and

(Continued on page 108)

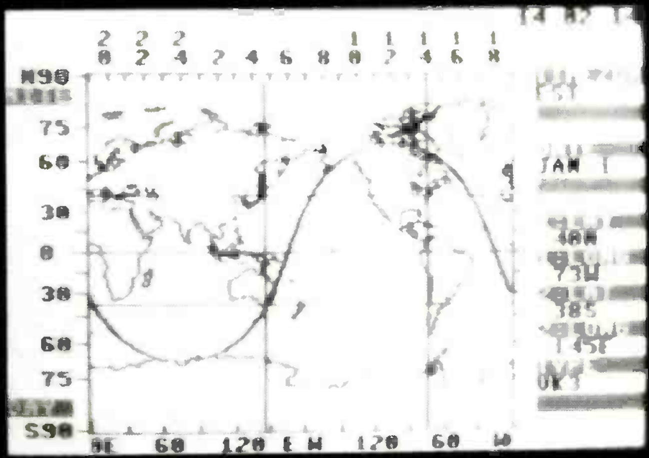


Fig. 6—If desired, a set of cross-hairs can be positioned on a selected second location (QTH).

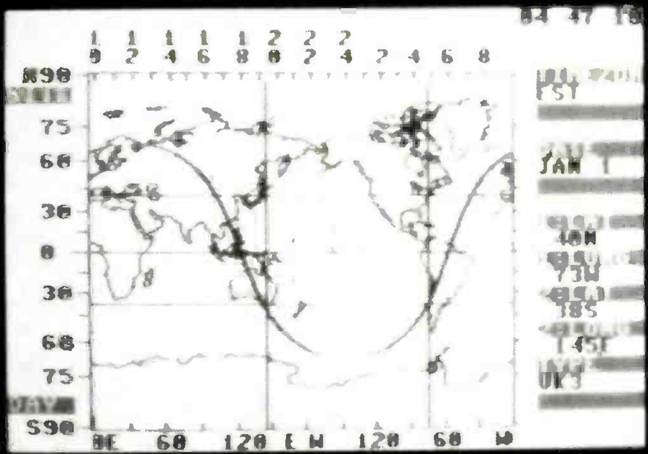


Fig. 7—The time of the Gray Line can be juggled to obtain the optimum conditions at a particular location (QTH).

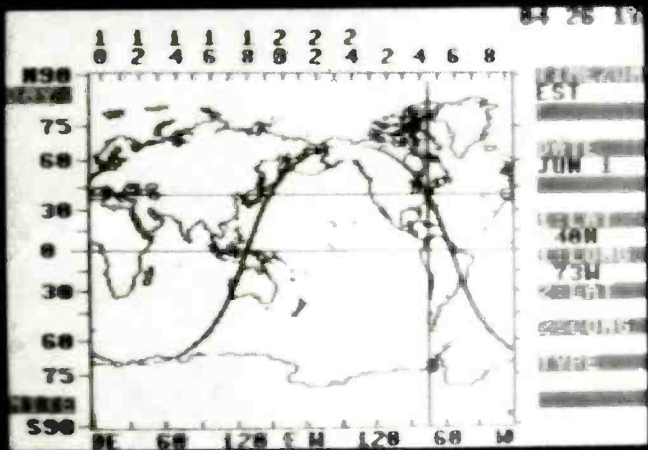


Fig. 5—Six months later on June 1, the Gray Line is almost

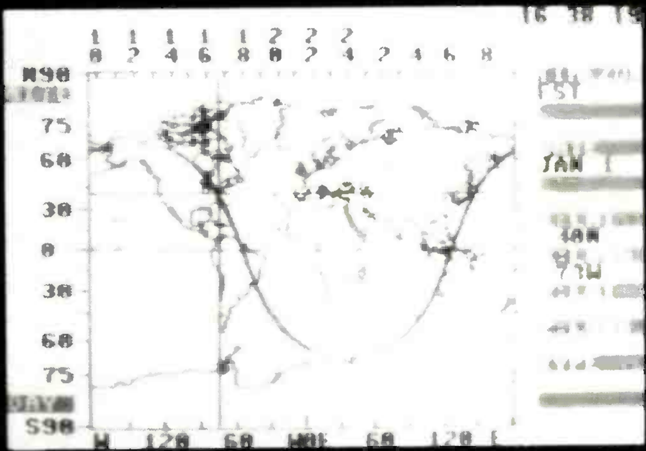
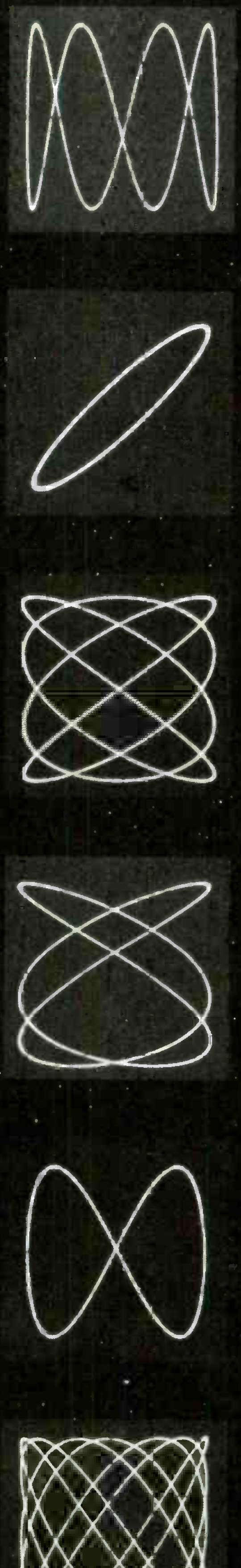


Fig. 8—Simply running the Gray Line through your QTH



UNDERSTANDING AND USING *Lissajous Figures*

Curious oscilloscope patterns that tell you about the input signal's frequency and phase

By TJ Byers

THE OSCILLOSCOPE IS A UNIVERSAL TEST INSTRUMENT CAPABLE OF MEASURING a wide variety of electrical signals. While most of us are familiar with the standard operation of the scope, not too many of us know about its more advanced uses, in particular, a display pattern called *Lissajous figures*.

Because of exhibitions put on by *electronic artists* at museums and art shows, many of us think of Lissajous patterns as a form of electronic artwork; actually, they are a method by which we can use an oscilloscope to measure a signal's frequency and phase.

Measuring Frequency

The usual method for displaying waveforms on an oscilloscope is to sweep the screen horizontally while modulating the vertical axis. The horizontal sweep is produced by a sawtooth waveform applied to the horizontal input. The sawtooth wave has a constantly-increasing voltage that generates a linear deflection of the beam across the face of the tube, as illustrated in Fig. 1. When modulation is applied to the vertical input, the beam moves up and down around the horizontal base line, creating a graphic representation of the waveform. (Actually, in that instance, we are using the sweep waveform as a substitute for a horizontal input signal, and we could just as easily replace the internal horizontal sweep signal with a signal through the oscilloscope's horizontal input.)

When the vertical signal frequency is equal to the horizontal sweep frequency one cycle of signal is displayed on the screen. A vertical input with a frequency higher than the horizontal input generates multiple waveforms on the monitor. In general, the number of signal cycles appearing on the screen is the ratio of the vertical input to the horizontal sweep frequency. Four cycles on a sweep frequency of 100 Hz, for example, yield an input frequency of 400 Hz.

Unfortunately, that is not an accurate way to determine frequency, because it's difficult to estimate portions of a waveform when the two frequencies are not exact multiples of each other—which leads to errors. *(More on next page)*

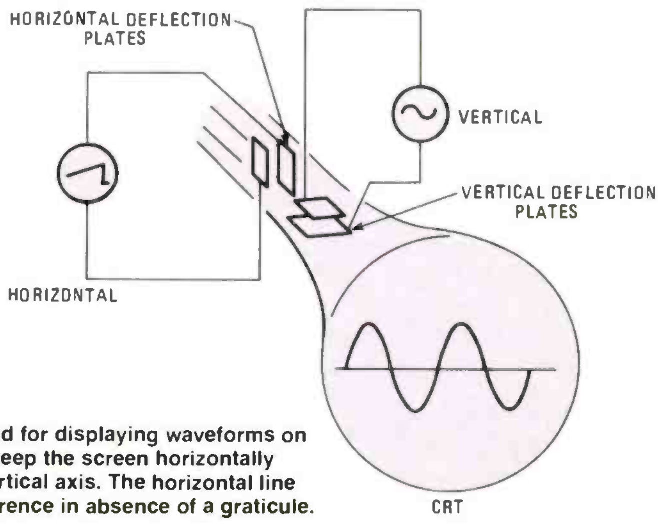
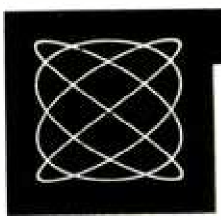


Fig. 1—The usual method for displaying waveforms on an oscilloscope is to sweep the screen horizontally while modulating the vertical axis. The horizontal line on the screen is for reference in absence of a graticule.



LISSAJOUS FIGURES

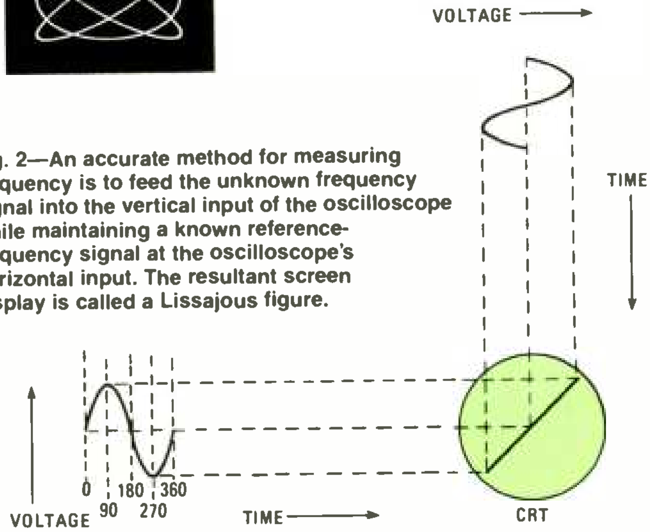


Fig. 2—An accurate method for measuring frequency is to feed the unknown frequency signal into the vertical input of the oscilloscope while maintaining a known reference-frequency signal at the oscilloscope's horizontal input. The resultant screen display is called a Lissajous figure.

Lissajous Figures

A more accurate method for measuring frequency is to utilize the oscilloscope as a frequency comparator. That is accomplished by feeding a sinewave voltage of unknown frequency into the vertical input while maintaining a sinewave voltage of a known reference frequency at the horizontal input. See Fig. 2. The resultant display on the screen is called a Lissajous figure.

Unlike a sawtooth voltage input as seen in Fig. 1, the sweep on the screen of the oscilloscope is no longer linear but sinusoidal, causing the beam to travel at different speeds over different portions of the screen creating a visible trace. Furthermore, because the rate of change of the scanning voltage never changes abruptly, none of the signal cycle is omitted by the trace and there is no retrace.

Figure 2 shows the result of one cycle of sinewave voltage sweeping another sinewave voltage. Starting with the 0° position of the sweep cycle, the trace is deflected to the right during the first 90° of sweep, whereupon the voltage increases to a maximum positive value.

As the sweep voltage progresses from 90° to 180°, the trace's amplitude decreases from maximum positive back to zero, retracing and repeating the values of the first quarter cycle. In other words, the beam trace returns to its place of origin.

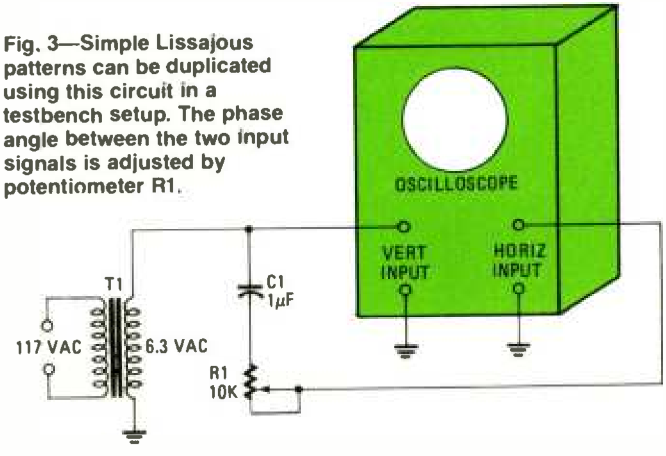


Fig. 3—Simple Lissajous patterns can be duplicated using this circuit in a testbench setup. The phase angle between the two input signals is adjusted by potentiometer R1.

As the sweep cycle continues from 180° to 270°, the amplitude of its trace increases as it did during the first quarter—but in the opposite direction. The beam is now deflected to the left and down. The final portion of the sweep, from 270° to 360°, retraces the path of the third quarter cycle, bringing the beam back to its starting point.

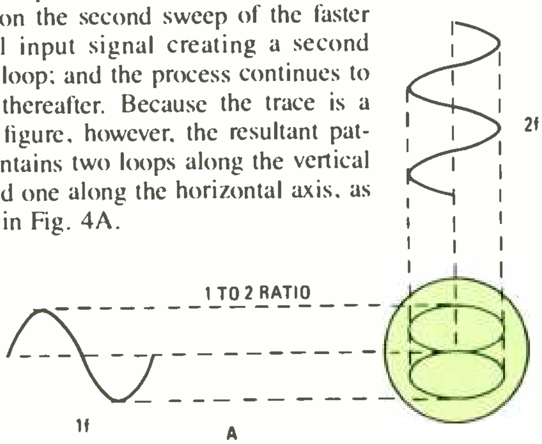
Notice that throughout that sweep cycle, the trace is always visible. If the vertical and horizontal signals are in phase, as they are in Fig. 2, they will create a continuous trace which we see as a single line. If the phase angle between the two signals changes from zero to 90° the line will open up—first to an ellipse and finally into a circle. (The circle occurs when two signals are 90° out of phase and the maximum amplitudes of both input voltages are equal.) Further, phase advancement to 180° brings the circle back together again to form a continuous line-trace.

That example is the simplest of the Lissajous figures, and it represents a 1-to-1 frequency ratio. The condition exists only when the input frequency is equal to the sweep frequency and the amplitudes of the sinewave voltages are equal. For the remainder of this article it will be understood that the amplitudes of the sinewaves under examination are of equal amplitude. That is achieved with oscilloscopes by variable gain amplifiers that connect to front panel controls.

For experimentation, we can duplicate the single line-to-circle pattern using the circuit shown in Fig. 3. The phase angle between the two signals is adjusted by potentiometer R1.

Determining Frequency Ratio

Should the sweep rate be twice as fast (double the frequency) as the vertical signal, only one-half the horizontal signal cycle is traced for each cycle of the vertical input creating a closed-loop trace. The other half of the horizontal signal is traced on the second sweep of the faster vertical input signal creating a second closed loop; and the process continues to repeat thereafter. Because the trace is a closed figure, however, the resultant pattern contains two loops along the vertical axis and one along the horizontal axis, as shown in Fig. 4A.



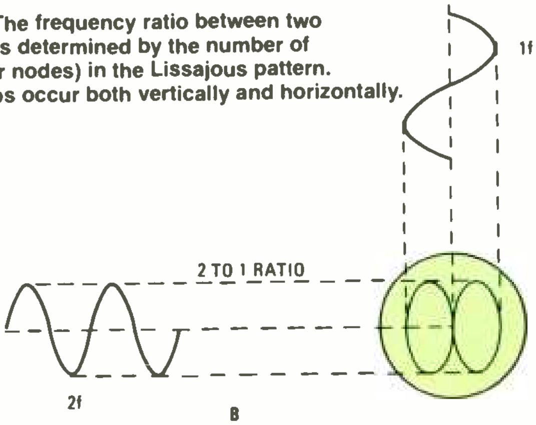


Fig. 4—The frequency ratio between two signals is determined by the number of loops (or nodes) in the Lissajous pattern. The loops occur both vertically and horizontally.

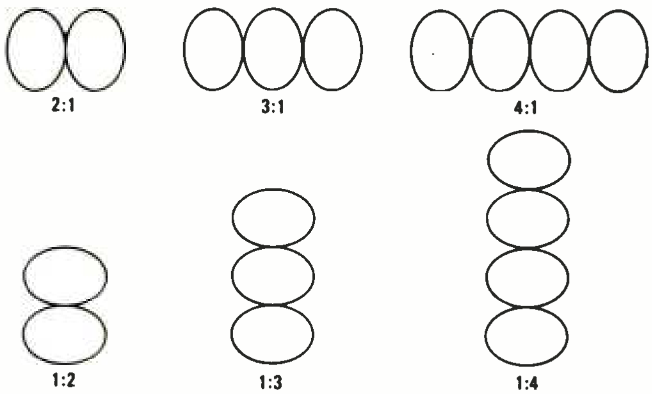


Fig. 5—When the horizontal sweep rate is slower than the vertical sweep rate (low frequencies cause sweeps slower than higher frequencies) the loops are displayed along the vertical axis. For horizontal sweep rates faster than the vertical input the loops are on the horizontal axis.

We can express that as a ratio of 1:2 (1 to 2). (Notice that we have followed common practice and stated the vertical frequency first in our ratio.) Similarly, a ratio of 1:3 produces three loops along the vertical axis and one along the horizontal, as shown in Fig. 5. Ratios of 1:4 and 1:5 generate four and five loops, respectively.

When the horizontal sweep rate is faster than the vertical input frequency, the loops are displayed along the horizontal axis, as shown in Fig. 4B. In that example, the sweep rate is twice the vertical input frequency, producing two full traces along the horizontal axis and one along the vertical axis. The ratio is expressed as 2:1.

The frequency ratio is determined by the number of loops in the Lissajous pattern. It is easy enough to see that if there are five loops along the horizontal axis, the frequency ratio is 5:1. By knowing that the horizontal frequency is 1 kHz, for example, we can deduce that the vertical input signal must be 5 kHz.

Because the 60-Hz line frequency is highly accurate and readily available, it is often used for Lissajous-figure frequency comparisons; its only limitation is that measurements above 1 kHz are hard to interpret.

A study of the trace patterns shown in Fig. 5 should more clearly indicate what to expect when comparing an unknown frequency to the reference frequency. Notice that when the frequency ratio exceeds unity, the number of horizontal loops exceeds the number of vertical loops. When the frequency ratio is less than unity, the number of vertical loops exceeds the number of horizontal loops. In both cases, we determined the frequency by counting the number of loops and entering them into a ratio format.

Fractional Ratios

While it is fairly easy to determine simple frequency ratios with Lissajous patterns, we can't overlook the odd combinations, because, more often than not, frequency ratios do not fall as exact increments of each other. It is more common to find ratios of 5:3 or even 19:20. Those ratios also can be displayed as Lissajous figures. In fact, it is the most powerful feature of the Lissajous method.

It is only a short step from simple Lissajous figures to more complex patterns. As the patterns grow more complicated, they grow nodes. Instead of the simple multiple-loop versus one-loop pattern, both axis start expanding. A frequency ratio of 5:3, for example, is displayed by five loops along the vertical axis and three loops on the horizontal axis. A ratio of 4:7 is four loops vertically and seven loops horizontally.

When determining the frequency ratio of complex Lissajous figures, simply count the number of nodes (we have been calling them loops until now) along each axis and put them in ratio format. The ratio is now expressed as a fraction which can be used to calculate the unknown frequency. The first pattern in Fig. 6, for instance, displays a 3:2 frequency ratio. If the sweep (horizontal) frequency is 200 Hz, then the vertical input is 300 Hz.

When dealing with complex Lissajous patterns, be aware that the corner loops are counted in both the horizontal and vertical directions, seemingly serving double duty. An examination of the other patterns in Fig. 6 should get you quickly familiar with the procedure.

Pitfalls to Avoid

If you're going to use Lissajous figures it will be necessary to develop some skill in counting and interpreting the patterns. High, low, or close ratios can be difficult to decipher because misinterpretation of Lissajous figures is quite easy when there are many loops to identify. Not only is it possible to miscount the loops, but under unfavorable phase conditions, loops may be obscured by overlapping lines.

Sometimes it's better to deliberately rotate the pattern by introducing a slight frequency misalignment. Minor frequency differences are reflected as a slow gyration of the Lissajous pattern, making it easier to identify and count the hidden loops. Poor phase conditions can also be corrected through external phase adjustment. If the scope has a phase control, adjusting it can often make the difference between an unreadable figure and an accurate one—Lissajous figures are easiest to interpret when the phase angle is exactly 90 degrees.

Adjustment of the oscilloscope's brightness, focus, and astigmatism controls can also be of help. The attainment of fine focus at the outer edges of a pattern—even at the expense of a fuzzy center—may provide the extra resolution needed to separate closely spaced loops.

Often, a complicated figure can be simplified by an adjustment in the reference frequency. A ratio of 20:9, for example, is an extremely difficult pattern to deal with. A slight increase in the horizontal reference frequency, however, reduces that pattern to a 20:10 ratio, which the oscilloscope displays as 2:1.

Lissajous patterns are an accurate and simple way to measure frequency using the ever-versatile oscilloscope. The accuracy of the method is limited only by the precision of the reference frequency, and measurements of 0.001% are not uncommon on the test bench at home.

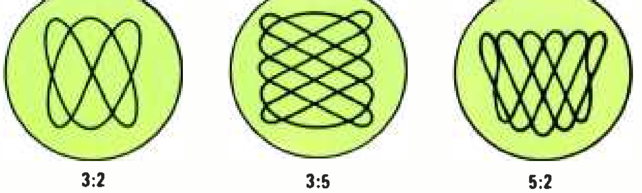
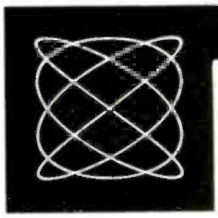
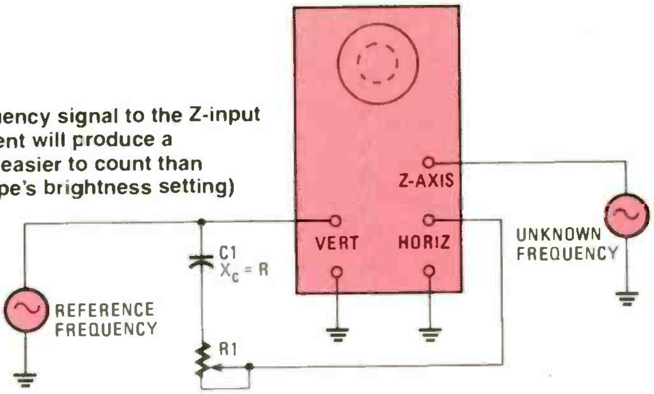


Fig. 6—When dealing with complex Lissajous patterns, the corner loops are counted in both the horizontal and vertical directions. However, the larger the number of the ratio, the harder it is to count the peaks, as illustrated in the 5:2 ratio. Should you find it difficult to count the loops, count the number of times a loop touches a vertical side of the display; likewise for the horizontal side.



LISSAJOUS FIGURES

Fig. 7—Applying the unknown frequency signal to the Z-input in this kind of test circuit arrangement will produce a circle with blanks (slots), which are easier to count than loops (depending on the oscilloscope's brightness setting) when the difference between the two frequencies is very large.



Intensity Modulation

An interesting variation to the Lissajous figure is the addition of Z-axis modulation shown in Fig. 7. The Z-axis is an input which permits us access to the CRT's control grid. When voltage is applied to that input, it varies the brightness of the display. Many scopes have that input located at the rear of the instrument. Be careful here, because the deflection plates are in the same area and the voltages may be high.

With a little ingenuity we can make the Z-axis work as a frequency counter for us. With that method of frequency measurement we again produce an integral number of modifications around a circle which are counted to determine the frequency ratio. This time, however, the modifications are alternate interruptions and enhancements in the brightness of the beam rather than loops and nodes. Actually they look like small crescents or moon shapes.

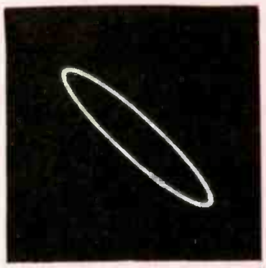
The basic idea is to establish a reference frequency on both the horizontal and vertical axis using a single-signal source. By adjusting R1, the phase angle between the vertical and horizontal inputs is adjusted to give a circular pattern on the screen. Next, an unknown frequency is applied to the Z axis. The Z-axis frequency modulates the brightness of the display. When the input voltage is properly adjusted, blank spaces will occur around the ring, indicating places where the beam's intensity is fully cut off by the driving Z-axis input.

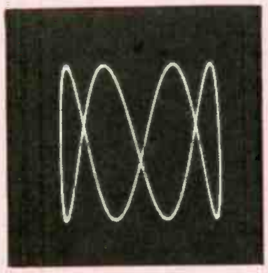
The frequency ratio is determined by counting the number of times the circle is interrupted by the Z-axis signal. (The interruptions appear as slots on the display. Five slots, for example, indicates a frequency ratio of 5:1.) Maybe you prefer to count the cresents—their number will be the same as the dark slots.

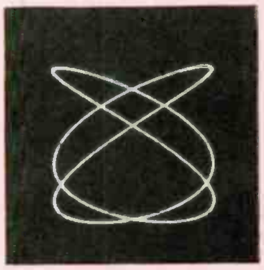
That method of frequency determination is particularly useful for high ratios of unknown-to-reference frequencies, because it is relatively easy to count large numbers of slots accurately. Unless the two ratios are exact multiples of each other, however, the pattern will rotate like a spinning wheel. A slight adjustment in the reference frequency corrects the problem. Also, be aware that the method is not suitable for measuring frequencies lower than the reference frequency. ■

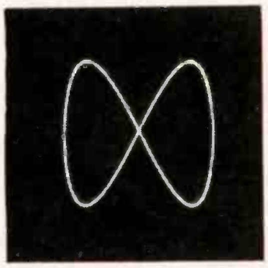
You Call the Ratio

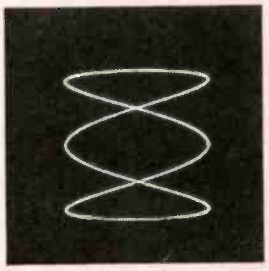
AFTER READING THE PREVIOUS PAGES of this article you should be able to determine the ratio of frequencies for the Lissajous figures shown in A through J. Try your hand at it! We show you how by providing the ratio of frequencies for Lissajous figure A. Answers are provided below.

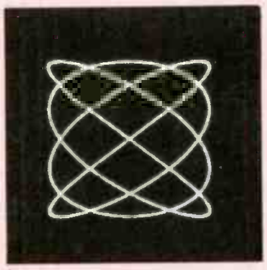


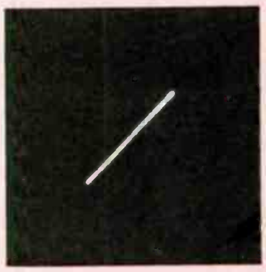


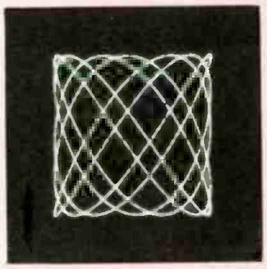


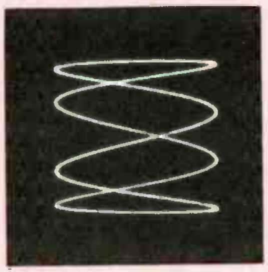


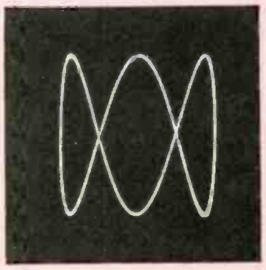












A 2:1 ______ F ______
B ______ G ______
C ______ H ______
D ______ I ______
E ______ J ______

ANSWERS

A–2:1, B–1:1, C–4:1, D–2:3, E–1:3, F–3:4, G–1:1 (vertical signal exactly in phase with horizontal signal), H–7:5, I–1:4, and J–3:1.

BUILD CRYSTAL, PLL, AND VCO OVENS AND HEATERS

By D.E. Patrick

Add stability to those temperature-dependant, frequency-determining and oscillator circuits with parts that are probably gathering dust on your workbench!

☐MORE OFTEN THAN NOT, IT'S *VARIATIONS* IN AMBIENT TEMperature rather than the absolute temperature that cause instability in frequency-determining circuits. Hence, most crystal-controlled, VCO, and PLL circuits can be stabilized by simply maintaining the circuit or its components at a fixed temperature—one that won't be affected by drafts, open doors and windows, or intermittent operation of the device in which the circuit is used.

The usual way that temperature stability is maintained is to enclose the frequency-determining device or circuit within a small oven that is heated to approximately 50–80 °C. While manufactured ovens are usually difficult to locate, and often prohibitively expensive when you do find one, you can build ovens suitable for home-brew projects from bits and pieces of hardware lying around the shop.

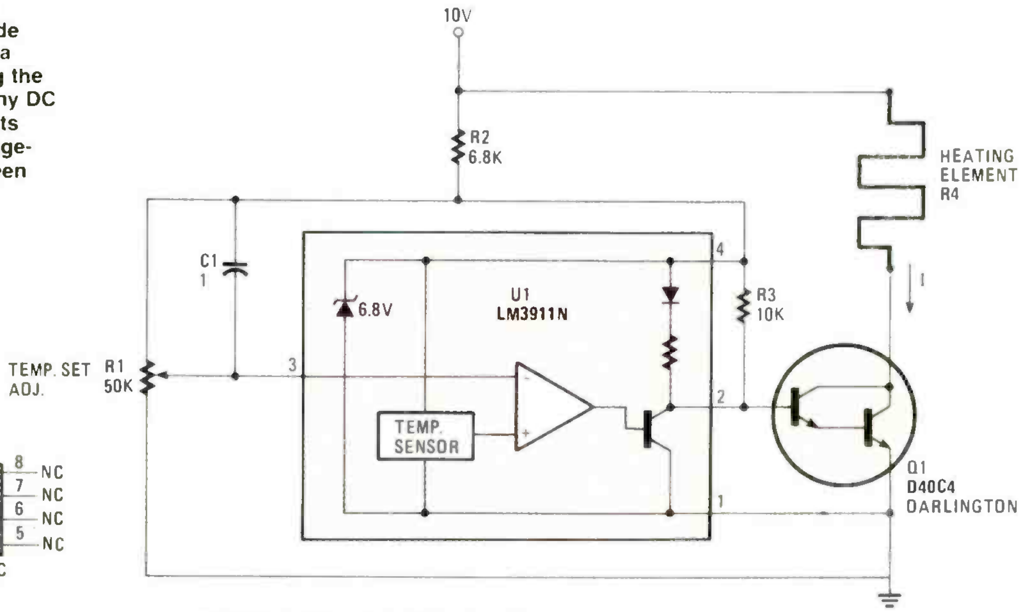
Keep It Inexpensive

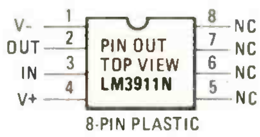
Building crystal, PLL, VCO, and component ovens is both cheap and easy. Using a temperature-controller integrated circuit, like the LM3911, which can hold oven temperatures within a few degrees of a set point, you can use panel lamps, resistors, thick-film resistor packs, and nichrome wire for heating elements.

For really tight temperature stabilization, you can build triple- and double-wall, and triple- and double-insulated enclosures with nothing more complicated than PVC or bakelite tubing lined with foil and fiberglas. And if you're looking to keep costs at absolute rock-bottom, an enclosure could be constructed out of a glass jar lined with foil and fiberglas and placed in an ordinary tin can lined with fiberglass.

But, the bottom line is that even if you build an oven from

Fig. 1—The LM3911 has an internal 6.8-volt, Zener-diode shunt regulator to provide a voltage reference, enabling the device to be powered by any DC source greater than 6.8 volts by simply dropping a voltage-limiting resistor (R2) between the power source and the integrated circuit.





PARTS LIST LIST FOR FIGURE 1

R1—50,000 or 100,000-ohm potentiometer
R2—6800-ohm, ¼-watt, 5% fixed resistor (see text)
R3—10,000-ohm, ¼-watt, 5% fixed resistor
R4—Heating device (see text)
Q1—Darlington amplifier, type D40C4 or Tip 20 (see text)
C1—1-μF, 16-WVDC, electrolytic capacitor
U1—LM3911 temperature controller integrated circuit

ADDITIONAL PARTS AND MATERIALS

Oven enclosure, heatsink (where required), hookup wire, solder, hardware, etc.

stuff you might find in the trash, you can end up with a thermally insulated case similar in performance to some laboratory-grade equipment. On the other hand, depending on the particular circuit or component—such as a crystal—you might be able to avoid building an oven by simply epoxy-cementing a couple of thick-film resistor packs to the side of a crystal to keep the beast's temperature stabilized.

Temperature-Stabilized Circuits

Figures 1 through 4 show how to build various temperature controlled devices using an LM3911 temperature controller, a special kind of integrated circuit that contains a *voltage reference*, a *temperature sensor*, and an *operational-amplifier* output circuit. As shown in Fig. 1, the LM3911's internal voltage reference is actually an internal 6.8-volt, Zener-diode shunt regulator, which means that the device can be powered by any DC supply greater than 6.8 volts by simply using a voltage dropping resistor (R2) between the power source and the integrated circuit. In effect, R2 functions as a voltage-limiting device.

PARTS LIST FOR FIGURE 3

C1—100-µF, 5-WVDC, electrolytic capacitor
C2—1-µF, 50-WVDC, electrolytic capacitor
C3—5-µF, 15-WVDC, electrolytic capacitor
D1-D6—1N4002, 1-A, 100-PIV, silicon rectifier diode
D7—1N457 200-PIV general-purpose detector diode
K1—50-mA coil, 24-VDC contact relay
Q1, Q2—2N2222 or D40C4 Darlington transistor
R1—27,000-ohm, ¼-watt, 5% fixed resistor
R2—5000-ohm potentiometer
R3—33,000-ohm, ¼-watt, 5% fixed resistor
R4—100,000-ohm, ¼-watt, 5% fixed resistor
R5—10-Megohm, ¼-watt, 5% fixed resistor
R6—12,000-ohm, ¼-watt, 5% fixed resistor
R7—18,000-ohm, ¼-watt, 5% fixed resistor
T1—117-VAC primary, 24-VAC secondary, miniature power, stepdown transformer
U1—LM3911 temperature controller integrated circuit

ADDITIONAL PARTS AND MATERIALS

Enclosure, heatsink, hookup wire, solder, etc.

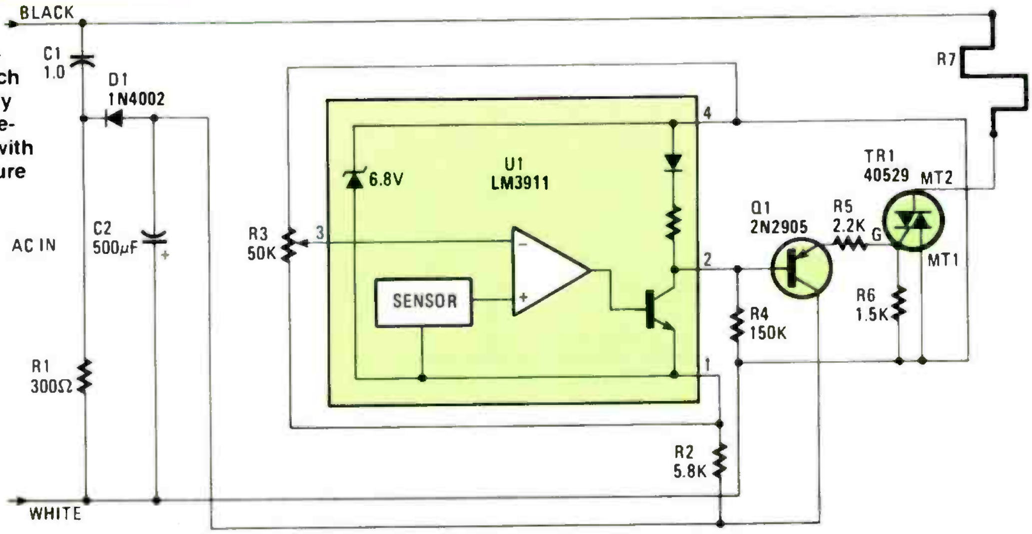


Fig. 2—In order to heat relatively large enclosures, which is rare, it might be necessary to use a triac-controlled, line-powered heater, as shown, with Q1 interfacing the temperature controller IC to the triac.

PARTS LIST FOR FIGURE 2

C1—1.0-µF, 200-WVDC electrolytic capacitor
C2—500-µF, 25-WVDC electrolytic capacitor
D1—1N4004 1-A, 400-PIV, silicon rectifier diode
Q1—2N2905 PNP general-purpose amplifier, silicon transistor
R1—300-ohm, 2-watt, 5% fixed resistor
R2—5800-ohm, ¼-watt, 5% fixed resistor
R3—50,000 or 100,000-ohm, potentiometer
R4—150,000-ohm, ¼-watt, 5% fixed resistor
R5—2200-ohm, ¼-watt, 5% fixed resistor
R6—1500-ohm, ¼-watt, 5% fixed resistor
R7—Heating device (see text)
TR1—40529 triac (or equivalent)
U1—LM3911 temperature controller integrated circuit

ADDITIONAL PARTS AND MATERIALS

Oven enclosure, heatsink (where required), solder, hookup wire, hardware, etc.

The temperature sensor reacts to temperature changes at a rate of 10mV/°K, where °K are divisions on the absolute temperature scale. On the more familiar Celsius scale, the sensor operates over the range of −25 to +85°C.

The sensor's output is connected internally to the operational amplifier's non-inverting input, while the inverting input is connected to an external voltage divider connected across the DC voltage supply. The output of the voltage divider is used as a "trip point," which the op-amp compares

PARTS LIST FOR FIGURE 4

C1—100-µF, 50-WVDC, electrolytic capacitor
C2—1-µF, 50-WVDC, electrolytic capacitor
D1-D4—1N4002, 1-A, 100-PIV silicon rectifier diode
R1—27,000-ohms, ¼-watt, 5% fixed resistor
R2—5,000-ohm potentiometer
R3—33,000-ohms, ¼-watt, 5% fixed resistor
R4—12,000-ohms, ¼-watt, 5% fixed resistor
SSR1—Solid-state relay
T1—117-VAC primary, 24-VAC secondary, miniature power, stepdown transformer
U1—LM3911 temperature controller integrated circuit

ADDITIONAL PARTS AND MATERIALS

—Oven enclosure, heatsink (where required), hookup wire, solder, hardware, etc.

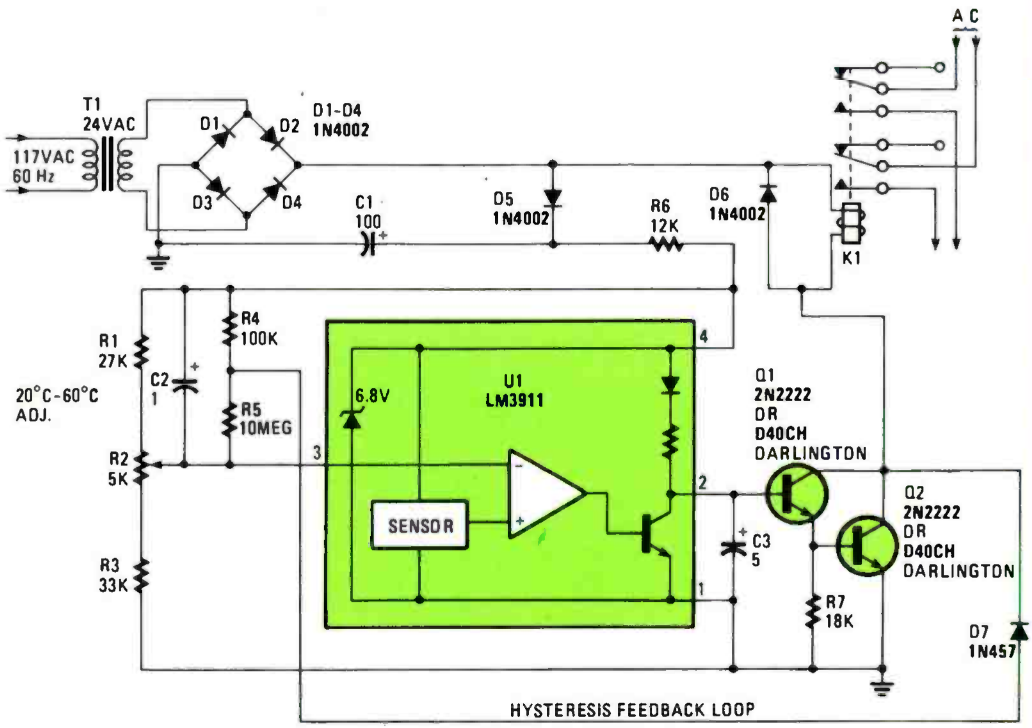


Fig. 3—In this circuit, designed for high-power heater control, transistors Q1 and Q2 are configured as a Darlington drive-amplifier. It is that combination that opens and closes the relay contacts to control the heating element.

with the output of the temperature sensor. In conjunction with the internal transistor driven by the op-amp, the comparison causes the LM3911's output to be switched. When the sensor's output is less than that of the user-set trip voltage, the LM3911's output is "off." When the sensor's voltage is greater than that of the trip point, the LM3911 is "on." In turn, the switching action of the LM3911 can be used to control high-power transistors and triacs, which in turn, control high-power heating devices.

Figure 1 shows a typical heater-control circuit using only the LM3911 controller. If the DC voltage source is greater than 6.8 volts, it can be reduced by installing resistor R2 between the voltage source and the integrated circuit. The trip point is determined by variable resistor R1, whose wiper is bypassed to the IC's voltage supply by capacitor C1. R1 can be any value from 50K to 100K. (The trip-voltage adjustment range can be narrowed for convenience in adjustment by installing a fixed resistor on either side of R1.) Since R2 serves only to drop the supply voltage, its nominal value can be calculated using the formula:

$$R2 = (V_s - 6.8) \times 1000$$

where V_s is the supply voltage. Thus, for the common power-supply values of 12 volts, 15 volts, and 24 volts, limit-resistor values of 5.2K, 8.2K, and 17.2K would be about right. (The

(Continued on page 108)

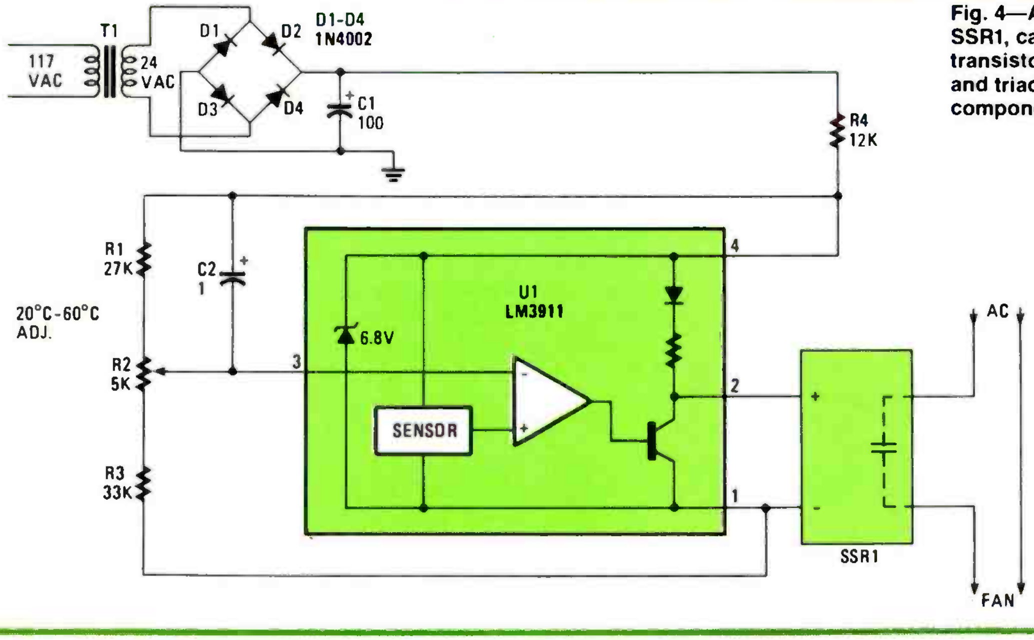


Fig. 4—A solid-state relay, SSR1, can be substituted for transistors, mechanical relays, and triacs in this junkbox component oven.

10 EASY STEPS TO... Replacing Transistors

Replacing in-circuit transistors and integrated circuits may cause more

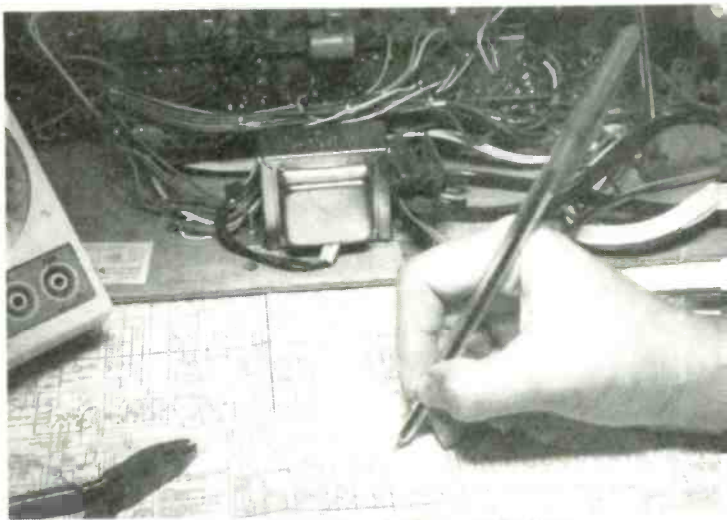
☐SINCE DEFECTIVE TRANSISTORS AND INTEGRATED CIRcuits cause most of the problems in electronic entertainment products, locating and testing those parts may quickly place the unit back in operation. Although learning how to troubleshoot defective solid-state components might appear to be a formidable task at first glance, it's relatively easy to learn and do if you follow our ten-step procedure on how to locate the defective component, what replacement component to use, and how it should be installed.

Step 1—*Isolating the Defective Component*

Determine in what stage or section of the device the trouble might occur by operating the unit. For example, if a cassette player is dead, you would go directly to the fuse, power switch, and low-voltage power supply. When a tape recorder's motor is rotating but there's no sound, suspect the audio circuit. Problems in the audio section may be isolated by touching the center terminal on the volume control with a screwdriver blade and listening for a hum in the loudspeaker. Also, you can inject an audio signal at the volume control: If a tone is heard in the speaker, the defective part is in the preamplifiers.

Likewise, in a radio receiver you would inject audio at the volume control: no signal indicates a dead audio section. If you can receive FM but not AM, suspect the AM converter transistor. If you can receive AM but not FM, look for a leaky or open transistor in the RF, oscillator, and mixer stages of the FM section.

Troubleshooting a TV chassis might take a little more time, because there are so many more circuit parts that it's more difficult to locate defective transistors and integrated circuits. Determine if correct low voltage is found at the horizontal output transistor when there's no TV raster. Reduced, or no voltage, may indicate a defective low-voltage power supply or regulator circuit. A leaky horizontal-output and damper diode might blow the main fuse. A horizontal white line or insufficient picture height points to a defective component in the vertical section. Check the color circuits when there's no color picture. Always try to isolate the section or circuits where the defective component might be before digging into the chassis.



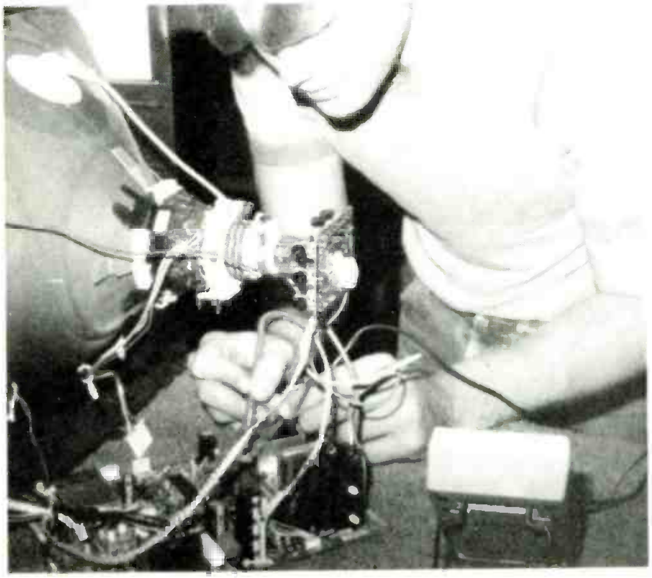
Repairing any consumer-electronics device may be very difficult without a schematic diagram. Besides showing the correct operating voltages, the diagram might give the correct transistor and integrated circuit part numbers.

Step 2—*Locating the Correct Diagram*

The schematic diagram or a wiring diagram is a "must" when trying to isolate a defective transistor or integrated circuit in a crippled chassis. As a general rule, both circuit aids—or additional service literature—will indicate the idle and operating voltages.

Besides voltage measurements, the schematic diagram might also show the part numbers of the transistors and integrated circuits. That information is very useful when you cannot obtain original parts and need to use universal-replacement parts.

Because signal tracing from stage-to-stage is often very slow and difficult, even with the schematic diagram or ser-



A TV technician is testing power transistors in a defective receiver. Most often, power transistors can be left in the circuit when testing for open circuits and leakage.

By Homer L. Davidson

and Integrated Circuits

damage than cure. Here's how to do it the right way the first time.

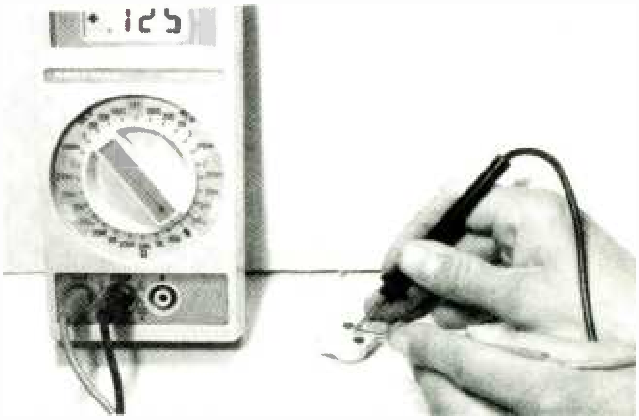
vice literature, some manufacturers include a chassis-layout chart to help you troubleshoot various stages. Others may show the location of transistors and integrated circuits through the use of "insert pictorials." Also, separate drawings might be provided when critical parts are located on individual printed-circuit boards. Exploded views of the cabinet, mechanisms, and printed-circuit boards show how the components fit together.

Make sure that a schematic diagram is included with the service literature when purchasing a piece of equipment. If not, now is the time to have it ordered. A schematic diagram can usually be ordered from the equipment's manufacturer or his servicing depot. Also, don't forget that Howard W. Sams publishes the schematic diagrams and service notes for practically every consumer-electronics appliance.

Step 3—*Pinpoint the Defective Transistor or Integrated-circuit*

A defective transistor can often be located using in-circuit voltage and resistance measurements because most are either leaky or open, never *weak* like a vacuum tube. An open transistor can be located in-circuit through resistance measurements by using a commercial transistor tester, or the diode-transistor test section of a DMM (digital multimeter). If you think the transistor is leaky, remove it from the equipment and test for leakage between all elements. (Very low resistance measurements between a transistor's elements often indicate a leaky transistor.)

Critical in-circuit voltage measurements can also locate a leaky or open transistor. Extremely high collector voltage with no emitter voltage usually indicates an open transistor. Very low voltage on all, or between two terminals of the suspected transistor may indicate a leaky transistor, while a 0.6-volt bias measurement between the emitter and base of a silicon transistor indicates that the transistor is normal. Of course, an intermittent transistor is more difficult to locate because it might only break down while in operation. Sometimes, all tests fail, and replacing the suspected transistor may be the only option.



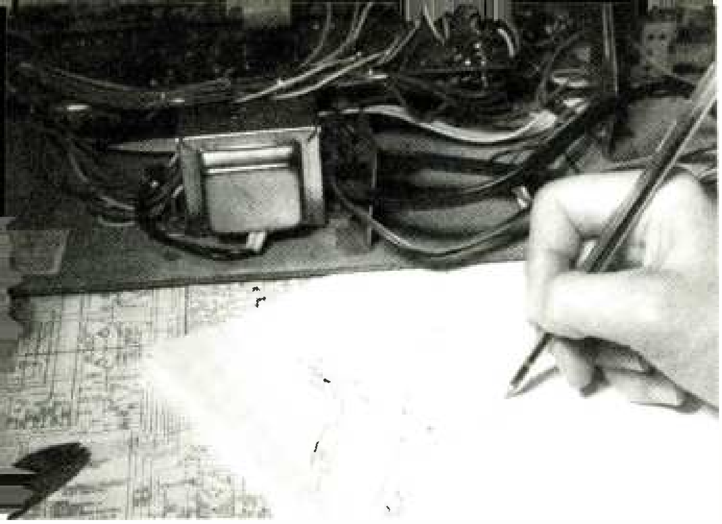
A suspected leaky transistor should be removed from the set and tested out of the circuit. Here, a 125-ohm leakage path is found between collector (metal body) and emitter terminals of this power transistor. Discard all transistors with a measurement under 200,000 ohms in both directions.

Defective integrated circuits are often best pinpointed by checking the input and output waveforms with an oscilloscope. (Do the CRT patterns look normal?) Audio integrated circuits may be signal-traced by using an external audio amplifier: If the input signal sounds clean, but the output is distorted, you've pinpointed the defective stage.

Accurate voltage and resistance measurements also help to locate leaky integrated circuits. Measure every resistor connected to the integrated circuit's terminals. Check each electrolytic capacitor in the circuit. If there's a signal going into an integrated circuit and no signal coming out, replace the integrated circuit even if the voltage tests are normal.

Visually inspect a *suspect* transistor or integrated circuit for "burn" and/or "heat" marks. While *burn* means really bad problems, a very *warm* component might indicate leakage or improper bias. On the other hand, if a transistor or integrated circuit is "red hot," it's a safe bet that it has an internal short. Inspect the body of a suspect integrated circuit for exploded sections: Check suspect transistors for "blown tops." And if you do uncover burned transistors or integrated circuits, don't forget to check for burned biasing resistors.

Every transistor may be checked in-circuit within minutes by using the diode-test function of a DMM. A normal resistance measurement between collector and base terminals indicates a good transistor. No-reading would indicate an open transistor.



Record all transistor terminals before removing the defective transistor from its circuit. Remember that when looking at the bottom side of the transistor that is held in your hand, the terminals are upside down compared to the mounted position.

Step 4—*Mark Down the Terminals*

Don't remove a transistor or an integrated circuit from a printed-circuit board before you make a drawing of the terminal connections—what goes where. Check to see if any other parts use the same printed-circuit connections; if so, also make note of them in your drawing.

In particular, take extra care to check whether some other component has its lead(s) physically wrapped around a transistor or another component, or was tack-soldered to the printed-circuit board, and will fall away when the transistor or integrated circuit is removed. Often, design changes are made on the assembly line; and rather than *re-do* the design of a printed-circuit board, the changes are simply "kluged" on the existing design

Step 5—Remove The Defective Part

Remove the solid-state device using a *light* (low-wattage) soldering iron or gun. Clean out the terminal holes with a round or square toothpick while heat is applied to the connection(s); or, you can desolder the leads and remove the excess solder by using a desoldering braid (Solder-Wick). Should you have a solder-suction device, use it—it is by far the best way to remove solder from a printed-circuit board. Be careful not to apply so much heat that a section of printed-circuit foil "pops" off the board.

In the absence of a solder-suction device, integrated circuits are more easily removed by using desoldering braid (Solder-Wick) and a *larger* soldering gun or iron (about 50–60-watts). Place a piece of braid adjacent to the integrated circuit's terminals and apply heat from the gun. Slowly pick up the excess solder from each row of terminals, making sure that each pin is loose from its printed-circuit foil. Lift the defective integrated circuit free of the board with the blade of a screwdriver; then clean off all the excess solder using a fresh section of desoldering braid.

Step 6—*Replace With Originals*

Always try to replace the defective transistors or integrated circuits with the original part number—besides mounting correctly, they work every time. (Look for the correct part number in the parts list of the service literature.) If the part isn't in stock locally, it can be ordered from the manufacturer or his service depot. Also, look for direct replacements in the advertisements of mail-order parts houses, because they will often stock components for which there is little demand in your local area.

Step 7—*Universal Replacement*

Replace a defective transistor or integrated circuit with a *universal-replacement part* when the original is not available because the part is too old, the manufacturer is no longer in business, or because it will simply take too long to order and get delivery on the part. Price and minimum-order amount may be a very important factor in the decision to use a replacement!

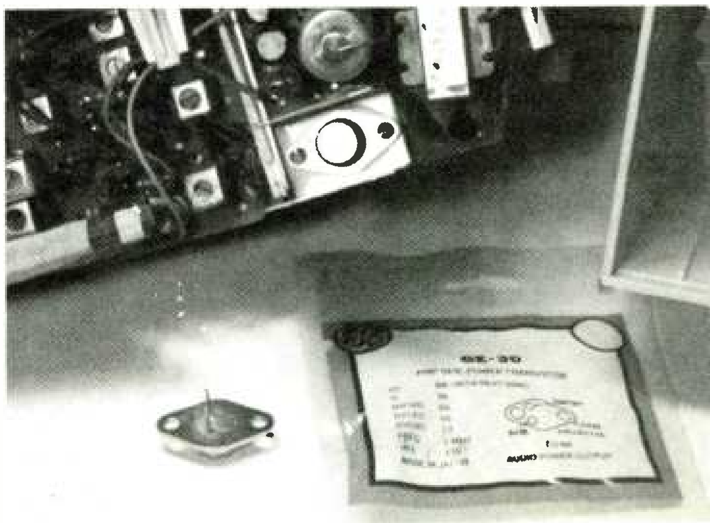
Universal-replacement transistors and integrated circuits will often work in many consumer appliances; however, depending on the particular circuit design, it might be necessary to make one or more circuit modifications in order to accommodate a universal-replacement part. For example, you might have to modify the mounting or socket used for a universal-replacement part. Worse, some universal-replacement parts might require realignment of a receiver's RF and IF stages.

Because RF and IF circuits can be sensitive to the characteristics of a particular solid-state device, always try to locate the original transistor. Also, never replace a plastic-body transistor with one having a metal case in the IF or oscillator stages of a radio or TV chassis.

If you must use a universal-replacement part in a critical circuit, play it safe by using a cross-reference transistor replacement manual. RCA, GE, Sylvania, Zenith, Motorola and Workman publish a few of the reliable solid-state replacement guides. The universal-replacement parts data may also be included in a Howard Sams Photofact.

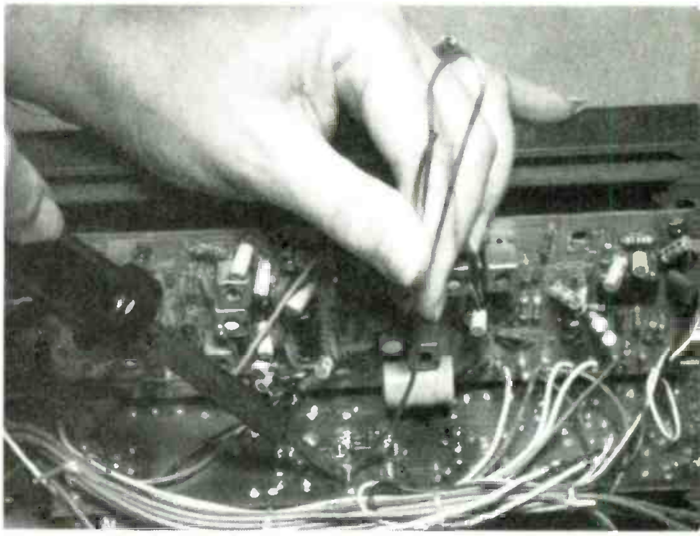
Step 8—*Replacing The Component*

Test a new transistor before it's installed, and make sure that the transistor has the correct polarity—NPN or PNP. An NPN/PNP test can be made with the diode-test mode of a digital multimeter (DMM) or transistor tester. Replacing a defective component with a defective replacement (it happens often) may mean several hours of unnecessary troubleshooting.



Most universal-replacement transistors work fine in audio circuits, but never replace a germanium transistor with a silicon type, or vice versa. The bias voltages are different.

A universal-replacement transistor may be located in several different replacement guides. Look for the type markings on the body of the transistor when the diagram isn't available.



Use a small soldering iron rated under 35-watts when soldering transistor or integrated circuit terminals to circuit boards.

If you use DIP integrated circuits, make certain that all leads have come through a hole before you solder the device, because it might be next to impossible to salvage the part if one or more terminals fold under during soldering. (Check to see that each pin has come through the correct hole.)

Solder transistor and integrated circuit terminals with a *small* soldering iron. Do not overheat the components. If needed, use long-nose pliers as a heatsink while soldering transistor terminals. Double-check the soldering of each terminal: A magnifying glass may help to determine if a good soldering joint has been made.

Step 9—*Heat Sinks and Cleanup*

Large power-output and regulator transistors are mounted on individual heatsinks, or the chassis itself might be used as a heatsink. Often, several transistors or integrated circuits might share a single individual heatsink.

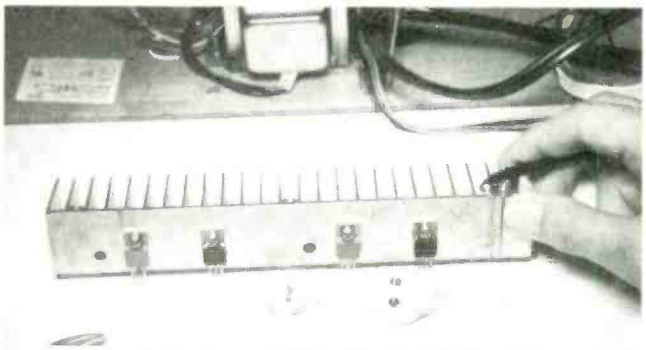
The collector terminal of a power transistor is *usually* the metal body, so it might be necessary to insulate the transistor from a grounded chassis or heatsink. This is generally accomplished by installing a piece of mica insulation under the transistor—between the transistor and the heatsink or chassis. To insure optimum heat transfer between the transistor and its heatsink, place a coat of silicon grease on both sides of the mica insulator. Always install a new insulator with the replacement transistor. *Always* bolt the transistor to the heatsink before firing up the unit; if not, before you know it the transistor will be overheated and ruined.

A power-output integrated circuit might be bolted directly to the metal chassis or mounted on a separate heatsink. Sometimes, an integrated circuit will have an integral metal clip that's bolted or soldered to the metal heatsink. Although the clip serves as a heat-pipe from the integrated circuit to the heatsink, to ensure maximum heat transfer, be sure to apply silicon grease between the clip and the heatsink.

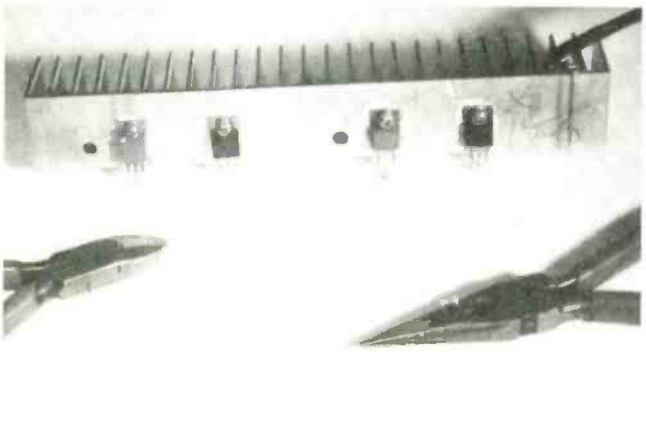
Make sure that transistor or integrated-circuit connections soldered to a printed-circuit board are not shorted by a solder splash: Clean up between the terminals by passing the edge of a small screwdriver blade between the terminals.

Step 10—*Checking Out The Unit*

There is nothing in this world more satisfying than when a repaired device works right-off after replacement of a solid-state device. Let the unit play for several minutes and then turn it off. Feel the transistors and integrated circuits for overheating. Power-output transistors and integrated circuits will normally run warm, but not too hot to the touch. Suspect a change in the emitter or base bias resistor if a transistor runs very hot. ■



The three most common types of transistors must have a mica insulator between the transistor and heatsink, because the body of each transistor is the collector terminal. Always install a new mica insulator when replacing a defective power transistor.



Most transistors are insulated from the heatsink with a mica insulator. Use a silicon grease (the white stuff) on both sides of the washer to insure the most efficient heat transfer between the transistor and its heatsink. A mica washer and white silicon grease are often supplied in a separate envelope with high-power, universal-replacement transistors.

2-METER DIRECTION FINDER

By Lou Hinshaw, WB0NRU

This hand-held device will help you track down mysterious radio signals

MAYBE IT'S BECAUSE 2-METERS OFTEN APPEARS TO BE A chit-chat band, or because hand-held transceivers are inexpensive and easy to come by; whatever the reason, in many cities the 2-meter band has become a hangout for *bootleggers*—unlicensed operators—many of whom take perverse pleasure in literally destroying the communications of others. The problem of deliberate interference became a rather severe problem out my way, so a group of *hams* decided to track down the miscreants in order that the proper authorities could put an end to their activities.

The means of *radio direction finding* (RDF) then available to us involved base stations equipped with directional beams. If at least two could give us a *fix* on the bootleg signal we could triangulate and approximate the general area it came from. Unfortunately, *approximate* isn't good enough when you're trying to actually catch someone in the act of using an unlicensed transmitter. We needed something that could be held in the hand, something that would work with a hand-held transceiver so we could track the *fox* right to his lair; and so we divised the direction finding loop antenna (we call it the 2-Meter Direction Finder) that is specifically designed to work with a 2-meter hand-held transceiver.

Construction

As shown in Fig.1, the RDF antenna consists of a coaxial loop supported on a small metal box. Three F-type female connectors such as used for cable-TV wiring provide the connections between the loop and the transceiver's antenna input.

The first step is to make the loop antenna, which is a 30-cm (11.8-inch) length of coaxial cable (any type)—having F-type connectors at either end—from which one inch of shielding has been removed at the center of the coax. The way to do that is to remove one inch of the cable's outer jacket, nibble through the center of the exposed shield with diagonal cutters, and then fold the exposed shield back over the outer jacket. If you don't want the antenna to flop around, do not cut away the inner conductor's insulation—it adds rigidity to the antenna. For neatness, tape can be wrapped around the exposed center conductor and shielding braid.

The coax will form a loop antenna when you loop it to fit the F-type male connectors on the metal coupling box.

PARTS LIST FOR 2-METER DIRECTION FINDER

- 3–F-type female chassis-mount connector
- 2–F-type male cable connector
- 1–BNC male cable connector
- 11.8-in. length of coaxial cable (see text)
- 1½-in. × 2-in. × 3¾-in. aluminum cabinet
- Wire, Solder, tape, etc.

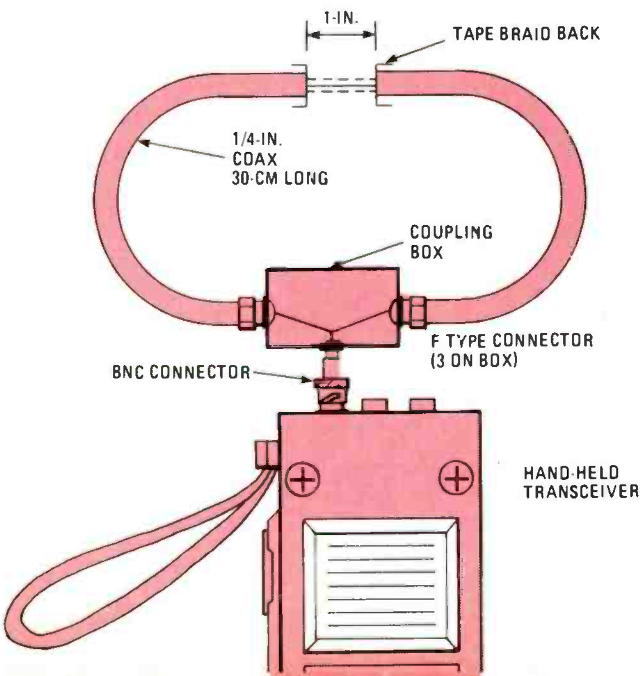
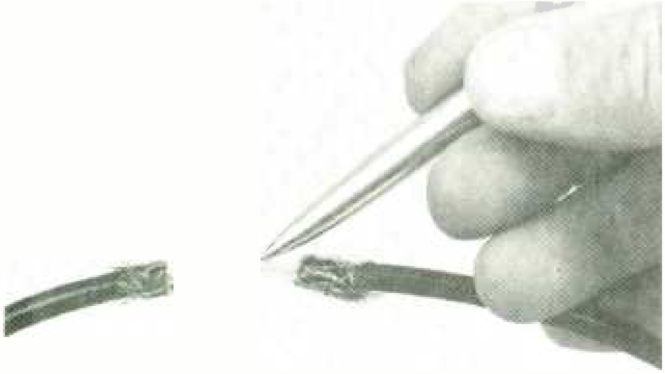


Fig. 1—This diagram makes the construction of the 2-meter direction finder appear so simple you may want to build it, and then buy a 2-meter hand-held transceiver. Remember to get an Amateur Radio ticket before you press the talk button!



The most important part of the antenna is the separation of the shield, which exposes the center conductor. To prevent strands of the shield from accidently shorting, fold them back and cover them and the center conductor with plastic tape. The pointer indicates the cable's center conductor, which should be left in place to provide necessary stiffness.

To use the direction finder, rotate the transceiver until the signal fades to the lowest possible level, which means that the ends of the loop are pointing at the signal source. ▶

The Coupling Box

The coupling box, shown in Fig. 1, basically consists of three chassis-mount F-type male connectors whose center conductors are interconnected by ordinary hook-up wire. The box itself can be an aluminum chassis box about 5-cm (2-inches) wide. A BNC connector—which is needed to fit the hand-held transceiver's antenna input connector—screws directly on the center of the box midway between the F-type connectors. Fortunately, the F-type connector's outer thread is usually the same pitch as a BNC connector's inner rear thread—the one used for the compression nut. See Fig. 2. (If you don't feel like making your own coupling box, you can use a 3-port TV cable hybrid-splitter having F-type connectors.)

To make connection between the BNC and F-type connectors, solder a short piece of stiff hookup wire into the center pin of the BNC connector, as shown in Fig. 2. When the BNC connector is threaded to the F-type connector the bare wire will slip into the F-type connector's center contact. If needed, a locknut will make the BNC and F-type connectors stay together.

Of course, if your hand-held transceiver doesn't use a BNC antenna connector, you'll have to make the necessary modifications for whatever you do use.

To The Hunt

To use the RDF loop antenna, get as close as you can to the *fox*, and as you approach, set the hand-held transceiver's squelch tighter—just low enough to receive the signal when the RDF antenna is broadside to the signal source. Keep in mind that the RDF antenna's maximum sensitivity is broadside to the signal source (transmitter); weakest sensitivity is when either end of the antenna points at the signal source.

Adjust (rotate) the antenna's position as necessary to get the narrowest cutoff angle. The signal will weaken as an end of the loop comes around to point at the signal source.

Thus, the antenna will be exactly end-on to the signal when the signal level falls so low that the squelch clamps the receiver off. (Loss of signal produces a little *pop* on our rig.) As you approach the *fox*, tighten the squelch to keep the cutoff window small and the direction precise. Watch out for 180 degree ambiguity: take three readings on compass headings perpendicular to the direction of the *fox*. The readings will converge pointing toward the *fox* and diverge going away. With practice, you can get pretty fast at the chase.

Drive carefully, and good hunting! ■

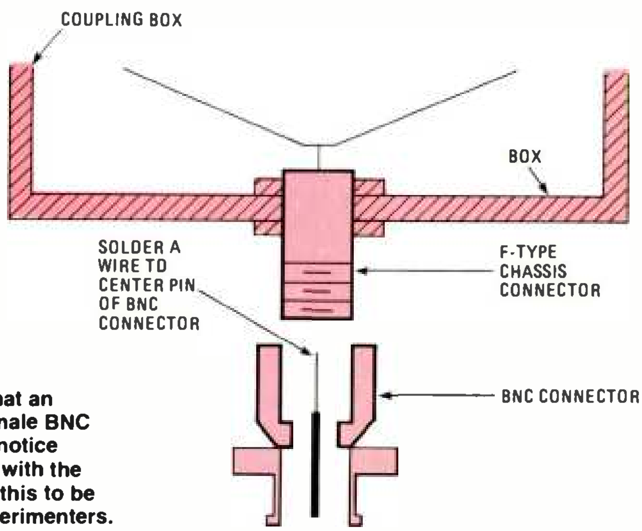


Fig. 2—Your first reaction to this diagram may be that an F-type female connector cannot properly fit into a male BNC connector. Before you write to the Editor, try it and notice that an internal thread in the BNC connector mates with the thread on the F-type connector. Once you discover this to be true, make a few friendly bets with other hobby experimenters.

ON-TIME RECORDER

Now you can gauge household energy consumption, allowing you to get a handle on fuel cost—without going into bankruptcy.

☐EVER WONDER HOW MUCH TELEVISION YOUR FAMILY really watches during the week? More accurately put: How much does it cost per week? Or, how much energy does that water heater consume? Those questions and similar ones have perplexed almost every consumer in light of rising fuel costs. Unfortunatly, those are questions that don't have pat answers; however, the *On-Time Recorder* covers both of those bases and a few others besides, as you'll soon see. But first let's get a general idea of the problem.

A Question of Accuracy

The problem with measuring household-energy consumption is that many appliances operate intermittently. Your iron, for example, may be rated at 1000 watts, but its heating element is controlled by a bimetallic-strip thermostat that's constantly opening and closing. Air conditioners, refrigerators, and water heaters all present the same basic problem. So then, how do we measure energy consumption?

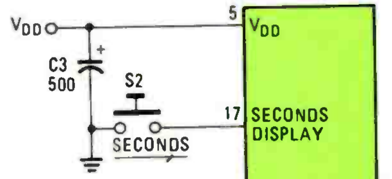
The only way to truly gauge the energy consumption of appliances is to determine accurately the length of time that current flows through their power cords—which the On-Time Recorder accomplishes by means of a special homemade sensor.

How It Works

The On-Time Recorder is based on National Semiconductor's MA1026 clock module (see Fig. 1). That unit, though slightly more expensive than others on the market, has a feature that's necessary for this application—a *hold* input. When the hold input (pin 31) is grounded, the internal counters discontinue their operation and the LED display freezes. Returning the hold input to its original state restores the module to normal operation without its going into a reset mode, as with some other digital clocks.

Power step-down transformer T1 with its 10.5-volt secondary winding (especially made for the MA1026 clock module) provides power to both the clock circuitry and the sensing device. T2 (by far the most interesting feature of this project) is a specially-wound transformer that's wired in series with the 117-volt AC source (PL1) and the SO1 outlet (into which appliances under consideration are plugged) and used as the sensory device. One leg of its secondary winding is grounded, and the other leg is connected to the non-inverting input of U1 at pin 2.

The reference voltage applied to the inverting input of U1 at pin 3 is set by potentiometer R1, LEVEL adjust. When current flows from PL1 to SO1, a very small voltage (less than .1 volt)



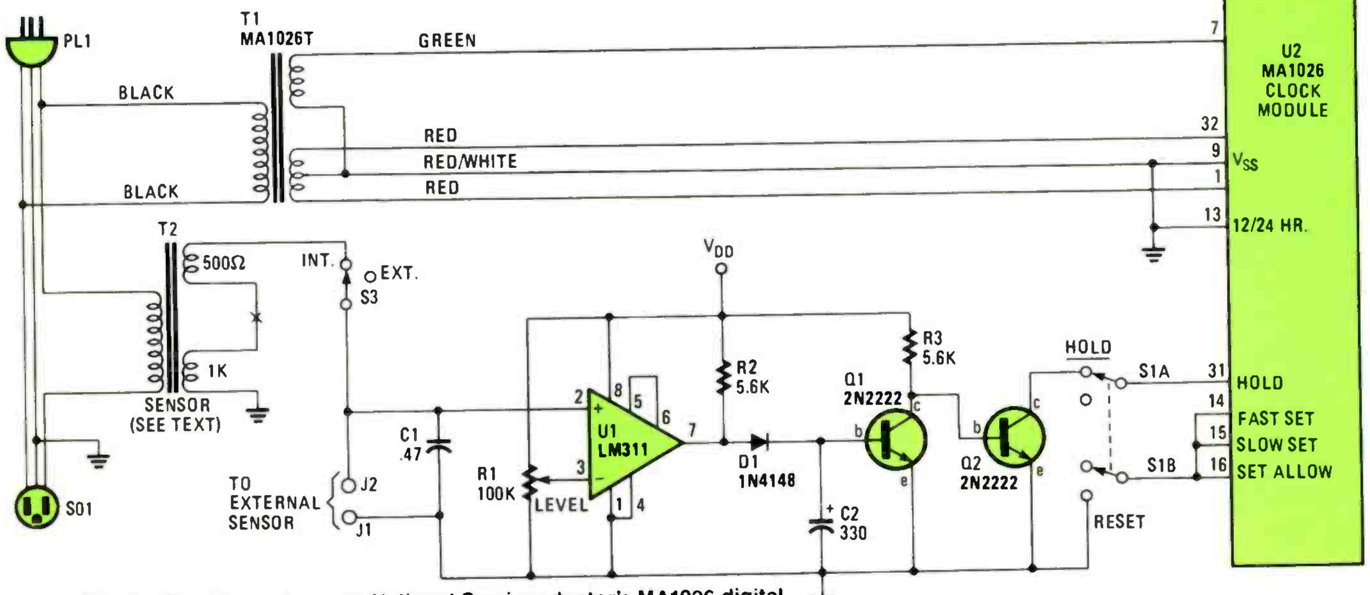


Fig. 1—The On-Time Recorder uses National Semiconductor's MA1026 digital clock module in conjunction with a home-brewed sensor to gauge the time that current actually flows through the appliance's power cord. The sensor is really an audio driver transformer that has been modified for this application.

is dropped across the primary winding of T2. That induces a larger voltage in T2's secondary winding, which is fed to pin 2 of U1. If the peak of the AC signal applied to pin 2 of U1 is greater than the DC level on pin 3 of U1, a string of zero-to-V_{DD} pulses are generated at the pin-7 output of the comparator. The pulses are then rectified and filtered by D1 and C2, and applied to the base of Q1, turning it on.

With Q1 turned on, its collector—which is tied to the base of Q2—goes to zero, turning Q2 off. When that happens, the ground is removed from pin 31 (hold); thus, the clock begins to record time.

When current ceases in the power line, the voltage on pin 7 of U1 falls to zero, turning Q1 off and Q2 on. Now, with Q2 once again turned on, a path through Q2 is re-established between pin 31 and ground, stopping the clock module's timing operation. Note that, since T1 is connected *upstream* from sensor T2, it does not affect the circuit's operation—nor is affected by it. It is important to note also that the circuit does not measure power or current, but merely the time during which current in the power line is above a certain level, as determined by the setting of R1. That's why R1's scale is not divided into amperes or watts on the unit's panel.

PARTS LIST FOR THE ON-TIME RECORDER

C1—0.47-µF, Mylar or ceramic disc capacitor
C2—330-µF, 10-WVDC electrolytic capacitor
C3—500-µF, 15-WVDC electrolytic capacitor
D1—1N4148 or 1N914 general-purpose, small signal-switching diode
J1, J2—Banana jack
PL1—Plug molded on 3-wire power cord
Q1, Q2—2N2222 general-purpose NPN transistor
R1—100,000-ohm, linear potentiometer
R2, R3—5600-ohm, ¼-watt, 5% resistor
SO1—Single 3-wire, 117-volt AC outlet
S1—DPDT miniature toggle switch
S2—Normally-open, momentary pushbutton switch
S3—SPST miniature toggle switch
T1—Step-down power transformer--type MA1026T: 117-volt primary; 10.5-volt secondary (supplier given below)
T2—Current sensor; made from an audio driver transformer (like Calectro D1-728), 1000-ohm primary, 500-ohm secondary (see text)
U1—LM311 voltage comparator, integrated circuit
U2—MA1026 clock module (supplier given below)

ADDITIONAL PARTS AND MATERIALS

Perfboard, wirewrap sockets, headers, metal or plastic case, hook-up wire, solder, hardware, lettering decals, etc.

NOTE: Both the clock module and transformer T1 can be ordered from Digi-Key Corp., 701 Brooks Ave. So., Thief River Falls, MN 56701; 1-800/344-4539.

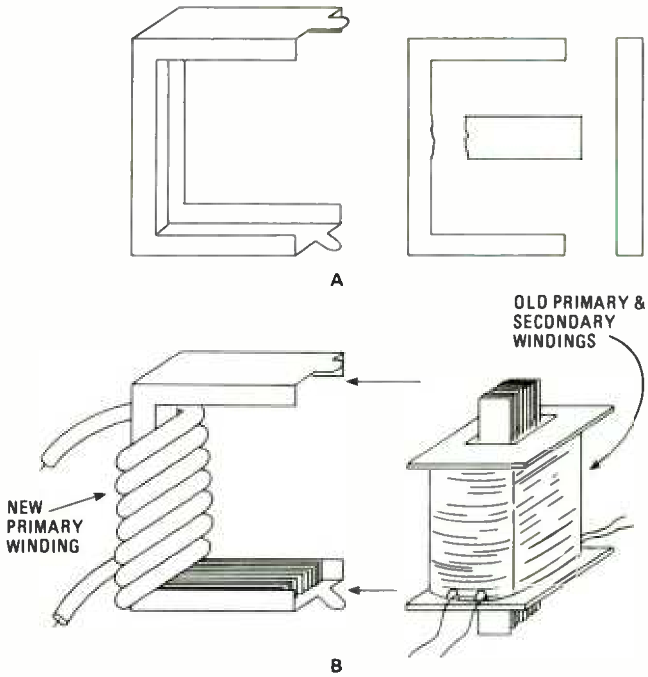


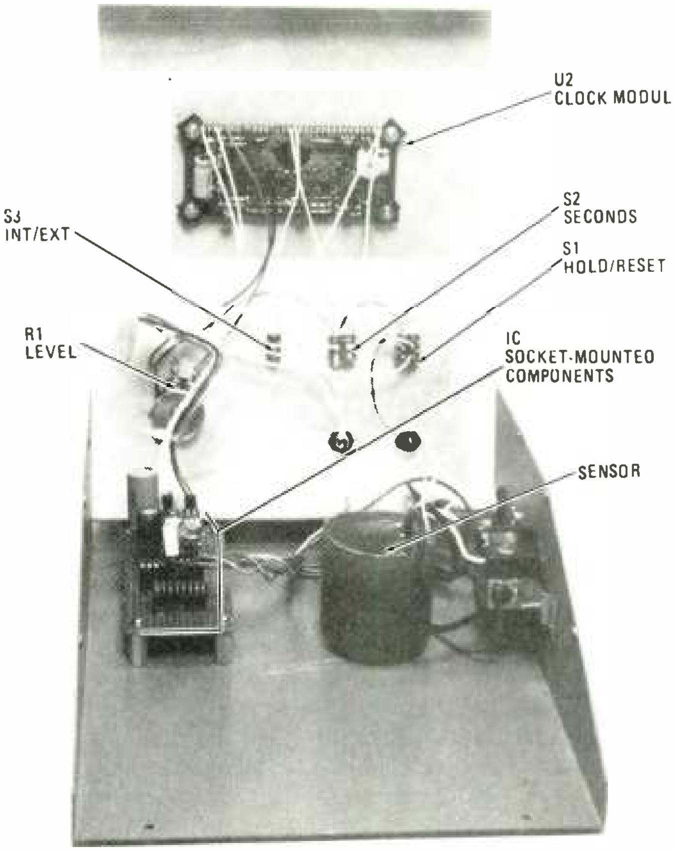
Fig. 2—The sensor is nothing more than a modified audio driver transformer. By following the outline shown and the instructions (in text), you should have no problems in putting this portion of the project together.

Sensor Construction

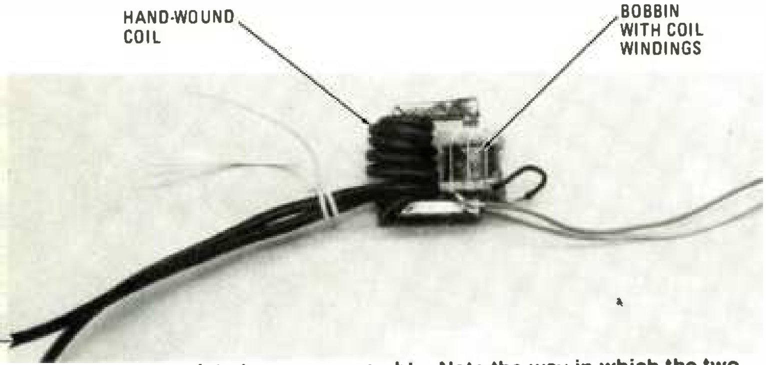
The current sensor (see photos) is a modified audio driver transformer (Calectro D1-728) with a 1000-ohm primary impedance and 500-ohm secondary impedance like those found in transistorized tape recorders and the like. However, any similar unit with a core measuring about ¾ × 1-inch should work. (The ones found in pocket radios are too small.)

Refer to Fig. 2. Begin building the sensor by carefully prying up the tabs that hold the metal frame to the core, and then separating the transformer housing from the core. Then separate the "I" portion of the core from the "E" portion (as shown in Fig. 2A), taking care not to damage the transformer windings. Now, using a thin-bladed knife, wiggle the laminations apart and pull them out one-by-one until you have a pile of "E's" and "I's," along with the plastic bobbin on which the coils (primary and secondary windings) are wound. Clamp each E-piece in a vise (one-by-one) and carefully break the center piece off, so that you are left with a "C." Then file the breaks smooth, and reassemble the "C's" back into the frame as shown. Now, wrap 10 turns of #18 gauge plastic-insulated wire around both the frame and the enclosed "C's," leaving leads about eight inches long.

Insert the "I's" into the bobbin and squeeze the assembly into the frame, making an "O." The bobbin's leads should protrude from the sides of the core, as shown. If things seem a little too tight, remove a turn of the #18 gauge wire. You should now be able, with some maneuvering, to fold the tabs of the frame over the I-pieces to hold the unit together. You now have a transformer with a primary of nine or ten turns and two secondaries (the old primary and secondary windings). A few rubber bands around the assembly will help keep your sensor from coming apart while you perform the next operation.



This inside view of the Recorder shows that the clock module is mounted in the top of the case. Square washers (cut from heat-shrink tubing) protect the circuit board from accidentally shorting to the enclosure through the mounting hardware, and the sensor is fully potted in polyester resin.



The completed sensor assembly: Note the way in which the two secondary windings are connected—through a short jumper wire. At this stage, the assembly is ready for potting.

The next job is to connect those secondaries in series so that they are in phase. Select a lead from each secondary winding as the center tap and wire the test setup shown in Fig. 3. Since you're dealing with 117-volts AC, be sure to tape all bare power-line connections and observe the usual safety precautions.

Plug a low-wattage device, such as a soldering iron, into the test fixture's outlet and insert the plug into a wall outlet. Measure and record the AC voltages on both the secondaries. (They should be less than one-half volt each.) Now take one lead from each secondary, twist them together, and connect the DVM to the remaining two leads. With the secondaries in series, you'll obtain a reading that's either the *sum* or the *difference* of the two original readings. If the reading is the sum, unplug the setup and replace the twisted leads with a short jumper. If the reading is the difference, reverse the leads of one of the secondary windings and measure again. Once the correct reading is obtained, install the jumper and you are ready for the final assembly step.

In its present state, the sensor is a rather loose, shaky affair. You can remedy that by dipping it into a can of plastic compound of the type used to coat the handles of tools, or by coating it with epoxy. Having some polyester resin of the type used with fiberglass on hand, I potted my sensor completely. Any method that strengthens the assembly and bonds the coils and laminations together will do. The bonding will aid in keeping down any transformer *buzz*.

The Rest Is Easy

Building the remainder of the On-Time Recorder is simple. The author used a scrap of perfboard as a chassis to hold the discrete components. Two headers or DIP-extenders, containing the components themselves, are inserted into wire-wrap sockets. Two more sets of headers and sockets carry the leads in from the off-board switches and other components.

The digital clock module comes pre-assembled with rectifiers, LED display, etc., mounted on a printed-circuit board. The most tedious part of the project is cutting and filing the rectangular hole in the top of the metal enclosure so that the display fits neatly. If you use a metal chassis, be sure to connect it, and all other ground points, to the third (green) wire of power cord PL1 for safety's sake. Power socket SO1, a single 117-VAC outlet, has a green-colored screw which should also be grounded.

Is It Working?

Once you have carefully checked your wiring for errors and are satisfied that there are none, it's time to test the circuit's operation. First, turn R1 fully counter clockwise and plug in the Recorder. The display should show some combination of flashing numbers. Switching S1 to RESET may, or may not, cause one of the dots on the display to start flashing. If the dot (separating hours from minutes) does flash, turn R1 slightly clockwise until it stops. The flashing dot means that

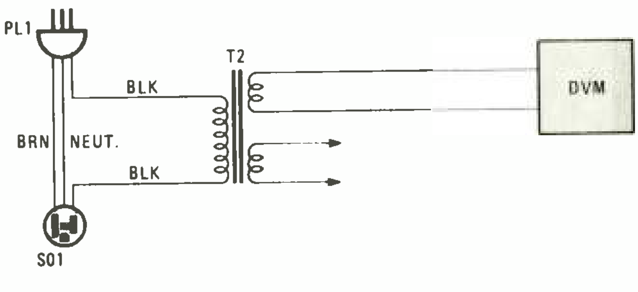
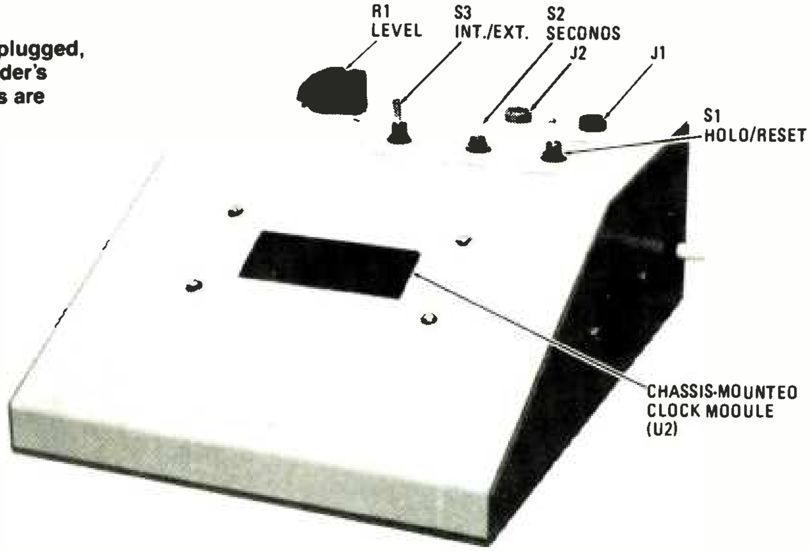


Fig. 3—The scheme used to check out the secondary windings of transformer T2 is a rather simple one. Simply measure the induced AC voltage across each secondary winding and record your findings. Next, connect the two windings in series and note whether the measured output is the sum or the difference of the previously recorded readings.

Outlet SO1, into which the appliance under test is plugged, is mounted on the right side of the On-Time Recorder's enclosure. All other controls, inputs and indicators are mounted on the enclosure's front panel.



the instrument is recording time, which is evident when S2 (SECONDS) is depressed.

The flashing is caused by the fact that the LM311 is not a perfect voltage comparator: Even with both inputs at ground potential, internal offsets and leakage may cause a slight voltage difference to be sensed.

Once R1 is adjusted so that the dot is no longer flashing, make sure that S3 is in the INT (internal) position and plug a low-wattage appliance into SO1. The recorder should begin to count off the minutes. Note that the sensitivity of T2 and the current-carrying ability of its primary winding limit the circuits use to appliances rated at between 35 and 1250 watts—below 35 watts, you'll find it difficult to adjust R1 for the correct threshold.

Operation

Now it's time to try out the On-Time Recorder in a real-life situation. Turn potentiometer R1 to about mid-range and plug an iron into SO1. Once it's warmed up, you may be surprised to find that, while in use, the iron is turning itself on and off at the rate of about four times a minute. Set the iron up on the heel and the off-time will increase relative to the on-time. (That is a good demonstration of the futility of trying to measure the iron's energy consumption by simply multiplying its wattage by the time it takes to do the weekly laundry.) The total amount of energy consumed is, of course, the product of the appliance's wattage and its on-time as measured by the Recorder.

Calculating the energy use of a food drier is a bit more complicated. The one I own has a 50-watt fan motor that operates continuously, while the 700-watt heating element operates intermittently. That's where R1 (the level control) comes into play. Set R1 to its fully clockwise position and turn the drier on. If the display shows that the appliance is off (dot does not flash), adjust R1 counterclockwise to just below the level where the dot begins to flash.

Then, when the temperature of the drier reaches its set-point, the Recorder's display should begin to follow the intermittent operation, even though the motor is always running. What you did was to set the LM311's reference voltage above that produced by the motor, but below that of the motor and heater in combination. The total power consumption of the drier is the total time that it's on (which you must keep track of yourself) multiplied by 50 watts—plus the total time the heater is on (taken from the recorder) multiplied by 700 watts.

The On-Time Recorder can be adjusted to ignore continuous power consumption up to 300 watts.

The External Feature

S3, the EXT (external) switch, along with J1 and J2, allow you to connect other sensors to the On-Time Recorder. For instance, if you wish to measure the energy consumption of a water heater, you need to build a special sensor to handle the heavy current involved. The heavy-duty sensor unit is built exactly like sensor T2, except that the primary consists of five turns of #12-gauge solid wire instead of ten turns of #18-gauge wire. That sensor is less sensitive than the built-in one. You can splice it directly into the water heaters' power line and run two light-gauge wires to J1 and J2 of the Recorder.

Actually, any type of sensor that generates a small voltage can be connected to the external jacks of the project. Figure 4 illustrates two fairly obvious examples. The sensory circuit shown in Fig. 4A allows the Recorder to be used as a stop-watch; while the one in Fig. 4B can be used to measure the amount of sunlight during the day, or with the proper adjustment to R1, it can be set to halt timing when the sun is obscured by clouds. And, if you're still not satisfied with the flexibility of your Recorder, you can add a handful of push-button and rotary switches to allow you to use the module as it was intended—as a digital clock. ■

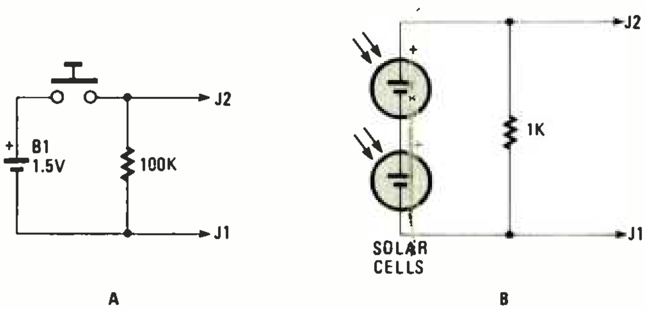
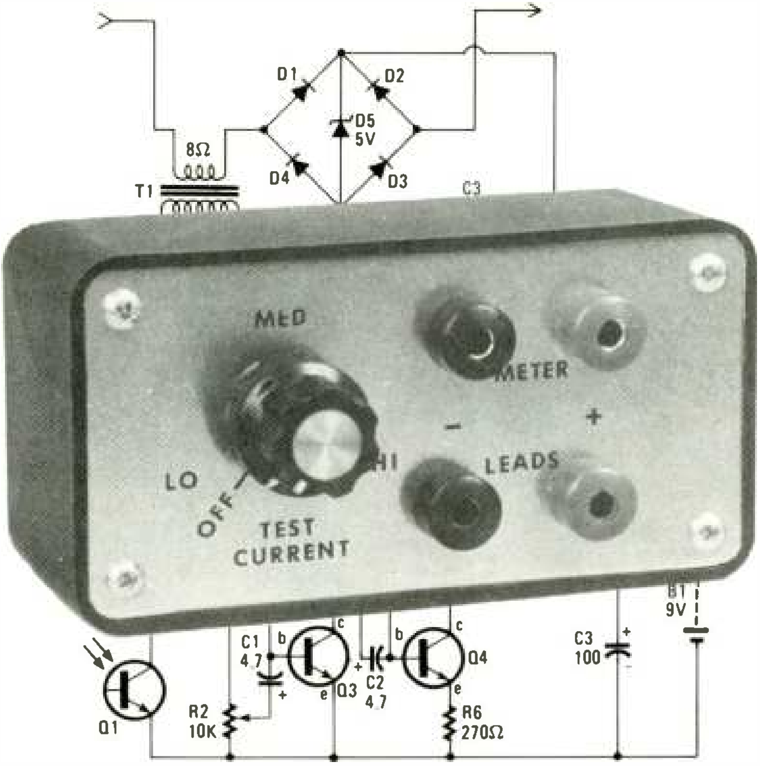


Fig. 4—The circuit in A allows the On-Time Recorder to be used as a stopwatch, while the circuit in B can be used to measure the amount of sunlight during the day. Or, if desired, potentiometer R1 may be used to set the On-Time Recorder so that its operation is halted when the sun is obscured by clouds.



PN JUNCTION TESTER

By Stan Muntz

Here is a budget tester for checking PN junctions in or out of circuit

☐ADVANCES IN THE FEATURES AND FUNCTIONS OF STATE-of-the-art electronic test equipment seem to occur almost daily. Oscilloscopes, signal generators, and meters are offering more capabilities with each new test-equipment catalog. I had no sooner purchased my first digital multimeter (DMM) when the next generation offered the *diode function test*, one of the easiest-to-use, yet one of the most effective diagnostic tools.

The diode function test is usually found on the resistance portion of a DMM's function selector, and is usually identified by the symbol:

To use the diode test function, you remove power and signal voltages from the device, discharge the capacitors, and set the DMM to the diode function test. The meter's test leads are then placed across a PN junction (a diode's anode-cathode; a transistor's base-emitter or base-collector). If the junction is forward-biased (red lead on the anode and black lead on the cathode) and if any resistance in parallel with the PN Junction is above a minimum value of 1000 ohms, the meter will indicate the forward junction voltage. That voltage should be 0.2 to 0.3 volt for germanium and 0.6 to 0.9 volt for silicon devices. If the meter does not indicate the proper voltage, then the leads are reversed and the test is repeated. If proper forward junction voltage is still not indicated, then the device may be considered defective.

R2 Setting	R2 (Ohms)	Test Current	Approx. Minimum Parallel Resistance (Ohms)
Low	5000	350μA	3500
Medium	2500	575μA	1500
High	0	1.5mA	750

Unfortunately, that kind of diode test is only built into late-model DMM's, but the same results can be obtained from an early-model DMM—even with a conventional VOM, if you use the *PN Junction Tester* interface shown in Fig. 1. However, when the tester is used with a VOM, the higher the meter's impedance the better the test results.

How It Works.

To understand how the circuit works, refer to Fig. 2—which is really Fig. 1 redrawn to show how an "unknown" diode (the PN junction) connects into the test circuit. The test circuit consists of a 3-volt power source (two 1.5-volt AA cells), R1, R2, S1, and diode Dx—the circuit component being tested. Resistor Rx represents any parallel resistance across the diode.

Resistor R1 limits the maximum test current to about 1.5-mA, while R2 controls the test current from the maximum of

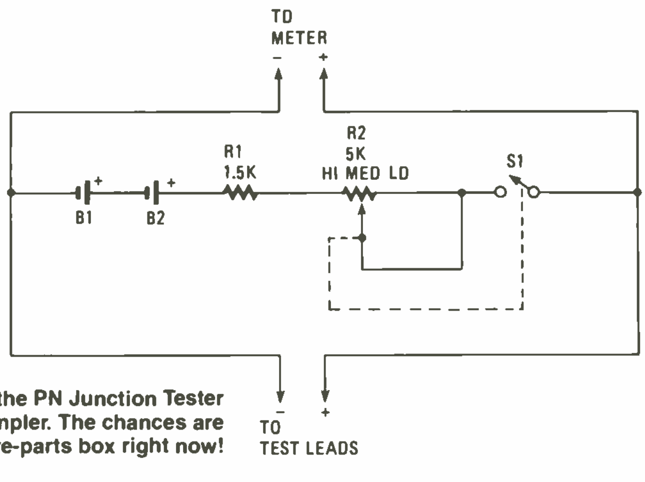


Fig. 1—The schematic diagram for the PN Junction Tester—they don't make circuits much simpler. The chances are that those parts are in your spare-parts box right now!

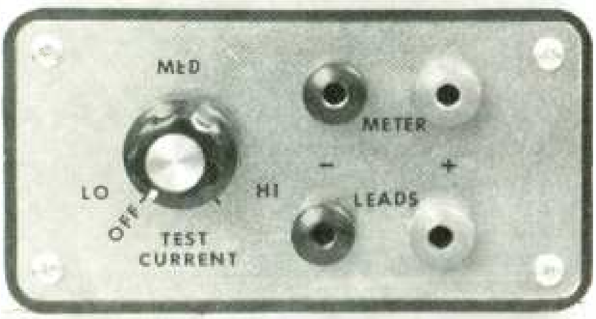
PARTS LIST FOR THE PN JUNCTION TESTER

B1, B2—1.5-volt AA battery
R1—1500-ohm, ½-watt, 10% resistor
R2—5000-ohm, linear-taper potentiometer
S1—SPST toggle switch
Cabinet, test leads, jacks (if used), hardware, wire, solder, press-on lettering, etc.

1.5-mA down to about $350\mu A$, assuming a junction voltage of 0.7 volt. If the PN junction is forward-biased, the meter will indicate the junction voltage; if the PN junction is reverse-biased, the meter will indicate the battery voltage of 3 volts. Table 1 shows the test currents for the three major settings of R2 and also the minimum allowable parallel resistance (Rx), which is the resistance (such as bias resistors) that can be in parallel with the PN junction without causing false meter readings.

Construction

The PN Junction Tester can be assembled in a small plastic cabinet as shown in the photographs. Assembly isn't critical, and just about any parts layout and wiring method can be used. You can use direct-wire connections for the input and output test leads as shown in Fig. 1, or you can provide input



If you decide to use test jacks instead of test leads, make certain that they are the insulated type if the cabinet's front panel is metal. The control's labeling isn't critical: *medium* is approximately midway between the end stops.

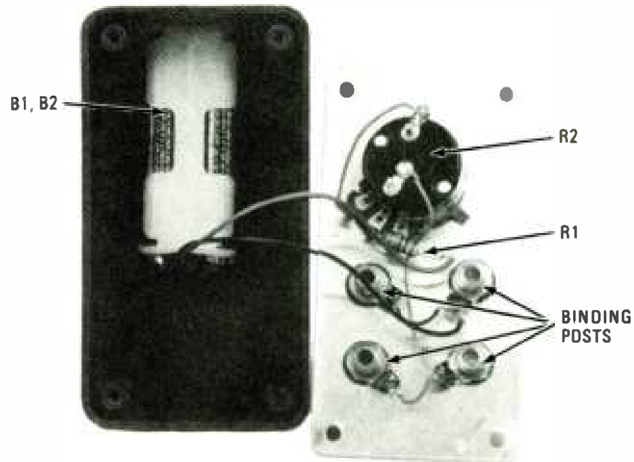
and output jacks to match the plugs on your existing test leads. If you use the jacks, and if your cabinet has a metal front panel, make certain the four test jacks are insulated from the panel. Use either fully-insulated jacks or conventional metal, multi-way jacks with insulating shoulder washers.

To ensure minimum current flow through the PN junction being tested when the device is first turned on, connect potentiometer R2 so that it is at maximum resistance—the *high* setting—when switch S1 is first turned on.

Since the current-draw from the batteries is small and flows only when testing, alkaline batteries are not required.

Checkout

To check out the PN Junction Tester, first open switch S1 and then connect the output test leads to the VOM or DMM; set the meter to any convenient voltage range—say, 20-VDC for DMM's and 10-VDC for VOM's. If you're using jacks,



The tester doesn't even take a handful or parts, so you can easily tuck everything into a small cabinet and substitute banana or tip jacks for the test leads.

simply plug in the meter's test leads. (Get the polarity correct.)

Close S1 and set R2 to the desired current: *low, medium, or high*. Advancing R2 will turn on the Tester's power and the meter reading should jump to 3-VDC. (If you don't get a 3-VDC reading, check for a wiring error or reversed test leads.) You're now ready to check out a PN junction.

Connect the Tester's test leads across the suspect PN junction, be it a diode or a transistor. (Make certain that power to the PN junction's circuit is off and the capacitors are discharged.) Use the test leads to check the forward and reverse voltages across the PN junction (simply reverse the test leads). A good junction should read 3-VDC reversed and the proper PN junction voltage (0.2–0.3 or 0.6–0.9 volt) when forward-biased. Any junction voltage that's unusually high or low should be questioned. (Are the capacitors discharged?)

By noting the color of the test leads (red or black), you will be able to identify the P (anode) and N (cathode) terminals of diodes and transistors when the meter indicates the device is forward biased.

As a general rule, or at least until you get the hang of things and want to customize your tests, use medium current (*medium* setting of R2) for most applications, low current for small signal devices and out-of-circuit tests, and high current for power supply rectifier diodes, or where there might be a low parallel resistance.

Build the PN Junction Tester today and get it on your test bench. You'll thank me the first time you reach for it! ■

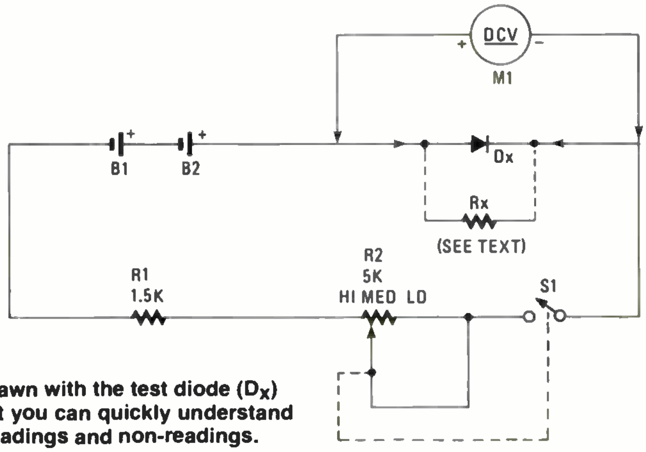
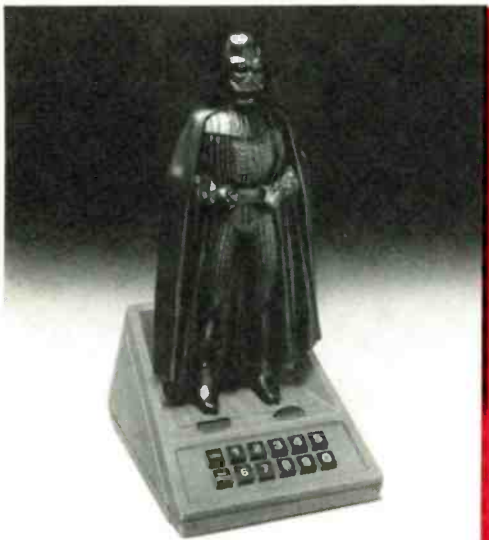


Fig. 2—This diagram is identical with Fig. 1; however, it is redrawn with the test diode (D_X) and associated circuit's parallel resistance (R_X) shown so that you can quickly understand how the circuit works. See the text for explanation on meter readings and non-readings.



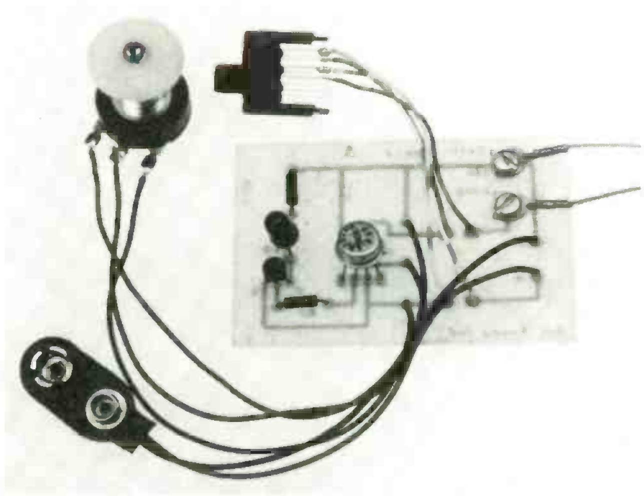
Telephone Projects for the Hobbyist

THE COURT DECISION THAT KILLED THE MONOPOLY THAT AT&T enjoyed for years not only broke up that communications giant, but also gave consumers the right to purchase and connect telephone equipment to the line. Manufacturers, seeing a developing opportunity, raced to fill the void that would be left as a result of that decision. You could now go into any large retail store to purchase and install all sorts of telephone equipment—something that only a short time ago made the engineers of AT&T see double.

So, let's take advantage of that courtroom decision by building three telephone-related electronic projects.

The first project, the *Tele-Guard* (built from only a few components and a telephone line cord), allows you to detect a listening device (bug) or an open telephone extension. (Is Aunt Wanda listening to my telephone conversation *again*?) Surely you've seen similar items advertised on TV, but the cost was out of reach to most of us. Besides, why give a manufacturer your hard-earned money when you can build a circuit that does the job just as well.

The second project is the much-sought-after *Telephone Hold Button*, with an added feature—it allows callers to listen to electronically generated music while they wait. The third project is really an extension of the music-on-hold circuit of project two. By ever-so-slightly modifying the synthesizer portion of the Telephone Hold Button, you can also get a *Telephone Melody Ringer* out of the deal. Instead of listening to the usual nerve-racking telephone ring, you can be serenaded with music that continues to play until the receiver is taken off-hook.



The bug detector uses so few parts that you might even consider building the circuit on perfboard, instead of printed-circuit board as pictured here.

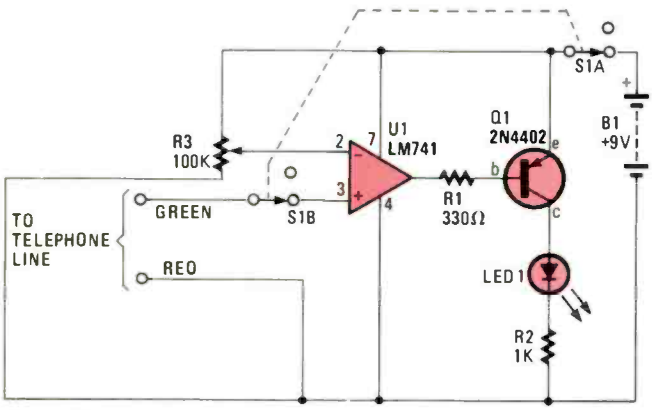


Fig. 1—The heart of Tele-Guard is a 741 op-amp that's used as a voltage comparator. When the telephone is on-hook, 50-volts appears across the telephone line's green and red wires. When the handset is lifted, the voltage drops to 5-volts DC. If a listening device is in operation or an extension is lifted, the voltage drops, ever so slightly, making bug detection a matter of simply monitoring the normal 5-volt off-hook level and comparing that to a reference voltage.

Although you might say that those circuits are novelty projects (and we're certainly in agreement), they do have a practical purpose. They increase the enjoyment of using the telephone.

Music-Generation Scheme

As an electronics engineer and hobbyist, I look for interesting electronic gadgets on the market and try to incorporate them into more-elaborate circuits. The most interesting gadget I've come across in recent years cannot be found at your local Radio Shack store or any other electronics supply house. It can only be found in a card shop. No, I am not ready

Up-grade your home phone system by adding some of the features found on the latest telephones without replacing your present equipment.

By Steve Sokolowski

for the funny farm; just hear me out.

By now we've all seen or heard of the very elaborate, but extremely small electronic marvel known as the Musical Greeting Card, which sells for between $3.00 and $7.00. Although, on the surface, computerized greeting cards may appear rather ordinary, closer inspection will reveal a micro-miniature integrated circuit, operating from a 1.5-volt battery, with a transducer wired in as the output device. (Refer to the photos for a comparison of the size of a musical card's on-board synthesizer to that of an ear phone.)

When the card is open, a small plastic band moves, closing a switch to supply power to the circuit, which causes the synthesizer to output the pre-programed melody. You can really appreciate the music synthesizer if you've ever tried to build similar circuits. Imagine what's involved; A crystal-controlled oscillator, frequency divider, ROM chips, etc. With such a building block at your disposal, why go through the painstaking task of building your own? Besides, you could never duplicate that micro-miniature circuit.

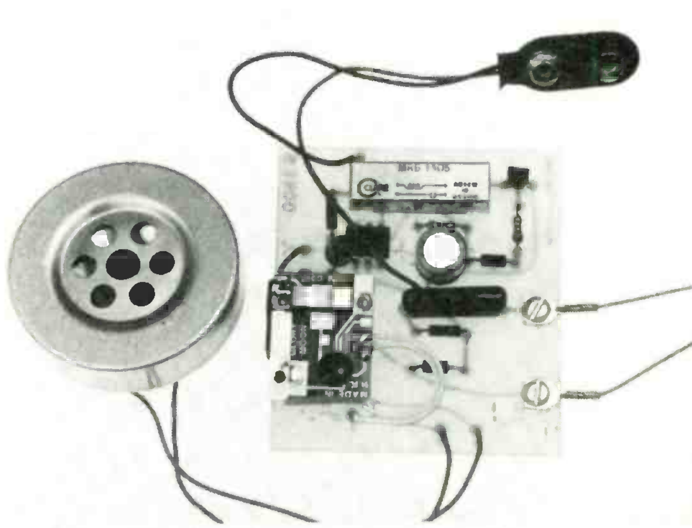
Tele-Guard

Tele-Guard is a rather simple circuit, based on an op-amp comparator, that compares voltage levels to detect an eavesdropper on your telephone line. It also informs you, using a small LED, when a telephone extension is off-hook. (Refer to Fig. 1.) The heart of Tele-Guard is a 741 op-amp that's used as a voltage comparator. When the telephone is on-hook, 50-volts DC appears across the telephone line's green and red wires (green is positive and red is negative). When the handset is lifted, the voltage drops to about 5-volts DC. Don't confuse the DC voltage with the 90-volt AC (at 20 Hz) that is used to excite the telephone's internal noise maker.

If a telephone listening device is in operation, or an extension is lifted, the voltage drops, ever so slightly, because the bug draws power from the line. And so, given that information, detecting a bug or off-hook extension is a simple matter of monitoring the normal 5-volt off-hook level and comparing that to a reference voltage. The reference is derived from a 9-volt battery and stepped down to the desired level through a 100,000-ohm trimmer potentiometer, R3. The 5-volt reference, taken from the wiper of R3, is fed to pin 2 of U1, the inverting input of the 741.

When the voltage on pins 2 and 3 are equal, the output of the comparator is equal to about half the supply voltage. That voltage level is fed to the base of PNP transistor Q1, turning it off. With Q1 off, no power is delivered to LED1, so it, too, is off, indicating that there are no listening devices being used. But when a bug (the little electronic power pirate) is inserted in the line, an imbalance is created between the pin 2 and pin 3. The lower input voltage forces the output of U1 to go to low, turning on Q1 and lighting LED1 to indicate that your line is being bugged.

R1, placed in series with the base of Q1, serves as a limiting resistor, while R2 does the same for LED1. S1 (a DPDT switch) is used to turn on Tele-Guard, and is also used to disconnect the the project from the telephone line. If S1 is left on, LED1 lights, but not to indicate a bug. Instead, it simply shows that the line voltage has returned to its on-hook state. Remember: when the receiver is hung up, the telephone line voltage increases to about 50 volts. With a 5-volt reference on pin 2 and a 50 volt input to pin 3, there is an imbalance in the



The small size of the circuit found in electronic greeting cards can truly be appreciated when compared to an ear phone While not so apparent in the photos, the circuit is really a sophisticated piece of electronics.

circuit; the LED lights as a result. Now let's connect it.

The easiest way to connect your circuit to the telephone line is to use an ordinary telephone line-cord having a modular plug (all of the necessary materials are available from Radio Shack, or can be salvaged from discarded telephone equipment). When wiring the line cord to the circuit, just match the color-coded wires, using Fig. 1 as a guide.

Installation and Test

Hooking this little gadget to the telephone line requires no special skills or tools. Simply plug the telephone line cord from Tele-Guard to a modular jack, put S1 in the "on" position, and lift the receiver. With no dial tone, adjust R3 (the 100,000-ohm potentiometer) until the LED just lights. Back off from that position a bit until the LED is out. To test the circuit, lift an extension and return to the original station. The LED on Tele-Guard should light, indicating that an extension is off-hook. Hang up the extension, and the LED will now go out.

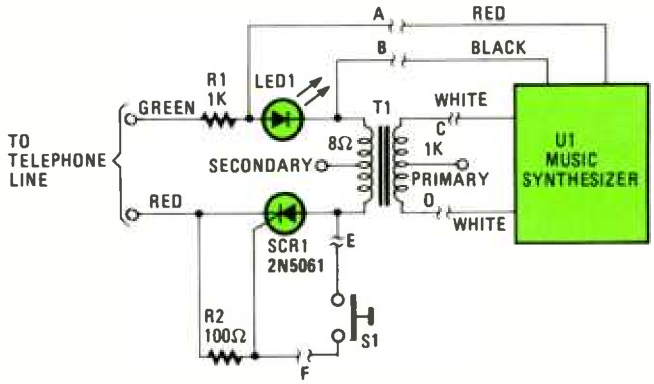
If the LED doesn't light as described above, reverse the red and green wires of the line cord going to Tele-Guard. (The wires to the telephone may have been crossed during the initial telephone installation). Remember to turn S1 to the off position when Tele-Guard is not in use.

Telephone Hold Button

The idea of placing a telephone call on hold is in no way new. Large institutions have been doing so for years. (How many time have you been put on hold and forgotten?) Recently, however, circuits have been designed so that radios, tape decks, and other audio equipment can be placed across the telephone line to entertain the party on hold with a musical interlude instead of forcing the caller to listen to dead silence. But then, electronically produced music did away with the cumbersome radio cables needed for music-on-hold (MOH).

Placing a call on hold or injecting audio into the telephone line is a lot easier than you might think. But, of course, before you can accomplish anything, you have to know the basics; so let's pause a moment to touch some of the bases.

The normal on-hook voltage across the standard telephone line is 50 volts DC. When the handset is lifted from its cradle, the impedance of the telephone itself (600 ohms) is placed across the line, causing the voltage to drop to 5-volts. All that's fine and dandy, but how we do place a call on hold? All we have to do is to fool the central-office switching equip-



ment into thinking that a telephone is still in use although it's not. To do that, we simply connect a resistive load across the line—in this case, a 1000-ohm resistor. In addition, we need some sort of indication that a call has been placed on hold. An LED can be pressed into service to handle that task.

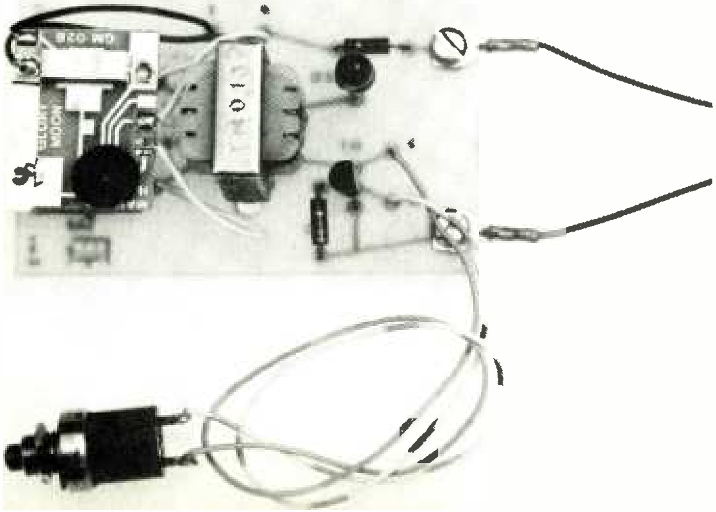
Refer to Fig. 2, the schematic diagram of the Telephone Hold Button. As you can see, the resistive load is R1, and the on-hold indicator is LED1. The musical output of a synthesizer is impressed onto the telephone line through an audio transformer, T1, which has its secondary (8-ohm) winding—in series with R1, LED1, and SCR1—connected in parallel with the telephone line and its a primary (1000-ohm) winding tied to the output of the music generator. The hold function is activated through silicon-controlled rectifier SCR1.

When S1 (a normally-open pushbutton switch) is depressed, the line voltage is applied to the gate of SCR1, causing it to conduct. With the SCR turned on (completing the series circuit on the secondary side of T1), a resistive load of about 1000-ohms is electronically connected across the telephone line, and LED1 glows. While still pressing S1, you are now able to hang up the telephone without disconnecting the call. If you remember the discussion earlier about the music module, it was stated that the synthesizer operates with a 1.5 volt battery. So let's think for a moment. The LED is now on, the voltage across an LED is about 1.5 volts. What if we take the two wires from the module and solder them across the LED (with the proper polarity)? You must be reading my mind—and guess what, it works!

Using that wiring arrangement, the voltage needed for the music generator is supplied through the generosity of your local phone company, thereby, helping to cut the operating cost of the Telephone Hold Button.

Music Module Preparation

To use the synthesizer with our project, the music-synthesizer board must be slightly modified. Refer to the photos. In the lower right hand corner of the board is the on/off switch. The switch must be soldered closed. If the switch is not soldered, oxidation will form on the copper trace, causing intermittent operation. The battery holder (the upper right hand corner) can be removed and two wires soldered in their place, since the 1.5-volts needed for synthesizer operation is received from the project boards. The top portion of the battery clip is positive, so solder a red wire to that point. The bottom section is negative, so a black wire is soldered to that trace.



The synthesizer board from an electronic greeting card is attached to the project board to produce the music-on hold circuit.

◀**Fig. 2—In our project, music-on-hold (MOH) is accomplished by first fooling the central-office switching equipment into thinking that a telephone is in use when a call has been placed on hold. Then, the musical output of the music generator is superimposed onto the telephone line through an audio transformer, T1, which has its secondary (8Ω) winding—in series with R1 and LED1, and SCR1—connected in parallel with the telephone line and its primary (1000Ω) winding tied to the output of the music generator.**

When soldering, be careful not to overheat the module. After all, we're working with a thermal-sensitive device and any excess heat can spell disaster for the delicate circuitry. The audio transducer that is wired to the board can be eliminated or retained, depending on the project you're building. To mount the music board to the main circuit, use double-sided tape, and wire the circuit using Fig. 2 as a guide. That's the easiest and the most economical method.

Installation and Test

To install the Telephone Hold Button, first connect the leads marked red and green in the schematic diagram of Fig. 2 to the corresponding wires within the telephone wall jack. With your Telephone Hold Button connected to the phone line, lift the handset from the cradle, press S1, and you should now hear the synthesizer play a tune; and LED1 should also be lit, but not to full brilliance. If the circuit seems dead, simply reverse the red and green wires of the line cord that's connected to the Hold Button (it's possible that the wires were crossed during the initial phone installation). Once reversed, again press S1 and check your receiver for a melodic output.

If the music comes through, you're all set. Now, to place a call on hold, just press S1, and while still depressing the switch, return the handset to its cradle. The LED will now glow brighter and stay on, and the holding party hears the music from the synthesizer. To reconnect a call, simply lift the handset: the LED will go out and the music will stop. You may also reconnect a holding party by lifting any extension phone connected to that line.

Melody Ringer

Now that we have a music-on-hold and a way to detect eavesdroppers, let's wrap things up with a Telephone Melody

(Continued on page 102)

PARTS LIST FOR THE BUG DETECTOR

B1—9-volt transistor battery
LED1—Jumbo red light-emitting diode
R1—330-ohm, ¼-watt, 5% fixed resistor
R2—1000-ohm, ¼-watt, 5% fixed resistor
R3—100-ohm, ¼-watt, 5% fixed resistor
S1—Double-pole, double-throw (DPDT) switch
U1—LM741 op-amp, integrated circuit
Printed-circuit materials, telephone line cord with modular plug, snap-on battery connector, solder, wire, etc.

PARTS LIST FOR THE TELEPHONE HOLD BUTTON

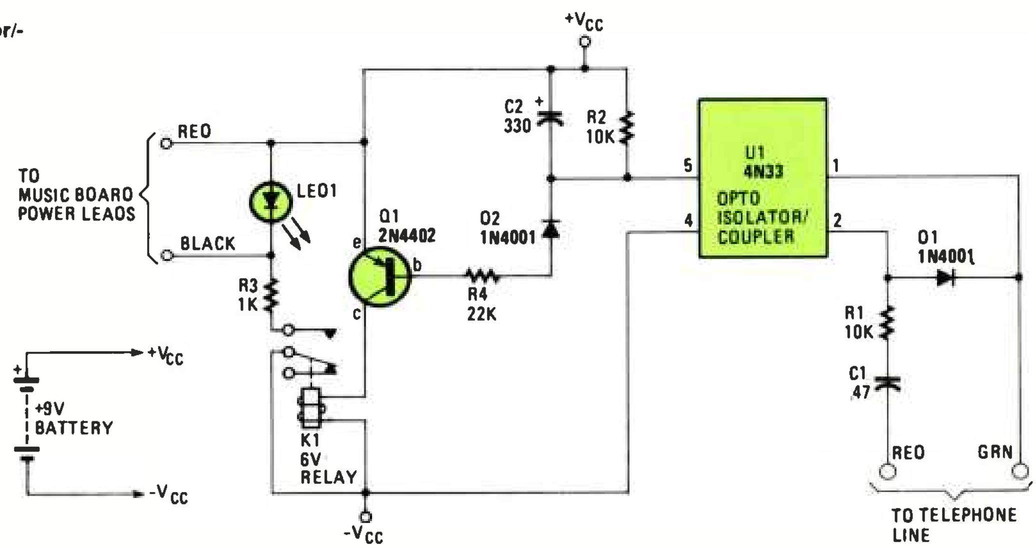
LED1—Jumbo red light-emitting diode
R1—1000-ohm, ¼-watt, 5% fixed resistor
R2—100-ohm, ¼-watt, 5% fixed resistor
SCR1—2N5061, silicon-controlled rectifier
S1—Normally-open momentary-contact, pushbutton switch
T1—Audio impedance matching transformer, 1000-ohm primary, 8-ohm secondary
U1—Music synthesizer, see text
Printed-circuit materials, telephone line cord with modular plug, solder, wire, etc.

PARTS LIST FOR THE MELODY RINGER

B1—9-volt transistor battery
C1—0.47-µF, capacitor
C2—330-µF, 16-WVDC capacitor
D1, D2—1N4001, 1-A, 50-PIV rectifier diode
K1—Single-pole, single-throw, 6-volt relay
LED1—Jumbo red light-emitting diode
Q1—2N4402, PNP, audio-frequency, medium-power preamp/driver transistor
R1, R2—10,000-ohm, ¼-watt, 5% fixed resistor
R3—1000-ohm, ¼-watt, 5% fixed resistor
R4—22,000-ohm, ¼-watt, 5% fixed resistor
Printed-circuit materials, telephone line cord with modular plug, battery snap-on connector, wire, solder, etc.

Note: The following is available from Del-Phone Industries, Inc., P.O. Box 150 Elmont, NY 11429: A complete kit of parts for Tele-Guard, $9.50; Telephone Hold Button, $13.00; Telephone Melody Ringer, $15.00, plus $1.50 shipping and handling per kit. New York residents, add sales tax. Please allow 6 to 8 weeks for delivery.

Fig. 3—When the optoisolator/-coupler detects the 90-VAC 20-Hz ring signal, pin 5 of U1 goes low, turning on K1, so that power is delivered to the synthesizer module each time a telephone-ring voltage is present across the telephone line.



SHORTWAVE OFFERS A

Shortwave news gives you everyone's point of view

ON THE EDGE OF A FIELD NEAR ROOSEVELT, LONG ISLAND, four monitors kept a round-the-clock watch on foreign shortwave stations, picking up and recording news broadcasts. The results of their monitoring were fed immediately by landline to the CBS building on Madison Avenue in downtown Manhattan, keeping the network news department abreast of developments around the globe.

State-of-the-art technology? Modern, efficient news-gathering techniques? No, that description is 45 years old, just a flash from the past! Back in 1941, that was how it was done. Today, of course, broadcast networks don't have to rely on shortwave radio for their news. There are circling swarms of communications satellites, instantaneous worldwide television, and reporters everywhere! So who needs shortwave for news monitoring in the 1980's? It's as out-of-date as Lillian Russell's bustle!

But, if that's the whole story, then why does the *U.S. Foreign Broadcast Information Service*, an arm of the CIA, tune in, round-the-clock, to what other radio voices are saying? Why does the BBC's own Monitoring Service have a staff of hundreds at its listening post at Caversham Park, 40 miles outside London? Why do the Canadians, West Germans, and Israelis all monitor news broadcasts on shortwave? And why, when a crisis occurs in some out-of-the-way backwater, do the press services and TV newsmen frantically go looking for a shortwave listener to find out what he has picked up on the air from Lower Wherezitania? The answer is that despite today's high-tech communications, there's still an awful lot of news and views to be found by shortwave listening!

That's not news, of course, to shortwave listeners. They know that one of the best ways to keep current on global events (and even more importantly—how it's all being interpreted in the various capitals of the world) is by systematically monitoring the regularly scheduled shortwave newscasts.

News? There is an incredible mass of it broadcast, in English, around the clock by stations from Moscow to Melbourne to Montreal to Manila and all the stops in-between

Propaganda? Like beauty, it is in the eye of the beholder. Some news is blatantly biased, even wildly improbable. Other newscasts have reputations for honesty that would put even Abe Lincoln to shame. But true blue or shades of another hue, shortwave can give dyed-in-the-wool *news junkies* a real-time picture of what other nations think of world events, or what they would have us believe.

It's tremendously informative (and, frankly, fun) to see who is reporting the latest hijacking incident, and how. Who is playing it up, down, or ignoring it all together.

The BBC Standard

For years and years it has been Britain's famed BBC that gets the high marks for coming out with the straight unadulterated stuff. Whether totally justified or not, BBC newscasts have become the standard by which other news is judged. All over the world, dating back to the old Empire Service in 1932, the British Broadcasting Corporation has had a reputation for telling the truth, the whole truth, nothing but the truth!

Oliver Whitley, its former External Services chief, some years ago declared—only partly in jest—that if the BBC were to announce the death of the Prime Minister of South Vietnam, and he were to appear the next day in the streets of Saigon, no one would recognize him!

The BBC's editorial reputation stems from its Royal Charter, which established the service as independent from government control.

Today, the BBC newsroom in London's Bush House, staffed by more than 100 newspersons, prepares over 200 separate newscasts in English and 33 other languages.

The BBC's English language World Service includes the *World News Hourly* plus other news broadcasts, the venerable *Radio Newsreel*, in-depth news reports from the BBC's correspondents, *Twenty-Four Hours*—a mix of interviews and press reviews, *Newsdesk*, *News About Britain*, and other programs.

Radio Moscow's World Service, the Voice of America, and Radio France International also have a heavy commitment to news in their English-language programming.

The VOA seems to have periodic squabbles between its news staff and policy makers over whether the service's role is to simply tell it as it is, or to serve as America's voice to the world, reflecting an official view.

Truth be told, policy biases are reflected—to a minor or major degree—in the newscasts of all "government" shortwave voices, even the BBC.

In the summer of 1985, under pressure from Prime Minister Margaret Thatcher, the BBC canceled an interview with an alleged Irish Republican Army leader in Northern Ireland. In response, irate BBC journalists went on a 24-hour news strike to protest the government interference.

With some broadcasters, that fight is never even waged. Radio Moscow has one of the slicker English-language news

TABLE 1—ABBREVIATIONS

BBC	British Broadcasting Corporation
CBS	Columbia Broadcasting System
CDT	UTC+7 hours
CIA	Central Intelligence Agency
CST	UTC +6 hours
EDT	UTC +6 hours
EST	UTC +5 hours
kHz	kiloHertz (1000 Hertz or cycles)
MDT	UTC +8 hours
MST	UTC +7 hours
PDT	UTC +9 hours
PST	UTC +8 hours
SWL('s)	shortwave listener('s)
TV	television
UTC/GMT	Universal Time Code/Greenwich Mean Time
VOA	Voice of America

WORLD OF NEWS

By Don Jensen

TABLE 2—ENGLISH LANGUAGE NEWSCASTS

COUNTRY Station (Broadcast)	Frequency (kHz)	Time (UTC)
ALGERIA		
Radio Algiers	17745	2000
ARGENTINA		
RAE	9690	0100
AUSTRALIA		
Radio Australia (Australian News)	6060 9580	1330
CANADA		
Radio Canada International	5960 11850	0000 0100 0400
CHINA		
Radio Beijing	9820 11685	0000
CUBA		
Radio Havana Cuba	6140	0300
CZECHOSLOVAKIA		
Radio Prague	9605 11990	1730
EAST GERMANY		
Radio Berlin International	9730	0015
EGYPT		
Radio Cairo	9475	0200
FINLAND		
Radio Finland (Northern Report)	11945 15400	1300
FRANCE		
Radio France International	9800	0315 0345 0415 0445 1600
GHANA		
Radio Ghana (National News)	3366	2245
GREAT BRITAIN		
BBC (World News)	5975 6175 9510	0000 0200 0500
(Radio Newsreel)	6075 6120	0015
(News Desks)	5975 6175	0600
(News About Britain)	6075 6120	0009
GREECE		
Voice of Greece	7430 9420	0345
ISRAEL		
Kol Israel (News, Spotlight)	7410 9435	0000
JAPAN		
Radio Japan	9645	0015
LIBYA		
Radio Jamahiriyah	15450	1900
NETHERLANDS		
Radio Nederland (World News) Neth. Antillies Relay Station)	9715	0830
NEW ZEALAND		
Radio New Zealand	9600	0900
NICARAGUA		
Voice of Nicaragua	6015	0130
PAPUA NEW GUINEA		
National Bc. Commission	4890	0900
POLAND		
Radio Polonia	7270	2230
PORTUGAL		
Radio Portugal	6095	0030
SOUTH AFRICA		
Radio RSA	6010 9615	0200
SWITZERLAND		
Swiss Radio International	9725 9885	0200
SYRIA		
Radio Damascus	9805 12805	2015
TAIWAN		
Voice of Free China (Relayed by WYFR, USA)	5965 6065	0300
TURKEY		
Voice of Turkey		
(Turkish Press)	7215	2100
(News)	9560	2300
UNITED ARAB EMIRATES		
Radio Dubai	11730	0330
UNITED STATES		
American Forces Radio TV	6030	0300
Voice of America	5995 6130 9650 11675	0000 0100 0200 0300
USSR		
Radio Moscow	6170 7115 9580 9720	-Hourly- 0000-0600
VIETNAM		
Voice of Vietnam	10040	1800
WEST GERMANY		
Voice of Germany	6145 9545 6120 9690	0100 0500
YUGOSLAVIA		
Radio Yugoslavia (Press Review)	15240	1530

The Voice of America uses many signal sources feeding many transmitters to keep the world up to date with accurate, reliable news.

productions. Its views scarcely ever come as a surprise to American listeners, although newcomers to the shortwave dial may be startled to find the accents of the announcers flawlessly American. The same cannot be said of the English language speakers on Taiwan's Voice of Free China, whose *sing-song* accents continually prompt the listener to wonder, "What did he say?"

From China

Radio Beijing—which used to be Radio Peking until China introduced a new system of transliteration from Chinese to English—has an interesting news operation. Although the Chinese seem a bit green at western-style journalism, their young English-language news staff is very enthusiastic, even though visitors say that the three-shift, 24-hour-a-day news operation still seems a bit makeshift. Radio Beijing, probably to ensure ironclad control, records everything on tape before it's aired.

Some broadcasters in smaller nations see little real purpose in offering global news coverage, because they often lack the facilities to do more than simply read edited wire copy from the major news agencies such as the Associated Press (U.S.), Reuters (United Kingdom) or Agence France Press (France).

Sometimes they focus on regional news that tends to be passed over by the broadcasting world's "big boys." Radio Finland's *Northern Report* is typical of that approach: taking a relatively in-depth look at the news from Scandinavia and northern Europe.

New Station

Shortwave news fans are looking forward to a brand new station scheduled to be on the air, broadcasting from a transmitter in Maine, sometime 1987.

The shortwave operation will be a new venture of the respected, Boston-based *Christian Science Monitor*.

David E. Morse, a spokesman for the Pulitzer Prize winning daily newspaper, says the station will tap the *Christian Science Monitor's* vast news resources to provide the same dimension of news one finds on the BBC.

The new shortwave station is expected to beam strong signals into Europe and Latin America, but, of course, it should be easily and widely heard in North America during its planned six-hours-per-day schedule.

How should you monitor the world's English-language news broadcasts? Systematically, seems to be the appropriate answer. Look for a rather broad range of viewpoints from the key stations representing the major hues in the ideological spectrum.

Begin in the early evening with one of the BBC broadcasts to give you an overall picture of what has been the day's breaking news and developing stories.

Follow that up, minimally, by tuning in newscasts from the Voice of America, Radio France International and Radio Moscow's World Service.

Radio Cairo and Kol Israel should be included among your Middle East listening stops. Catch the news from Radio RSA in Johannesburg, South Africa. Radio Japan and Radio Beijing are minimal Far Eastern news sources.

And, just for fun, and a radio glimpse of what most broadcasters behind the Iron Çurtain used to sound like, listen in—try 6,200 kHz at 0330 UTC/GMT—to Albania's Radio Tirana, an unrepentant throwback to the Cold War era decades back.

All of those should be easily heard, but there are many more English- speaking stations offering news. Hunt them out as your interests indicate or as daily events dictate.

News Around The World

Here is a sampling of English-language news broadcasts aired by some shortwave stations around the world. The larger broadcasters air news at numerous other times and on many frequencies. Times are in Universal Coordinated Time (UTC), also known as Greenwich Mean Time (GMT). UTC/GMT equals EDT + 4; CDT/EST + 5; MDT/CST + 6; PDT/MST + 7; PST + 8 hours. Frequencies do change periodically. If you fail to hear the station on a particular frequency at the listed times, tune around a bit: you probably will find the broadcast that way. ■

Announcer reading the news in studio of Germany's Deutsche Welle (Voice of Germany, in English) located in Cologne.

Taping a remote interview for Swiss Radio International's English language service on a tourist sight-seeing boat.

Introducing Model-boat electronics....

MOCON "A" MODEL-BOAT REMOTE CONTROLLER

By W. Richard Freeman

Treat yourself to all the pleasures of model racing, without falling prey to skyhigh prices!

ELECTRONIC MODELS OF EVERY TYPE CONCEIVABLE—from the old four-engine B-17 bombers and single-engine Corsair fighters, PT boats, and battleships of the World War II era to the more modern F-14's, F15's, and aircraft carriers (better known as floating cities)—can be found in the marketplace. And anyone who's ever sought to maintain a link to the past (or to toy with the future) through those electronic beauties knows that they *ain't* exactly cheap. In fact, depending on your interests, a single purchase can cost as much as $1000 or more (certainly beyond the means of the average hobbyist).

But now, using one channel of your two-channel R/C unit and the circuit that we'll describe, you can operate the throttle of your model boat—shifting from full stop to full ahead, slow, and then reverse. *Mocon "A"* (the circuit that makes it all possible) controls both the rotation speed (rpm) and direction (forward/reverse rotation) of a 12-volt DC brush-type motor through a mechanical actuator.

Figure 1 shows a typical installation. The 1/35-HP motor used by the author is a replacement for an auto-heater blower; it draws slightly less than 5 amperes at start-up. The entire control unit, less the motor and servo actuator, is built on a printed-circuit board and housed with all components in a 4-3/8 × 2-1/2 × 1-1/4 inch plastic utility box. Mocon "A" can be built using common hand tools; and all parts, except for the printed-circuit board, are readily available.

How It Works

A full range of motor-output rpm is obtained by driving the motor with a variable pulse-width squarewave. A train of narrow pulses causes the motor to just turn over. As the pulse width is increased, the motor receives more power; thus its rotation speed increases. As shown in the schematic diagram of Fig. 2, Mocon "A" uses a 555 oscillator/timer (U1) as the waveform source. Pulse width is set by the position of potentiometer R1, which is adjusted through the remote-controlled, servo actuator. The squarewave output of U1 is applied directly to power transistor Q1, which drives the motor.

Motor-rotation reversal is accomplished by a spur of a cam mounted on the shaft of R1, two microswitches (S2 and S3), and the locking mechanism from a ball-point pen (as shown in the photos). As R1 is adjusted counter-clockwise, motor speed is reduced. At a point where rotation nearly ceases, the spur of the cam comes into contact with the top of the ball-point pen, depressing it. Through a push rod, that motion is transferred to a spring reversing lever, which toggles S2 and S3. When R1 is turned in the clockwise direction, the pen mechanism latches, holding S2 and S3 in the reverse condition. Once selected, reverse speed is as controllable as forward speed.

By again turning R1's shaft counter-clockwise a little

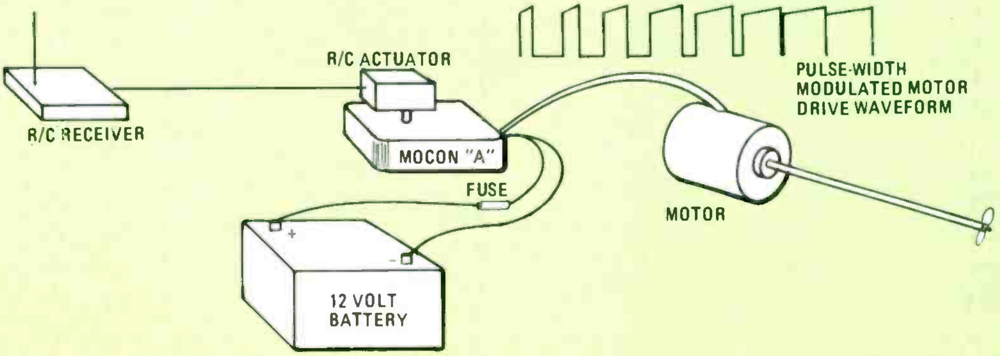


Fig. 1—The Mocon "A" Remote Controller is designed with water-sport enthusiasts in mind, but the concept can be modified to work with other motorized electric models. For instance, model race cars and other automobiles, or aircraft (which, of course, would have no need for the reverse rotation mode of Mocon "A") might be controlled with such a circuit.

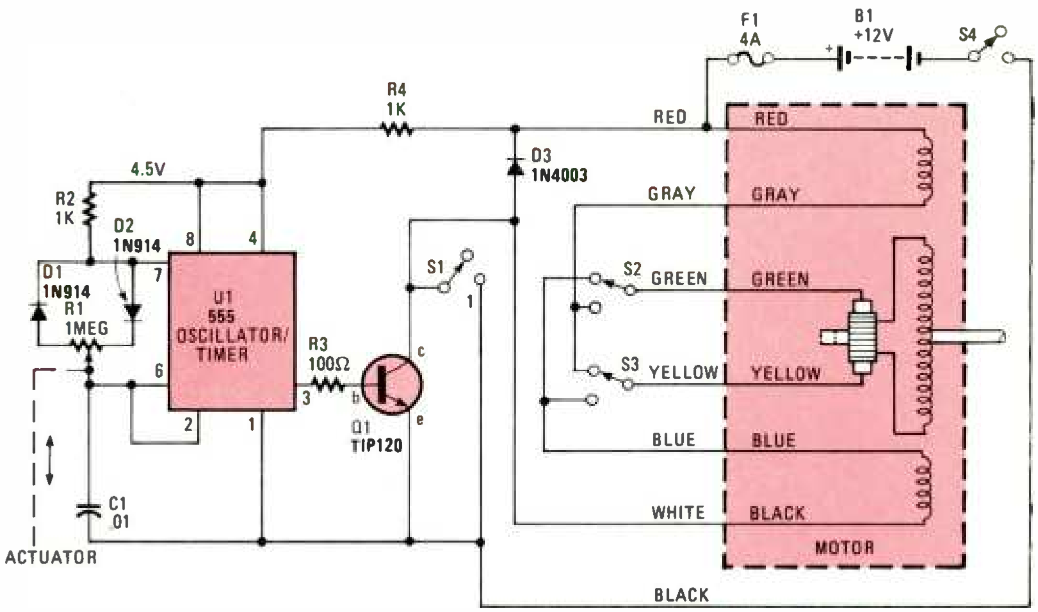


Fig. 2—The schematic diagram of Mocon "A" shows a relatively simple circuit that, with proper construction, provides complete control over electric-powered model boats. The motor's rpm is determined by the duty cycle of the squarewave output of the 555 timer/oscillator, while the direction of rotation is controlled by S2 and S3 through a switch-reversal mechanism.

beyond stop, the pen mechanism is again depressed. On clockwise rotation, the mechanism is unlatched, allowing S2 and S3 to select forward motor rotation. As R1 continues to turn clockwise, motor rpm increases to a maximum point where a lobe on the cam actuates S1, closing its contacts, which bypass transistor Q1 to provide maximum power to the motor.

Motor Modifications

The motor used by the author was modified from its original series-wound configuration in order to provide the reversing feature. If a motor with a permanent-magnet field is used, the modification is not necessary. A point to observe, however, is that the motor selected must have its brushes set normal to the commutator, not set at an angle that would hinder reverse rotation.

Figure 3A shows how the motor was originally wired, and Fig. 3B shows the changes that are required. To rewire the unit, mark the two halves of the motor housing and remove the two nuts and washers. While pressing inward on the shaft, slide the front half of the motor housing off. Watch for shims on the motor shaft and on the face of the front bearing. Be sure to put the shims in a place where they can easily be found when reassembly time rolls around.

Next, clip off and remove the two power leads. Select new conductors of the colors indicated, and cut to the length required for your installation, plus six inches.

Route one conductor at a time through the grommet (which was originally used for the power conductors) on the rear half of the motor housing. Remove about a ¼-inch of insulation from the ends of the conductors for soldering to the motor. Route the conductors as shown in Fig. 3C, using the plastic brush support as a strain relief. Solder the black and the red conductors to the lugs from which the power conductors were cut. Next, cut the brush pigtail from the stator conductor (heavy single-strand enamelled wire) at two places. Route gray and green conductors through holes in the brush support and solder one conductor to each end as shown. Do the same

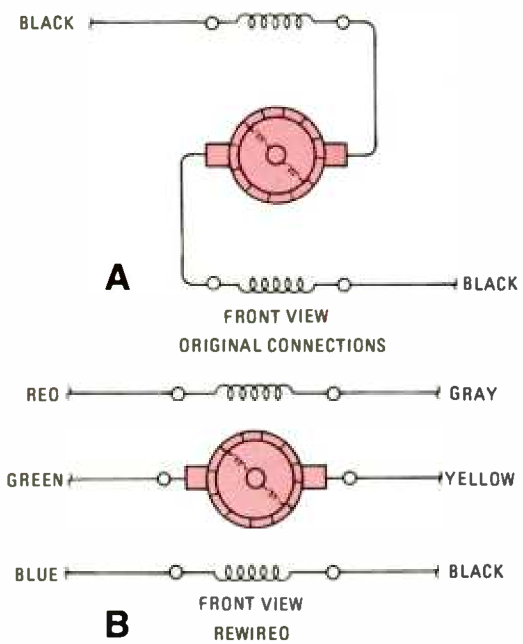
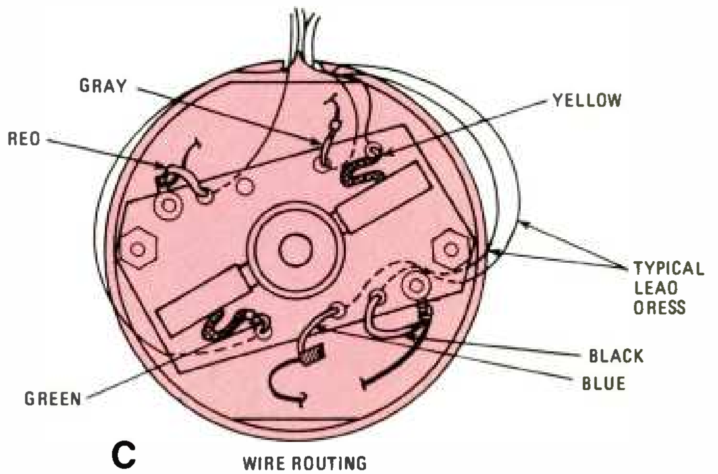


Fig. 3—The 1/35-HP motor used to propel your model ship must be modified to provide both forward and reverse rotation. In A, the motor is shown with its original connections; B shows the modifications that must be made, and C depicts the actual motor and the points inside the motor where new leads are to be connected.



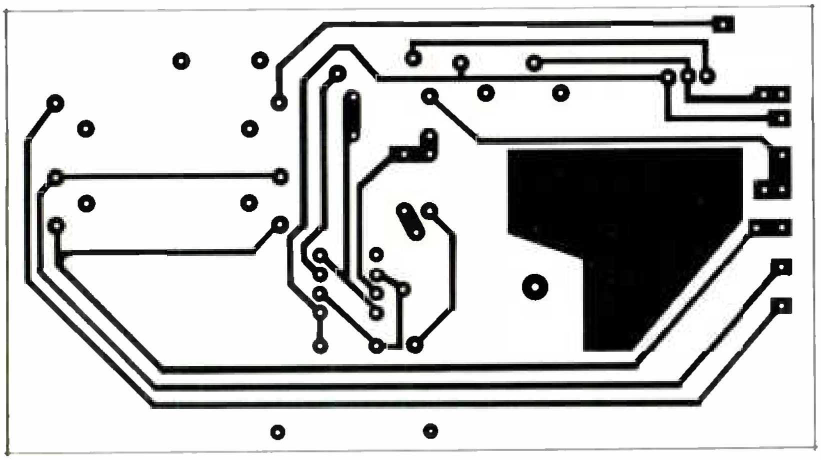


Fig. 4—The printed circuit for the Mocon "A" Model-boat Remote Controller—on which all the electronics parts, except for the motor and the servo actuator, are mounted—can be etched on a copper-clad blank measuring 4¼ × 2¼-inches.

on the opposite side of the brush support, using yellow and blue conductors. Dress the leads away from the rotor and reassemble the motor. Tighten the two nuts slowly while spinning the motor shaft to make sure that it turns freely.

Controller Construction

The electronics for the Mocon "A" Controller were mounted on printed-circuit board. A full-size template, which can be lifted from the page or copied, is provided in Fig. 4 for those wishing to etch their own boards. Once etched, mounting holes must be drilled, and the board must be trimmed to fit easily into a utility box. The utility box has internal guides which are removed down to ⅛-inch from the bottom of the box. At the top of the box, a ¼-inch diameter hole is drilled, through which the servo actuator rotates the wiper of R1.

With that accomplished, you can now drill holes in the board, through which the components will be mounted. Note that the photos show R1 mounted flat to the printed-circuit board with its shaft protruding through a 5⁄16-inch hole in the board. Once the hole is drilled, temporarily install R1 on the board and mark the shaft at a point about ½-inch above the printed-circuit board surface. Then remove and cut the shaft. But hang on to the cut-off portion.

Now we come to the cam (see Fig. 5), which was made of

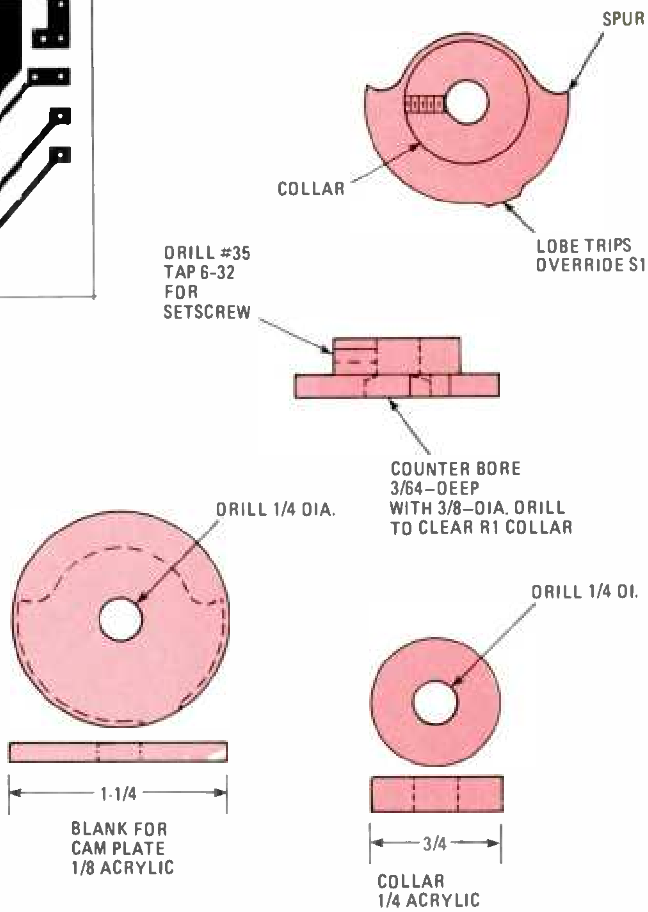


Fig. 5—Fabricating the cam assembly is really quite simple: All that's needed are two small pieces of acrylic plastic of the thickness indicated and cut as shown. The two pieces are then bonded together to form the cam assembly. (All dimensions are in inches.)

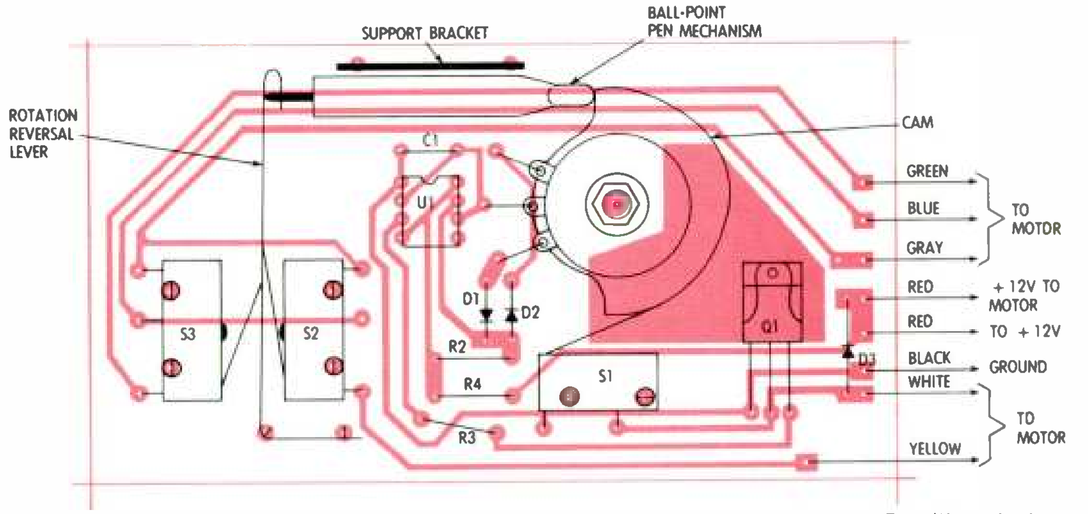
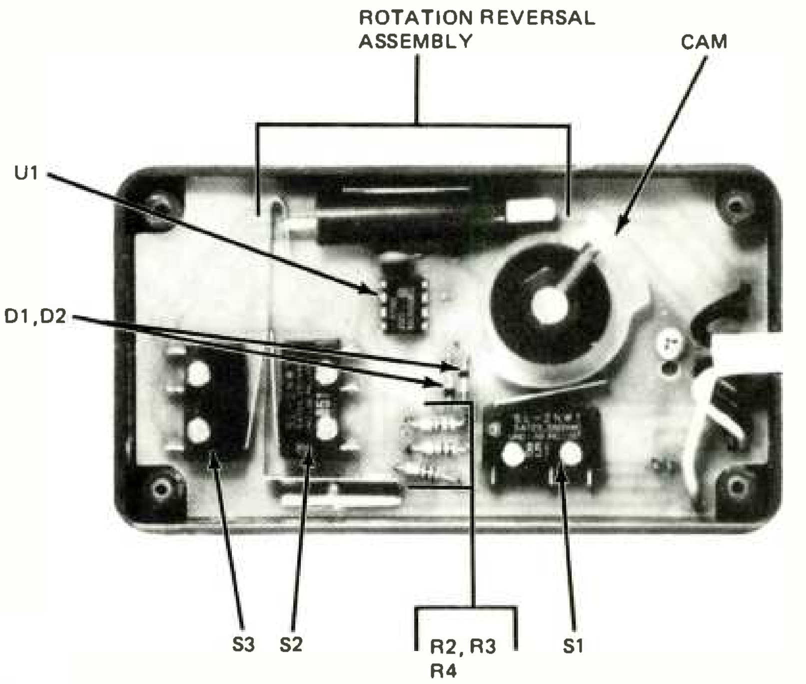
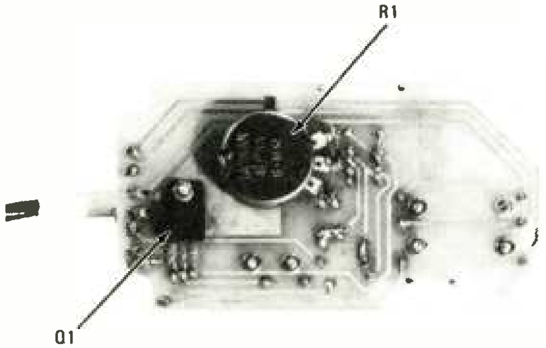


Fig. 6—The parts layout for Mocon "A" can be a bit deceptive; transistor Q1 and potentiometer R1, although shown as if mounted on the component side of the board, are actually attached to the copper side. The heavy foil area, on which the tab of the transistor rests, provides limited heatsinking for the unit. The shaft of R1 protrudes though the board (from the copper side) and is secured in place with the normal mounting hardware.



The printed-circuit board of the Mocon "A," as viewed from the component side of the board makes the controller's operation easy to understand. The cam, driven by the servo actuator, depresses the pen mechanism, which in turn contacts the rotation reversal lever, allowing motor rotation to be reversed.



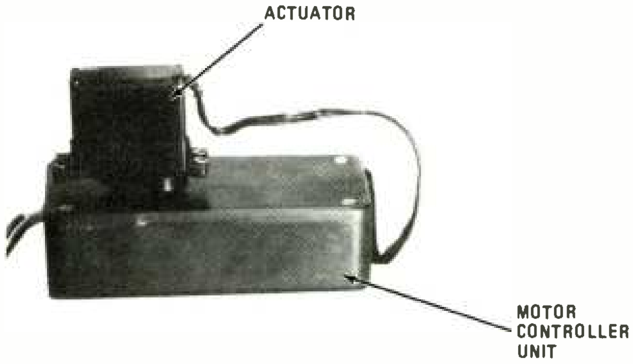
The fully assembled printed-circuit board for the Mocon "A" Model-boat Remote Controller as viewed from the foil side of the board. Note the positioning of the two foil-side mounted components; the transistor, Q1, is positioned so that the metal tab rests against the large copper area when its leads are bent. The shaft of potentiometer R1 is inserted through the hole in the board and the unit is secured with hardware.

two pieces of acrylic plastic: one ¾-inch in diameter and ¼-inch thick; and the other 1-¼-inch in diameter and an ⅛-inch thick. A hole saw or fly cutter can be used to make the collar. The cam plate should be drilled, then scribed with the contour shown in Fig. 5 and cut oversized. Using the cut-off piece of R1 shaft set vertically in a scrap of wood as a jig, assemble and cement the two parts together. Next, drill and tap the collar for a 6-32 setscrew. Counterbore the cam plate side to 3/64-inch depth using a ⅜-inch bit.

Assemble the smaller components on the printed-circuit board and solder them in place, using Fig. 6 as a guide and taking careful note of component orientation. Note that Q1 is mounted on the foil side of the board with its tab secured to the large copper area, which acts as a heatsink for the transistor, with hardware. Next, secure potentiometer R1 and the microswitches in position. Use tinned copper wire to connect the microswitches, and use short but slack loops of hookup wire to connect the potentiometer to the appropriate printed-circuit traces. Next, we'll need to make the spring reversing lever (see photos), which installs between the lever arms of S2 and S3. Using Fig. 7A as a guide, make the reversing lever from a piece 1/64-inch spring brass—fold the cut along the dash lines as indicated in Fig. 7A. Position the reversing lever on the component side of the board with the cut projections protruding through to the copper side. Epoxy the foot of the reversing lever on the component side and solder the cut projections to their respective pads on the foil side.

Now move on to the pen-support bracket assembly. Using Fig. 7B as a guide, make and install the pen-support bracket using solder and epoxy. Trim the pen mechanism to approximately 1-¼-inch in length. Do not cement the pen mechanism yet; instead, hold it in place with a clamp or rubber band. Next, solder the eight power and motor-control leads in place, with F1 (a 4-ampere fuse) in with the positive power lead. Check the wiring carefully. Install the push rod between the ball-point pen mechanism and the reversing spring, and adjust the reversing spring to actuate S2 when the reversing spring is not under pressure from the push rod.

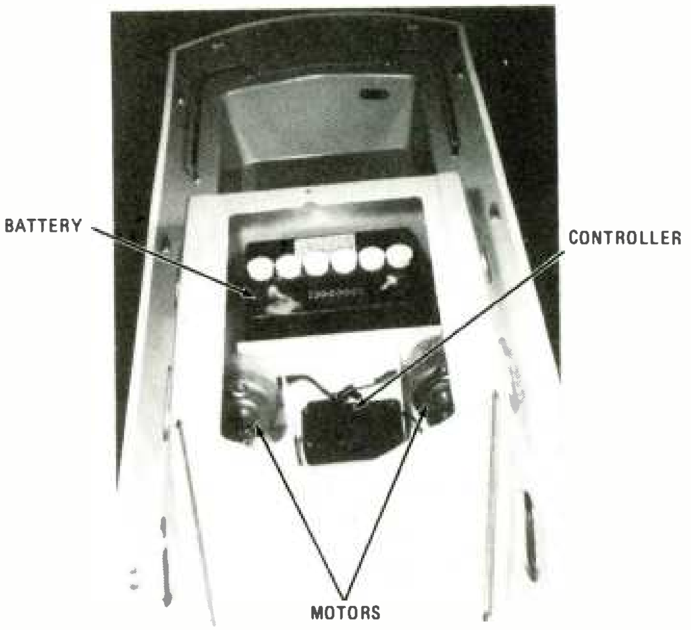
Operate the ball-point pen mechanism to apply force to the reversing spring; S2 should de-actuate and S3 actuate. Now for the great moment! Connect Mocon "A" to the motor, turn R1 shaft to its counter-clockwise position. Release the reversing spring so that S2 is actuated. Apply 12-volts DC to the system and the motor should turn slowly. As R1 is turned clockwise, motor speed should increase. When maximum speed is reached, actuate S1 by hand. The motor rpm should increase slightly. Release S1 and decrease motor speed to 5 or so rpm.



The servo actuator is mounted to the outside of the motor controller, and connected to the wiper of R1. A wire from the actuator is connected to a two-channel, remote-control receiver, which picks up the command signals.

PARTS LIST FOR MOCON "A"

C1—0.01-µF, 50-PIV ceramic disc capacitor
D1, D2—1N914 small-signal, switching diode
D3—1N4003 1-A, 200-PIV rectifier diode
F1—Slow-blow fuse, 4-A, (Radio Shack 270-1277)
Q1—TIP120 NPN Darlington transistor (Radio Shack 276-2068 or similar)
R1—1-Megohm, linear-taper potentiometer
R2, R4—1000-ohm, ¼, 5% resistor
R3—100-ohm, ¼-watt, 5% resistor
S1–S3—Subminiature single-pole, double-throw (SPDT) lever switch (Radio Shack 275-016 or similar)
U1—555 oscillator/timer integrated circuit (Radio Shack 276-1743)
Printed-circuit materials, Grainger 2M272 1/35-HP, 12-volt motor, spring brass sheeting, ball-point pen mechanism, 0.098-inch diameter (aluminum) welding rod, enclosure (Radio Shack 270-221 or similar), hardware, solder, etc.



The Mocon "A" Model-boat Remote Controller can be used in a "twin engine" arrangement to increase the model's speed.

Operate the ball-point pen mechanism to release S2 and actuate S3. Then turn R1 clockwise. Motor rpm should increase in the reverse direction. Turn R1 counter-clockwise to stop motor rotation, and install the cam on R1 shaft, pressing it down *only* far enough to allow the setscrew to be set up lightly. Turn the cam to find exactly where to cut the lobe needed to actuate S1 at maximum rpm, and where to locate the spur that will operate the pen mechanism. Remove power and remove the cam. Cut the cam carefully, fitting and testing for best operation. Install the cam, and cement the ball-point pen mechanism in place, and install the entire assembly in its enclosure.

Connection between the R/C servo actuator and the cam collar is made by cementing the actuator plate directly onto the top of the collar (the setscrew may have to be removed). The servo actuator itself is mounted on the top of the utility enclosure.

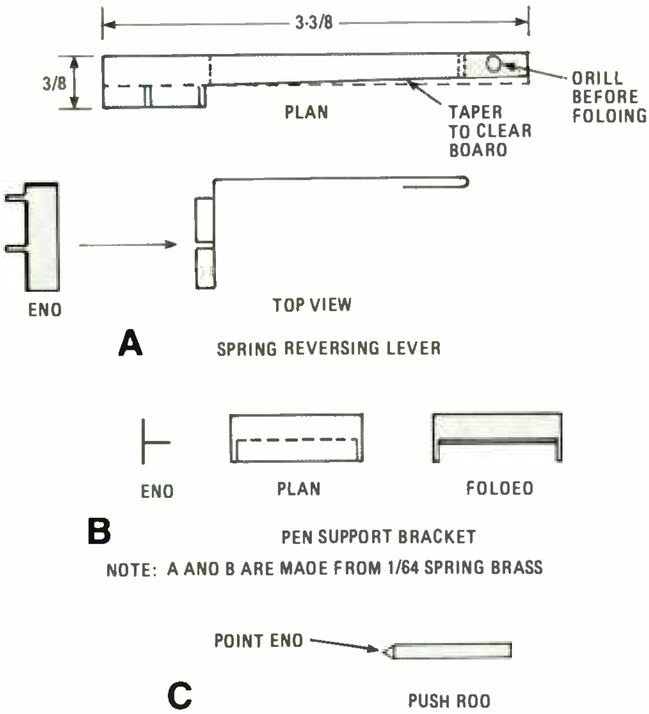
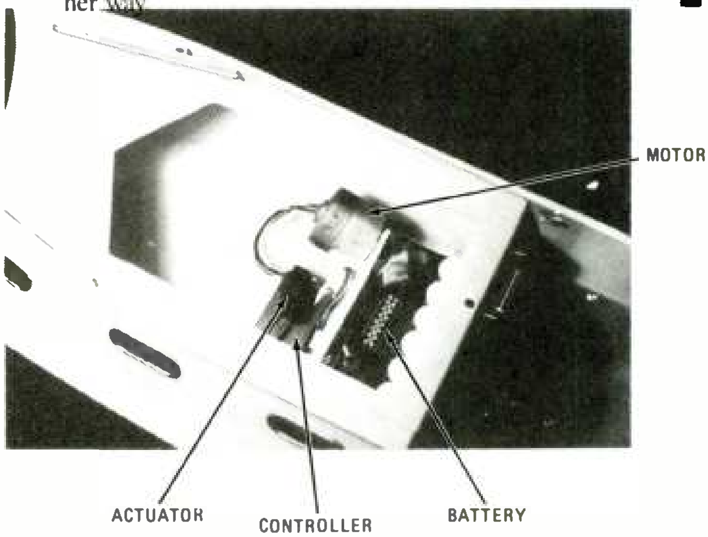


Fig. 7—The motor-rotation reversal lever as well as the pen-support bracket is made from 1/64-inch thick spring brass cut to the dimensions (given in inches) shown and bent. The push rod, which pushes against the reversal lever, can be made from a 0.098-inch diameter welding rod, or perhaps even an old heavy-wire clothes hanger, or some similar material.

Troubleshooting

If the motor shaft turns freely without power applied, but does not turn under power, check the battery connections and fuse F1. If the motor was not overloaded, check diode D3 and replace if bad. Apply power to the system; if the motor doesn't run, close override switch S1. If the motor still doesn't run, check the closed contacts of S2 (or S3) using a voltmeter while power is on. If the motor runs only with S1 closed, check for +4.5 (±0.5) volts between U1 pin 4 and ground. If no voltage is present, replace R4. If voltage is present, connect earphones across U1 pin 3 and pin 1. A tone indicates that U1 is oscillating. If no tone is heard, check D3 and replace Q1. If you still get no tone, remove power and check D1, D2, and R1. Lastly, replace U1.

May fair winds and a following sea speed your vessel on her way. ■



The author installed Mocon "A" in a rather large model boat, and powered the system from an ordinary automobile battery.

UNIVERSAL SERIAL PRINTER ADAPTOR

By Herb Friedman

An inexpensive way to match your computer to budget-priced printers and also get a printer buffer.

EVEN IF YOU JUST GLANCE AT THE ADVERTISEMENTS for personal-computer equipment occasionally, you know that the marketplace is awash in a sea of high-performance printers at what is best described as *ridiculously* low prices. For not much more than what it would cost for a night out on the town you can now purchase a high-performance printer that just a few short months ago was well beyond what you could afford.

It all comes about because most business users of personal computers want their printers to have 100 percent IBM compatibility; that means that the printer must have all the special character and graphic symbols that are normally available from the IBM Graphics Printer. Those special characters and graphics are produced primarily through ASCII codes higher than 128, the same codes that other printers use for italic characters and proprietary graphics.

As far as computer dealers are concerned, without the IBM graphics most printers will just gather dust on the shelf; so virtually all non-IBM compatible printers are being dumped at prices too low to be believed. In fact, when IBM came out with their latest printer—the *ProPrinter*—authorized IBM dealers dumped IBM's own Graphics Printer for about $225.

The only problem you might have in interfacing one of those bargain printers with your computer is that they use what is called a *Centronics parallel input*. If your computer has a conventional RS-232 serial-printer output, as do many of the latest computers, you can't use a parallel printer without using some kind of serial-to-parallel adapter between the computer and the printer. The only problem with adapters, however, is that they often work with one kind of computer but not another. If you want to use the adapter/printer with two or more computers having slightly different serial-printer ports, you'll most likely have trouble getting the *combo* to work correctly.

The best way to resolve the entire problem of printer compatibility is to assemble our Universal Serial-to-Parallel Adapter, one that will work at any conventional RS-232 baud rate, and which can be automatically programmed for either 7- or 8-bit serial outputs. (The older Radio Shack Color Computers and the Apple II were 7 bits; newer computers are 8 bits.) You must untangle 7- and 8-bit outputs, because most serial adapters and printers won't work if they're looking for 8-bits per character and the computer is only sending 7, and vice versa.

While you could build a universal adapter from scratch (assuming you had the know-how and could locate the all the parts) the home-brew device would probably cost more than the whole kit and kaboodle—including the printer—was worth. The least expensive and most convenient way to assemble a universal serial-to-parallel printer adapter is *not* to build from scratch, but rather to modify what is already a notably excellent commercial device so that it will work with virtually every kind of RS-232 serial-printer port.

Just such a device is the *Super Cosmos Connection*, a serial-to-parallel adapter originally intended for Radio Shack's Color Computer. Since there were actually two different Color Computer models, the Super Cosmos Connection is designed to handle every possible Color Computer baud rate and bit rate, which just happens to work out to be every possible baud and bit rate used for RS-232 serial-printer ports. The device even contains an automatic *fudge factor* that shifts 1200 baud to 1250 and 2400 baud to 2500 (certain computers don't use the conventional 1200 and 2400 baud.)

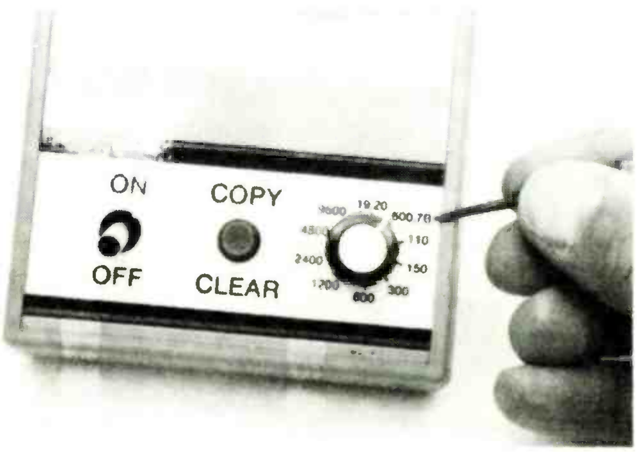
One Control For All Modes.

Best of all, as shown in the photographs, all modes are selected by a single switch: There are no internal jumpers, DIP switches, or shorting plugs of any kind. All operating parameters are determined by a single front-panel selector.

As you can see from the photographs, the baud-rate selection is calibrated in conventional steps from 110 to 19,200 baud. Note, however, that there are two 600-baud positions,

Although this serial-to-parallel printer adapter was originally intended for Radio Shack's Color Computer, by substituting standard connectors and matching cables you can match almost every computer RS-232 serial I/O to a Centronics-type printer.

A single selector determines the baud rate and the bit rate for the adaptor. The adapter normally functions with 8 bits. It comes up in the 7-bit mode when the selector-switch pointer is set on 600,7B before the adapter's power is turned on.



one of which is labeled 600,7B—meaning 600 baud at 7 bits. In every other position the adapter is set for 8 bits; but if the selector is set for 600,7B before the power is turned on, it *comes up* at 600 baud in the 7-bit mode. If the selector is then moved to another baud rate, the bit rate remains at 7. The baud-rate *fudge factor* works in a similar way. If the selector is set for 110 baud and then the power is turned on, the 1200 and 2400 baud positions are automatically *fudged* to 1250 and 2500 baud. For conventional 1200 and 2400, you could set the selector directly to 1200 or 2400 before power is applied, or adjust the selector after the device is turned on.

One other *extra* feature is that the adapter has a built-in 8K buffer that is easily expanded to 32K in 8K increments. Three empty prewired sockets are provided for 8K CMOS memory IC's, type HM6264LP-15, which you can purchase directly from the adapter's manufacturer or from local parts distributors. To upgrade the buffer, you simply plug the chips into their sockets; there are no jumpers or switches to adjust when expanding the memory. Just keep in mind that CMOS chips are sensitive to static electricity, so make certain that you're connected to ground through a wire in series with a 1-megohm, ½-watt resistor. Do not handle or install a memory chip if you're not properly grounded.

Modifying the Adapter

Although the adapter's baud and bit rates are universal, the connectors aren't, having originally been intended for the DIN connectors of Radio Shack's Color Computer. But all it takes to make everything universal is to replace the adapter's DIN connectors with the conventional 25-pin D-connectors normally used for RS-232 serial I/O connection, and to use connector pins that can match those of a short adapter cable. By using various adapter cables, the serial-to-parallel adapter can be made to work with any serial I/O port.

The Super Cosmos Connection adapter has two connection cables. The one with the gray DIN connector goes to the computer. The cable with the black DIN connector goes to the modem. The adapter's printer output has its own Centronics-type connector. The reason why the adapter has two DIN connectors is that the Color Computer uses the same set of serial I/O connections for different functions depending on whether it's feeding a printer or a modem. Refer to, and compare, Figs. 1 and 2. The Cosmos adapter automatically switches the functions: When the adapter's power switch is turned ON, an extra set of contacts automatically disables the modem connections; when the adapter's power switch is OFF, it rearranges the connections from the computer and connects the modem. If your computer also has only one serial I/O port, we suggest you retain the printer/modem switching to avoid frequent cable substitutions. Just change the DIN connectors to conventional RS-232 D-connectors, using the wiring order shown in Fig. 3.

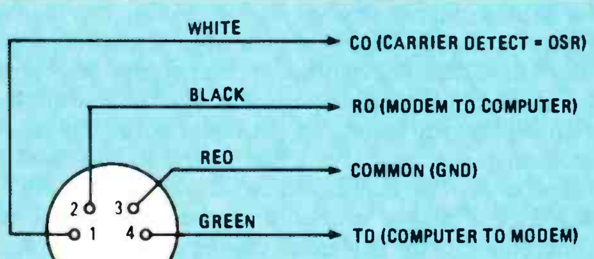


Fig. 1—Software determines the electrical connections of the RS-232 output. This is the modem setup.

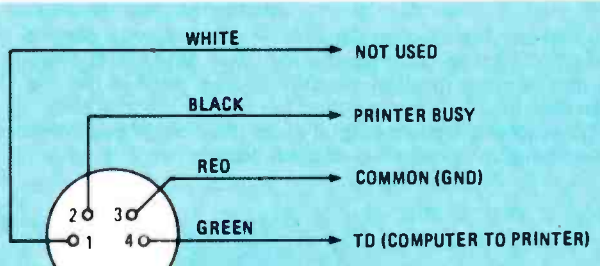


Fig. 2—The RS-232 socket uses only three connections when driving a conventional serial printer.

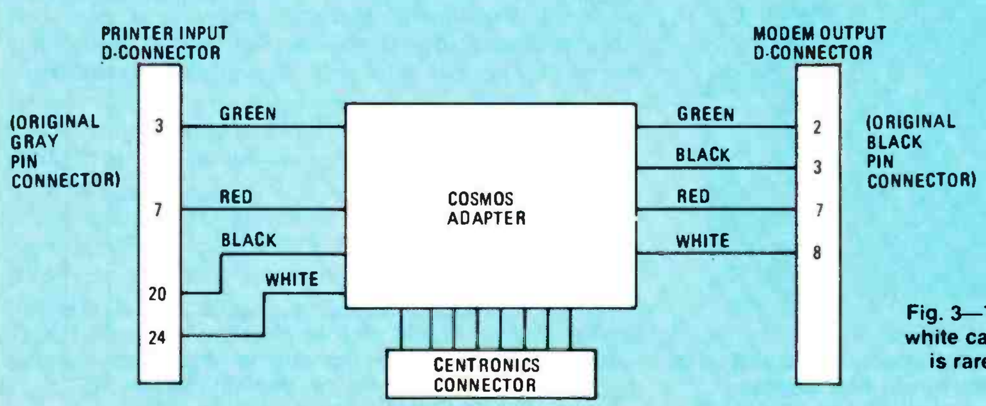


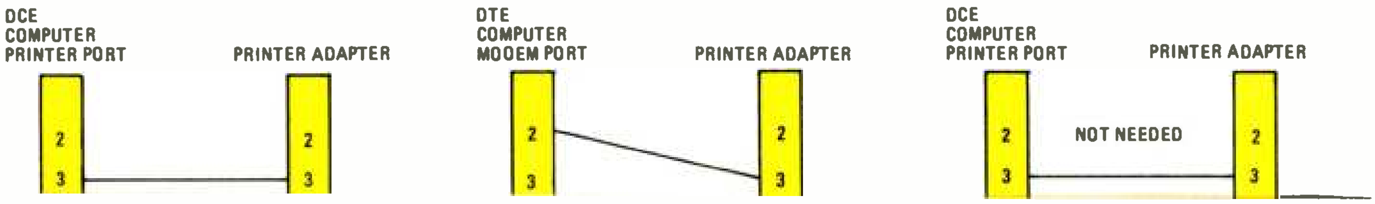
Fig. 3—The unused wire color-coded white can be parked on pin 24, which is rarely, if ever, needed or used.

I/O, and direct-memory access (DMA). Let's take a look at each of those key methods, as well as a variation of the programmed I/O method called "memory-mapped I/O."

Programmed I/O

The simplest and the most widely used way of getting data into and out of a microprocessor is to simply pass it through

sending ASCII characters to an external printer. Printers are slow mechanical devices and they cannot operate as quickly as electronic circuits. If the microprocessor sends the information to be printed at its maximum rate, the printer will not be able to keep up. Data will be lost. For that reason, some circuitry must generally be incorporated to permit the remote printer to tell the computer when it has received a character



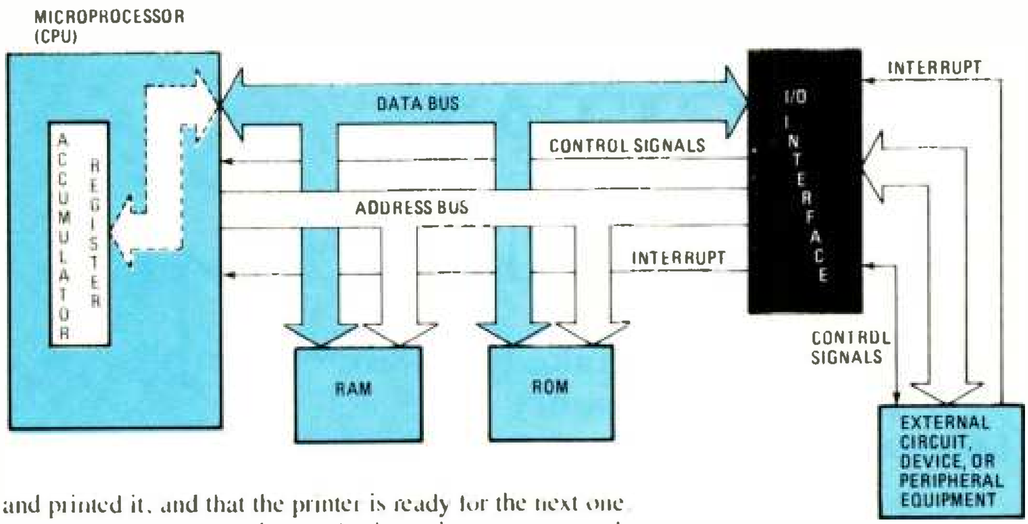


Fig.1—The most commonly used way to get data into and out of a microprocessor is to simply pass it through the accumulator, or one of the general-purpose registers.

and printed it, and that the printer is ready for the next one.

The same is true on input. An input instruction may be executed, but the external device may not have data ready to put on the bus. The external device must signal the interface, which can then inform the microprocessor of its readiness.

The readiness indication is usually handled by a short segment of instructions that poll the external devices waiting for a signal that indicates they are ready. A single logic signal generated within the external circuit or device and passed along by the interface can be placed on the data bus and the microprocessor can read it repeatedly looking for a particular condition. If the pulse is a binary 0, then the external device is not ready. If that pulse becomes binary 1, then the readiness condition is signaled. The microcomputer inputs that pulse, checks its value with a short sequence of instructions, and determines that data may now be sent or received.

The actual transfer of data takes place when one or more control signals are sent from the CPU through the interface to the external device. Those control signals are either generated directly by the microprocessor or can be derived from selected signals on the microprocessor control bus using simple logic gates.

Interrupt I/O

A modified form of programmed I/O is called "interrupt I/O." Every microprocessor has an input signal called an interrupt. It does not *have* to be used; but if it is used, it greatly facilitates input/output operations.

An interrupt is a signal from an external circuit or device indicating to the CPU that some input or output operation is called for or desired. (Refer back to Figure 1.) That is similar to the input signal described previously, which must be periodically checked with an input operation to ascertain if the external device is ready. The interrupt provides a way to signal the microprocessor and causes it to interrupt any program in progress and perform the desired I/O operation.

Using the polling technique described in programmed I/O is a wasteful and time-consuming process. It means that the microprocessor must continually look for an input signal from the external device. It simply waits until that external device is ready. That is an inefficient use of the processor because ordinarily other computing operations *could* go on while you are waiting. Interrupt I/O makes that possible. The microprocessor may go about executing other programs until an input or output operation is desired.

When an interrupt occurs, the microprocessor finishes executing any instruction currently in process. Then, it stores the content of the program counter in the stack. (Recall that the stack is an area of RAM set aside for temporarily holding addresses and data words.) By storing the program counter, the microprocessor thereby remembers its place in the current program. Remember that the program counter always points to the next instruction to be executed. Once an instruction is complete, the program counter is incremented so that it points to the next instruction in sequence in the program. By storing that address, the processor can pick up where it left off once the called-for input or output operation is complete.

In addition to storing the program counter, other information may also be saved. The contents of the accumulator, which usually contains the intermediate results of a calculation, is also stored on the stack. The contents of other registers may also be saved in the stack if necessary. The saving of all that information may take place automatically in some processors, but in others, special instructions associated with the stack must be used. For example, a PUSH instruction causes register data to be put on the stack. A POP or PULL instruction causes information to be retrieved from the stack and put back into the appropriate register.

Once the status of the microprocessor has been saved, the interrupt signal causes the program counter to be automatically loaded with a predetermined address. In some microprocessors, that address is zero (0000 hex); in others, it is the maximum address value (FFFF). With that number loaded into the program counter, the microprocessor then looks for an instruction at that location and fetches the instruction word stored there. That is usually a jump or a branch instruction that loads the program counter with another address that points to a subroutine stored in RAM that will carry out the desired I/O operation.

A subroutine is a short sequence of instructions designed to perform some specific operation. It may be a calculation or some other process. In this case, it is an input or output routine using the standard input and output instructions described under programmed I/O. That subroutine sends data to the device requesting service or accepts input from it. The input or output subroutine passes the data through the accumulator and usually stores it away in memory for later use.

Once the I/O operation is complete, a "RETURN" instruction at the end of the subroutine is executed. That causes the microprocessor to go back to where it left off. It automatically retrieves all of the data stored in the stack and the address for the program counter. The microprocessor then

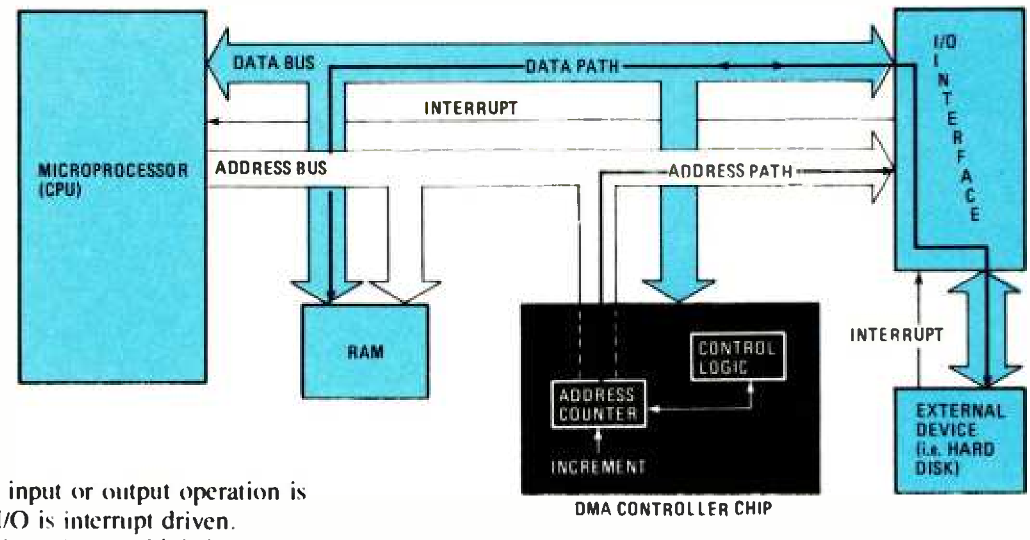


Fig. 2—In direct memory addressing, a DMA controller is connected as if it were an output device. It can therefore be set up by the microprocessor prior to a given operation.

continues with the program it was executing prior to the interrupt.

Interrupt I/O is an extremely efficient and productive way to handle input or output data transfers. It allows the computer to continue computing as long as no input or output operation is desired. Most microprocessor I/O is interrupt driven.

Where more than one I/O device exists, multiple interrupts must be dealt with. That is usually handled by an external interrupt chip, which accepts inputs from several sources and generates a single interrupt to the CPU. The chip also helps the microprocessor identify which external device generated the interrupt, so that the proper address can be put on the address bus for enabling that device interface prior to executing the I/O sub-routine associated with it.

Memory Mapped I/O

Some microprocessors use a special form of I/O known as memory-mapped I/O. Special input and output instructions are not used. Instead, the existing load and store instructions are used.

In this method of input/output, a peripheral device is treated as if it were simply another memory location in RAM. In many microprocessor applications, the full amount of RAM isn't used. Those unused locations may be used for input/output operations. The external circuits or devices that are to send or receive data are still connected to the data bus and receive an enabling address from the address bus. To perform an output operation, a STORE instruction is executed. Recall that a STORE instruction simply takes the contents of the accumulator or some other register and sends it to a location in RAM designated by the address portion of the instruction. That address word identifies the external circuit or device to receive data.

An input operation is performed with a LOAD instruction. The LOAD instruction says to find a word at the address given in memory and bring it into the accumulator or some other designated register. The external sending device simply appears to be a memory location where the desired word is. Other than that, input/output operations are carried out in the same way. Either programmed or interrupt data transfers may take place. The 6800 and 6502 microprocessors discussed previously in this series use memory-mapped I/O exclusively.

Direct-Memory Access

The third basic type of input/output operation is known as "direct-memory access" or DMA. As its name implies, input/output operations take place directly between the microcomputer RAM and the external circuit or device through an interface. The microprocessor or CPU is completely bypassed.

Input/output operations using microcomputer instructions and causing data to be passed through the accumulator or a general purpose-register and an interface are usually a slow process. While it is more than adequate for peripheral devices and circuits, there are applications where the processor can not act fast enough. In those cases, DMA can be used. In DMA, the speed of the input/output operation is limited only by the RAM's read/write times. Those are typically very fast, on the order of several hundred nanoseconds or less. For that reason, extremely high data rates can be achieved. That is necessary when dealing with high-speed peripheral devices such as floppy and hard disks. In data-acquisition applications where high speed analog-to-digital and digital-to-analog converters are used, DMA is also invaluable.

To use DMA, some external circuitry is required. That is usually contained in a single-chip LSI integrated circuit known as a DMA controller. It contains all of the necessary logic and addressing circuits needed to perform the operation. As shown in Fig. 2, the DMA is connected to the microprocessor as if it were an output device. In that way, the microprocessor can be used to set up the DMA controller prior to a given operation. For example, before the data transfer can occur, the controller must know the starting address in RAM where the data to be transferred is stored. Alternately, that address may point to the beginning of a sequence of memory locations where input data is to be stored. Using a special subroutine, the microprocessor sends the information to the DMA controller. The address is stored in a special address counter. That address is placed on the microprocessor address bus. The DMA controller seizes control of the address bus and causes the RAM to recognize its address rather than the one directly from the microprocessor itself.

The DMA controller also takes control of the data bus. As the data transfers occur, the DMA address counter is incremented. That causes data to be output from sequential memory locations to the external device or causes input data from the external device to be stored in sequential memory locations. Data to or from the external device or circuit is put on the data bus where the RAM circuitry accepts it and stores it. Alternatively, memory may put the desired data on the data

things. It loads the storage register and also sets the interrupt flip-flop. The output of this flip-flop goes to the interrupt-request input line on the microprocessor, signaling the microprocessor that input data is ready.

The interrupt causes the current instruction to finish executing; then the status of the processor is stored in the stack. An interrupt service routine is then executed. That is an input instruction that will cause the input data to be read in.

When the input instruction is executed, the contents of the interface register will be transferred into the accumulator register. That is done by first activating the interface. The input instruction, or in the case of memory-mapped I/O microprocessors, the load-accumulator instruction, causes an address to be placed on the bus, which is decoded by the interface. That decoding enables the input interface. The decoding AND gate turns on the three-state logic buffers connected between the interface storage register and the microcomputer data bus. Recall that three-state logic circuits can assume the normal binary 0 and binary 1 output states,

in the interface circuit shown here, the address decoder will turn on the bus buffers, thereby allowing the data stored in the interface register to be placed on the bus and then read into the accumulator by the input instruction. Note that a control pulse from the microprocessor is also a part of the decoder AND gate input. That pulse will occur while the address is applied and will cause the register data to be strobed onto the bus as the bus buffers are activated.

I/O Integrated Circuits

While simple interfaces like those described above can be implemented with various MSI and SSI logic gates, in practice, most parallel-data interfaces are implemented with special input/output integrated circuits. Those devices are designed specifically to connect microprocessors to external circuits and devices. Virtually all of the circuitry required in an interface is contained within those interface chips.

Some examples of the most widely used interface chips are the Intel 8255, Motorola 6820/6821, MOS Technology 6522,

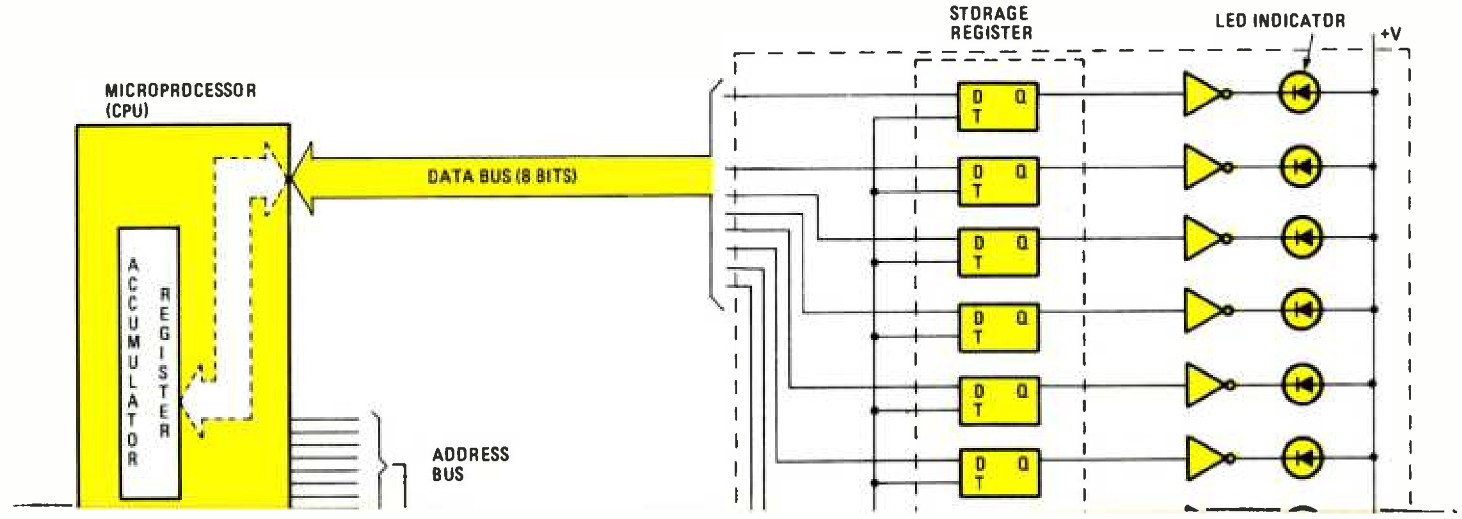
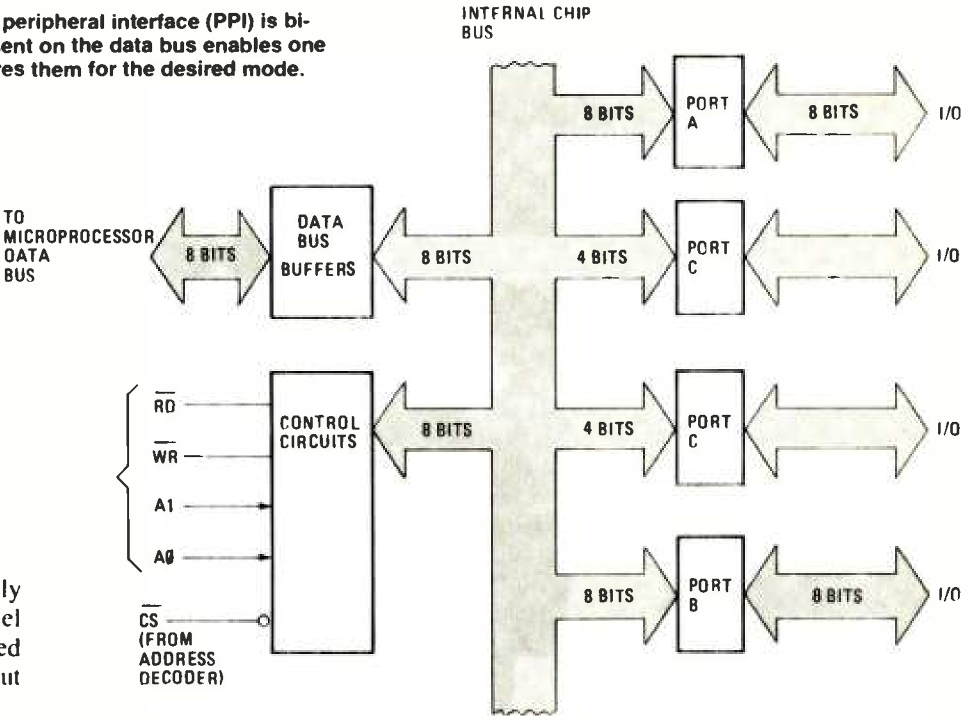


Fig. 5—The programmable peripheral interface (PPI) is bidirectional. An 8-bit word sent on the data bus enables one or more ports and configures them for the desired mode.



and Zilog PIO. Those chips typically feature two or three complete parallel interface circuits that may be configured under program control for either input or output operations.

Figure 5 shows a simplified block diagram of the Intel 8255 programmable peripheral interface (PPI). It consists of three input/output ports. They may be used independently for either input or outputs. Each port contains a storage register for holding data and also provides the necessary three-state bus buffers.

The configuration of the 8255 is determined by a special control word sent by the microprocessor as part of a program-initialization sequence. That 8-bit word specifies which of the ports will be used, whether input or output operation is desired, and the desired mode of operation. That 8-bit word is sent over the data bus to the 8255 and stored in the control logic. There it is decoded and various logic circuits enable one or more of the external ports and configure them to the desired operation.

The 8255 can operate in three basic modes. In the first mode, the three ports are simply configured for either input or output operation. One or more of them may be used. Note that port C is divided into two independent 4-bit sections. Those may be used separately or together as an 8-bit input or output port.

The second mode allows only the use of 8-bit ports A and B. Port C, either one or both sections, is used to accept "handshaking" signals from or to the peripheral circuits. These handshaking or strobe signals allow the interface and microcomputer to communicate with one another. That permits the timing and control of the data transfers.

The third mode is where only port A is used for both input and output operations. Again, port C is used for handshaking operations.

Finally note the control signals that come into the 8255. The CS line means *chip select*. Usually the output of a NAND gate address decoder is connected to this line. That enables the chip when the proper address is received. Input bits A0 and A1 are the two lower order address bits from the address bus. Those are used to select which of the three ports or the control word register to be selected by the CPU to send or receive data. The RD and WR control signals are strobes from the microprocessor that cause data transfers to take place.

Programmable Interface

Another example of an LSI interface chip is the Motorola 6820 or 6821 programmable interface adapter (PIA). That device contains two fully configurable 8-bit data ports, A and B. A simplified drawing of the chip is shown in Figure 6. It contains two data registers used for storing data temporarily in either an input or an output operation. Associated with each of the data registers is a data-direction register (DDR) and a control register (CR). Those registers are loaded with control words from the microprocessor. Those words designate the operation of the PIA. The DDR word configures the I/O registers for either input or output operations on a bit-by-bit basis. The control register sets up various control lines for use as interrupts or handshaking lines with the peripherals. The control logic processes the interrupts, helps select the chip, and determines which internal register receives data from the microprocessor bus by interpreting the input address lines.

Overall, both the 8255 and 6820 are extremely flexible I/O circuits that can be configured to deal with almost any type of external circuit or peripheral device.

Serial Interfacing

So far, all we have talked about are parallel interfaces, those that move data in parallel 8-bit (or more) chunks. The data path into and out of a microprocessor is the parallel-data bus, so it makes sense to move data in that format. It is fast and convenient.

However, there are occasions when serial data must be used. One example is where data are to be transmitted to and received from a floppy or hard disk. Another example is where data are to be exchanged with a video terminal or some data-communications device such as a modem. In those cases, data are sent in 7- or 8-bit segments, one bit at a time. Most data transmitted serially in this way are ASCII characters. Recall that the ASCII code represents letters (both upper and lower case), numbers, punctuation marks and other special symbols as a 7 or 8-bit code.

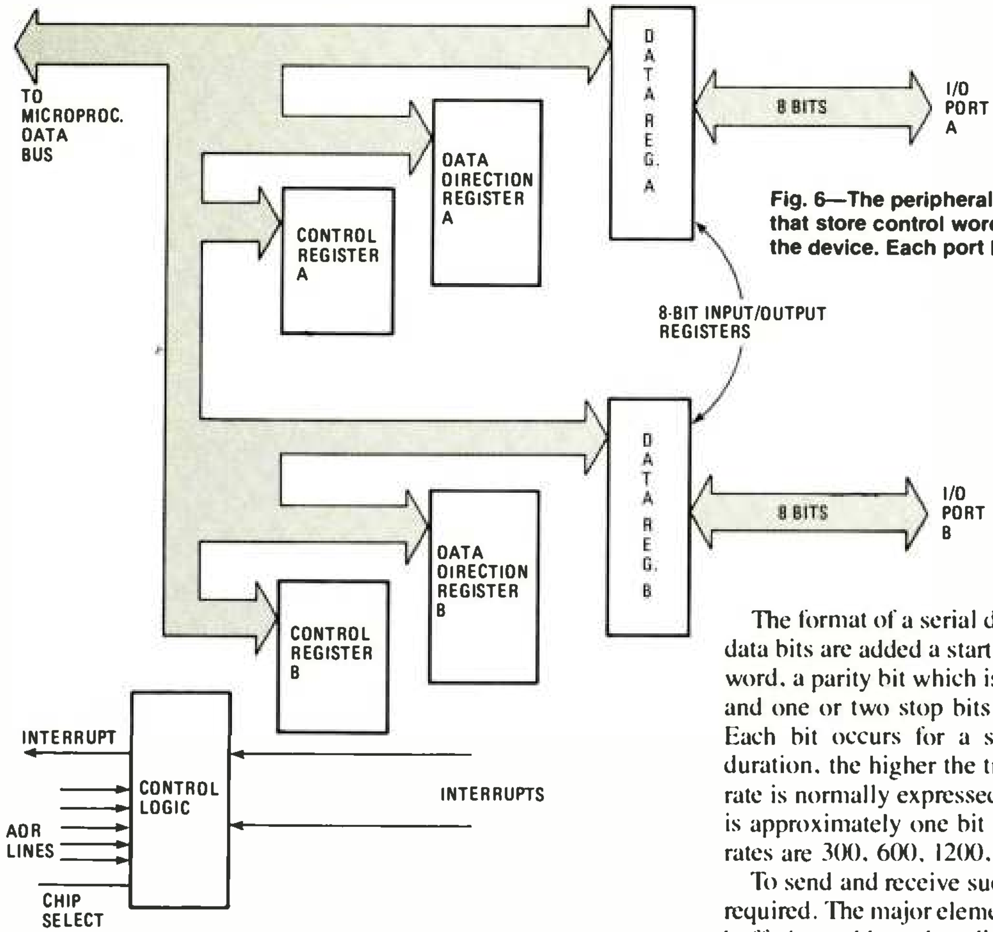


Fig. 6—The peripheral interface adapter (PIA) has registers that store control words which designate the operation of the device. Each port has its own pair of registers.

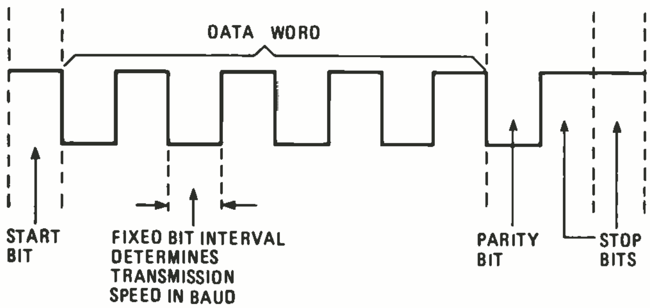


Fig. 7—In an asynchronous serial-data transmission, bits representing data are flanked by start and stop bits that tell the receiving equipment when to expect data, and when the data is complete. The parity bit is a form of self-test, or it can be part of the data.

The format of a serial data word is shown in Fig. 7. To the data bits are added a start bit to indicate the beginning of the word, a parity bit which is used for error-detecting purposes, and one or two stop bits to designate the end of the word. Each bit occurs for a specific duration. The shorter the duration, the higher the transmission rate. The transmission rate is normally expressed in terms of baud, where one baud is approximately one bit per second. Typical standard baud rates are 300, 600, 1200, 2400, 4800, 9600 and 19.2K.

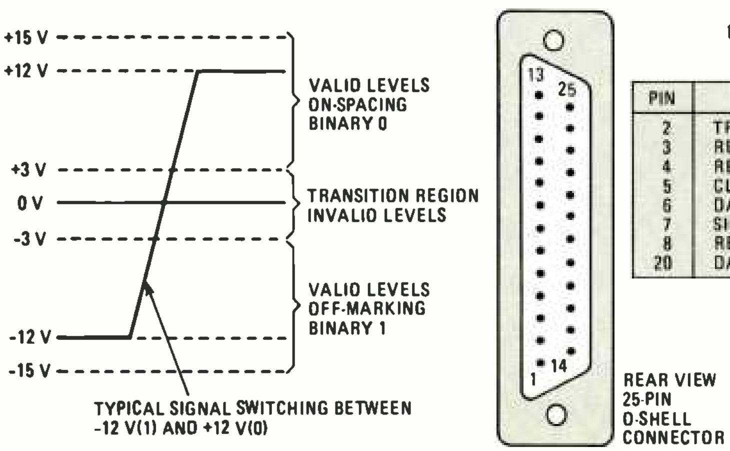
To send and receive such serial data, a special interface is required. The major elements of such a serial port include bus buffering, address decoding, parallel/serial conversions, logic control, and logic-level matching.

The main purpose of that interface is to provide parallel-to-serial conversion for output data and serial-to-parallel conversion for input data. The interface should also add, extract and respond to the stop, start and parity bits. Further, it should control the transmission/reception baud rate.

Finally, the interface must make the external serial device compatible with the interface. That generally means using the proper connector and signal connections as well as logic-voltage levels. Most serial devices conform to the popular RS-232 interface. That is an Electronic Industries Association standard that specifies all of those characteristics. They are summarized briefly in Fig. 8.

The UART

The main logic functions of the serial interface are usually taken care of by a special LSI serial interface chip called a



PIN	FUNCTION
2	TRANSMITTED DATA
3	RECEIVED DATA
4	REQUEST TO SEND
5	CLEAR TO SEND
6	DATA SET READY
7	SIGNAL GROUND
8	RECEIVED LINE SIGNAL DETECTOR
20	DATA TERMINAL READY

Fig. 8—RS-232 signals operate between ±12-volts. Special circuits convert them to and from 5-volt TTL.

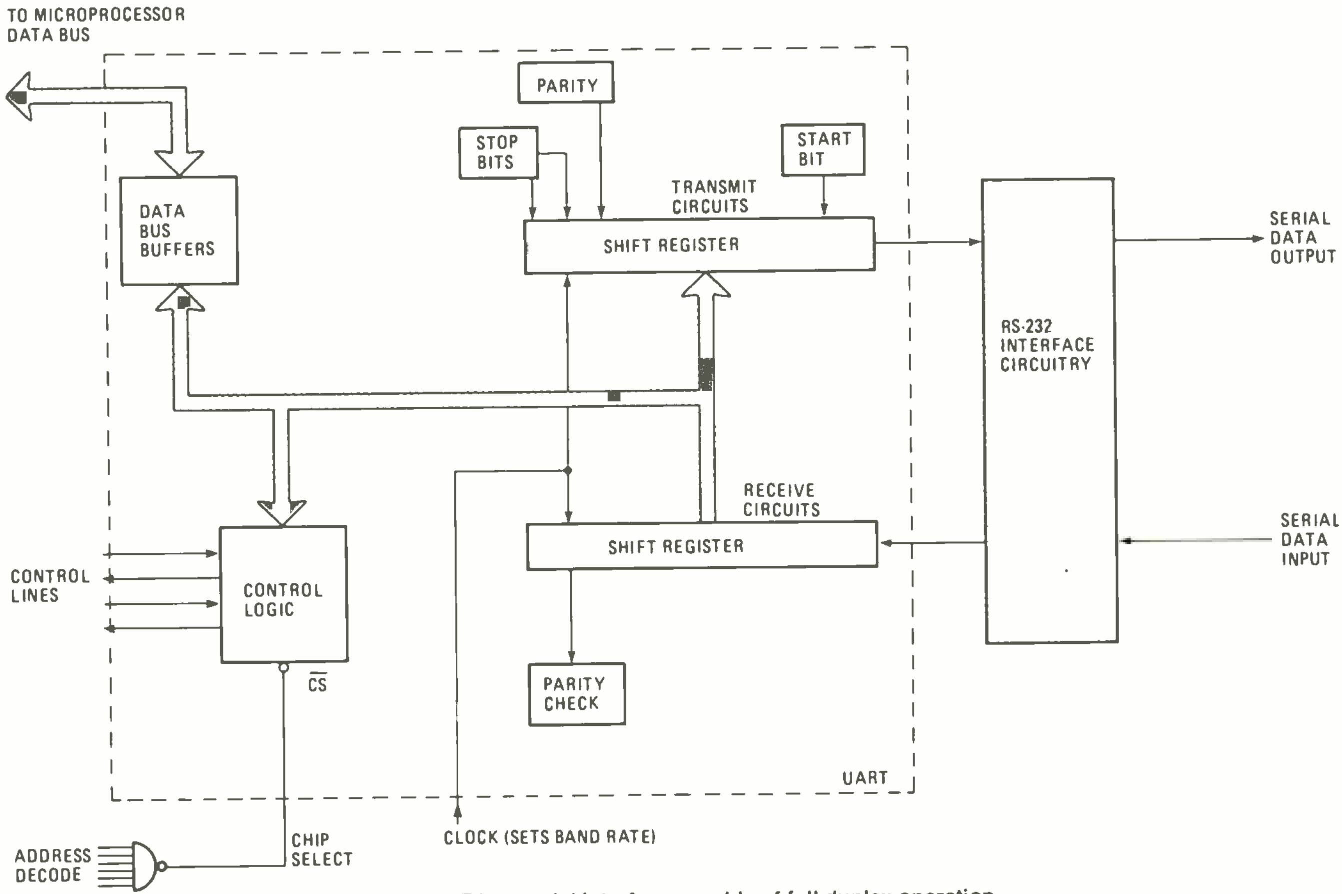


Fig. 9—A UART in a serial interface capable of full duplex operation.

UART, or universal asynchronous receiver transmitter. A simplified block diagram of a UART integrated-circuit chip is shown in Fig. 9.

Bi-directional data-bus buffers connect the CPU data bus to the UART. Inside the UART, there are two separate sections: one for transmitting, the other for receiving. The heart of each section is a shift register that performs the parallel-to-serial or serial-to-parallel conversion as required. Other logic circuits add the stop, start, and parity bits in the transmit mode or extract and respond to them in the receive mode. Most UART's can operate full duplex, meaning send and receive operations can take place simultaneously.

The UART chip is set up and controlled by the host microprocessor. Special data words transmitted to the UART specify things like baud rate; 1 or 2 stop bits; odd, even, or no parity; and data word length from 5 to 8-bits. A short initializing subroutine in the main program sets up the UART prior to its use.

Another way to create a serial interface is to do it with software. A short program can be written to do the parallel/serial or serial/parallel conversions, deal with the start, stop and parity bits as well as provide the timing for a desired baud rate. The interface simply uses one bit of the data bus. A minimum amount of hardware is required. We will show you how that is done in the next and final installment of this series—devoted to microprocessor programming. ■

SHORT QUIZ ON DIGITAL FUNDAMENTALS—LESSON 9: INPUT/OUTPUT OPERATIONS

1. List the basic types of I/O methods used in microcomputers.

a. ________________

b. ________________

c. ________________

2. What register in the CPU is usually used for I/O operations?

a. instruction register

b. program counter

c. accumulator

d. address register

3. An external signal that signals the CPU for an I/O operation is called a(n) ________________.

4. The stack is a(n):

a. set of registers

b. read-only memory

c. first-in first-out memory

d. area in RAM for temporary storage

5. Which type of I/O makes the most efficient use of CPU time?

a. interrupt

b. programmed

c. memory-mapped

d. DMA

(Continued on page 104)

TOXIC-GAS DETECTOR

Protect yourself and your family from dangerous gases with a toxic-gas-sensing circuit!

By Charles E. Shoemaker

☐A TOXIC-GAS DETECTOR IS USEFUL DEVICE TO WARN OF the existence of a situation that can be hazardous to one's health. For instance, it might be used to detect unusually high levels of carbon monoxide, say, within the passenger compartment of your car. Or it might be used to detect the presence of ammonia, which can irritate your lungs, within the confines of your work area. Well, the *Toxic-Gas Alarm* (which we'll show you how to build) can sense the presence of those, as well as other possibly dangerous gases.

Circuit Analysis

Figure 1 shows a schematic diagram of the Toxic-Gas Alarm. The major device in the circuit is SR1 (a TGS812 toxic-gas sensor manufactured by Figaro Engineering Inc). That gas-sensitive semiconductor (acting like a variable resistor in the presence of toxic gas) decreases in electrical resistance when gaseous toxins are absorbed from the sensor surface. A 25,000-ohm potentiometer (R5) connected to the sensor serves as a load, voltage-dividing network, and sensitivity control and has its center tap connected to the gate of SCR1.

When toxic fumes come in contact with the sensor, decreasing its electrical resistance, current flows through the load (potentiometer R5). The voltage developed across the wiper of R5, which is connected to the gate of SCR1, triggers the SCR into conduction. With SCR1 now conducting, pin 1

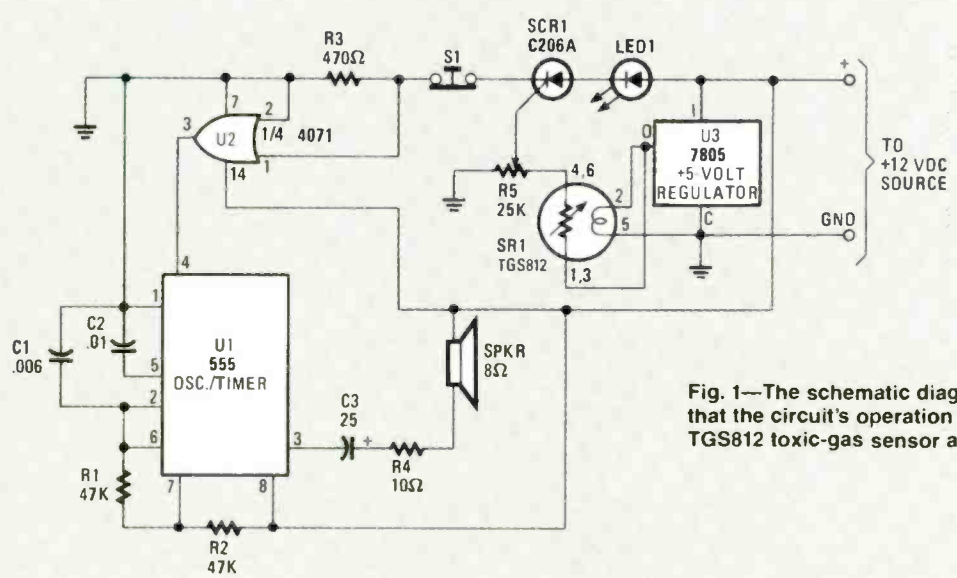
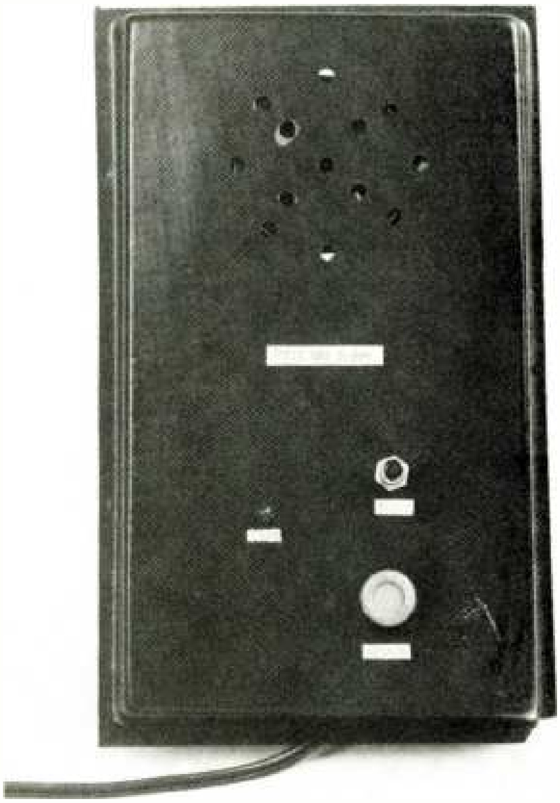


Fig. 1—The schematic diagram of the Toxic-Gas Alarm shows that the circuit's operation revolves around two devices; a TGS812 toxic-gas sensor and a 555 oscillator/timer IC.

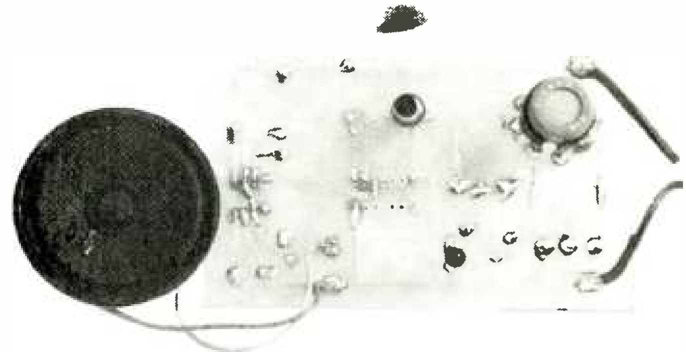


The author chose to house his prototype of the Toxic-Gas Alarm in a vacuum-formed container with a sliding access bottom. Any enclosure of sufficient size can be used.

of U2 (¼ of a 4071 quad, 2-input OR gate) is tied high through switch S1. Since pin 2 of U2 is tied low, U2 pin 1 acts as a gate control input—depending upon the logic level present at pin 1 of U2, the oscillator/timer (U1) is enabled or reset. U1 is configured as a multivibrator to produce a high-pitched sound, similar to a smoke alarm's audio output, with a frequency of about 1.6 kHz.

With U2 outputting a high at pin 3, which feeds U1 pin 4 (RESET), U1 is triggered into oscillation. The output of U1 drives an 8-ohm speaker, SPKR1, via a series resistor/capacitor combo, producing a high-pitch warning signal. However, the output signal might just as well be fed to an amplifier (with some minor modification) to increase volume. A low on pin 4 causes U1 to reset, and no signal is delivered to speaker SPKR1.

Once triggered, the alarm continues until RESET is activated by a press on S1. That disconnects the power from the circuit, effectively, placing a low logic level at pin 1 of U2, causing its output to go low. The output of U2 is then applied to pin 4 of U1, which causes it to reset. The switch must be held for about 12 seconds after removal of the vapor to allow for restabilization of the sensor. (The manufacturer's guidelines call for a 1- to 2-minutes recovery time, but that was not necessary in our tests; of course, our concentration of vapor was minimal.) Resistor R3, switch S1, SCR1, and LED1 form a voltage dividing network. Pin 1 of U2 is held low through R3 when SCR1 is in the off state. LED1 was added as a visual indicator in case of failure in the 555 timer/oscillator IC and also as a monitor of the gating circuit.



Construction

There's nothing particularly critical about the construction of the Toxic-Gas Alarm. In fact, the circuit is so simple that it could be laid out on a perfboard, but for convenience and accuracy, printed-circuit construction is recommended. A full-scale template of the Toxic-Gas Alarm's printed-circuit board is shown in Fig. 2, and its parts-placement diagram is shown in Fig. 3. Either the positive or negative, photo-resist method of printed-circuit-board etching may be used to produce your own printed-circuit board.

The TGS812 sensor (see photos) is a 6-prong, plug-in module, which (if desired) may be placed a distance from the alarm unit. A socket can be purchased with the sensor, although a standard 7-pin tube socket will work. (That's the pattern that the author used, which is why the template shows a 7th unmarked pad at the sensor position.) The specification sheet for the TGS812 gas sensor indicates a heater voltage of 5.0 volts; circuit voltage of 10 volts (24-volts max.), and a load resistance of 4000-ohms.

However, it was decided for layout convenience to use a 5-

PARTS LIST FOR THE TOXIC-GAS ALARM

SEMICONDUCTORS
LED1—Light-emitting diode, jumbo, red
SCR1—TIC206A silicon-controlled rectifier, 0.2-mA gate
SR1—TGS812 toxic-gas sensor (see supplier below)
U1—555 oscillator/timer, integrated circuit
U2—4071 quad, 2-input OR gate integrated circuit
U3—7805 +5-volt, 1-A, voltage-regulator integrated circuit

RESISTORS
R1—47,000-ohm, ¼-watt, 5%
R2—47,000-ohm, ¼-watt, 5%
R3—470-ohm, ¼-watt, 5%
R4—10-ohm, ¼-watt, 5%
R5—25,000-ohm, linear-taper potentiometer

CAPACITORS
C1—0.006-µF, ceramic-disc
C2—0.01-µF, ceramic-disc
C3—25-µF, 25-WVDC, non-polarized, electrolytic

ADDITIONAL PARTS AND MATERIALS
S1—SPST normally closed, pushbutton switch
SPKR1—Miniature 8-ohm speaker
Printed-circuit materials, IC sockets (8 pin and 14 pin, optional), standard 7-pin, vacuum-tube socket, hook-up wire, hardware, solder, etc.

The gas sensor used as the basis of the Toxic-Gas Alarm fits neatly into any standard 7-pin vacuum tube socket.

Note that in the author's prototype several components—the toxic-gas sensor, LED1, and S1—have been mounted to the copper side of the board.

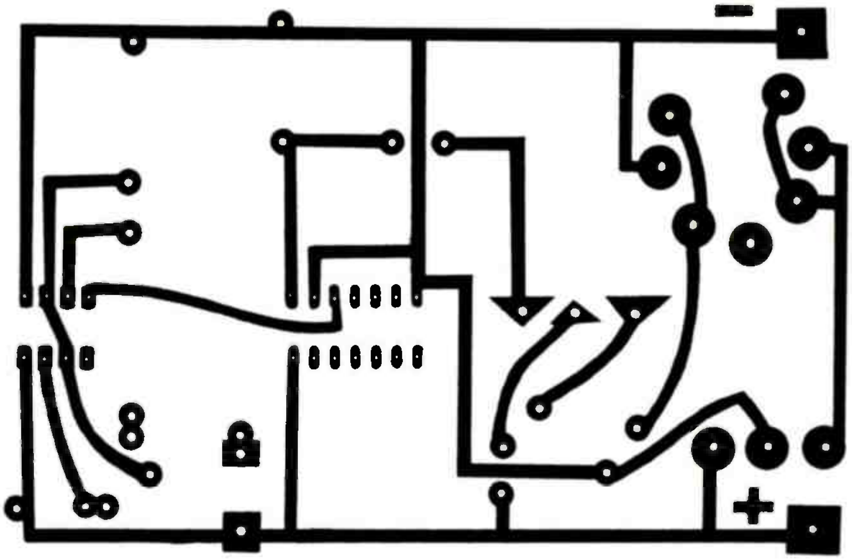


Fig. 2—This same-size template of the Toxic-Gas Alarm foil layout can be photocopied from the page and used to photo- etch your own printed-circuit board for this project.

volt supply for the semiconductor elements of the TGS812 in spite of the suggested 10 volts, thus reducing the standby current. A 7805 regulator is used to meet the 5-volt requirement for the heater and semiconductor elements. One can use an automotive battery as a power source or build an AC/DC converter (power supply). The total current draw in the operational mode (alarm on) is 211 mA. Standby current is 135 mA, which includes the 120 mA heater current. One can see from the current draw in the standby state that a battery of hefty capacity is necessary if operated in a portable manner.

The Toxic-Gas Alarm worked fine with alcohol, lacquer thinner, benzene, ammonia, etc., as noted by the manufacturer. The specification sheet furnished with the sensor lists carbon monoxide and sulphur dioxide, in addition to organic solvent vapors. SCR1, a C206A, has as low-current (.2 mA) "turn on," thus, its sensitivity is excellent. The circuit's sensitivity can be set by adjusting potentiometer R5.

Once the project is complete, it may be housed in a vacuum-formed container with sliding access bottom (see photos), as the author did. Once the circuit is operational, you can simply adjust potentiometer R5 for the level of sensitivity desired. ■

Note: The toxic-gas sensor (TGS812), is available from Figaro Engineering Inc., P.O. Box 357, 322 Wilshire Drive East, Wilmette, IL 60091; or telephone 312/256-3546. Priced at $10.50, plus $2.00 shipping/handling charge. Please allow 6–8 weeks for delivery

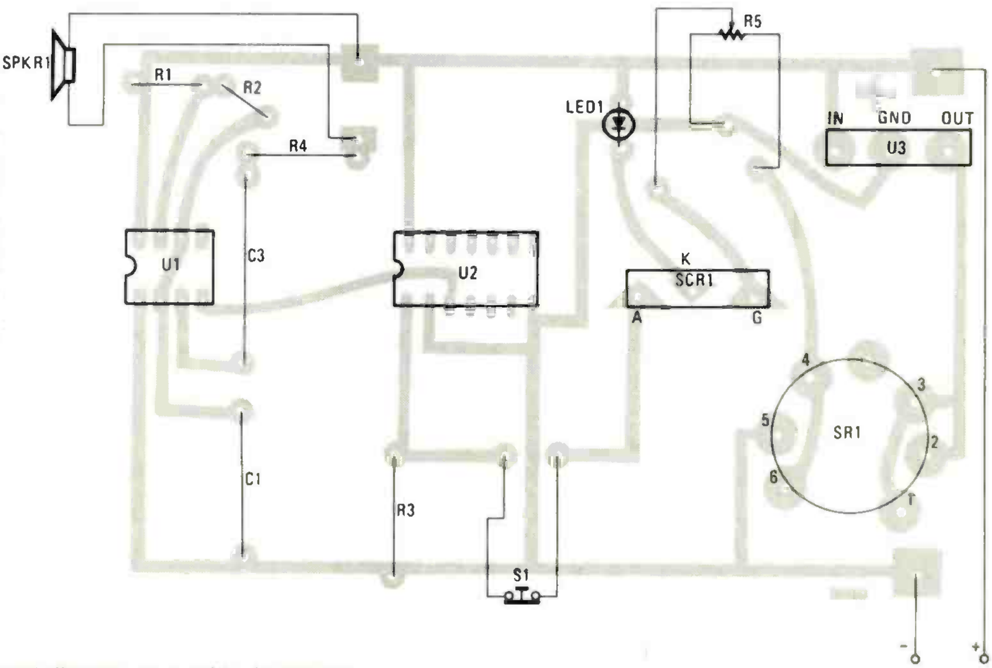


Fig. 3—Using this parts-placement diagram as a guide, install the components as indicated. Make sure that all socketed components are properly seated, and that all polarized components are correctly oriented.

By Charles D. Rakes

CIRCUIT CIRCUS

Unring those bells and other telephone tricks

THIS MONTH WE WILL LOOK AT SEVERAL uncomplicated and inexpensive circuits to use in conjunction with your telephone system. Any way that it's possible to add benefits to your basic telephone service without causing an increase in the monthly bill is definitely a plus in the never-ending struggle against the billion-dollar utility companies; so scrutinize each of these circuits and build one that will give you an extra telephone function for free.

A brief look into the basic telephone system at the subscriber's end will help you to understand and use these circuits. A pair of wires connects each phone (including all extension phones with the same calling number) to the equipment housed in the telephone's central office. One of the two wires is green in color; it's referred to as the *TIP*, or *T*, and is normally positive. The other line is usually red and is called the *RING*, or R, and is negative. The central office supplies 48-VDC to the phone line that supplies most power needs at the subscriber's end.

Until the phone is taken off-hook the 48-volts remains on the line, but it drops to 10-volts or less when the phone goes off-hook. Always double-check the phone's line voltage and polarity with a DC-voltmeter, and don't be too surprised if the polarity and wire color coding are reversed. Our old friend "Murphy" could be at work at your local telephone company, too, so be careful.

Ring Them Bells

Have you ever had the ringing of the phone undo your day? Like when you're sacked out after a long day in the salt mine and some clown calls to check on the condition of Prince Albert in his can. (For some reason children never cease to find this funny—at 2 AM.) If so, the circuit shown in Fig. 1 can solve the problem by replacing the ringer with a 117-VAC lamp; instead of *ring ring*, a *blink blink* lets you know someone's trying to get you.

On the other hand, should you need something louder than a conventional telephone bell to get attention, you can use the same circuit to activate a 117-VAC bell or gong—and no one is going to ignore that kind of noise.

Figure 1 works this way: I1, a small neon lamp which is triggered into conduction by the telephone's ringing voltage, passes just enough current to activate the LED in optocoupler U1, which in turn triggers the 6-A Triac that controls I2—a 117-VAC lamp or bell. (Capacitor C1 is necessary only when the circuit is used to drive a bell.)

The circuit can be built on a small piece of perfboard and can be housed in a small plastic cabinet. Actually, you can use any assembly technique that you prefer; just keep the 117-VAC clear of the telephone line's wires.

PARTS LIST FOR FIG.1

- C1—39-pF, 600-VDC disk capacitor
- D1—1N4002 1-A silicon rectifier
- I1—NE-2 neon lamp, or equivalent
- I2—20- to 100-watt 117-volt lamp
- P1—Power plug
- R1—10,000-ohm, ½-watt, 10%, resistor
- R2—220-ohm, ½-watt, 10%, resistor
- TR1—Triac, 400-WVDC, 6-A, Radio Shack 276-1000
- U1—MOC3010 Optoisolator/coupler, Radio Shack 276-134
- Wire, solder, cabinet, etc.

The actual operation is uneventful until a call comes in. If a lamp is used it will flash off-and-on at the ringing rate, which is normally around 20-Hz. If you are in sight of the lamp you will certainly not miss a call. Oh, by the way, you will need to turn off the telephone's ringer (look on the underside of the phone) if you don't want both sight and sound coming on at the same time.

If a 117-VAC bell is used, connect it in place of the lamp.

Phone to Switch

Figure 2 is a line-activated solid-state switch. Each and every time a phone on the same line or calling number is taken off-hook the circuit will be activated to control an external electronic circuit.

If several extension telephones are used on one phone line, the circuit can be useful as a "busy" indicator, especially if you have a teenager living at home. LED1 contains a special flashing red LED that makes an excellent indicator for a "busy" circuit condition. A line-activated solid-state switch can be used for each of the extension phones so everyone can have the advantage of knowing when the line is open for use. The solid-state switch can be used for several other phone activated applications, such as automatically turning on a cassette recorder, starting a phone-use timer, a phone-use counter, etc. A small relay can be connected at points "A" and "B," in place of LED1, to control external circuits.

A 117-VAC-to-6-VDC plug-in power supply can be substituted for the battery to keep the operating cost at a minimum.

The 48-VDC on-hook phone-line volt-

(Continued on page 105)

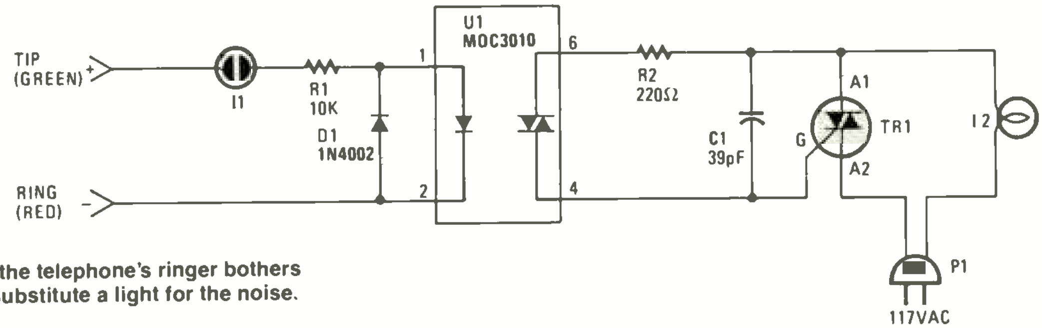


Fig.1—If the noise of the telephone's ringer bothers you, this circuit will substitute a light for the noise.

The... ULTIMATE BURGLAR ALARM

Hands-on's Hands Off!

By Byron G. Wels and Robert M. Woletz

☐WHILE THERE HAVE BEEN MANY KINDS OF PORTABLE BURglar alarms in the past, few equal the compact size of this unit, which allows it to protect almost anything, almost anywhere. That's because it can be attached at any angle or in any position to computer terminals, typewriters, television receivers, audio equipment—or anything else you feel is likely "to grow feet and disappear." The alarm is fully self-contained (doesn't interfere with the operation of the unit to which it is attached), and can be quickly and easily be disarmed in case you want to move the unit.

How it works

Motion detector MD1, a dangle-switch that you fabricate yourself, is the heart of the unit. As shown in Fig. 2, it is nothing more than a wire-loop terminal through which a weighted wire-pendulum contact is suspended. When the device is disturbed, the pendulum swings and the two contacts (loop and pendulum) touch, closing the switch.

The motion detector is part of a series circuit (Fig. 1) that also includes battery B1, keyswitch S1, and DPDT relay K1. When the detector is disturbed its contacts touch, which causes relay K1 to pull in and close both sets of its normally-open contacts. One set of contacts applies power to BZ1—an electric horn (buzzer); the remaining contact set is wired to *self-latch* the relay so that the alarm will remain on even if the motion detector is restored to its "safe" position.

Keyswitch S1 controls both the alarm's off and reset functions so that only the person with the key can disable or reset the alarm unit. If a would-be burglar triggers the alarm, and then attempts to stop the noise by replacing the alarm, it will still continue howling because of the latching effect of the relay.

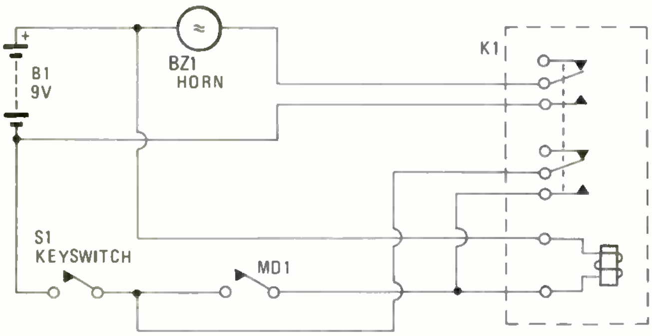


Fig. 1—Schematic diagram for the burglar alarm reveals the latching effect of relay K1 when the unit is activated by keyswitch S1 and triggered by motion detector MD1.

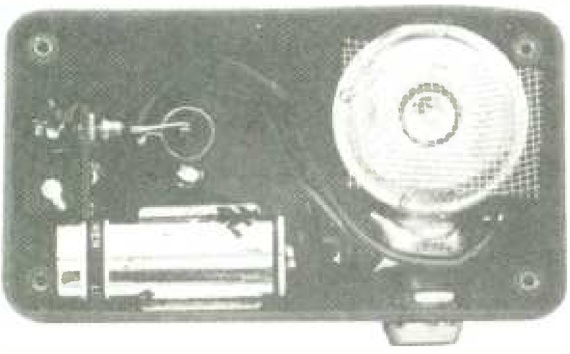
Building The Alarm

Although the recommended way to build the project is with a 9-VDC relay and horn, components with a 9-VDC rating are often hard to get because they're primarily available from industrial and surplus distributors. If you can't locate 9-VDC components, we suggest you use a 12-volt power source and a 12-VDC relay and horn. The 12-volt power source can consist

(Continued on page 98)

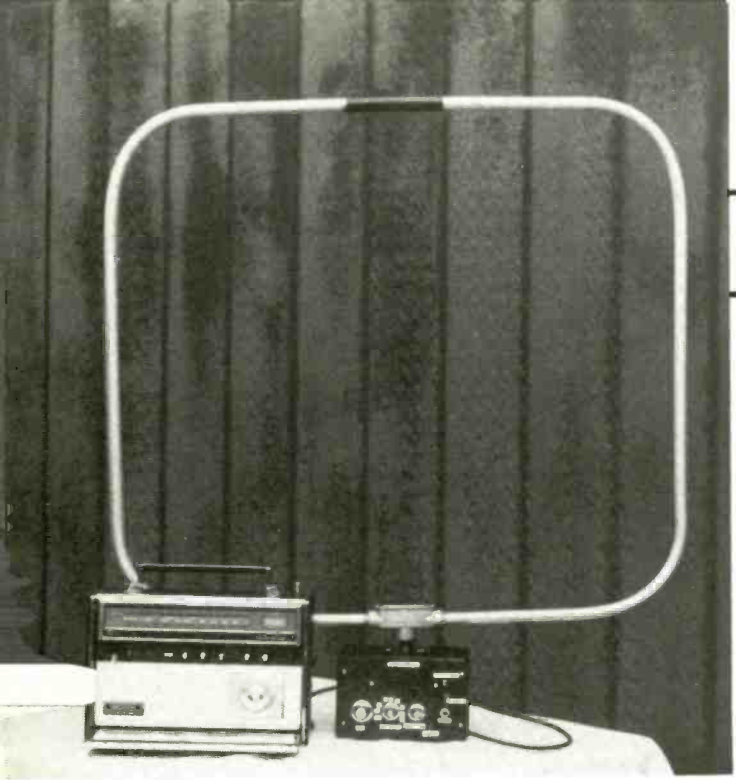
PARTS LIST FOR THE ULTIMATE BURGLAR ALARM

B1—9-volt transistor radio battery
BZ1—9-volt horn or buzzer
K1—DPDT, 9-VDC DIP reed-relay
S1—SPST miniature keyswitch
Wire, miniature plug and jack, cabinet, solder, perfboard silicone cement, battery holder, battery contact clips



Any parts layout will work as long as nothing interferes with the motion-detector switch. Keep the wiring clear of the detector so it can be turned to keep the pendulum vertical.

The detector is fashioned from a miniature phone plug and two paper clips. Note the solder blob that weights the end of the switch's pendulum for a more-rapid response time.

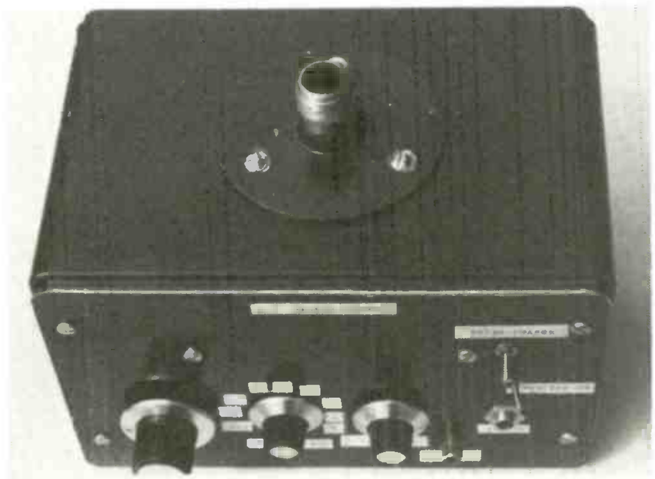


BC MAGNUM BOOSTER

By Charles D. Rakes

TAKE ONE GOOD AM BROADCAST RECEIVER, ADD THE *BC Magnum Booster*, and presto, you've got a magic combination that will allow you to ferret out those elusive, low-powered, pipsqueak, AM radio stations located out in the heartland of our great nation. If you're curious as to what's going on in those outlying hamlets, communities, and small towns—where one or more local low-power AM radio stations normally *reach out and touch* only local area residents—then build this large-loop booster amplifier and receive the stations you never knew were out there.

The Booster (as it will be referred to throughout the remainder of this article) with its large, shielded-loop antenna, adds an extra degree of directional selectivity to aid in the reception of distant stations operating near the frequency of AM stations in your local area. It can be used with any broadcast (BC) band receiver that has an external antenna input. And if your receiver doesn't have provisions for an external antenna, *no problem*—one can easily be added. So, if you've been longing for a super add-on that will enable you



The floor flange is mounted top dead-center of the cabinet and centered over the phone jack that will mate with a phone plug connected to the loop antenna.

to pull in those distant AM stations, plug in your iron, and while it heats up, read on to discover how the Booster *does its thing*.

Digging For Understanding

Figure 1 shows a schematic diagram of the Booster. The RF signal picked up by the loop antenna is tuned to the desired broadcast frequency via S1 (which sets the circuit's frequency limits through C2–C8) and variable capacitor C1, which functions like a FINE TUNE control. From there, the RF signal is fed to N-channel FET Q1 for amplification. The output of the FET amplifier is buffered by emitter follower Q2, while resistor R3 sets the amplifier's gain.

With selector switch S2 in the NORMAL GAIN position (which should suffice about 75% of the time), the amplified RF output of Q2 is fed through jack J1 and delivered to the connected receiver. However, the other 25% of the time, the received signal may be too weak to produce a solid output for the receiver. Therefore, additional gain is needed. By setting S2 to the BOOST position, the signal is rerouted through Q3 (an additional amplification stage), raising the signal to a usable level. Upon leaving Q3, the signal is then buffered by Q4 (offering a better match to the receiver's antenna input circuit) and fed through J1 to the receiver. The high-gain BOOST position should enable you to pull in those hard-to-get DX stations.

As an extra feature, Q5 (a 2N4249 preamp/driver transistor) and its associated components are connected in an RF detector circuit that allows the Booster to serve as an emergency receiver that's capable of picking up several local stations. When the need arises, all you have to do is plug your headphones into J2 and you're ready for reception.

Getting It All Together

The first step in the construction of the Booster is to get the parts (see Parts List) that make up the the circuitry and large loop antenna. First, you'll need a 10-foot section of ½-inch diameter, rigid aluminum conduit tubing. Cut the tubing in half and thread one end of each half: The other end remains

Pulling in those distant AM stations is no problem if you make this RF amplifier part of your receiver's front end.

smooth. Bend the two pieces of aluminum conduit—each conforming to half of the loop antenna, as shown in Fig. 2—and screw the threaded ends into the T-junction box.

The tubing can be shaped free hand; however, the task is greatly simplified by the use of a *Benfield conduit bender*. Just follow the general layout and the dimensions shown in Fig. 2 in building your loop. The air gap at the top of the loop is then covered with a section of plastic pipe or tape. Next, push one end of a 12-foot length of Belden #8443 three-conductor cable through the loop at the junction box until the end exits the other end of the loop, as shown in Fig. 3. Series-connect the wires as indicated to produce the three turn loop antenna. Since the full 12 feet of cable won't be required, cut off each end, leaving about 3-inches of the red and black wires for connection to a standard ¼-inch phone plug.

Let the phone plug hang, tip down, through the bottom of the "T" junction box, as it will plug into the phone jack mounted on the top of the cabinet. Any good-quality heavy-duty metal cabinet can be used to house the circuitry, but use one having a large enough base so as to give stability to the movement of the loop.

Drill a ⅜-inch hole top-dead-center of the cabinet for a mating phone jack. A floor flange is then centered over the

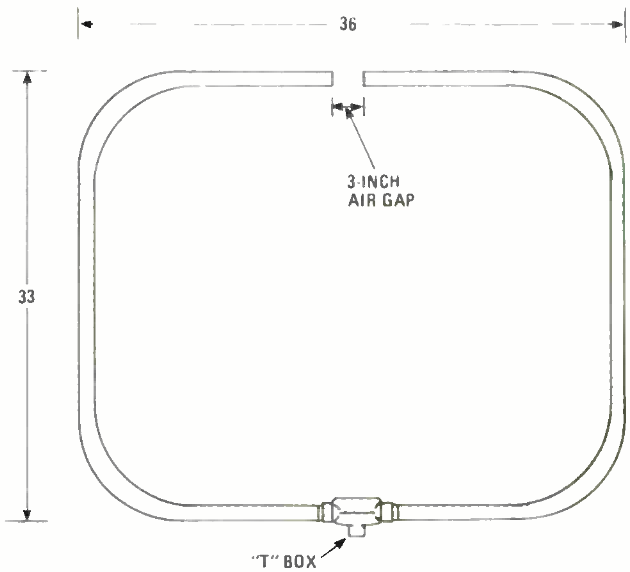
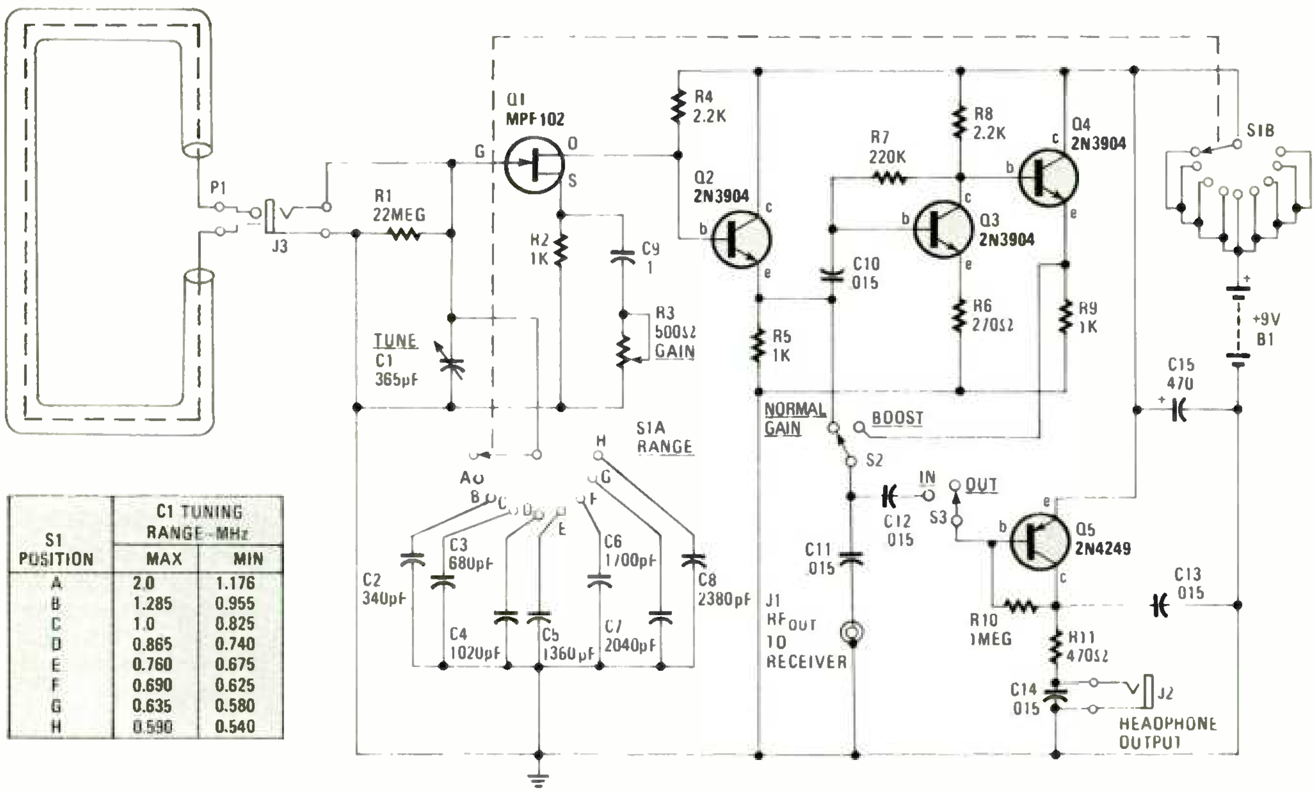


Fig. 2—The Faraday Shield for the loop antenna is made from 1½-inch aluminum conduit tubing. The loop itself is nothing more than a length of three-conductor cable, connected to form one continuous three-turn coil.



S1 POSITION	C1 TUNING RANGE-MHz	
	MAX	MIN
A	2.0	1.176
B	1.285	0.955
C	1.0	0.825
D	0.865	0.740
E	0.760	0.675
F	0.690	0.625
G	0.635	0.580
H	0.590	0.540

Fig. 1—The Magnum Booster, using a handful of common parts, provides the signal amplification necessary to pull in those elusive AM stations. In addition to its intended use, the circuit features a low-power headphone output that allows it to be used as a radio receiver in emergency situations.

phone jack mounting hole, and three mounting holes for the flange are marked and drilled.

With that accomplished, mount the phone jack to the cabinet top and bolt the floor flange in place centered over the jack. Set the main section of the cabinet aside for now, and move on to the circuit board and front-panel assembly.

The actual component layout isn't critical, and the circuit can be put together using any construction desired. The author's prototype was built on a 2- × 5-inch section of perfboard—which supports the majority of the small components—that mounts to the front panel (see photos). Your circuit can be similarly wired using the Fig. 1 schematic diagram and the photos as a guide. The other parts—C1, S1–S3, R3, J1—are mounted on the front panel and connected to the perfboard-mounted components through lengths of wire. As the components are wired in place, check your work for errors such as the connection of polarized components, transistors, etc; doing so helps to ward off most of the common wiring errors.

Next, clear off a work area large enough to swing the loop

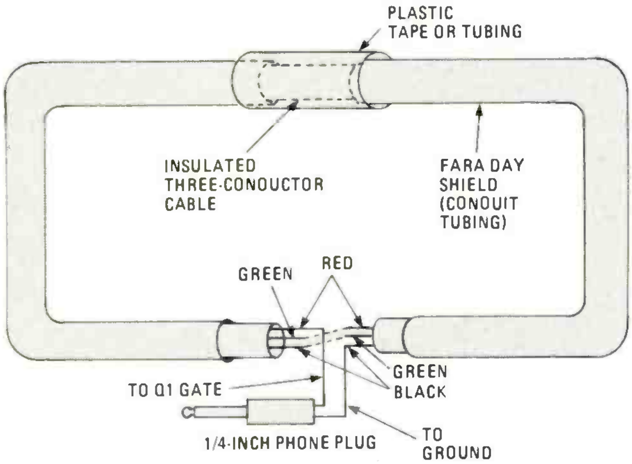
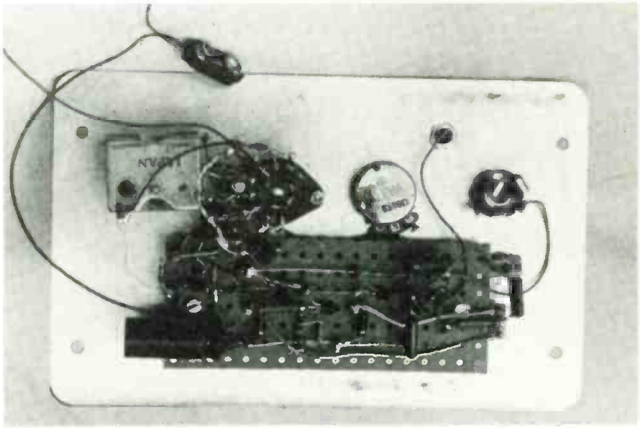


Fig. 3—This diagram shows the method used by the author to form the three-turn loop antenna inside the conduit tubing. The loop is fabricated by connecting the three conductors (within the cable) end-to-end, so as to produce one continuous conductor.



The circuit board for author's prototype was mounted to the front panel of the enclosure, along with the various controls and output jacks. Note that seven capacitors, C2–C8, are mounted directly to seven of the nine contacts of S1A—the first two are unconnected.

full circle (360-degrees). Thread the antenna loop assembly onto the flange, which at this point, should be secured to the top of the cabinet. Turn the loop clockwise until it just bottoms out. That's the end of rotation for one direction. But a full turn counterclockwise can be made to bring the loop full circle. The author's floor flange came with a 1-inch piece of threaded pipe; but if one doesn't come with yours, a 1 or 1-½-inch length of pipe must be threaded into the floor flange to accept the loop's junction box. Insert the phone plug connected to the loop into the jack in the middle of the floor flange.

Check-Out Time

Connect a 9-volt battery pack to the circuit and rotate S1 to any of the tuning positions. As a quick checkout, plug a set of high-impedance headphones (2000-ohms or better) into J2. Set R3, GAIN, to maximum, S2 to NORMAL GAIN, and S3 to the IN position. With the headphones on, aim the loop antenna toward a local radio station and set RANGE switch S2 to a position that includes the tuning range for the desired frequency. *(Continued on page 98)*

PARTS LIST FOR THE BC MAGNUM BOOSTER

SEMICONDUCTORS
Q1—MPF102 N-channel FET
Q2–Q4—2N3904 NPN silicon transistor
Q5—2N4249 or 2N3638 PNP silicon transistor

RESISTORS
(All fixed resistors are ¼-watt, 5% units unless otherwise noted)
R1—22-Megohm, ½-watt
R2, R5, R9—1000-ohm
R3—500-ohm, linear-taper potentiometer
R4, R8—2200-ohm
R6—270-ohm
R7—220,000-ohm
R10—1-Megohm
R11—470-ohm

CAPACITORS
C1—365-pF variable, broadcast tuning
C2—340-pF (two 680-pF in series—see text) ceramic disc
C3—680-pF, ceramic disc
C4—1020-pF, ceramic disc
C5—1360-pF, ceramic disc
C6—1700-pF, ceramic disc
C7—2040-pF, ceramic disc
C8—2380-pF, ceramic disc
C9—0.1-µF, mylar
C10–C14—0.015-µF, mylar
C15—470-µF, 16-WVDC electrolytic

ADDITIONAL PARTS AND MATERIALS
B1—9-volt battery pack (or 6 AA cells)
J1—RCA phono jack
J2, J3—Phone jack, standard ¼-inch diameter.
L1—Loop (see text)
S1—Double-pole, 9-position (DP9T) rotary switch
S2, S3—Single-pole, double-throw (SPDT) miniature toggle switch

Metal cabinet (5 × 51/2 × 8¼-inch), headphones (2000-ohm or better), battery holder (6 AA-type), 10-foot length of ½-inch aluminum tubing, T-junction box, floor flange, 12-feet of Belden #8443 wire, knobs, wire, solder, etc.

TV WIRELESS FM MIKE

A wireless microphone combined with a little imagination can eliminate late-night TV viewing woes

By Byron G. Wels

IF YOU'RE INTO WATCHING LATE-NIGHT TV AND LIVE IN A house full of early risers (who also go to bed early), or an apartment complex (where the walls are paper thin), then you've probably wished for some way to channel the audio to its intended listener. Of course, many modern TV sets are outfitted with an extension earphone jack, through which audio signals can be fed through some kind of headphone to your waiting ears. Even with an extension output, you're stuck with another dilemma: the earphone wires shadow you wherever you go, limiting the distance you can move from the receiver. Well, the *TV Wireless FM Mike* can eliminate both those problems.

But then there's the other side of the coin: there are just as many TV receivers that have no extension speaker output included in their makeup. If your TV set falls into that category, you're not excluded from using this scheme; such an output is easily added, and we'll show you just how it's done. So, all can treat their ears to the melodic pleasures, without disturbing the rest of the world.

The Benefits

The TV Wireless FM Mike plugs right into the extension output of the TV receiver, bypassing the receiver's internal speaker. The signal is instead routed to a modified FM wireless microphone, which transmits a low-level FM signal that can be picked up by any FM receiver. As an example of where such a device might be used, let's say that there's a live concert on TV and you aren't satisfied with the sound quality from the TV set's dinky little speaker. Simply turn on the TV Wireless FM Mike and your FM receiver, and the TV audio emerges from your stereo speakers, giving you a level of sound quality you never knew your TV possessed! The sound is restored when the plug is removed.

An added benefit comes if you have a TV set in your bedroom and your wife wants to watch TV while you want to sleep. No problem. All she has to do is connect the unit and wear a small pair of earphones connected to a Walkman-type FM receiver. She hears all the TV sound and you hear nothing. You can sleep! But, the greatest benefit of this unit comes from its potential use by someone with a hearing problem.

Normally, the TV volume is adjusted so that the afflicted person can hear it, and the others in the room (as well as the whole neighborhood) must put up with the elevated sound. But with the TV Wireless FM Mike, the TV sound in the room is kept at a comfortable level for those with normal hearing, with the sound coming from a small FM receiver. The afflicted person uses a Walkman-type FM receiver (clamping the headset around his or her ears) and can set the volume to a comfortable level.

Someday, perhaps, a similar device will be incorporated in all television receivers, but there's no point in waiting. So let's concentrate our efforts on building our own.

Putting it Together

It is essential that, first, you start out with a good-quality wireless FM mike. We selected the Radio Shack Model 33-1076 for its easy availability. Begin by modifying the wireless FM microphone, using Fig. 1 as a guide. To do so, the labels must first be peeled off to get at the small Phillips-head screws that hold the unit together. Since the cover is part of the battery holder and it is to be eliminated, small wire leads must be soldered to the battery terminals for connection to an external battery and switch.

And since we're not going to be using the unit as a microphone any longer, the small electret microphone must go. You'll find that the mike body is mounted on a small black rubber washer, with two holes for the leads. Use a long, heavy sewing needle to remove the washer by picking it away. That gives you access to the leads. Clip the leads off close to the mike body, leaving the leads that remain on the transmitter portion of the assembly as long as possible.

Connect a length of miniature audio cable to the remaining leads (the ground conductor to one and the center conductor to the other). For convenience, the unit can now be mounted in a small plastic box, with suitable holes for the switch, the

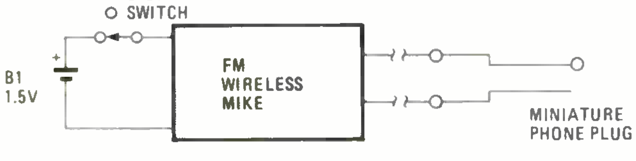
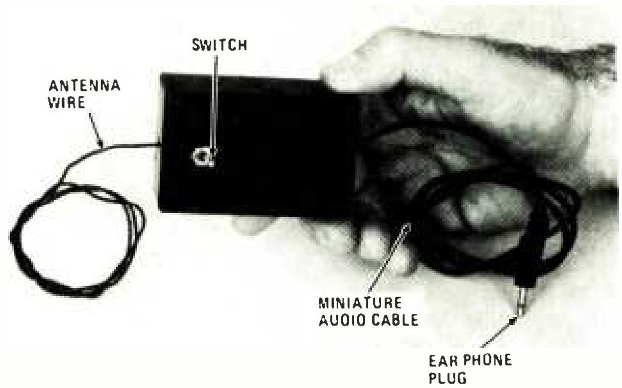


Fig. 1—Modifying the FM mike is relatively simple. Extend the battery connections to a pair of wires with a SPST toggle switch connected in series to turn the unit on and off; add a small-diameter audio coax from the wires where the mike was connected and terminate it with a miniature phono plug.



Only three holes need be drilled in the plastic case; one for the audio cable, another through which the FM mike's antenna is extended—which can be hung loosely outside the case—and the final one for switch mounting.

audio cable, and a smaller hole through which the wireless mike's antenna can protrude. The components are then mounted to its enclosure using silicone cement. At the unattached end of the audio cable, connect a plug that will mate with the earphone jack on your TV set.

Adding an Extension Output

If you do not have an earphone jack on your TV, you can add one very easily. Obtain a miniature closed-circuit audio jack, and connect it as shown in the Fig. 2 diagram. First make sure that the TV set is turned off and its plug removed from the wall outlet. Remove the back of the set and drill a

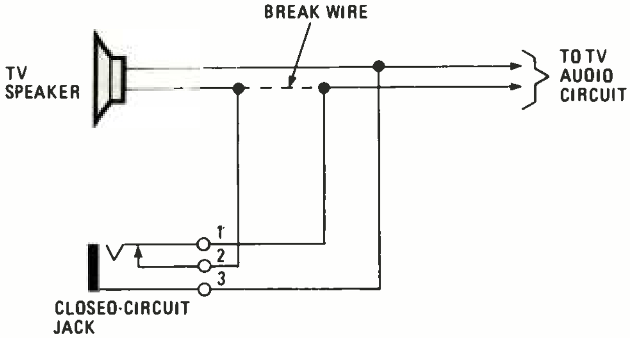


Fig. 2—If you don't have an earphone jack on your TV set, here's how to add one, the easy way. Be sure that you use a closed-circuit jack so that inserting a plug into the jack disrupts the audio signal path to the TV set's internal speaker and removing it from normal operation.

quarter-inch mounting hole for the jack in the fibreboard back of the set. Use a larger drill, reamer, or countersink to remove any burrs.

Mount the jack tightly in position, then cut one of the leads that feed the speaker as shown in Fig. 2. (The dashed line going to the speaker indicates the normal audio path.) Connect the wire from the speaker to one side of the jack, and a wire from the audio circuit to the other side of the jack. Since we're using a closed-circuit jack, the speaker remains connected to the audio signal source as long as no plug is inserted into the jack. Note that from the audio source, the signal travels through the line to terminal 1 of the closed-circuit jack, which is shorted to terminal 2. From there, the signal is fed to the speaker.

PARTS LIST FOR THE TV WIRELESS FM MIKE

B1—1.5-volt, AA battery
S1—Single-pole, single-throw (SPST) toggle switch
Wireless FM microphone (Radio Shack #33-1076 or similar)
Plastic box enclosure, solder, phone jack (see text), hook-up wire, silicone cement, hardware, etc.

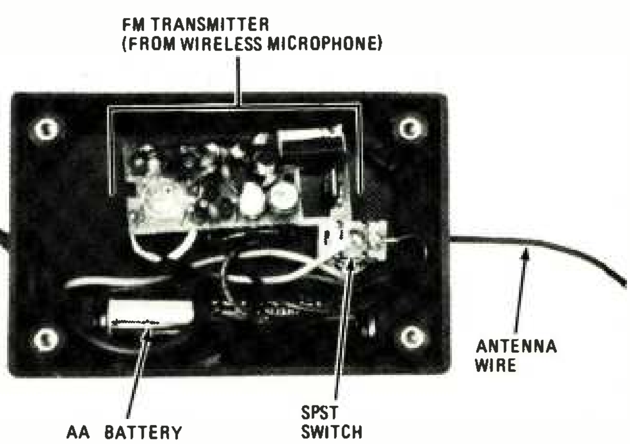
But when a plug is inserted into the jack, disrupting the audio signal path to the TV set's internal speaker, the audio signal is diverted through the jack to the alternate output device (in this case, the modified, wireless FM mike). Removing the plug restores normal operation. It's just that simple. Replace the back of the set, making sure that the line cord plugs into its receptacle on the chassis. You are now ready to see how well you've followed the instructions.

Testing The System

With the TV Wireless FM Mike unplugged from the TV, turn on the set. Sound should come out of the TV's internal speaker. Turn the Wireless Mike on, and insert the plug into the earphone jack. Tune an FM radio across the band until you hear the TV sound. You may find the TV audio sitting right on top of an operating FM station. If so, retune the FM receiver for a quiet spot on the dial, a place where no signals are heard. Using the small plastic screwdriver that comes with the FM mike, carefully tune the mike until you hear the TV sound clearly through the FM receiver. Make a note of the dial position on the receiver (that's the position to which you'll tune to hear the TV audio on an FM receiver throughout the house).

Remember too, that you're now dealing with *two* volume controls—the one on the TV set and the one on the remote FM receiver. We've found that the best way to handle that situation is to set the FM receiver volume (while on a standard FM station) to a comfortable level, and then plug in the TV Wireless FM Mike, slowly adjusting the TV volume until the sound is heard clearly and comfortably. That prevents overdriving the FM wireless mike, and causing distortion.

Well, there you have it—a little project with big value. ■



Inside the unit, you can see that the case needs only enough room to accommodate the FM wireless mike and the battery, along with a few interconnecting wires.

SAXON ON SCANNERS

By Mark Saxon

Listen beyond the standard bands of scanner frequencies!

MANY PEOPLE GET A SCANNER AND SEE that it covers the standard communications bands: 30 to 50 MHz, 118 to 130 MHz, 150 to 174 MHz, and 450 to 512 MHz. After that, they spend a lot of time wondering what they're missing on frequencies not covered by their scanners—forgetting that FM broadcasting covers 88 to 108 MHz, and TV broadcasting occupies a somewhat healthy chunk of the spectrum, too. Nevertheless, there are two-way communications bands that get the deaf-ear treatment from lots of scanner users. For instance, there are the federal communications bands, which run from 137 to 144 MHz, 148 to 150 MHz, and 225 to 420 MHz.

While a few scanners may include some small portion of that spectrum along with the standard bands, you still have to wonder what's happening on frequencies you can't scan. Kinda gets to you after a while!—Right? Have no fear. Several of the latest generation of scanners have tackled the problem head-on and with a vengeance. Scanners like Regency's MX-5000 (see photo) cover every frequency from 25 to 550 MHz without a single gap. That means it covers all of the two-way and federal agency bands; FM broadcasting; TV audio; several amateur bands; CB Radio, and the frequencies above and below the CB channels that have become so popular with bootleg two-way operators.

In order to *inhale* the many different transmission modes used over such a wide swath of frequencies and services, the unit has been designed to receive AM signals as well as wideband and narrow-band FM. It can be put into a SCAN/SEARCH mode to root out previously unknown signals spaced at (selectable) 5, 12.5 or 25 kHz increments. Then your better discoveries can be easily entered into the MX-5000's twenty scan channels. Of course, it has the expected scanner trimmings: scan delay, lockout buttons, microprocessor programming, and 24-hour digital clock. The only complaints we had with the unit were the need for better night-lighting of the LCD display, an overly-loud programming *beep* that cannot easily be stifled, and the use of a BNC antenna connector instead of the so-called Motorola connectors that have been somewhat standard in the scanner field for several years.

On the whole, the MX-5000 performs well, and lends several new levels of listening and a whole new aura of excitement to anybody's interest in scanning. The unit comes with a separate power supply and telescoping metal-whip antenna. Ask any of Regency's many local dealers for a demonstration of this exciting new breed of scanners. Once you get hooked on monitoring federal agency and military frequencies, you'll want to explore every single nook and cranny—the latest generation of scanners makes it possible!

Don't Box Me In

Speaking of hearing as much as possible on your scanner, a number of readers have written about a proposed piece of federal legislation called the *Electronic Communications Privacy Act of 1986*. Introduced into the Senate by Sen. Patrick J. Leahy (D-VT), and into the House by Rep. Robert W. Kastenmeier (D-WI), it appears that the entire fiasco was the end result of intense lobbying by the cordless-telephone industry, which has long sought to promise its customers communications privacy equaling regular landline phone service.

Instead of offering an expensive voice-scrambler option to cellular customers wanting that type of privacy, it seemed easier to convince legislators that scanners and their owners were a lot of busy-bodies up to no good! Early drafts of the bill were blatantly anti-scanner and seemed to extend prohibitions against monitoring most of the transmissions that one might encounter over all frequencies except Ham, CB, broadcast, and police frequencies. With some small amount of window-dressing added to make it all look less than totally preposterous, they've been saying that *the primary intention of the proposed legislation is to stop federal agencies from electronic snooping on cellular frequencies, computer transmissions, data transmissions, etc.*

Since the first-version drafts, there has arisen a mighty howl from scanner users, led by SCAN—the largest national, scan-

(Continued on page 97)

Regency's new MX-5000 scanner is a gap buster tuning from 25 to 550 MHz.

CIRCLE 26 ON FREE INFORMATION CARD

By Herb Friedman

FRIEDMAN ON COMPUTERS

Is that *little-known work* really worth the time and trouble?

☐AN INTERVIEWER ONCE SOUGHT TO INgratiate himself with the great playwright Noel Coward by fawning over one of the playwright's more obscure efforts, claiming that it was a "*little-known work that never got the attention it deserved.*" Coward replied that *little-known works that never got the attention they deserved, never deserved any.*

The same kind of thinking applies to much of the closeout personal-computer hardware now being sold (supposedly) at a tiny *fraction of its original cost.* Seemingly daily, someone discovers a warehouse jammed to the rafters with computers originally hailed by someone as a *new breakthrough in the state-of-the-art.* Whether they were in fact some kind of breakthrough is immaterial—whatever breakthrough the computer might represent, it or its peripheral is often incompatible with generally available software, operating systems, interconnections, or printer-driver codes. Almost without exception, all the stuff works as claimed in advertisements. The question is, "What to do with it after you've got it?"

For example, a discontinued but very fine CP/M computer that is bundled with a decent assortment of wordprocessing, database, and spreadsheet software is presently being offered at an exceptionally low price. If that's all that you'll ever need, it's a dynamite value. The problem, however, is that the computer uses a proprietary disk format. That means, if you want to use *other* software there's no way that you're going to find it in the proper disk format. More important, there's no conventional modem program *ported* for the computer, so there's no way you can even take a protocol feed via modem from someone who has the program for another computer (which is program piracy, anyway).

On the other hand, the disk-interchange program called *Media Master* does include that computer, as well as many other odd-balls. In fact, with Media Master you could most likely run software originally intended for other computers—but, remember *most likely* doesn't mean *positively*.

More Discoveries

Another little-known-work is a famous-make commercial-quality printer presently being offered for little more than pocket change. It, too, appears to be a great value; except that, it does not respond to conventional printer control-codes, nor does it have a conventional input suitable for home-and-family computers. An accessory interface is needed. Now combine the cost of the printer with the price of the interface and the total comes to more than the discounted price of a modern printer that uses standard printer codes and has the required input.

So, any time you're offered a little-known work at an exceptionally low price, consider whether it requires additional expense to get it up and running, and whether it can use generally available software. If you intend to write your own BASIC programs, the computer might prove an outstanding value, but keep in mind that service might be unavailable in the near future. Who fixes it if it breaks down three days after the guarantee runs out?

For The Big Jobs

Although *integrated software* is the hottest thing going, for many, it will be more trouble than it's worth. If you're not familiar with the term "integrated software," it means several individual programs within a common shell, so that one function can access bits and pieces of the others. For example, the wordprocessing function could extract just the names and addresses from a related database to be used for a mailing list.

Let's take that mailing list for illustration purposes, and see what really happens. Assume that you're helping out some local community organization by running their mailing list. Depending on the particular printer and the width of the labels, typical commercial mailing-list software can print one to five labels across. But integrated software usually can only print one across (a strip of single labels). If you want to print a mailing list for photocopying to standard Avery mailing labels, it can't be done through conventional integrated software.

Also, most integrated software won't *pull up* the printing if an address line is blank, although some mailing list software will. What it boils down to is this: If your data consists of last name, first name, company, and address, the lack of an entry on the company line produces a blank line. In addition, integrated software is generally limited to the address

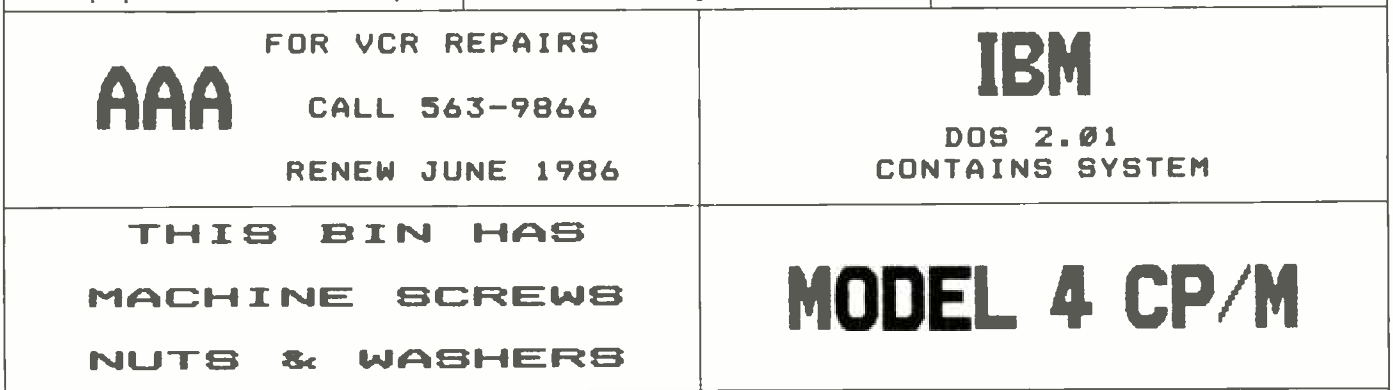


Fig. 1—Labelmaker prepares labels in various fonts and is available for a several makes of personal computers.

data and one or two extra lines for sorting. But specialized mailing-list programs, on the other hand, allow twenty, thirty, or even more individual identifiers to be used for sorting mailing lists.

Small, specialized programs also can be designed to optimize the system. For example, Fig. 1 shows some of the custom labels that can be almost instantly prepared by a program called *Labelmaker*. Labelmaker actually shows a screen preview of what you'll get from the printer. Try to do that with conventional word-processing programs, integrated software, or BASIC programming, and you might spend hours just getting a single label right.

Calculation is another place where bigger isn't necessarily better. A built-in calculator accessed through a "window" is featured by several high-powered software packages, but they are usually limited to just a few math functions. If you're into heavy calculations—like figuring how much to set aside for a college education, or how much you can afford as a monthly payment on a house or condo, or how many millions you'll have from your yearly IRA investments—you'll be plugging in numbers until the wee hours of the morning using a *window* calculator.

On the other hand, something like the BUSINESS PAC software (which contains 100 small, mostly financial programs) will give you exactly the program needed for any business calculation. In the same time required just to access and figure out how to use a window calculator, you can run five, ten, maybe twenty different financial projections using BUSINESS PAC. We could get into other illustrations, but you've probably got the picture. ■

SAXON ON SCANNERS

(Continued from page 95)

ner-owners association. Since then, the wording of the proposed law has been toned down a bit.

You may wish to contact your Senatorial and Congressional representatives to express your displeasure, and/or ask for their positions on the bills. Better yet, join and support SCAN (P.O. Box 414, Western Springs, IL 60558)!

A More Pleasant Topic

Several readers have noted that there are all-band scanner antennas that will do well on every frequency between 30 and 500 MHz, but ask, "*What about scanner owners who are mostly interested in monitoring one particular group of VHF high-band or UHF band channels?*" They suggest that there must (or should) be a more inexpensive approach than going all-band. And, so there is: Purchase a relatively inexpensive, VHF, ground-plane antenna.

Such an antenna consists of a single vertical radiator and four drooping radials. With only a few minutes of work, using a hacksaw or good wire cutters, you can trim such an antenna for peak performance within the desired frequency range. Some examples are:

MHz	Vertical	Drooping
118 to 136	23 in.	26½ in.
150 to 174	15 in.	26½ in.
225 to 300	10 in.	13 in.
300 to 400	6¼ in.	12 in.
406 to 420	6 in.	10 in.
450 to 512	5 in.	8 in.

Reader Burleigh Rawlinson of Louisiana asks about using a scanner to hear transmissions from satellites. Why not? That is, if your scanner is capable of tuning in some of their frequencies outside of the microwave bands. On 135.575 MHz your columnist has heard the ATS-3 satellite. Between 142.415 and 142.425 MHz every 90 minutes (when operating), there is about 5 minutes of transmission from (assumed to be) the Soviet Salyut Space Station. The signal starts out at 142.425 MHz, then because of the Doppler effect, it drops to 142.415 MHz. ■

THE ULTIMATE BURGLAR ALARM

(Continued from page 89)

of eight series-connected AA or AAA batteries. Use what ever size battery for which you can get an appropriate holder. Keep in mind, however, that the cabinet must be able to accommodate the 12 volt power pack.

The motion detector, MD1, is constructed and assembled to a miniature phone plug as follows: First, wind a paper clip around a mandrel that's approximately ⅛" in diameter. (A screwdriver shank, dowel, or even a child's crayon can be used as the mandrel.) Begin by straightening out the paper clip, then form several close-wound turns. Remove the clip from the mandrel, and with a sharp diagonal cutter, clip away the excess, leaving a one-full-turn loop attached to the straight part of the clip.

About ½" from the loop, form a right-angle bend in the clip in a direction away from the loop and clip away the excess, leaving perhaps a ¼" "handle." Solder this handle to the outside terminal of the plug.

Now take another similar paper clip and straighten it out. Using another paper clip as a form, wrap a few close-wound turns around it, and clip away the excess, leaving one turn. This forms an "eye" at one end of the clip. Form a second clip in the same way, and put one "eye" inside the other so the wire swings freely in any direction. Close the eyes by squeezing them with pliers.

One of these "eyes" suspends its wire inside the formed loop attached to the outer connection of the plug. The other "eye" wire is soldered to the plug's center connection. Arrange the wires and loop so that the suspended wire passes through the approximate center of the loop. Cut the suspended wire so it extends ¼" below the level of the loop.

Puddle some solder on several sheets of newspaper, and while it is still molten, put the end of the suspended wire into the solder pool. Remove your soldering iron and allow the solder to cool thoroughly. As you can now see, tilting the detector in any direction will cause the contacts to close.

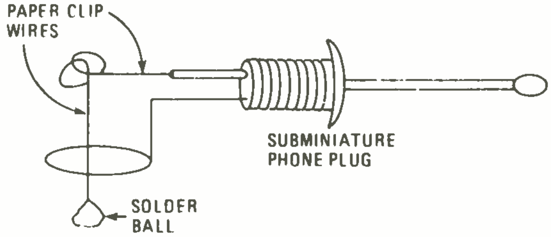


Fig. 2—Motion detector is fabricated from straightened paper-clip wire and mounted to a subminiature phone plug. The solder ball adds weight to the pendulum.

The alarm shown in the photographs uses a 9-volt power-supply system because a transistor-radio type 9-volt battery is generally available. A mounting clip for the battery can be attached to the case with silicone cement. We installed the miniature jack for the motion detecector on an upright piece of perforated wiring board (*perfboard*) in such a manner that the motion detector can easily be rotated to compensate for odd angles of mounting. (The suspended pendulum of the detector must always be oriented vertically, regardless of what position the alarm is in.)

To test the unit, place it on a flat surface and turn the keyswitch to the on position. Ask somebody to pick the unit up. When he or she does so, the horn will scream raucously, even after the unit's put down again. Turn it off by operating the keyswitch.

To put the unit to work, attach it to the back of the object you are protecting. It can be attached by almost any means that's most-convenient. We've even used double-sided tape or silicone cement. There is no need to use screws or bolts—that's overkill. Then open the top and be certain that the suspended pendulum of the detector is centered in the loop. That's all there is to it. You're protected. The alarm will sound when the unit is moved. ■

BC MAGNUM BOOSTER

(Continued from page 92)

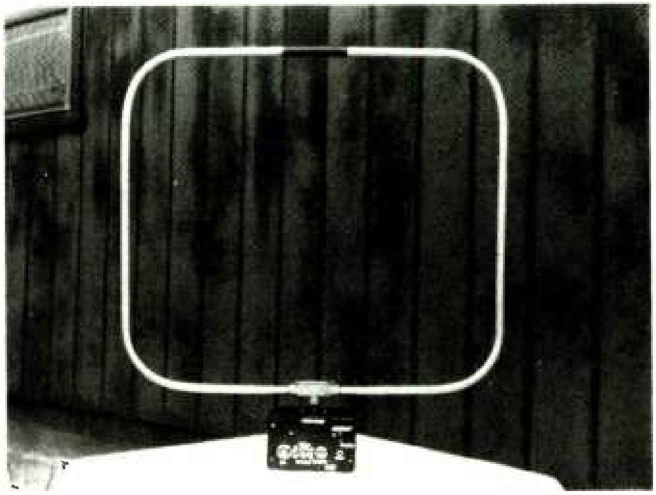
Tune to a station using C1. If all is OK, you should have plenty of audio level. If not, the GAIN control, R3, can be used to increase the volume. Use the table provided in Fig. 1 to determine the tuning range of each position of the selector switch. Try several other local stations to see just how useful the Booster is as an emergency receiver.

Now prepare a shielded cable to make connections between the Booster and your favorite BC radio receiver. Using a 3- or 4-foot section of coax (most any type will do), connect an RCA phono plug to one end. To the other end, connect a plug of the type necessary to mate with the receiver's external antenna input. If your favorite receiver does not have an external antenna input, connect a ferrite-loop antenna coil to the output of the coaxial cable and place the coil parallel to (but not touching) the receiver's internal antenna tuning coil. You'll need to experiment with the coil's location to obtain the best possible results.

Tune your radio to the desired AM station. If the signal is too weak to copy, turn on the Booster, aim the loop toward the transmitter and tune to the station's frequency. If the radio station comes in loud and clear nothing else is needed, but if the signal is still on the weak side, flip S2 to the BOOST position and the added gain should do the trick.

Align the sides of the loop antenna in the direction of the station you want to receive to get maximum signal pickup.

The Booster amplifier offers a fair degree of selectivity in its own tuning circuit, but the receiver used should be relied on to separate closely spaced stations. ■



Although case size and type is not specified, it is important that the enclosure have a large enough base so as to provide a support for the large loop antenna. With the project completely assembled, the loop should be able to freely rotate 360 degrees.

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3 TELEPHONE PROJECTS

(Continued from page 63)

Ringer. Using the same music synthesizer as in the music-on-hold project, all that's needed are a few additional components to activate the melody module whenever the telephone rings. It might also be used as an extension ringer for the outdoors. But now, let's get into the nuts and bolts of our circuit.

Refer to Fig. 3. When a telephone call is being received, there's a 90-volt, 20-Hz AC signal across the telephone line. That voltage is applied to the telephone's internal bell, causing it to ring in sequence with the 20-Hz signal. To detect that large voltage input, an optoisolator/coupler, U1 (a 4N33 with its Darlington output), is placed across the telephone line.

The 4N33 incorporates a small LED that radiates light-energy on a light-sensitive area of a Darlington transistor-pair when a voltage is applied between pins 1 and 2. Light radiation falling on the light-sensitive area of the Darlington causes it to conduct, providing power to (or completing) the circuit that follows. Note that pin 4 of U1 is connected to a negative side of the power supply; thus, when the Darlington pair is turned on, the low side is at (effective) ground.

With the Darlington turned on, a low appears at pin 5 of U1, which is connected to the cathode of D2 (a 1N4001 diode), forward-biasing it. With that in mind, let's see what happens when a phone call comes in.

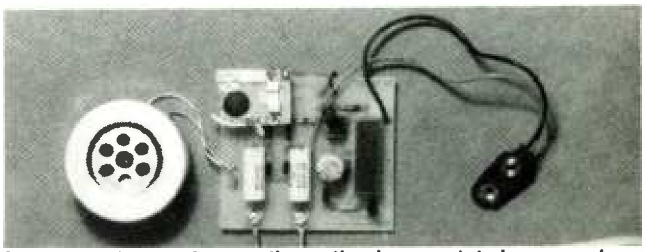
The 90-volt AC signal is applied to the circuit via a telephone line cord. C1 (a .47-µF/250-volt capacitor) is used to keep the normal DC telephone voltage from entering U1, so that its internal LED is not always biased on. If that happens, we have trouble. Seeing that an LED draws a small amount of current, we can place a 10,000-ohm resistor (R1) in series with the line to drop the voltage to a lower level. Since D1 (connected across the line) conducts every half cycle, a pulsating DC voltage is applied across pin 1 and pin 2 of U1.

The low side of a 9-volt battery is connected to pin 4 so that when a signal is applied to pins 1 and 2 of U1, its internal Darlington transistor-pair turns on and its output at pin 5 goes low. That low is applied to the parallel combination of C2 and R2, causing the capacitor to charge immediately to the supply voltage. At the same time that low is applied to the cathode of D2, forward-biasing it. With D2 forward biased, a low is applied to the base of Q1, turning it on, as C2 begins to discharge through R2.

The collector of Q1 is connected to the coil of a SPST relay (K1) so that when Q1 turns on, the relay is energized (closes contacts). The contacts of K1 are connected in such a way that 9 volts is delivered to LED1 through dropping resistor R3. To power the music generator, I used the same trick I discussed earlier. The red and black power leads of the synthesizer are soldered across LED1.

So with this configuration, every time a telephone-ring voltage is present across the line, K1 energizes (closing its contacts) and applies power to the music generator so that a tune can be heard. If the transducer that is supplied with the module is producing an audio signal that is too low, just replace it with a larger crystal element. I've tried a telephone-receiver element as a replacement and it works very well.

With a 9-volt battery attached to the power points on the board, connect the Telephone Melody Ringer in parallel with the existing telephone line (red to red and green to green). Next, to test the circuit, place a short across pins 4 and 5 of U1. The circuit should start to play a tune. Remove the short; the tune should continue for about 2 to 4 seconds, depending on the actual value of R2. (Remember, a 10,000-ohm, 5% tolerance resistor can have an actual resistance anywhere between ± 500-ohms of the rated value.) After the above test, you may leave the ringer connected to the line, so that when the telephone rings, you'll be serenaded with the song. ■



An electronic greeting card's synthesizer module is pressed into service to produce the Telephone Melody Ringer. If you build the music-on-hold (Telephone Hold Button) project, both circuits can share one synthesizer.

UNIVERSAL SERIAL PRINTER ADAPTOR

(Continued from page 76)

If you're using a conventional modem, remove the black DIN connector and substitute a male RS-232 connector with the conventional pin connections shown in Fig. 3, keeping in mind that the white wire is a CD (carrier detect). If your computer also requires a CTS (clear to send) handshake, simply short pin 8 to pin 6 (pin 6 is the CTS). For modem use, the white wire from the serial port to the adapter's *input connector* comes out of the adapter on modem pin 8. Keep in mind that the automatic modem connection is an extra; the real purpose of the adapter is to match any serial computer, buffer, driver, or whatever, to a Centronics-type printer.

Using the Adapter

Connect the computer's serial I/O port to the adapter; connect the adapter's Centronics output to the printer; set the adapter's baud rate selector to the desired baud/bit rate, and apply power to the adapter. Whenever the computer outputs data to the printer, the serial data stream will be converted to parallel for the printer. Although it will appear strange at first, you will get the screen cursor back in a matter of seconds—long before the printer stops printing. That is because the computer's output really flows into the adapter's memory, from which it's fed to the printer as fast as the printer can handle it. If the buffer isn't large enough to hold all the data, it will accept data from the computer as it outputs to the printer. Eventually, the computer is *emptied* and available for use even though the printer is still printing. Those extra buffer "K's" make that possible and cuts down on computer-wait time!

The red power light (COPY CLEAR) on the adapter also serves as a memory dump switch. If you want to stop printing and flush everything out of the buffer instantly, simply press the combination pilot lamp and switch.

Now if you have had some of the troubles that we have had hooking-up printers and modems, then maybe you'd be looking for the adapter we described. For information on the Super Cosmos Connection write to Cosmos Computer Services, Inc., 620 Stuart Street, Green Bay, WI 54301, or telephone 414/432-4635. If you wish, circle No. 25 on the Free Information Card in this issue. ■

DIGITAL FUNDAENTALS

(Continued from page 84)

6. The program used to service a request for an I/O operation is called a(n) ________________.

7. In DMA I/O, data transfers take place between the __________ and the __________.

8. Treating a memory location like an I/O port is called ________ ________ ________.

9. The circuit that connects the computer to the external device is called a(n) ________________.

10. What circuit acts as a buffer between the inputs from a peripheral device and the CPU?

a. register
b. three-state drivers
c. decoder
d. multiplexer

11. The most commonly used serial interface is the __________.

12. What is the name of the LSI circuit that performs serial-to-parallel and parallel-to-serial conversions?

a. PIA
b. DMA
c. PPI
d. UART

13. What address is being decoded by the gate in the figure below?

14. Serial data transfer speed is expressed in either ________________ or __________.

ANSWERS

1. a. programmed I/O
b. interrupt I/O
c. direct-memory access
2. c. accumulator
3. interrupt
4. d. area in RAM used for temporary storage
5. a. interrupt
6. subroutine
7. memory and I/O device
8. memory-mapped I/O
9. interface
10. b. three state drivers
11. EIA RS-232
12. d. UART
13. 01100110
14. baud or bps (bits per second)

12 ONE-EVENING PROJECTS

(Continued from page 33)

that R3 and R4 also are equal. Now, suppose that when the bridge is balanced, R1 is 1000 ohms and R2 is 9000 ohms; R2 is nine times as large as R1, so we have the same relationship between R3 and R4. The value of R4, the unknown, is nine times the value of the standard, R3. So if R3 is 5000 ohms, R4 is 9 x 5000 or 45,000 ohms.

A capacitance bridge is just a step away, as shown in Fig. 12B. The standard and unknown resistors have been replaced by standard and unknown capacitors. The DC source has been replaced by an AC signal, and the null indicator replaced by one responsive to AC. Now, the ratio of resistances on one side of the bridge are compared to the ratio of capacitive reactances on the other. Fig. 12C does the same thing.

Figure 13 is a very basic capacitance bridge but it will do an excellent job if you select your standard capacitors with care and use a good linear potentiometer (preferably wirewound) for the resistance arms. Standard capacitors of .001- and 0.1-µF will permit you to measure capacitances in ranges of 0.0001- to 0.01- and -.01 to 1.0-µF, respectively.

The tone generator is an astable multivibrator using a pair of 2N2222 transistors. The bridge excitation signal is developed across potentiometer R4, in the collector circuit of Q2. Figure 14 shows how your scale will look. Most potentiometers have a *dead* zone at the ends where the arm can be moved through a few degrees without a corresponding change in resistance. When you are making up your scale, use a multimeter to locate the edges of these zones: mark them on the dial. Then, locate the center of the resistance range and mark it 1.0. With a group of 100-pF, 0.001-, and 0.01-µF capacitors rated 5% or better, you can pinpoint markings for known values. Calibrating the scale is easy when you alternate the capacitors as standards. ■

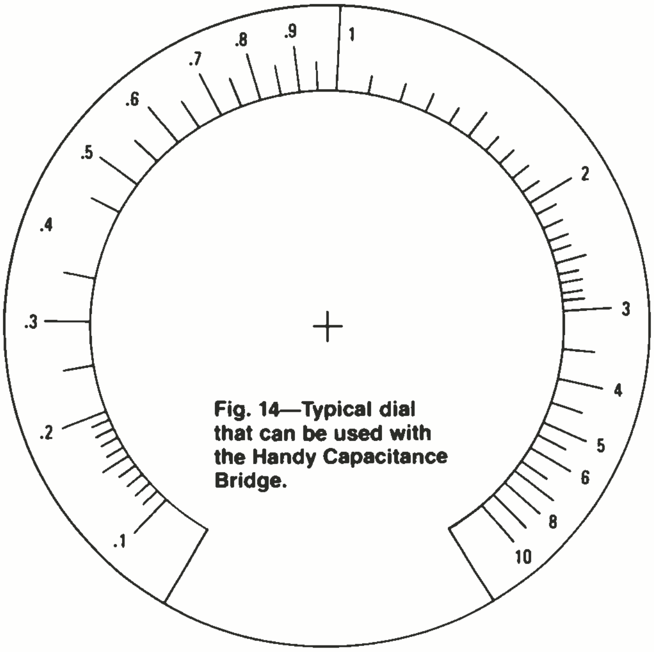


Fig. 14—Typical dial that can be used with the Handy Capacitance Bridge.

CIRCUIT CIRCUS

(Continued from page 88)

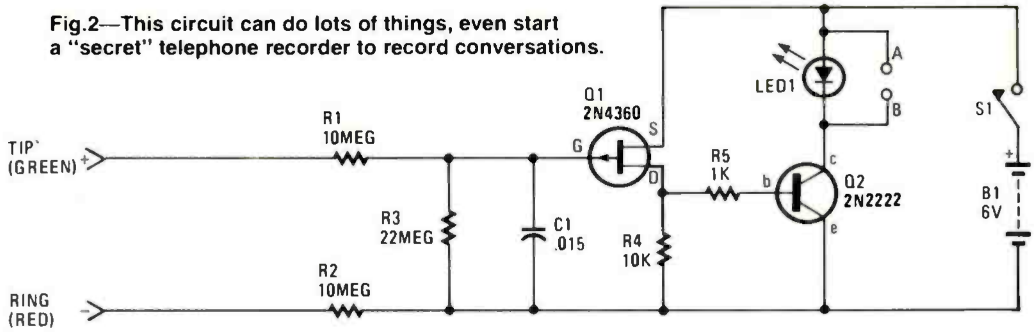


Fig.2—This circuit can do lots of things, even start a "secret" telephone recorder to record conversations.

age keeps Q1 in the cut-off condition, allowing no current to flow through resistor R4, hence Q2 remains off. (Resistors R1 and R2 keep the solid-state switch circuit from causing any problems with the telephone's central-office equipment.) When a phone is taken off-hook, the line voltage (tip to ring) drops to 10-volts or less, which forces Q1 to turn on, which in turn causes Q2 to trigger LED1, or a relay which might be used in lieu of LED1.

PARTS LIST FOR FIG. 2

B1—6-volt battery (four AA cells)
C1—0.015-µF, 100-WVDC Mylar capacitor
LED1—CQX21 Flasher LED, Radio Shack 276-036B
Q1—2N4360 or 2N4342 FET
Q2—2N2222 NPN silicon transistor
R1, R2—10-Megohm, ½-watt, 10%, resistor
R3—22-Megohm, ½-watt, 10%, resistor
R4—10,000-ohm, ½-watt, 10%, resistor
R5—1000-ohm,½-watt, 10%, resistor
S1—SPST switch
Wire, cabinet, solder, etc.

Another simple telephone project is the "in use" indicator shown in Fig. 3. This circuit functions as a line-current sensor and can be connected in series with either of the phone lines. For the circuit to indicate an "in use" status for all phones on a single line, it must be connected in series with the phone line before, or ahead of all phones on the line. Since the power for the circuit is supplied by the phone company, a circuit could be added to each phone as an off-hook indicator.

Once in a while it would be handy to amplify or record a telephone call, and you can do it with the simple circuit shown in Fig. 4. The 8-ohm secondary winding of a miniature transistor output transformer is connected in series with either of the telephone lines. The 1000-ohm primary winding can feed either a cassette recorder or an audio amplifier. ■

PARTS LIST FOR FIGURES 3 AND 4

D1-D4—1N4002 silicon rectifier
LED1—Light emitting diode
T1—Transformer, audio output, 1000-ohm primary, 8-ohm secondary

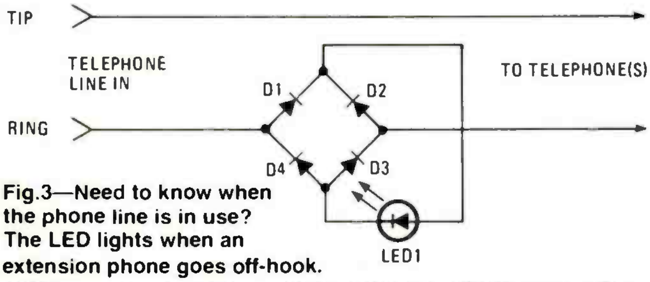


Fig.3—Need to know when the phone line is in use? The LED lights when an extension phone goes off-hook.

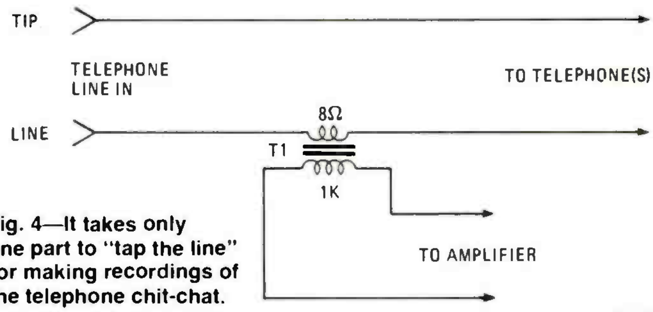


Fig. 4—It takes only one part to "tap the line" for making recordings of the telephone chit-chat.

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BOOKSHELF

(Continued from page 15)

True BASIC—A Complete Manual By Henry Simpson

If you've found the standard BASIC language too cumbersome or too slow, yet you prefer it to other, less-universally used languages like Pascal or C...then True BASIC may be your answer!

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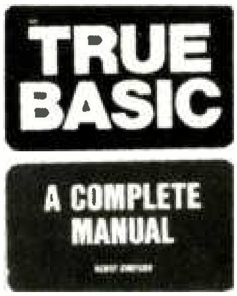

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offer, it also provides all the step-by-step know-how that you'll need to use and program in this first BASIC modeled on the proposed ANSI (American Nation Standards Institute) standard BASIC.

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Published by Tab Books, the text highlights specifics on which BASIC functions have been updated and improved. How-to's for translating programs from the standard BASIC dialects into True BASIC. Details on the powerful new graphics features and sound/music-generating commands.

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Henry Simpson is a former West Coast Editor of Digital Design magazine. His previous books for Tab include Serious Programming for the IBM PC/XT/AT, Serious Programming for the Apple II/IIe/IIc, and Serious Programming for the Commodore 64. True BASIC, a 197-page softbound book published by Tab Books Inc., PO Box 40, Blue Ridge Summit, PA 17214, retails for $14.95

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LETTER BOX

(Continued from page 4)

put would make a beacon that could be seen for miles at night. Thank's again for a magazine which after working for a computer company all day reminds me why I got involved in electronics in the first place—It's fun!
—C.S., Worcester, MA

Antique Radio Diagrams

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—G.C., Greenville, SC

CRYSTAL, PLL, AND VCO OVENS AND HEATERS

(Continued from page 47)

closest standard resistor values will do.)

Since the LM3911's maximum output is approximately 2 mA., it will directly drive Darlington amplifiers such as the D40C4, or even a TIP 20, which can control load currents in excess of 200 milliamperes. By using an external amplifier to boost the current-handling capacity of the temperature controller, it is possible to use heaters made from 4 to 6 GES mini panel lamps, #22 nichrome wire, power resistors, 2-watt carbon resistors, or even thick-film resistor packs, all of which are suitable for small enclosures.

In order to heat relatively large enclosures, which is rare, as shown in Fig. 2, it might be necessary to use a triac-controlled line-powered heater. (Transistor Q1, in Figure 2, interfaces the temperature controller IC to the triac.)

Another kind of circuit used to control a high-power heater is shown in Fig. 3. In this instance, transistors Q1 and Q2 are configured as a Darlington drive-amplifier for relay K1, whose contacts control the heating element. Alternately, as shown in Fig. 4, solid-state relay SSR1 can be used as a substitute for transistors, triacs, and mechanical relays.

Small Oven Construction

For small ovens (see photos), one of the best and simplest oven designs, such as those used for crystals, is a double wall enclosure separated by a fiberglass insulation or the equivalent. Bakelite or PVC tubing works well. However, even a glass or plastic jar inside a piece of tubing or a tin can will work.

The inside enclosure should have a minimum of ¼-inch to ¾-inch of insulation between itself and the outside enclosure. However, when Bakelite or glass is used for the inside enclosure, you can simply wrap a nichrome heater around a thin layer of insulation, wrap the insulation around the inside enclosure, and then place another layer of insulation around that before inserting it into the outer tube or enclosure.

The heater may also be placed inside the inner enclosure. For example, you can use nichrome wire wrapped around suitable insulators, resistors, etc. However, you need to exercise some care in placement to avoid hot spots.

Final Notes

Try to get as much heat-sinking of the temperature controller IC as possible. For example, when using the LM3911 on a printed-circuit board, attach the unused pins to some copper foil, which provides a large surface area for good thermal bonding. In breadboard configurations, you may want to attach the unused pins of the LM3911 to a small piece of copper sheeting for best thermal regulation.

Generally, regardless of the oven's mechanical assembly, the LM3911 is adjusted so that the oven's temperature range falls between 50 to 65°C.

In any case, with small enclosures it takes about 15 minutes to stabilize at the set point.

Finally, you can often avoid using an oven with a crystal oscillator or other temperature-stabilized components by using a thick-film *cermet* resistor pack as a heater. Simply epoxy-cement the resistor pack directly to the crystal or component and control the current through the pack with an LM3911 temperature controller. Generally, those resistor packs have a maximum rating of 125°C; but, with good heat transfer, they can be used as heaters to hold a crystal at 85°C with little or no problem at all.

For best results, a thermally conductive epoxy should be used to mount resistor packs, while the unused pins of the LM3911 should be soldered to the crystal can and/or epoxied. Exposed contacts can be protected with RTV (silicon rubber) adhesive. ■

GETTING THE EDGE ON DX'ing

(Continued from page 38)

extra effort, the computer can be instructed to update the Gray Line every 15 minutes. On a monthly basis, it creates the curve for the first and fifteenth of each month. (The significant variations in the shape of the curve take place nominally in 15 days.)

Regardless of the particular function selected by the user, instructions to the computer are made through notably simplified menus, such as the *Solution Menu* shown in Fig. 9. Although location 1 must, as previously mentioned, be entered in latitude and longitude; location 2 can be "unique"—meaning latitude and longitude, country (nation), call area or prefix, or by zone. Recognized call areas such as W1, W2, W3, VK1, VK2, VK3, etc., are available only for the U.S.A., Canada, Australia, and the U.S.S.R. Nations can be identified either by their name (e.g., United Arab Emirates), by DXCC prefix, or by zone (from the forty CQ Magazine zones). If you enter a location by name, the cross-hairs usually go through the capitol of the country; and if you specify a zone, the cross-hair usually runs through the center of the zone. However, when the central portion of a zone is unpopulated, as in the Pacific, the lines run through the more populated area.

Even if you're not interested in DX'ing, think of the fun you can have figuring out what's going on where the blue of the night meets the gold of the day. ■

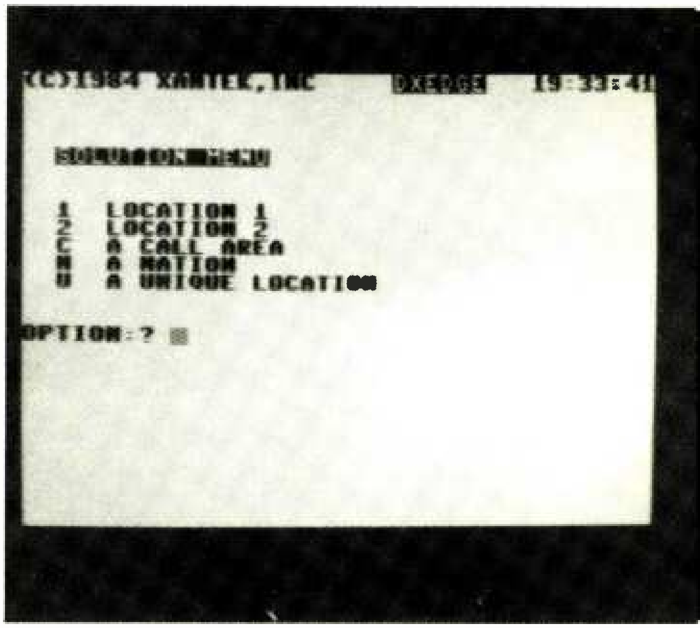

Fig. 9—While the "home" QTH location must be entered in latitude and longitude, the second location can be entered by latitude and longitude (unique), call prefix or area, country name, or zone.

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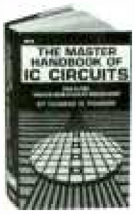

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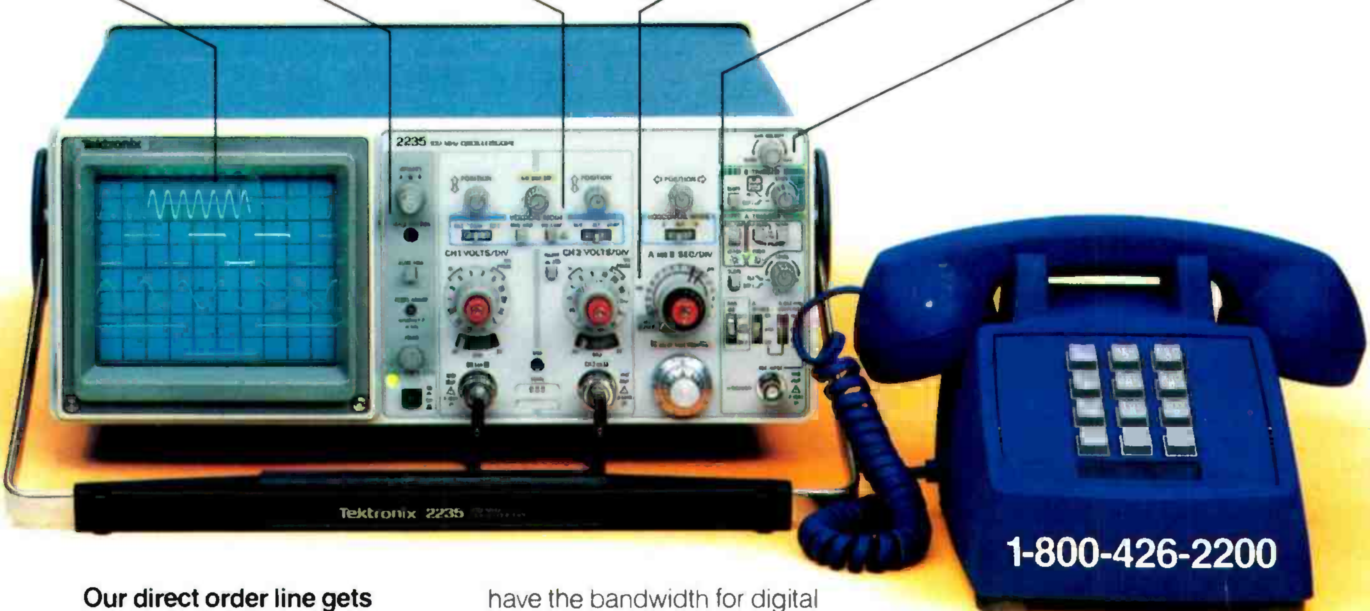

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