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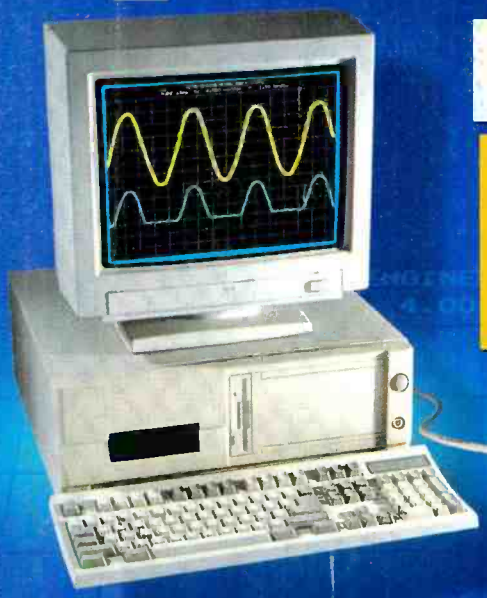

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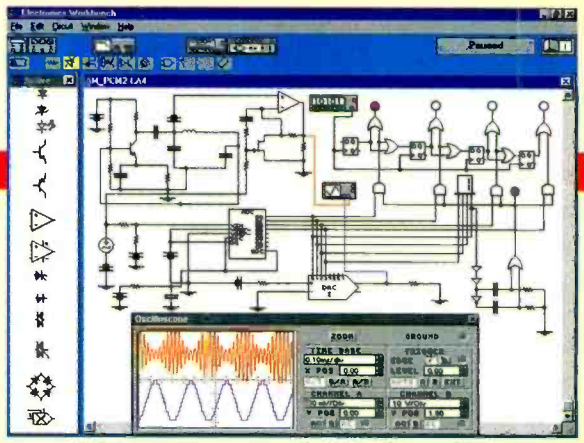

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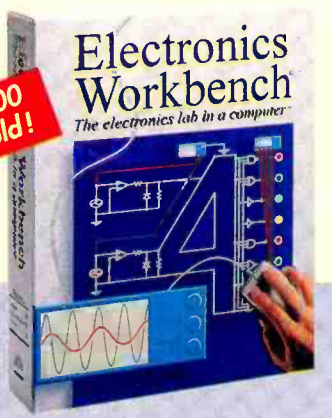

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NOVEMBER 1996
Vol. 13, No. 11

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COVER STORY

33 Build the Easyscope
Use this circuit to turn your PC into a dual-channel, digital storage oscilloscope. For about $85 you can enjoy the features of a stand-alone unit that might cost $1000 or more—*Robert G. Brown*

CONSTRUCTION

41 Build an Active High-Impedance Probe
This compact unit will greatly improve the accuracy of your DMM by eliminating the problem of circuit loading—*Skip Campisi*

47 Build a Capacitance Meter Adapter
This simple add-on circuit makes it possible to measure capacitance with any digital multimeter—*Marc Spiwak*

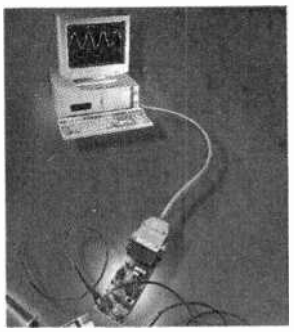
50 Build an Inductance Meter Adapter
Use your DMM to find the values of inductors—*Marc Spiwak*

52 Build a Surround-Sound Switchbox
Add surround sound to your home theater or stereo—*Ted Rowen*

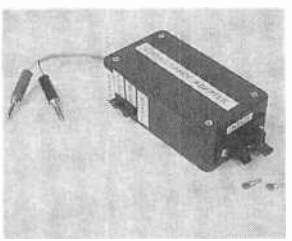
FEATURES

44 Becoming an Electronics Engineer
Here's an insider's view of the profession and what it takes to get started—*Lyle Russell Williams*

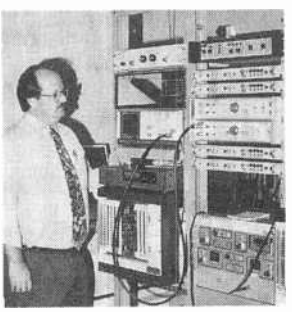
57 Learning About Simple Function Generators
No workbench is complete without a square- and triangle-wave-form generator. Here are the fundamentals of how these devices work—*Ron C. Johnson*



Page **33**



Page **47**



Page **44**

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NOVEMBER 1996

PRODUCT REVIEWS

23 Gizmo
Canon ES5000 Eye-Control Hi8 Camcorder, Comfy Activity Center Keyboard, Microsoft Easyball Computer Mouse, Oregon Scientific Personal Weather Station Model BA-312E Alarm Clock, Psion Series 3A Pocket Computer, and much more.

COLUMNS

12 Multimedia Watch
Spring COMDEX and PC Expo—*Marc Spiwak*

20 Net Watch
National Semiconductor—*Dan Karagiannis*

64 Think Tank
Telephone Circuits—*John Yacono*

68 Computer Bits
Web Authoring Tools—*Jeff Holtzman*

70 Scanner Scene
Check Out These New Channels—*Marc Saxon*

73 Circuit Circus
Crystal Sets—*Charles D. Rakes*

75 Ham Radio
Baluns and Other Broadband Transformers—*Joseph J. Carr*

78 Antique Radio
Back to the Star Roamer—*Marc Ellis*

81 DX Listening
The "Other" Time Standard—WWVH—*Don Jensen*

DEPARTMENTS

4 Editorial

6 Letters

8 New Products

61 Electronics Library

83 Popular Electronics Market Center

118 Advertiser's Index

118A Free Information Card

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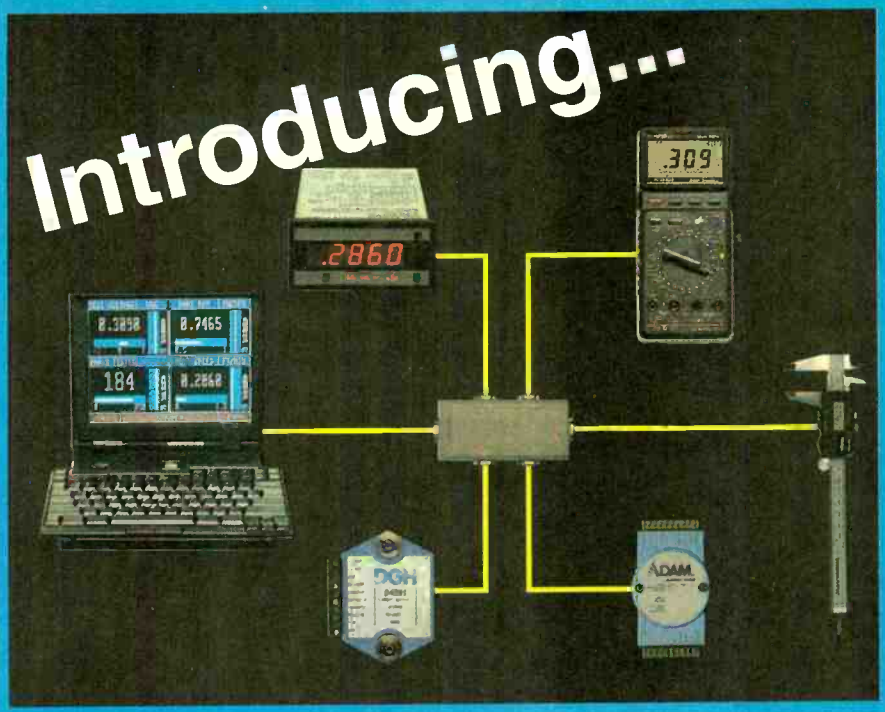

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Editorial

Affordable Test Gear

Every hobbyist needs test gear. We all know that without the right equipment it can be difficult to troubleshoot and get the bugs out of a project. Of course, oftentimes you can't buy the right equipment for the "right" price. But that does not mean you should go without the gear you need.

This month, **Popular Electronics** focuses on affordable test gear you can build. With these simple projects you can enhance your workbench without hurting your wallet.

For starters, there's the *Easyscope*. Plug this circuit into your PC's parallel port, load up the available software, and your computer is transformed into a dual-channel, digital storage oscilloscope. For about $85 or so you can have the capabilities of a device that otherwise might cost well over $1000! The story begins on page 33.

Then there's our *Capacitance Meter Adapter*. It's an easy-to-build circuit that will let you measure capacitance with any DMM. The story begins on page 47. If you'd like to use your meter to measure inductance as well, you can build the *Inductance Meter Adapter*. That story begins on page 50.

Or perhaps you'd simply like to be able to take more accurate readings with your DMM. If that's the case, you should build the *Active High-Impedance Probe*. It raises the impedance at your meter's inputs to eliminate the errors that result from circuit loading. The story begins on page 41.

Those projects, combined with our features on the electronics-engineering profession (see page 44) and function generators (see page 57), make this an issue no hobbyist should be without.

Enjoy!

Dan Karagiannis

Dan Karagiannis
Managing Editor

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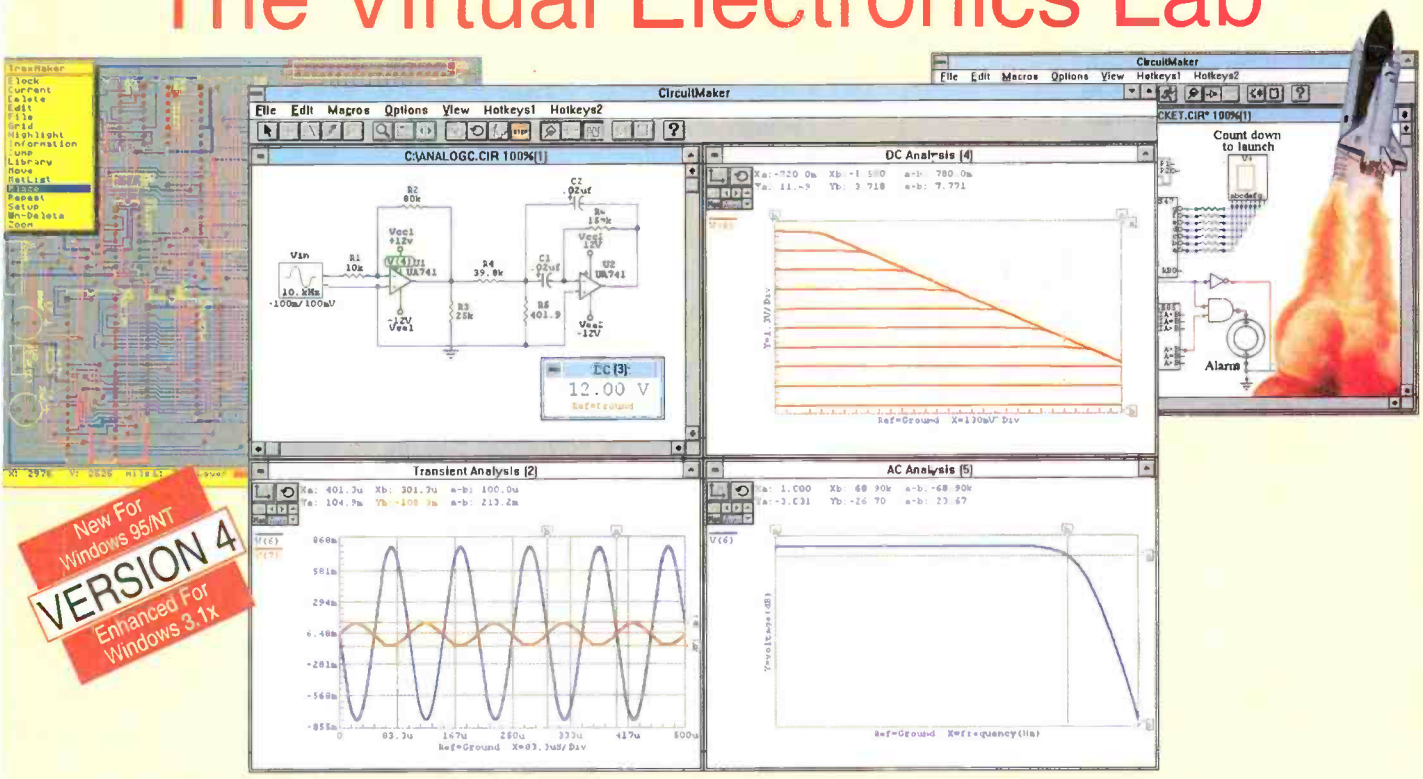

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LETTERS

Strobes, Lights, and a Bio-Stimulator

STROBOSCOPE CORRECTIONS

For any of you who have built the Solid-State Stroboscope in the September 1996 issue, and are having problems with the unit, we have an update. Due to the long lead time between designing such a project and its actual publication (6 to 12 months), and the number of people involved in its handling, errors do creep in occasionally!

Although the text, Parts List, and schematic call for IC2 to be a standard 555 timer, such an IC might not function properly. Use a TLC555 CMOS timer (available from RadioShack) instead.

On the schematic itself, the pinouts and shaft rotations for R4 ("F.P.M") and R8 ("duration") were omitted. The pinout for R4 is: pin 1 to R3, pin 2 to IC1, and pin 3 to R5. Note that R4 rotates clockwise towards the R5 connection. The pinout for R8 is: pin 1 to R7, pin 2 shorted to pin 3, and pin 3 to IC2. That way, potentiometer R8 should rotate clockwise towards the IC2 connection.

The text mentions that R3 and R5 should both be close to 680 ohms for best linearity. Actually, to achieve the best linearity, trim R3 and/or R5 to a suitable value for your particular CD4046 (IC1). Depending on the manufacturer of the CD4046, you may need values of 1 ohm to over 1000 ohms for best performance.

We're sorry for any inconvenience these errors might have caused.

—Skip Campisi

ADDING RUNNING LIGHTS

Daytime running lights are mandatory in Canada and are now standard on some new cars in the U.S. Anthony J. Caristi's article "Add Daytime Running Lights to Your Car" (**Popular Electronics**, July 1996) provides an easy way to upgrade older cars. However, I am concerned about the longevity of the semiconductors used in the project.

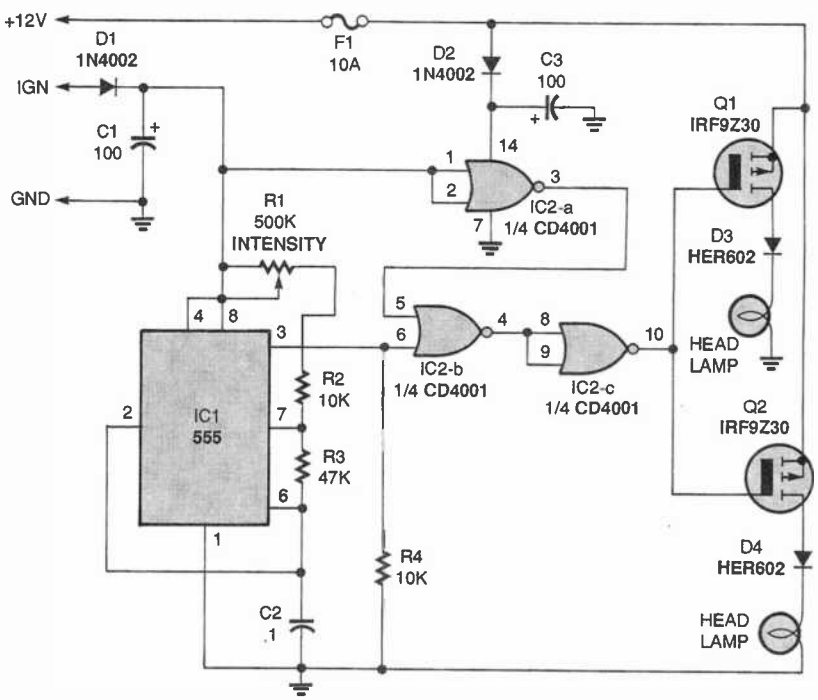

Fig. 1. This is the corrected schematic from the "Daytime Running Lights" article. The MOSFETs are now shown as P-channel types.

The 12-volt DC power in an automobile is an extremely hostile environment for electronics. The normal "12 VDC" is actually 14.4-volts DC due to the alternator voltage required to charge the battery. During cold weather, the steady-state voltage can be as high as 16.3 volts DC with a weak battery. Automobiles are also full of heavy induction loads, such as motors, relays, air conditioner clutches, ABS solenoids, etc., which can generate high energy spikes reaching 40-volts DC.

During a typical (25°C) day's fully charged battery start-to-run cycle, you can see spikes that exceed 16-volts DC at the battery, and almost 20-volts DC at the alternator. RTCA Spec DO-160 requires that any 14-volt DC battery/alternator-powered electronics must withstand the voltage surges shown in Table 1.

TABLE 1

Time (Seconds)	DC Surge Voltage
5.0	16.7
3.0	16.9
1.0	19.0
0.4	21.2
0.2	22.5
0.1	23.6
0.01	40.0

The design shown in the article might have reliability problems in the following areas.

First, the absolute maximum supply voltage for 4000-series CMOS and the 555 timer IC is +18 volts DC. The maximum gate-source voltage of Q1 and Q2 is ±20 volts DC. Those devices will not survive the normal automotive voltage surges without a power supply that has adequate spike protection. The battery is a massive power filter, and just look how its voltage is yanked around by the alternator and the load changes

continued on page 16

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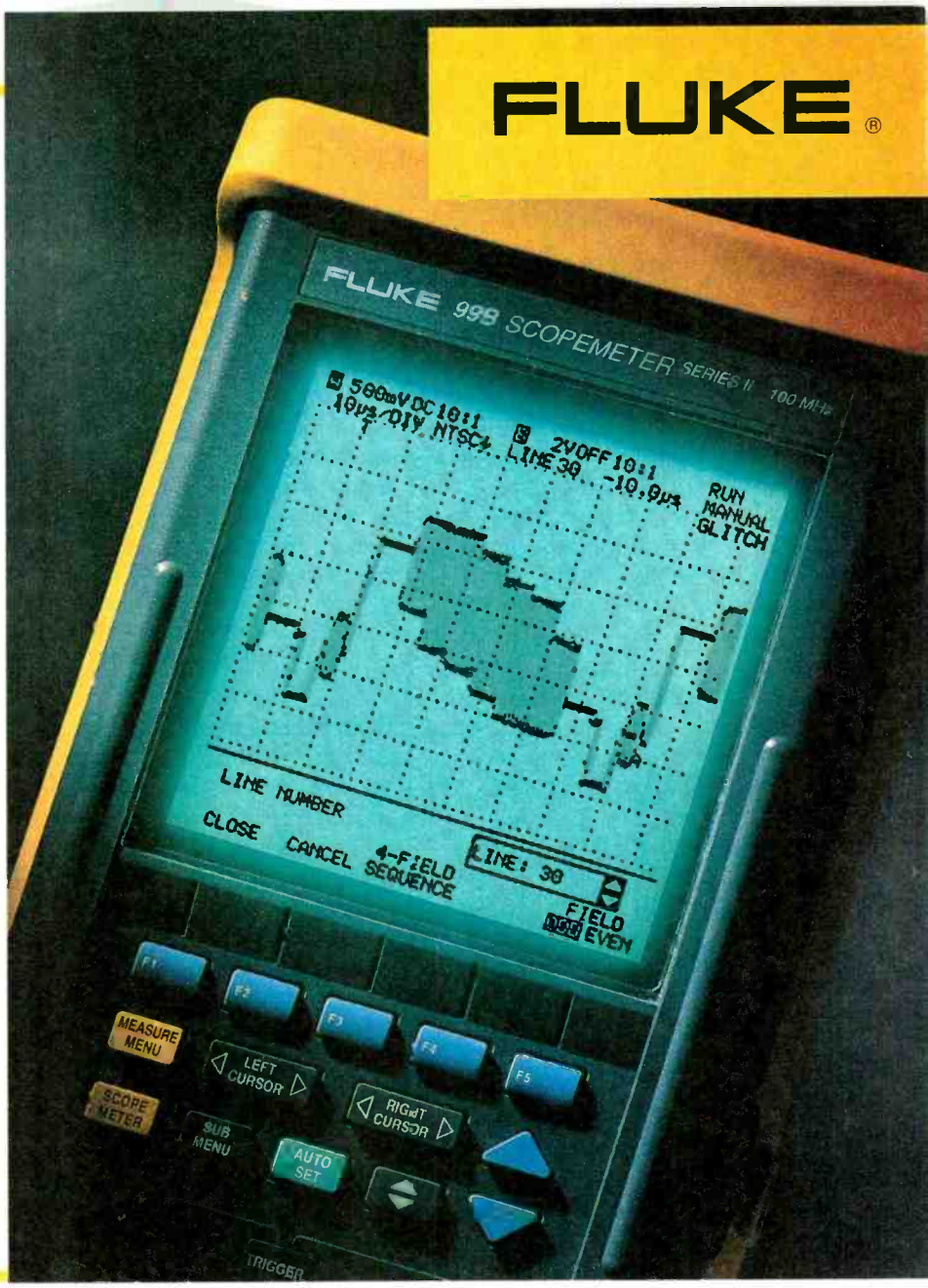
(Here's a hint.)



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The DV format, which has been accepted by 55 manufacturers worldwide, provides 500 lines of horizontal resolution, no color blur, an extremely stable picture, and CD-quality sound. It also features time code and cassette memory for accurate editing and convenient indexing of tape content.

The DCR-VX1000 has three-CCD imaging, a 20× precision digital zoom with 10× optical lens, a 180,000-pixel color viewfinder, the advanced "Super SteadyShot™" stabilization system, and both manual and automatic controls. A dichroic prism system splits incident light into its red, green, and blue components, which are directed to one of the three 410,000-pixel CCDs, for a total resolution of 1,230,000 pixels. The image-stabilization system, which does not degrade the quality of the picture, uses both vertical and horizontal motion detectors to overcome even the severe shaking caused by shooting from a moving car on a rough road.

The camcorder's Photo Mode with adaptive frame interpolation allows full-frame, high-quality still-image recording. It can be used to produce a video slide show with sound or, when linked to the optional CVP-M1 video printer, photographic-quality prints. Cassette memory stores the recording date and time of each video recording and Photo Mode frame, for easy access.

The DCR-VX1000 Digital Handycam, complete with rechargeable lithium ion battery, wireless remote control, and a 60-minute Mini DV cassette, has a suggested retail price of $4199. For more information, contact Sony Consumer Products Group, 1 Sony Drive, Park Ridge, NJ 07656; Tel. 800-342-5721.

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The CLT-986 900-MHz cordless phone has a suggested retail price of $349.99. For further information, contact Sanyo, 21350 Lassen Street, Chatsworth, CA 91311-2329; Tel. 818-998-7322; Fax: 818-701-4149.

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SOLDERING IRON CONTROLLER

The *Dial-Temp Controller* from *M.M. Newman Corporation*, designed for use with wood-burning tools and hot knives, as well as soldering irons, allows users to adjust tip temperatures from 150°F to full heat, depending upon the task at hand. Compatible with any fixed-temperature tool from 15 to 600 watts, it eliminates the need for sensitive temperature-control stations in many applications. It plugs into any 115-volt AC outlet, and features a grounded wall plug and receptacle for safety.

The Dial-Temp Controller converts any fixed-temperature soldering iron into a variable temperature iron for use with heat-sensitive devices. Woodburners, hot knives, and other such

AmericanRadioHistory.Com

Fifteen years of microelectronic research makes conventional antennas a thing of the past!

This little box uses your home's electrical wiring to give non-subscribers, cable subscribers and satellite users better TV reception!

by David Evans

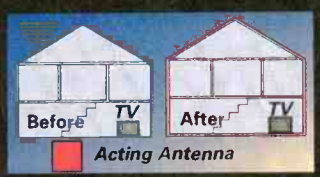
Technology corner

1. Why don't conventional antennas work as well as the Spectrum?

■ When TV signals are tuned at the TV channel's center frequency, optimum tuning has been achieved.

■ Other antennas can't offer center frequency tuning like the Spectrum Antenna can. They only offer such tuning up to the edge of the center frequency. As a result your TV picture remains snowy.

2. How does Spectrum use a home's electrical wiring as an antenna?



Believe it or not, the Spectrum Antenna simply "activates" the giant antenna that already exists in your home. Essentially, it uses all of the wiring throughout your home's walls and ceilings to make an antenna as large as your house for unbelievably clear reception of local broadcasting.

3. Spectrum antenna features

Parallel 75 ohm resistance
For minimum loss of signal

Signal search control
For selecting multiple antenna configurations

Polarized three-prong plug for grounding
For optimum signal grounding to eliminate noise and static

Resonant fine tuner control
For dialing in crisp, clear TV/stereo reception, eliminates ghosting

Dual AC outlets with built-in surge protection
For plugging in additional TV/stereo equipment guarding against damage and electrical surges

Until recently, the only convenient way to guarantee great TV reception was to have cable installed or place an antenna on top of your TV. But who wants to pay a monthly cable fee just to get clear reception, or have rabbit-ear antennas that just don't work on all stations? Some people just aren't interested in subscribing to cable. Or they may live in an area where they can't get cable and TV-top antennas aren't powerful enough. And what about those people who have cable or satellite systems but still can't get certain local stations in clearly?

Now, thanks to fifteen years of microelectronics research, a new device has been developed that is so advanced, it actually makes conventional antennas a thing of the past. It's called the Spectrum Universal Antenna/Tuner.

Advanced technology. Just imagine watching TV and seeing a picture so clear that you'd almost swear you were there live. Just plug the Spectrum Antenna into a standard AC outlet and plug your TV into the Spectrum. You can remove the unsightly clutter of traditional TV-top devices gathering more dust than television signals. Get ready for great reception. Your TV will suddenly display a sharp, focused picture thanks to its advanced design "Signal Search" and "Fine Tuner" controls.

Uses your home's electrical wiring. The Spectrum Antenna is a highly sophisticated electronic device that connects into a standard wall outlet. The outlet interfaces the Spectrum Antenna with the huge antenna that is your home wiring network. It takes the electrical wiring in your house or apartment and turns it into a multi-tunable, giant TV reception station which will improve your TV's overall tuning capability. The results are incredible. Just think how much power runs through your home's AC wiring system—all that power will be used to receive your local broadcasting signals.

How it works. Broadcast TV signals are sent out from the local broadcast station (ABC, CBS, NBC, etc.). They interface with your home's AC power line system, a huge aerial antenna network of wiring as large as your home itself. When the Spectrum Antenna interfaces with the AC line, the signal is sent to its signal processing circuit. It then processes and separates the signal into 12 of the best antenna configurations. These specially processed signals route themselves into 12 separate circuits. The Spectrum Antenna includes a 12-position rotary tapping switch, the "Signal Switch" control, which gathers twelve of the best antenna configurations.

The "Signal Search" offers varying antenna configurations for the user to select from the best signals of all those being sent. The signal then passes through the Spectrum Antenna's special "Fine Tuner" circuit for producing crisp, clear reception.

Risk-free offer. The Spectrum Universal Antenna/Tuner comes with our exclusive 90-day risk-free home trial and a 90-day manufacturer's warranty. Try it, and if you're not satisfied, return it for a full "No Questions Asked" refund.

Who can use Spectrum?

- *Cable users-You have cable but you can't get certain local stations in clearly.*
- *Non-cable users-You don't have cable and want the stations to come in more clearly*
- *Satellite users-You have a digital satellite system but can't get local stations in clearly*

Limited time offer! We realize that most people have more than one TV in their home. We are offering a special discount on additional Spectrum Antennas so you get great reception on all your TVs!

Spectrum Antenna™.....$39 $4 S&H

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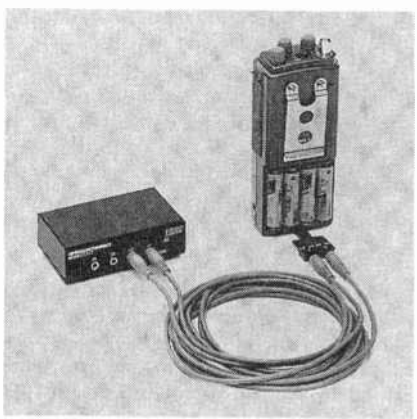
tools can be adjusted for the materials being carved or cut. Providing a 15-amp capacity, the controller can also moderate hot-plate temperatures. A dial on top of the unit is used to make temperature adjustments.

The Dial-Temp Controller costs $39.95. For additional information, contact M.M. Newman Corporation, Hot Tools Division, 24 Tioga Way, P.O. Box 615, Tioga Way, MA 01945; Tel. 617-639-1000; Fax: 617-631-8887.

CIRCLE 82 ON FREE INFORMATION CARD

SCANNER COMPUTER CONTROL INTERFACE

Optoelectronics' CX12AR computer control interface for the AOR AR8000 and CI-V (Icom R7000 and R7100) receivers not only allows CI-V to RS-232 conversion, but also provides complete interfacing for computer control of the Icom R7000 and R7100, which Icom's CT17 will not. The CX12AR's two operating modes are switch-selectable between full duplex and half duplex. The dedicated squelch status input is wired for high-speed scanning. A software-controlled tape-recorder control output is also provided. A demo version of Scanstar software, which is compatible for use with the OptoScan456/535, Icom R7000 computer control, and the AOR AR8000, is included.



The CX12AR converts TTL serial-interface signal levels compatible with most personal computers. It allows up to four different Optoelectronics devices equipped with serial ports to be connected to one computer port in a star network configuration. The interface can be used to download memory from the Scout to a PC. After downloading those frequencies, you can check them against the optional Spectrum CD-ROM FCC database. Switched in RS-232 mode, the interface can be used as a data-logging device for the popular M1 frequency counter.

The CX12AR computer control interface has a suggested retail price of $99. For more information, contact Optoelectronics, 5821 NE 14th Avenue, Fort Lauderdale, FL 33334; Tel. 305-771-2050; Fax: 305-771-2052.

CIRCLE 83 ON FREE INFORMATION CARD

PLAIN-PAPER MULTI-FUNCTION FAX

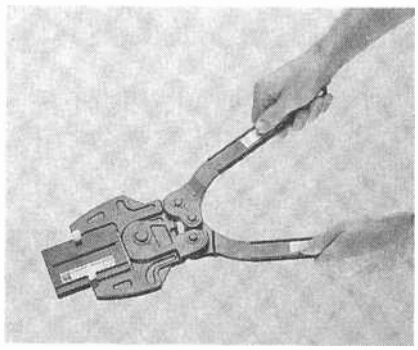
Samsung's FX4200 "Multifunction System" is a six-in-one product that serves as a full-function inkjet color printer, a stand-alone facsimile machine, a PC fax, a PC scanner, a telephone, and a copier. It can fax directly from a personal computer, and can receive and transport material directly into the user's PC. The FX4200 has 512K of standard memory, with an additional 512K available as an option. It offers 300-dot-per-inch printing resolution.

The FX4200 Multifunction System has a suggested retail price of $999.00. For more information, contact Samsung Electronics America, Inc., 105 Challenger Rd., Ridgefield Park, NJ 07660-0511; Tel. 201-229-4000.

CIRCLE 84 ON FREE INFORMATION CARD

RIBBON-CABLE ASSEMBLY TOOL

Jensen Tools' efficient *Ribbon-Cable Assembly Tool* makes good use of leverage to terminate cable connections. The long-handled tool converts a little energy into many pounds of pressure. Well constructed entirely of steel, it produces reliable, repeatable, high-quality results.



The Ribbon-Cable Assembly Tool can be used with interchangeable dies to accommodate a wide variety of connector styles and sizes. Optional dies are available for 14-, 16-, and 18-pin DIPs; card edge and D-sub connectors; sockets; and delta ribbon.

The Ribbon-Cable Assembly Tool, with anvil, costs $65. Dies cost $19.95 each. For additional information, contact Jensen Tools Inc., 7815 South 46th Street, Phoenix, AZ 85044; Tel. 800-426-1194; Fax: 602-438-1690.

CIRCLE 85 ON FREE INFORMATION CARD

TRUE-RMS AC/DC CURRENT TRANSDUCER

Amprobe Instruments' Model A-1000 clamp-on AC/DC current transducer will allow a non-true-RMS digital multimeter to read true-RMS current. Designed for use with DMMs, recorders, and other suitable equipment for accurate, non-intrusive measurement of AC, DC, and complex waveform currents, it also features waveform-display capabilities.

The A-1000 converts the measured current to a DC voltage by a true-RMS-to-DC converter. Most clamp-on transducers output waveform current only. Using advanced Hall-effect technology, the A-1000 can accurately measure currents up to 1000 amps RMS, making it a powerful tool for use on inverters, switch-mode power supplies, industrial controllers, automotive diagnostics, and other applications that require accurate isolated-current measurements.

continued on page 69

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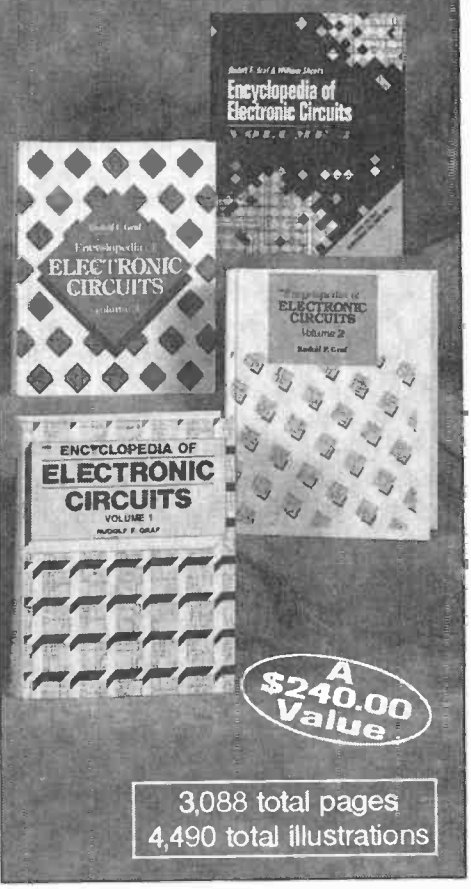

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Multimedia Watch

Spring COMDEX and PC Expo

By Marc Spiwak
Technical Editor
Windows Magazine

Early in June I attended the 1996 Spring COMDEX show in Chicago. Everything about the show was slow-moving and congested with people—vendor booths, food supplies, bathrooms, transportation, lodging, you name it—all packed! And I'm told that spring COMDEX is much smaller than fall COMDEX.

PC Expo in New York City is always at the Javits Convention Center. PC Expo isn't as big as COMDEX, but the two shows are very similar otherwise.

I saw a lot in the way of desktop video at both shows. Now pretty much every new PC (fast Pentiums) can play MPEG 1 movies (Video CDs) running software MPEG. With a really fast graphics accelerator, the *Number Nine Imagine 128 Series 2* for one, you can watch the video in full screen. I saw it demonstrated in a fast Pentium playing T2 from a CD onto a wide-screen monitor (HDTV proportions), full screen!

MPEG hardware is very popular too. It allows video playback on slower machines and interactivity with MPEG video on fast ones. MPEG is an important buzzword these days. It seems a little funny to me that we're all in such a hurry to get our PCs to play video as well as our entertainment centers, but as long as it costs nothing I think it's great. What's really happening is that we're getting closer to the point where the PC and home entertainment systems become one and the same.

NEW SOFTWARE

New from Discovery Channel Multimedia is *Savage*, a survival game where you slip into the skin of a lion and practice surviving on the Serengeti. Within a realistic 3-D landscape, Savage simulates what it's like to be a lion on the hunt, whether it's to stalk, hunt, kill, feed, or protect. The virtual landscape covers the equivalent of 100 square miles. Ten levels of gameplay take you through different stages of a lion's life, from a young playful cub all the way up to the leader of the pride. Complications include the constant need for water, enemies and prey on the loose, Maasai warriors, poachers, tourists, and more. You can be the king of the jungle for $49.95.

Savage is a survival game where you are a lion surviving on the Serengeti. The virtual landscape covers the equivalent of 100 square miles.

If you are into aircraft, or if you enjoy watching *Wings* on the Discovery Channel, you'll want to pick up a copy of *Wings: Saigon to Persian Gulf,* also from Discovery Channel Multimedia. This disc is an encyclopedia of military aircraft and aviation from 1975 to 1996. With it you can jump from one air base to the next, touring the bases and the planes that land there. You'll learn how and where different planes have been used in battle, what sort of weapons the planes have, and more. You can study different wars and the role that aircraft played, learn combat techniques, and dig through a database for facts and information on more than 500 aircraft and 250 weapons systems. This one has a suggested retail price of $49.95.

Wings: Saigon to Persian Gulf is an encyclopedia of military aircraft and aviation from 1975 to 1996.

Dr. Schueler's Home Medical Advisor Pro 5.0 has finally arrived. This update represents a near tripling of the information contained in the last release, and it's now a 3-disc set. The software helps you diagnose symptoms, search for medical terms, browse more than two hours of video footage and over 800 photographs, and pore through tons of new medical data. Information on more than 4000 drugs is also included. One of the neatest things about this title is that you'll see some pretty intense medical images of body parts, organs, deformations, infections, diseases, and so on. A strong stomach is a must. For that reason, the software has a censoring feature built in that lets you block certain images from certain people. You can purchase this title for a street price of around $49.95.

"Microsoft Home" apparently now stands for things you can do at home in addition to software you can run there. Two new CD-ROM titles from Microsoft prove this: *Complete Gardening* and the *Reader's Digest Complete Do-It-Yourself Guide.* The do-it-yourself guide details nearly any kind of home project you can think of, such as fixing sinks and drains, painting, electrical work, and woodworking. Nearly 1000 articles teach you the best way to do home repairs. It'll also help you master the use of some 600 hand tools. Complete Gardening shows you everything you need to know to keep your landscaping healthy and the outside of your home looking beautiful. It helps you select the right plants, tells you how to plant and care for them, diagnose problems plants are having, and more. This pair of discs will definitely help you to keep your house looking as good as the neighbor's, indoors and out, and for only $34.95 each.

Microsoft updates its Bookshelf CD-ROM every year. Well, the *Bookshelf 1996/97 Edition* is here, and it has been updated with new information and a

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Breakthrough device repels pests... without chemicals or traps!

The new Transonic ESP generates ultrasonic and sonic noises to drive away annoying pests electronically.

by Thomas R. Buchanan

Ticks that torment your pet. Crickets that chirp incessantly. Bees and wasps that build nests under your eaves. Spiders that spin webs endlessly. Are you waging a constant battle to get rid of household pests? If you're like me, you don't like using poisons or traps, especially if you have small children. Until now, there weren't other options. Fortunately, now there is a solution.

Drive them away. Now, thanks to modern technology, there's a better way to get rid of household pests—the Transonic ESP. This remarkable new electronic device uses high-frequency sound waves to repel common pests. Best of all, the Transonic ESP doesn't trap or kill them—it drives them away. Pests are forced to flee the area to get away from the annoying and confusing sound waves. Therefore, there are no dead bodies or unsightly messes to clean up.

Ultrasonic/sonic repellent. The key to the Transonic ESP is a patented electronic sound generator which broadcasts powerful ultrasonic and sonic noises in the five to 50 KHz range. These frequencies and pulse sequences are extremely uncomfortable to insects and small rodents. Pests are forced to leave or die.

Why it works. Most wild creatures depend on their acute hearing abilities for survival. They rely on hearing mechanisms for communicating with each other, for establishing territorial boundaries and for locating available food sources.

When critical hearing frequencies are disrupted by high-frequency pulses, insects and small rodents feel threatened and confused. They are forced to leave. Remaining in the area causes apathy and immobility.

Just plug it in. The Transonic ESP comes with its own transformer which plugs into any standard outlet. To operate, simply press the appropriate button on the front panel. You can repel fleas, ticks, spiders, bats, mice, rats or squirrels, depending upon the sound frequency you select. (For optimum performance, follow proper pest control practices.)

Optional motion sensor. The Transonic ESP's optional motion sensor turns the unit on when pests approach, increasing the surprise factor and effectiveness. An optional 50 foot extension cord allows you to place the Transonic ESP unit in remote areas that don't have electricity, like the attic.

The versatile Transonic ESP is perfect for home, barn or storage shed.

Factory-direct offer. The Transonic ESP is an extremely cost-effective way to control pests. And through this special factory-direct offer, it's even more affordable. In order to introduce this product to the public, we're offering a $25 discount off the retail price. Right now, you can purchase the new Transonic ESP for only $99.

Risk-free. The Transonic ESP is backed by our exclusive 90-day risk-free home trial. Try it in your home, garage, barn—anywhere. If you're not completely satisfied, just return it for a full "No Questions Asked" refund. The Transonic ESP is also backed by a two-year manufacturer's warranty. Most orders are processed within 72 hours and shipped UPS.

Transonic ESP ..... ~~$124~~ $12 S&H
With special factory-direct offer $99
Motion Sensor ..... $39 $4 S&H
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Tired of battling pests?

Fleas and ticks. *Famous for causing skin discomfort, these pests also spread disease and parasites.*

Spiders. *Eliminate webs draped across your furniture and in the corners of your living room.*

Bats. *Dark places invite bats to roost. They can make a mess of your attic or storage building.*

Squirrels. *Gnawing squirrels in your walls or attic can cause structural and electrical damage.*

Mice and rats. *Well-known carriers of disease, rodents can be hard to get rid of once they have infested your home or office.*

The Transonic ESP covers an area of up to 5,000 square feet.

Are poisons and traps endangering more than just household pests?

Traps. In addition to the trouble of setting up a trap and the danger of accidentally stepping into it, you also face the unpleasant task of disposing of the animal once it is caught.

Foggers. Using a fogger is both time-consuming and inconvenient. You must cover up all of your belongings in order to shield them from the chemicals. You also must wait several hours for the fumes to disperse before re-entering the area.

Pest sprays. Exposing your carpet and furniture to chemicals can be potentially dangerous, especially if you have young children who are still crawling. Plus, chemical sprays are difficult to apply in a way that eliminates all the pests, especially the hidden ones.

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new user interface. All of the useful reference material you're accustomed to seeing in Bookshelf is still there: The American Heritage Dictionary, Third Edition; The Original Roget's Thesaurus; The World Almanac And Book Of Facts 1996; The Concise Columbia Encyclopedia, Third Edition; The Columbia Dictionary of Quotations; The People's Chronology; and the National Five Digit ZIP Code and Post Office Directory. New in this edition are the Concise Encarta 96 World Atlas and the Microsoft Bookshelf Internet Directory 96. This is one useful piece of reference material for $54.95.

Philips Media has recently released *Voyeur II*, which puts the player in the voyeur seat equipped with a video camera and perfect views of what's going on with the cast of decadent and power-hungry characters. Elizabeth Duran, the object of your obsession, is played by Jennifer O'Neill from the movie "Summer of '42." Elizabeth has inherited a lucrative biomedical institute from her murdered colleague and lover, Dr. Everett Cussler. Elizabeth is prepared to risk her own life to find out who killed Everett. The player must now try to prevent Elizabeth's murder by piecing together the Cussler family's twisted story. You can catch an eyeful of Voyeur II and help save Elizabeth for $49.95.

A second interactive game from Philips Media is *The Improv Presents: Don't Quit Your Day Job*. It makes you a Hollywood talent scout looking for the hottest new comic for late-night TV. Everyone you meet thinks they're funny. The game lets you wander a 3D rendered version of the Improv in Los Angeles. The disc costs $49.99.

3D Landscape from Books That Work is a new CD-ROM that lets you create realistic views of what your landscaping *could* look like, but probably doesn't right now. You can create 3D views of your layouts, walk through virtual tours of your garden, select plants from an expandable 800+ plant database, observe seasonal changes to your planned garden, and more. A shopping list feature automatically keeps track of your planting budget. Mouse clicks place trees, shrubs, flowers, pathways, fences, and walls into your design. The large plant database will help you select the right plants for your particular climate and desired floral effect. Now if only the software could keep some of my plants alive.

Corbis sent me two interesting titles for this month: *Volcanoes: Life on the Edge* and *Critical Mass: America's Race to Build the Atomic Bomb*. Volcanoes, of course, deals with volcanoes—lots of them. Photojournalist Roger Ressmeyer has captured the world's most spectacular volcanoes on film, and you get to accompany him on his travels around the world. Plenty of photos, maps, documents, paintings, and artifacts reveal the science and history of volcanoes. You can also visit famous eruptions from the past, such as Pompeii, Krakatau, and Mount Pelée.

Explore a 3D rendered version of the Improv in Los Angeles in The Improv Presents: Don't Quit Your Day Job.

Critical Mass takes you back to wartime Los Alamos in America's quest to be the first to develop an atomic bomb. It truly was an unprecedented effort, and one that won the war for us. Critical Mass introduces you to the people behind the effort, the scientific principles involved, the apparatus that was constructed, the effects that the bomb had on the war, and more. The two Corbis titles are $49.95 each.

The 11th Hour is now available, and I finally got around to checking out a copy. It is well worth taking a look at. In this Trilobyte game, players assume the role of Carl Denning, an investigative reporter for the TV show "Case Unsolved." Players follow Denning as he searches for his producer/lover, who disappeared during a murder investigation in Henry Stauf's hometown 70 years after the original tragedies of the 7th Guest. Some gamers report that the interface is a little slow. It seems to take forever to move from one location to another. But if you liked the 7th Guest, you are likely to enjoy this sequal.

Macmillan Digital USA has released *Planet Earth: Explore the Worlds Within*. Users explore the world, and the worlds within it, in this multimedia combination of an atlas and an ency-

continued on page 67

WHERE TO GET IT

Books That Work
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Digital Satellite TV?

Should I own or not?

What does it really cost?

Can I get my local stations?

Will it work on my set?

Can I use it with two TVs?

Do I still need an antenna?

What else do I need?

Can I block channels?

What if I need help?

What does the red button do?

What about surround sound?

Should I disconnect my cable?

How big is it?

Any *more* questions?

If you're a little fuzzy about digital satellite TV, we can clear things up. Whether you choose to own the equipment or lease, we're the only nationwide retailer that offers RCA®-brand DSS, with DIRECTV® and USSB™ programming—or PRIMESTAR® service and programming—all under one roof. We've got the systems, we've got the accessories, we've got the answers. For a store near you, call 1-800-THE-SHACK℠.

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LETTERS

(continued from page 6)

in the oscillograph. Capacitors C1 and C2 cannot provide protection against the spikes and surges described above, and, in fact, aggravate the surges by providing an extremely long peak-hold for the highest voltages.

Second, the design rules for CMOS devices require that the power supply voltage must be turned on before the inputs. If fuse F1 opens or is intermittent, IC2 will be destroyed because its inputs will be powered from the ignition source without a Vdd supply; IC2 can also be damaged by the spikes at the ignition source, which are always higher than those at the battery. As a minimum, the inputs need a 10,000-ohm series resistor and a diode clamp to Vds.

Finally, the maximum Vds for Q1 and Q2 is –50 volts DC. Given the surge voltages that might be present, I would not feel comfortable with MOSFETs rated less than –80 volts DC.

Incidentally, the IRF9Z30 is a p-channel device. The symbol in the schematic is for an n-channel device.
C.H.
Tinton Falls, NJ

Thank you for an interesting and informative letter. I always welcome comments on my designs.

I am aware of the extremely hazardous electrical environment in a vehicle in which high-voltage spikes can destroy sensitive solid-state devices. That was certainly considered when I designed the Daytime Running Lights circuit (shown in Fig.1).

You might be interested to know that one of my designs containing a 555 timer and a 50-volt poser MOSFET transistor has been installed in about 10,000 New York City taxicabs for a couple of years now, and to my knowledge there has not been one failure.

The choice of the IRF9Z30 50-volt transistor was made for two very important reasons. First, it is an 18-ampere device that has a surge current rating of 60 amps. More important, its drain-to-source resistance is only 0.14 ohms, which allows the device to power the headlamp with about 1-watt of average dissipation. Higher voltage HEXFETs have much less current-carrying capability and also have considerably more drain-to-source resistance. That would result in excessive heat being dissipated—an unacceptable condition.

I cannot accept your statement that "If fuse F1 opens or is intermittent, IC2 will be destroyed because its inputs will be powered without a Vdd supply." I have performed tests with a CD4001BE to simulate that condition and have not been able to destroy the chip. While it is always good practice to follow design rules, the possibility that IC2 will fail if F1 opens is extremely remote.

There are other points in your letter that I would like to address. A vehicle with a properly operating charging system will have a battery terminal voltage between 13.5 and 15 volts while the engine is running. A voltage of 16.0 or more will overcharge the battery and indicates a fault in the regulator or alternator.

The maximum allowable Vdd voltage to 4000-series CMOS devices is 20 volts, not 18 as you state. There is a difference between the maximum power supply voltage rating and the absolute maximum voltage that can be applied. The value of capacitors C1 and C2 was selected to provide transient protection to the circuit, and they certainly do not aggravate the surges. If that was true then one would eliminate the capacitors entirely—an absurd conclusion.

A little analysis of the circuit will show why this is so. As you know, in an automotive application such as this, neither the voltage across the battery, nor the voltage across the alternator, has much significance. What is important is the voltage across C1 and C2.

There is a voltage drop of about 0.6 volts across D1 and D2. Assuming a worst-case scenario where the battery voltage is, say, 15.5 volts, C1 and C2 will charge up to 14.9 volts.

Now, in order for the voltage across the 100-µF capacitors to increase 5.1 volts to 20 volts, current from a voltage transient, through some unknown source impedance and the 15-ohm D1 or D2 resistance, must flow into the capacitors. The amount of steady-state current for 0.01 seconds is easily approximated.

The voltage increase across the capacitors is given by the expression:

volts = amperes × time/100-µF capacitance,

or

current = (5.1) (100 E – 6)/0.01 = 51 milliamperes.

You must realize that the voltage transient, through its inductive and resistive source impedance with unknown rise time, must deliver this current level into the capacitor for the full 10 milliseconds to bring it to 20 volts. 40 volts at 0.051 amps is 2 watts. It must do this with other normal electrical loads connected in parallel with the Daytime Running Lights circuit. I don't believe that will happen. Of course, because we do not know the values of all the unknown parameters, the only way to find out how much voltage C1 or C2 can handle is to examine each capacitor, under actual operating conditions, with an oscilloscope or other instrumentation. That is obviously not practical.

I am always interested to know if there are instances in which my designs fail in the field, so that I can take corrective action. In my opinion, no additional circuit protection is necessary. Let me know if you do build the circuit and experience a failure. On the other hand, if you need peace of mind, you can obtain very large-value capacitors, 1000 to 10,000 µF or more, to use in place of C1 and C2. Digi-Key is one source.— Anthony J. Caristi

BIO-STIMULATOR CORRECTIONS

In my article, "Build a Bio-Stimulator" (**Popular Electronics**, June 1996), the secondary winding of audio transformer T1 is 1000 ohm with a 500-ohm center tap. Do not use the center tap. Doing so will result in a serious reduction of the output, or no output at all. Cut and remove the (black) center tap lead.

Some readers who have built the circuit might have noticed a small ramp on the leading edge of the pulse, due to varying part tolerances from different manufacturers. To correct this, change R5 from a 15,000-ohm resistor to a 20,000- or 22,000-ohm resistor.—Robert A. Heil ■

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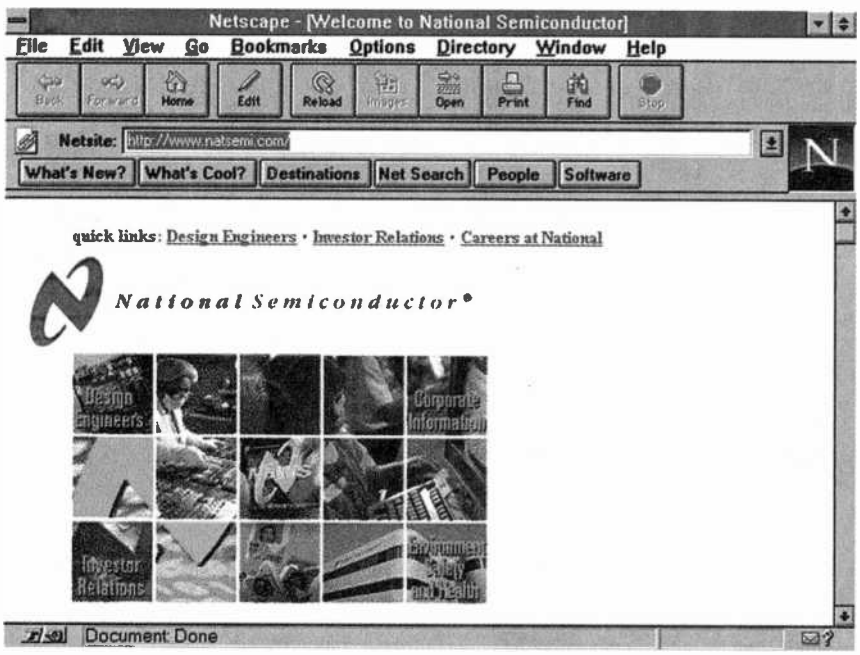
NET WATCH

National Semiconductor

BY DAN KARAGIANNIS

When I started writing this column exactly a year ago, I knew exactly what I wanted to cover in the first issue: A site that featured online versions of data sheets, and a site that offered electronic components for sale. As for the former, I was disappointed in the one I originally thought I would use. I ended up covering a different one (Harris) that turned out to be a good site as well. And as for the component-selling site, well ... I couldn't find one worth mentioning at all.



National Semiconductor's Web site lets you search for part descriptions and applications, making it a useful spot for any hobbyist to visit.

So now, on the anniversary of this column, it's time to make up for what I wanted, but couldn't have, in the first installment of *Net Watch*. Both of those sites are by companies that should be quite familiar to readers of this magazine: National Semiconductor and Digi-Key. Let's get right to them.

NATIONAL SEMICONDUCTOR

Flip through the pages of any issue of this magazine and take a look at the circuit diagrams—a lot of them have something in common. What is that, you ask? Well, when it comes to the ICs used, you'll find that most of them are either National Semiconductor parts, or parts for which National has an equivalent. That means it's likely you'd want to take a look at a National data sheet every once in a while.

In the past, consulting a data sheet has meant looking in a data book. National Semiconductor just happens to have enough data books to fill a small bookcase! Collecting all those books and looking through them is not always a possibility. Now, thanks to the National Semiconductor Web site, you can do away with endless page flipping.

As I mentioned earlier, I covered the Harris Semiconductor site in the November 1995 *Net Watch*. We also visited the Motorola Web page in April 1996. Both provide search engines and downloadable data, and the sites are really useful, but it always bothered me that National didn't have similar capabilities at their site. When I logged on recently, though, I was happy to see that National caught up with the pack.

When you first access the site you are presented with a few options: About National gives you some information about the company and the cities its branches are located in, Investor Information provides you with business details that are generally not of interest to the average hobbyist (unless you like investing, that is), and News at National gives you an insider look at the company's announcements.

The link we're most interested in, though, is the Search feature. When you select it, you are presented with four different search engines. The first one is Non-Technical Information, which lets you enter text relating to (you guessed it) non-technical data found on the site. In other words, if you'd like to find out about a new plant opening somewhere, or perhaps a job opportunity at the company, here's where you'd hunt.

The second engine is for those who like to browse through parameters, such as a part type or product category. This is the way to go if you don't know exactly which part you're looking for.

Now we get to the really neat engines. The Technical Information: Part Information Search lets you enter a part number, partial part number, or keyword to find what you're looking for. For example, let's say that you want to find an LM567. Simply type that into the box, and hit enter. You will be provided with the links to data sheets for the different types of chip (in this case, LM567, LM567C, etc.).

You have two options for receiving the data sheets: e-mail and downloading. Why anyone would choose e-mail as an option is a mystery to me; the download option lets you click on the file and get it right on the spot. The data sheet (it's actually a few pages) comes in a .pdf file, which means you'll need Adobe Acrobat to view it. If you don't already have the software

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installed on your system (many Net users find the need to download Acrobat at some point), you can download it from a link given at this site.

How's the quality of the file? By zooming in with Acrobat you should be quite pleased with how clear it is. And if you have a laser printer that can work with .pdf files, your printout should look pretty much just like the actual pages in a National data book. Of course, I had to compare them side by side to be certain, because I haven't opened a data book in months thanks to this site!

Also, the data sheets contain more than just specifications. They have a few simple applications on them as well. If you'd like to find a more advanced application, there's usually a link or two to one at the bottom of your Part Information Search result page.

If the only thing you are looking for is an application circuit, whether you know the chip you'd like to use or not, try the last of the engines: the Technical Information: Application Notes Search. That lets you enter any text at all to search through National's application notes and related documentation. You'll be surprised at how many circuits there are floating around this site. Even though they are hidden in these applications documents, the number of schematics you'll come across rivals any circuit-cookbook site I've seen.

Back on the main homepage, there are a few more menu choices: Design Engineer Resources gives you links to the search engines just described and to ordering resources for various types of documentation. Environmental Health & Safety and Community Care are links that let you know what National is doing to give something back to the community. Careers at National lists current job openings at various sites. Finally, Comment lets you get in touch with the company.

DIGI-KEY

Just like National's parts are found in many of the circuits in this magazine, most of the parts themselves can be bought from one source: Digi-Key. In fact, you've probably seen them mentioned as a source numerous times in this magazine.

When you access this great site, you are presented with a few options. Let's get to them now.

Product Finder lets you search for a product, view current pricing, and check stock status. The information is updated daily. There are currently two ways to find a product. The first is a part-number search; just enter a Digi-Key part number or a part number from a manufacturer that they stock. The second is a product lookup, which uses menus based on product type (of course, this is a slower way to search).

HOT SITES

National Semiconductor
http://www.natsemi.com

Digi-Key
http://www.digikey.com

When you have found the part you need, just click on the part number. Information on stock status and pricing is available. If your browser doesn't support tables, click on the non-table version.

You will also be presented with a link to a .pdf file of the page from the Digi-Key print catalog in which the item appears. You can use that file with Acrobat (as we discussed earlier).

Electronic Catalog is a link that lets you download a complete Digi-Key catalog in .pdf format. The most current copy of the catalog is always available.

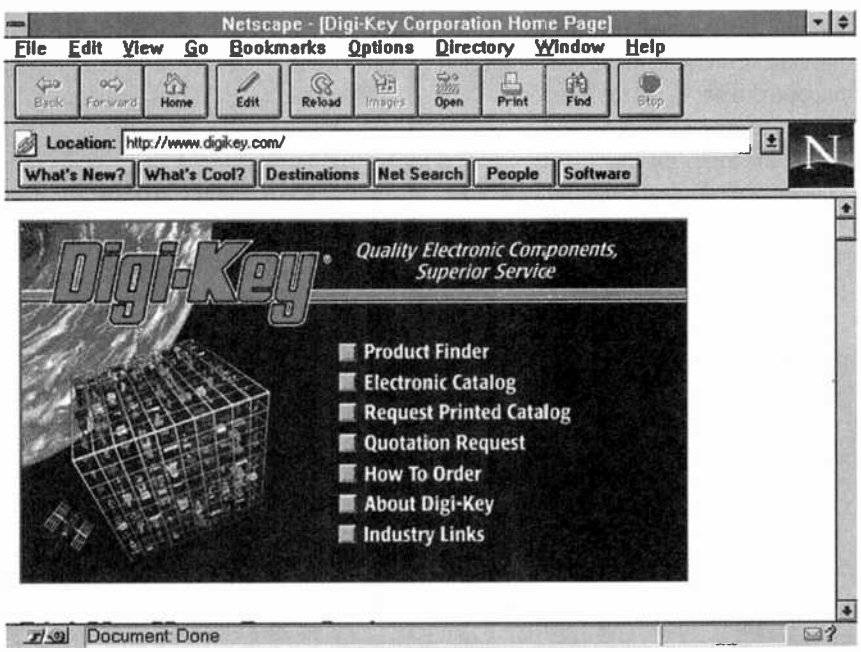
Request Printed Catalog allows you to do just that. Despite how handy online data is, sometimes you're away from your computer.

Click on Quotation Request for pricing on production-run quantities. Some of you out there might consider selling kits of your own circuits, after all.

Selecting How To Order will provide you with all the ways to get those products you might choose. For those without a credit card, it's possible to download an order form (yes, in .pdf format).

There is an About Digi-Key link that gives you information on the company history, a corporate profile, and a message from the president. You might also want to check out the Industry Links, which let you jump to industry-related sites.

Before I sign off this month, I'd like to mention a hot new spot on the Web that you'll be hearing more of in the months to come. That's our site at http://www.gernsback.com. In addition to the issue information there now, there will be downloadable files and even a searchable index of back issues in the months to come. If you have any questions or comments feel free to e-mail me at peeditor@gernsback.com or snail-mail me at *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735.



Digi-Key's site features an online part search and daily updated warehouse stock information.

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GIZMO®

The Eyes Have It

ES5000 EYE-CONTROL HI8 CAMCORDER. Manufactured by Canon U.S.A., Inc., One Canon Plaza, Lake Success, NY; Tel. 516-488-6700. Price: $2200.

By virtue of our job description, a lot of gizmos pass our desks. Many of them are interesting, some are "cool," others merely gimmicky. A rare few are truly innovative. The *Canon ES5000* Hi8 camcorder definitely is.

The camcorder's main claim to fame is an optical system called Eye Control that allows the movement of the user's eye to control the focus and to operate a variety of functions. The ES5000 also boasts the world's longest optical zoom and highest resolution color LCD viewfinder.

Canon has long been active in the research and development of optical and medical-diagnostic equipment. That expertise translates nicely into a consumer product that, in the words of Canon Video Division director and general manager Ted Ando, "demonstrates the potential of the human-machine interface that is expected in the 21st century."

In the case of the ES5000, the interface is virtually seamless. A brief calibration procedure acquaints the camcorder with the particular workings of each user's eye. Three user memories are provided to store settings. Two are "permanent" ones intended for frequent users (although they can be erased and recalibrated at any time). An additional "guest" setting allows a third person to use the camcorder without messing up either of the stored settings. Each time the guest setting is used, the previous calibration is automatically canceled, so anyone can use the ES5000—assuming, that is, that its owner is willing to share it.

You can calibrate the camcorder in, well, the blink of an eye. (See the box for a technical explanation.) After turning the program dial to the CAL position and setting the EYE CONTROL switch to 1 or 2, you look through the viewfinder and push the START/STOP button. A flashing yellow dot appears at the right side of the LCD; you must stare at it until it stops flashing. The procedure is repeated with a flashing dot on the left side of the LCD; when that one stops flashing, you're through. It takes less than 30 seconds. By repeating the calibration in different shooting situations, such as low or bright light, the camcorder learns still more about the user's eye functions, and becomes more accurate.

There are a few potential calibration pitfalls, although most are easy to avoid by following the basic rules of videography—hold the camcorder steady, look straight into the viewfinder—and trying not to blink. We were concerned, however, with the manual's warning that Eye Control works better if you don't wear glasses. That had one very near-sighted tester worried—needlessly, as it turned out. Wearing eyeglasses didn't seem to have any negative effects on the calibration process.

In no time at all, we were using our eyes to focus the camcorder. We knew that the ES5000 was properly calibrated because a box in the LCD tracks the eye's movements, letting the user know precisely what part of the image the camcorder is focusing on.

We expected to need some time to adjust to this new way of shooting video. Instead, the only thing that took time getting used to was the new-found freedom that Eye Control offers. At first, it felt strange not to be shifting the camcorder and fiddling with controls. But we got over that *fast*, as we began to appreciate just how natural it is to let your eye do the focusing.

With most camcorders, your subject must be centered in the viewfinder for the autofocus system to work properly. When you use the ES5000, however, that's no longer the case. At a family vacation, for instance, you can focus on the kids diving off the end of a dock that's at the left side of your field of view, then simply move your eyes toward the float several yards out in the lake (on the right side of the viewfinder) as they swim to it and climb out of the water. There's no need to move the camcorder or mess with the zoom control. The focus remains on the subject whether it is near or far, stationary or moving, off-center, or even at full telephoto.

When you've got the hang of Eye Control focus, you're ready to try out the ES5000's on-screen "switches," which allow you to operate a host of camcorder functions using Eye Control instead of manual controls.

A couple of caveats: Only one function can be eye-controlled at a time, and none

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HOW EYE CONTROL WORKS

Canon's Eye Control mechanism, located in the ES5000's viewfinder, consists of a color LCD, a dichroic mirror, twin infrared LEDs (light-emitting diodes), a condenser lens, and a BASIS sensor. A dedicated microprocessor calculates the data collected by the Eye Control mechanism and activates the eye-controlled functions.

As shown in Fig. 1, the color LCD at the top of the viewfinder relays the image created by the camera to the eye by bouncing it off the mirror and through the diopter lens.

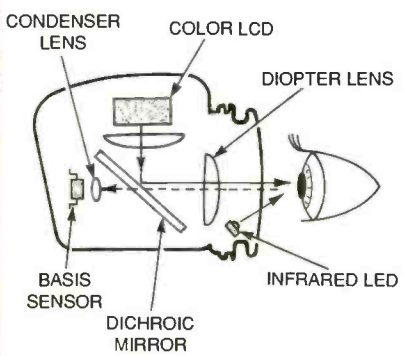

Fig. 1. Here are the basic components of Canon's Eye Control system.

A pair of parallel LEDs create an invisible beam of infrared light that illuminates the user's entire eye (Fig. 2). The light reflected from the user's eye and the center spots from the LEDs pass through the dichroic mirror—which is built to be transparent to infrared light while reflecting light of other colors—and are collected by the condenser lens.

The condenser lens then carries the reflected light to a sensor where the image of the eye and the position of the LED spots are detected. The sensor sends the information to the microprocessor, which identifies the center of the user's eye and the center of the LED spots.

It is the position of the center of the eye relative to the center of the LED spot that allows the microprocessor to calculate the rotation angle of the eye, which is how the camera determines which area of the viewfinder screen the user is looking at (see Fig. 3). The calculation occurs in a fraction of a second, so the Eye Control system responds almost as quickly as the user redirects his eye.

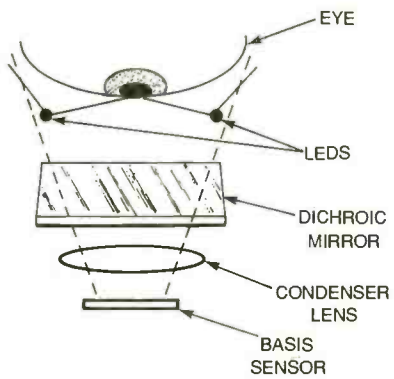

Fig. 2. This overhead view of the Eye Control system shows the twin LEDs illuminating the user's eye with an infrared beam. The position of the beam spots and the image of the user's eye reflect through the dichroic mirror and then pass through the condenser lens and are combined to form an image on the BASIS sensor.

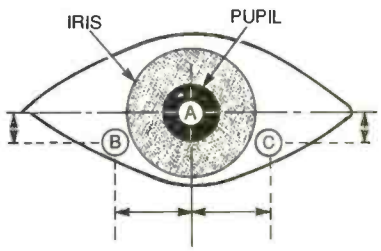

Fig. 3. This is a forward view of Eye Control. Based on information supplied by the BASIS sensor, a dedicated microprocessor calculates the rotation angle of the eye by identifying the center of the user's eye (A) relative to the center of the LED beam spots (B or C). This calculation allows the camcorder to determine where the user is looking.

can be accessed via the eye when you're using Eye Control to focus. Fortunately, all Eye Control functions can also be operated using the camcorder's buttons.

The FRAME LOCK button is located on top of the camcorder next to the viewfinder, within easy reach of the right index finger. Pressing FRAME LOCK freezes the focus in place and frees your eye to operate the other eye-controlled functions. It also comes in handy when taping a stationary subject.

When FRAME LOCK is held down for three seconds, a menu of seven "switches" appears in the LCD. As you keep holding the button down, an arrow moves down the list. When the arrow is pointing to the function you want, release the button to select it. The menu disappears, and the chosen "switch" appears in the viewfinder.

The seven functions that can be accessed via Eye Control are fade, date and time display, title display, record review, recording start/stop, white balance, and digital effects/mixing. Most of those are self-explanatory. Fade can be used to make the picture fade out and back in at any time, not just at the end of one scene and beginning of another. Record review lets you play back the last few seconds of tape and returns the tape to the end of the recording for a smooth transition.

Selecting digital effects/mixing calls up new menus. The digital effects include close-up, which magnifies the subject two times; strobe; freeze; art, which adds a paint-like effect known as solarization; mosaic, which breaks the picture up into squares by enlarging some of the pixels; and 16:9, which creates widescreen images. The digital mixing functions create different transitions between scenes. Overlap gradually dissolves one scene into the next. Scroll causes the first scene to scroll off the screen from left to right as the next scene scrolls in to replace it. Wipe opens the scene as if a curtain in a theater was opening, revealing the image from the center out to the sides. Zoom fade starts with the entire image shown as a tiny square in the center of the screen, and enlarges it to fill the entire screen. Fade trigger gradually fades the image in from black.

Using Eye Control to operate basic camcorder functions and special effects does not come as naturally as eye-control focus. In fact, we preferred to use the manual controls which, fortunately, are well-placed and easy to use.

A slide switch on top of the ES5000, which is usually in the 40× Zoom position, can be moved to either the effect or the mixer position using your left hand (with the camcorder held in your right hand, that is). Moving the slide switch reveals two buttons: The SELECT button is used to scroll through the effect or mixer options, and the ON/OFF button is used to activate or deactivate your selection. Using those manual controls, we were able to create all the special effects we wanted without turning off the eye-control focus or shaking the camcorder.

Even if we had fumbled with the controls, the ES5000's optical image-stabilization system would clean up after us—without degrading the image quality or reducing the field of view, as is often the case with electronic image-stabilization systems. The optical system uses Canon's Vari-Angle Prism (VAP) technology. A special silicon-based oil fills the area between two glass planes. When the camcorder moves, sensors detect any horizontal or vertical movement of the camcorder. That data is sent to a microprocessor that transmits information to prism actuators that adjust the prism's angle to compensate for camera shake by

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properly refracting light. There are several different compensatory programs for dealing with various types of movements, such as the slow vibrations caused by hand-held recording or the fast vibrations produced by shooting from a moving vehicle. The entire process takes a fraction of a second. In addition, the ES5000's image stabilization is proportional to the focal length of the lens, where electronic image stabilization systems apply a single level of compensation to the entire zoom range.

Image stabilization is particularly important when you're using a telephoto zoom, which also magnifies any bouncing or jittering. The ES5000's 20× optical zoom—the longest optical zoom range of any camcorder today—is coupled with a digital zooming feature that brings the range up to 40×, allowing the camcorder to capture images from 4mm wide angle to 80mm telephoto. According to Canon, its optical technology, in which light passes through a series of glass elements designed to work together for a more precise focal point, produces images that are noticeably sharper than those of electronic zooms. The only downside is a reduction of battery life.

The rotary zoom control is located just above and to the right of the viewfinder, where it can be easily controlled with your index finger. The control responds to varying pressure—push it all the way, and it turns quickly; nudge it slightly for slower zooming. Transitions are smooth and quick. The power zoom can travel its entire range in as little as four seconds or as long as 20 seconds, with seven speeds in between.

The ES5000 offers still more advanced features and functions. Its color viewfinder offers resolution not quite up to par with black-and-white viewfinders, but much better than any color ones we've seen before. With 180,000 pixels, the 0.7-inch viewfinder delivers an image with approximately 350 lines of resolution.

There are four pre-programmed auto-exposure modes—sports, portrait, sand & snow, and low light—as well as "easy recording" and "auto" programs for those who would rather not be bothered with settings. A dial at the top front of the camcorder, just above the lens, is used to select the mode. When the green rectangle that represents easy recording is selected, several advanced features (including digital effects and mixing) are off limits. In auto mode, you can have all the fun you want with the special effects, while the camcorder does all the work. Because the ES5000 is aimed primarily at serious and semi-professional videographers, it also offers manual control of focus, exposure, white balance, and shutter speed.

For editing, the camcorder is equipped

(Continued on page 29)

Kid-Style Keyboard

THE COMFY ACTIVITY CENTER KEYBOARD AND SOFTWARE. From Comfy Inc., 1054 Saratoga-Sunnyvale Road, Suite 10, San Jose, CA 95129; Tel. 800-99-COMFY. Price: $100.

Today's kids are incredibly sophisticated. Thanks mainly to television, they're exposed to people, places, and situations that previous generations didn't encounter before hitting puberty, if not adulthood. Yet as impressive—or frightening, depending on your point of view—as their social awareness might be, it pales in comparison to their technical savvy. The generation raised on "Sesame Street" and rental videos has an intrinsic understanding of anything that gets plugged in. Unpack a new VCR, and your kids won't need to glance at a manual to figure out how it works. (Neither will you—just let them explain it to you.) And it's not only the front panel they're comfortable with. Any kid with a videogame console has learned the ropes of connecting components to a TV.

All that technical know-how extends to the PC as well. Buy a computer for your home, and just *try* to keep your kids away from it. Older kids will have it up and running, and their favorite software installed, before you know it.

But the children don't have to be old enough to read—or even talk—to develop computer-mania. If they can manage to crawl over to the desk and pull themselves to a standing position, they'll be all over your keyboard, enjoying the clacking noises and maybe even noticing that when they hit the keys something happens on the screen.

Babies are fascinated by computers, but that doesn't mean you want them messing around with yours. In a perfect world, you'd be able to buy them their own kid-proof, kid-friendly PC, and not worry about them destroying yours. In the real world, there's the *Comfy Activity Center*, a keyboard and CD-ROM package designed for children aged one to six years old.

Minimum system requirements for using the Activity Center are an IBM-compatible 386/33-MHz PC with a dual-speed CD-ROM drive, MS-DOS 5.0 (6.0 is recommended), 2 megabytes (MB) free hard-disk space, 4-MB RAM, a VGA monitor, and a SoundBlaster or compatible sound card. The keyboard, when plugged into the parallel port of your multimedia PC, provides your kids with access to Comfyland, a world of fun and learning for pre-schoolers. It does *not* al-

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As an added bonus, the Comfy keyboard encourages parent-child interaction.

low inquiring little minds and busy little fingers to get into your Lotus spreadsheets, Quicken financial records, or the business presentation you've been developing for the past three weeks.

The Activity Center is designed with small kids in mind—no tiny keys imprinted with incomprehensible letters. Instead, its large, brightly colored buttons are emblazoned with recognizable pictures. On the left-hand side of the keyboard is a telephone handset that the child can use to talk to his new friends in Comfyland. A row of speed-dial keys, decorated with those friends' pictures, makes it easy for the child to "call" the party he wants. The center portion of the Activity Center features larger keys with pictures of musical instruments, used to make those instruments play music on screen. A row of different-colored "color/music" keys, used to play music and paint colors on screen, spans the bottom of the keyboard. At the top is a "surprise roller" that changes the pace of the on-screen action and sometimes makes unexpected things happen. In the top right corner is a pause button. Below it are three buttons, "labeled" with a sun, a moon, and a cloud, that allow the user to change the time and weather in Comfyland.

Comfyland is located on the two CD-ROMs that come with the keyboard, and on other Comfy-compatible discs (readily available in computer stores and Toys-R-Us). The two included CD-ROMs are *Touch-n-See: The First Step*, designed for one-year-olds, and *Comfyland* for kids aged two through six.

Can a one-year-old really get anything from a computer? We were skeptical, even though our son had been trying to get his hands on our PCs before he reached his first birthday. In fact, he was only ten months old when he began his "tests" of the Comfy Activity Center. Even at that tender age, he had a blast.

We set the monitor and keyboard on the living room floor, and let Christopher figure out the rest. He headed straight for the phone, always a favorite plaything, and then began pressing buttons. It was difficult to tell if he was aware of cause and effect (pushing this button causes that to happen on the screen), but he loved pressing the buttons, watching the characters, and gabbing on the phone. We have to admit that we had a good time playing with it with him.

Touch-n-See has three levels of play intended to correspond to children's development between one and two years of age. The first level presents colors and sounds and introduces the characters who populate Comfyland. The second play level adds narration and introduces names for the colors, shapes, objects, and sounds that the child learned to manipulate in Level 1. The third level presents "exercises" in reasoning and comprehension. Kids learn to associate shapes with objects they see every day, interact with the characters, draw conclusions from observations, and put their past experience to use to produce a desired result. This is where cause and effect comes into play.

At 15 months of age, Chris was using the Activity Center differently than he had six months earlier—but not much more effectively. Having just entered his climbing stage, he preferred using the keyboard as a step stool to help him reach, and hug, the monitor. Although he now realized that pressing the buttons affected the action on screen, as he sat, stood, and jumped on the keyboard, he created a fast-changing, often random, collage of sounds and images that kept him utterly enthralled. He was not truly interacting with the on-screen characters, however.

Obviously, you'll have to supervise your toddlers' Comfy-time—at least until they're old enough to sit safely on a chair in front of the PC—and that's another bonus. Your child interacts not only with on-screen characters, but also with his parents.

Your participation doesn't end when your children graduate to "Comfyland." The included "Parents' Guide" not only explains the basics of installation and functions, but also contains a wealth of "Activity Suggestions." The booklet outlines the educational value of games in child development, and the specific ways in which the Comfy Activity Center is supposed to help your children develop motor, social, and thinking skills.

According to Comfy, the Activity Center enhances motor sensory skills by teaching children to correlate the objects on screen with those on the keyboard, distinguish shapes and colors, improve aural perception by becoming familiar with and changing the sounds of musical instruments, and relate what is seen and heard to what is done to the keyboard. Early language skills are honed as kids learn to call objects by their names; understand concepts such as "up" and "later"; formulate and express questions, warnings, and instructions; and learn about new concepts pertaining to the weather and time. New thinking skills include the abilities to remember characters, objects, sounds, and events; focus on particular stimuli, understand cause and effect; and appreciate the humor in the stories. Children can stretch their imaginations by participating in the story's plot and playing pretend games with the Comfy characters. Such interaction also helps kids learn accepted forms of behavior when playing with others, and introduces positive social values such as friendship, compromise, and respect. Finally, by presenting kids with positive experiences and feedback, as well as a sense of control over the keyboard, the Activity Center is said to promote healthy emo-

(Continued on page 30)

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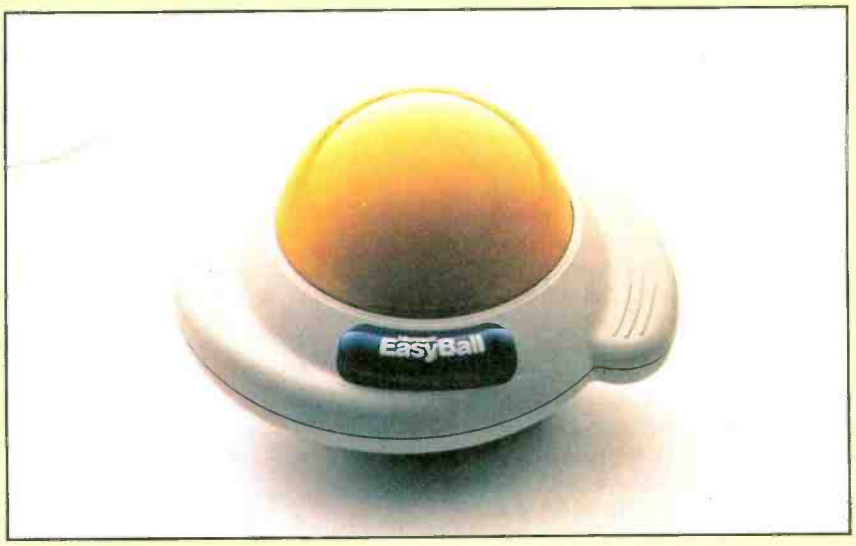
Easy Does It!

EASYBALL COMPUTER MOUSE FOR CHILDREN. From Microsoft Corporation, One Microsoft Way, Redmond, WA 98052-6399; Tel.: 206-936-6399. Price: $54.95.



Being a child means continually learning new skills, and children are always proud to master new feats. They are not always successful, however, because they have not yet developed the cognitive ability or physical agility and strength to do everything they'd like. If you've ever watched your children struggle to do something—climb up a slide, open a sealed toy, pour a glass of milk—that was simply beyond their level of development, you know how heartbreaking it can be to see the frustration on their small faces.

To design an input device for children aged two through six, Bill Gates' (who is learning first-hand about the triumphs and defeats of babyhood) Microsoft Corporation (which has a vested interest in creating happy new computer users) recently conducted studies in which young children were observed using several types of mice, two sizes of trackballs, a mouse pen, a tablet with pen, a touch screen, and a joystick designed for kids. Several conclusions were reached.

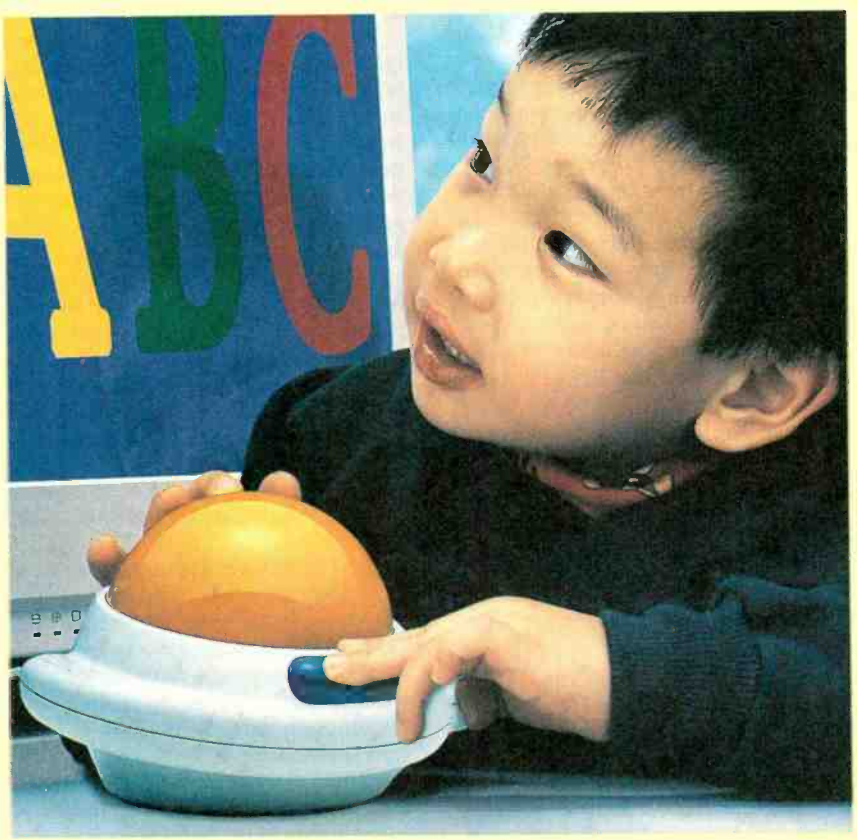
While both cognitive and physical abilities differed widely even among children of the same age, several factors remained true across the board. Large motor movements are easier for kids, so devices that require precise control are not well suited for young hands. The kids in the studies had trouble with the pen, tablet, and joystick, and even the mouse stymied many. Stationary devices tended to downplay the problem of inadvertently pressing buttons while moving the mouse (or moving the mouse when pressing its buttons). All the kids enjoyed repetitive actions, so the device would have to be rugged enough to withstand repeated pushing of its buttons. Kids expect a response from their actions, so they like to be able to feel and hear something each time they press a button. Too many buttons just confuse youngsters, who also have trouble locating the cursor on-screen. Finally, the younger children, in particular, have trouble reaching desktop controllers in most adult-sized home PC setups.

Taking those factors into consideration, Microsoft's design team came up with the EasyBall Computer Mouse, supposed to look like "a bright yellow sun surrounded by Saturn rings." Small enough for tiny two-year-old hands, yet engaging enough to hold a six-year-old's interest, the EasyBall is a yellow trackball ("Computer Mouse" is something of a misnomer) encircled by easy-grip white rings, with one large blue button that can be pressed with either hand. The stationary device can be placed on a desk or held on a lap.

Two CD-ROMs are packaged with the EasyBall. *Pointerland* allows children to pick their own cursor icons—larger and easier for kids to see—with such choices as an airplane, a rocket, an ant, or a baby chick. A farm scene in Pointerland allows kids to point and click to activate sound and animation. Two default software settings are used to adjust sensitivity and double-click speed, depending on the child's level of ability.

Once they've selected their personalized cursors, older kids will have little use for Pointerland. Microsoft's *Explorapedia: The World of Nature*, designed for kids 10 years old or younger, is more likely to hold their interest. The interactive multimedia encyclopedia teaches children about various natural habitats—rain forests, lakes, etc.—with animation, music, games, activities, and narrated text for pre-readers.

The EasyBall driver works with any software that supports a Microsoft-compatible pointing device. Its dual-input driver allows both the EasyBall and a sec-



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ond pointing device for adults to be connected at the same time, each in its own port if two are available, and replacing the user's existing mouse software with the EasyBall software. If only one serial port is free, an optional MouseSwitch adapter that will allow another pointing device to share a port with the EasyBall is available from Microsoft for $14.95.

The EasyBall will work with virtually any PC, even those with an 8088 microprocessor; MS-DOS version 3.1 or later, Microsoft Windows version 3.1, and monochrome video. You'll need a 3.5-inch high-density disk drive to install the mouse drivers, 4MB of available hard disk space, and Microsoft Windows 3.1 or later to run the software supplied on CD-ROM. Pointerland requires 4 MB of RAM and a VGA or better monitor; a sound board and headphones or speakers are recommended for Pointerland. The Explorapedia requires MS-DOS 3.1 or later, Windows 3.1 or later, a PC with a 486X or higher microprocessor, 4 MB of RAM (8 MB is recommended), 8 MB of available hard-disk space, a double-speed or faster CD-ROM drive, a 256-color VGA or a Super VGA monitor, a sound board, and headphones or speakers.

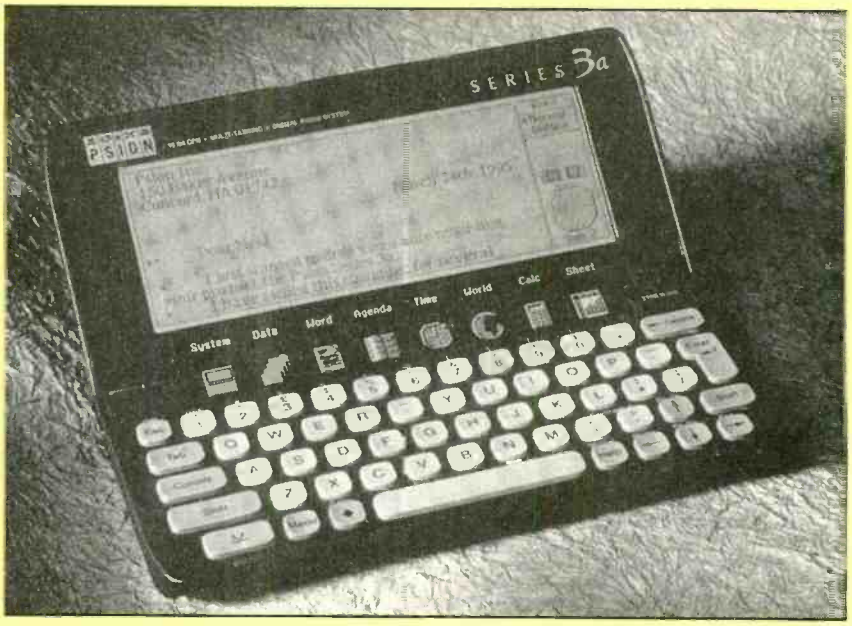
We put our three young product testers—Peter, aged 6½, Robert, aged 3½, and Christopher, 15 months—to work with the EasyBall, with mixed results. Christopher was simply too young to get the point (he preferred to sit on the thing). Peter, who has been using an ordinary mouse for a few years now, preferred to stick with what he was used to. He saw no advantage to using the EasyBall to play any of his favorite games; apparently, he has no recollection of his frustration when first learning to use a mouse.

Robert, on the other hand, was the ideal candidate for the EasyBall. His small hands were quite adept at manipulating the EasyBall, particularly when compared with his usual struggle with a standard mouse. He enjoyed sitting cross-legged, holding the EasyBall on his lap.

(By the way, Peter and Robert's mother—a few decades older than the target user group—also preferred the EasyBall to a standard mouse.)

The two younger kids exhibited no interest whatsoever in the Explorapedia. Peter browsed through it for a few minutes before asking to go back to playing "Putt-Putt Goes to the Moon." Maybe when the school year starts, he'll be able to put the Explorapedia to better use.

The EasyBall is a rugged, child-proof device. Microsoft claims that its single button has a life cycle of 10-million actuations. We can't back that claim, but we can attest to the fact that the EasyBall withstood being dropped, dragged, banged, tugged, and fought over. ■



Pocket Power

PSION SERIES 3A POCKET COMPUTER. From Psion Inc., 150 Baker Avenue, Concord, MA 01742; Tel. 508-371-0310. Price: $595.

As much as we've tried to avoid it, it finally happened: We can't live without our computers. That's true not only at our home or office, but anywhere we might find ourselves.

We got a laptop to solve the problem, but it wasn't a total solution. It was a good, reasonably lightweight machine, but it wasn't small or light enough. So we wouldn't always take it with us unless we were certain that we'd need it. Of course, we always ended up needing it, whether to get a phone number from our contact database, or to collect a file by e-mail.

Well, now it seems as if we've found a way to satisfy our thirst for data without putting undue stress on our weak backs: the *Psion Series 3a* pocket computer.

Get one thing straight from the start: The Psion Series 3a is not a desktop PC, and it's not a laptop PC. It's a palmtop PC. And depending on your frame of mind, it's either extremely limited or extremely powerful. We'll start off with its limited side.

First, the keyboard is virtually unusual for typing. The whole computer measures just 6½ × 5½ × 1 when it's opened, and the average key measures just over ¼-inch square. We knew from first glance that we were going to have to get used to becoming two-finger typists. Fortunately, a Psion representative let us know about a technique that everyone at the company uses: Hold the 3a in the palms of your hands and use your thumbs to enter information. That little tip saved us a lot of time and made us reasonably proficient at entering data and text.

The keyboard isn't the only place where small size is a problem. The screen is also on the small side (5 × 1¾ inches), its resolution isn't the highest (480 × 160 pixels), and it has no backlight. But let's be realistic here. The computer weighs under 10 ounces when its clamshell case is closed, it really will fit in a shirt pocket and it's powered by a pair of AA batteries that will last through up to 80 hours of use. Pretty amazing, huh? What's even more amazing is how much functionality Psion was able to pack into the machine.

The computer is powered by a V30H NEC microprocessor, which is compatible with the 80C86. The operating system is not DOS based, but instead is custom-written—probably a good thing if you want to achieve speedy performance. Even so, the data file formats that the applications create are compatible with mainstream DOS, Windows, and Macintosh applications.

The software built in to the Series 3a includes a word processor, a database, a spreadsheet, a scheduler, a world time-clock, a spell checker, a solitaire game, and a digital voice recorder.

Most of the built-in programs can be accessed in two ways. The first is by a row of eight membrane keyswitches below the screen. The second is through the SYSTEM screen, which is called up by the first membrane switch. The other seven membrane switches are repeated on the system screen, along with applications that don't have their own switches: the spell checker, Patience (the solitaire game), voice recorder, and access to the program editor for the Psion 3a's OPL language.

As you might expect, the word pro-

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cessor is normally our most often-used computer application. We expected that the Psion version would be enough for typing short notes and memos. We weren't ready for its power.

The word processor includes basic wordwrap and search-and-replace capabilities, and the 3a's spell checker/thesaurus program can be accessed from within the application. Three type fonts (Proportional, Pica, and Elite) are available. Each font can take on a number of sizes, and can be underlined, italic, or bold.

The display isn't WYSIWYG (what you see is what you get). Although it can indicate the font; and bold, italic, and underlined characters, character size is not indicated. That's just as well—we wouldn't want to look at 20-point type on a screen 1¾ inches high. Most of the font settings are seen only when a page is printed.

The word processor has an outline mode that makes large documents easier to work with and to keep organized. Text from other documents or other applications can be imported into the word processor with ease. Templates and paragraph styles allow for quick and easy document formatting.

The default word processor screen shows 11 lines of 52 characters. However, five zoom views are available to make the screen characters larger or to allow more information to fit on screen.

We didn't have the parallel link that we would have needed to print from the Psion Series 3a. So any files we created we saved either as plain text files or in the RTF (rich text format). That way, they were compatible with Microsoft Word and other word processors. We could use our serial PCLink to move the files over to our main PC.

The database application is intended mainly for storing contact information—names, addresses, and phone numbers. Information is stored in fields on a series of "labels."

When the program is first started up, the labels have fields for names; home, work, and fax numbers; addresses; and notes. However, choosing "Edit Labels" from the menu allows the labels to be customized so that you can store and manipulate any kind of data you want.

"Agenda" is a powerful organizer for maintaining your schedule and notes. What we like best is the way it lets you view information in multiple ways. For example, you can scroll through your appointment book day by day, or, with the press of a key, view your schedule a week at a time.

Another keypress, and you can view a year planner, which shows symbols for selected entries over an entire year. We preferred the List view, which shows a list of entries in date order. A to-do view is also available, and an anniversary view shows all anniversary entries, month by month. The appearance of those views can be customized to match your preference.

The spreadsheet application is intended to let you store all kinds of numerical information and to perform calculations based on the entries. It is patterned mainly after versions 1A and 2 of Lotus 1-2-3, and, therefore, its operation is pretty standard.

Although the spreadsheet application normally works in its own file format, files can be saved in other formats as well: WKS, WK1, and DIF. Files in those formats can be opened on the Psion as well. Not everything can be transferred successfully, however. For example, a Lotus WKS file will come through with all information intact. However, the spreadsheet application can't understand Lotus macros. The cells containing the instructions making up the macro will come through OK, but you can't run the macro on the Psion 3a.

The calculator program performs functions similar to a pocket calculator, but in a way that conforms to the keyboard of the 3a. The calculator can be set up in general, hex, fixed, and scientific modes, and it can also work along with the OPL programming language. If there's a function that is not supported, you can write your own function and call it up within the calculator.

The World and Time applications are important but normally act in the background. Time is always running, keeping the computer's real-time clock up to date, and ringing alarms for important appointments and reminders. The World application keeps track of where you are, so it can determine such things as whether to dial an area code before your contact's number.

The digital audio recorder is intended mainly to record short notes that would be used, for example, as alarm sounds—"Doctor's appointment!" for example. File sizes get large in a hurry—eight kilobytes for each second recorded. The microphone is built in, so recording is a snap.

A speaker is also built into the Psion 3a. Be careful! The speaker's permanent magnet can end up causing problems if you toss the unit on your desktop and it lands on top of any diskettes. The speaker can also work as a tone dialer for the contacts in your database.

The built-in applications do their jobs surprisingly well. But we were surprised at the amount of hardware add-ons and software programs that are available for the computer.

Psion offers software/hardware combinations to link the 3a to a PC or Macintosh, to connect it to a modem, or to allow it to send faxes. But log onto Compuserve or search through the Internet, and you'll find an unbelievable amount of shareware for the unit—everything from navigation programs to graphics applications. It's not too surprising that people are finding a lot of uses for the Psion 3a—it's a powerful pocketful.

Unfortunately, the solid-state disk drives used by the machine are not standard PC cards, but are proprietary to Psion. The same is true for the input/output ports, which require special hardware/software solutions.

The 3a multitasks; you don't have to shut down an application if you want to start another. For example, if you're in the middle of creating a document and you want to insert a name and address from the database, you can just hit the button to launch the database, highlight the text, and copy it to the document. Also, when you turn the power on, you're returned right to the spot where you left off. In addition, you don't even have to turn the power off. The 3a does it automatically after a few minutes of non-use.

All in all, the Psion Series 3a is a remarkable machine—and we didn't even begin to really test all of its potential capabilities. But now, we never leave home without it. ■

THE EYES HAVE IT

(Continued from page 25)

with a LANC terminal, making it compatible with just about any edit controller. For playback, it offers Hi8 video, hi-fi stereo audio, and the convenience of its own remote control, which can be used to make the viewfinder displays—titles, menus, etc.—appear on the TV screen. You can also turn the camcorder on and off, operate its zoom lens, and rewind the tape using the remote control.

Instead of the standard nickel-cadmium rechargeable battery, the ES5000 uses a lithium ion battery that is significantly smaller and lighter. Lithium ion batteries have no "memory effect," so it isn't necessary to fully drain the battery before recharging it. The included battery provides one hour of recording time; the 2½-hour BP-924 lithium ion battery is available as an option.

All of those functions and features—which, by the way, are housed in a camcorder that weighs less than two pounds and measures about 4 × 4 × 7 inches—contribute to the ES5000's high levels of performance and convenience. But they all pale in comparison to the ES5000's Eye Control technology.

Eye control focusing is so natural, so easy ... so *mindless*. You don't have to

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think about using it, any more than you'd have to think about moving your eyes while watching a ping-pong game, or your kids playing catch. You just look, and so does the camcorder.

Eye Control freed us to shoot more interesting, and more watchable, footage. We could put the camcorder on a tripod (zero shake) and keep the baby in focus as he chased the cats around the deck. At a graduation ceremony, we could seamlessly shift the focus from the graduate in the foreground to his alma mater in the background (as he artfully blurred out of focus) just by looking to the left side of the frame where the building was.

After a short time using the ES5000—and creating some of the best video we've ever shot—it's hard to imagine going back to the old way of shooting video. ■

KID-STYLE KEYBOARD

(Continued from page 26)

tional development in young children.

And it's fun, to boot! The Comfyland characters tell stories, attend a birthday party, or go to the zoo.

We had to recruit some older volunteers to try out the Comfyland software—our neighbors, Peter (6) and Robert (3). Peter was a bit too sophisticated for Comfyland, but Robert had as much fun playing in Comfyland as Christopher did with the Touch-n-See disc—without climbing or using his feet. He was well aware that pushing buttons caused things to happen on screen, and got a kick out of the whole thing.

Adding the Comfy keyboard to your home computer's printer port needn't stop you from getting work done. When you need to print something, it's easy enough to disconnect the Comfy keyboard. (The addition of an A/B switch, not included, would make it easier yet to go from work time to playtime.)

In our experience, the Comfy keyboard, when not plugged in, tended to find its way to the floor of our office—most often because Chris would see it on the desk, reach up, and pull it crashing down. He liked to pull it around by its cord or the telephone wire, and would sometimes use it as a chair or step stool. We're happy to report that the kid-friendly keyboard is also ruggedly kid-proof.

We can't say that playing with the Comfy Activity Center will turn our child, or yours, into an emotionally secure, clear-thinking, well-coordinated good citizen. At the very least, however, the hours that Christopher spent in front of the computer were more productive than those in front of the TV. ■

Weather Wake-Up

PERSONAL WEATHER STATION MODEL BA-312E ALARM CLOCK. From Oregon Scientific, 18383 South West Boones Ferry Road, Portland, OR 97224; Tel. 800-853-8883. Price: $69.95.

If you're like us, the first thing you want to know when you wake up in the morning is what kind of weather to expect that day. Will you have to leave extra time for your commute to work? Carry an umbrella? On weekends, it's even more important. Will it be a beach day? Will the family picnic get rained out? Should you just rent a bunch of videos and not leave the house all weekend?

We keep the clock radio tuned to a news station that provides traffic and weather updates every ten minutes. Unfortunately, as we're rushing through the morning routine, we can't always time it so that we're in the room with the radio during the 30 seconds or so when the weather is reported.

So we decided to replace that old clock radio with the Personal Weather Station from Oregon Scientific, which promised to give us around-the-clock weather information, as well as a digital clock with alarm functions. It would even warn us of impending storms.

The Personal Weather Station is a compact, wedge-shaped device that stands just 4.5 inches tall. Its front panel is dominated by a large LCD readout, which displays the time or date on top and weather information on the bottom. Bright-blue, high-contrast HiGlo™ backlighting is activated by pressing a wide bar at the top of the unit. Below the LCD is a row of five function buttons labeled MODE, ALARM, MEM, up arrow, and SET. The back panel contains a compartment for the four "AAA" batteries that power the unit, the Celsius/Fahrenheit switch, and a reset button.

The device provides only rudimentary alarm functions. There's no volume control (the alarm is relatively quiet) or snooze options.

The weather-forecasting and storm-warning system works by reading the barometric pressure, using a microprocessor-controlled sensor. It takes the Personal Weather Station about 24 hours to become acclimated to your location. Then, by monitoring the rate and consistency of barometric pressure changes, it displays forecasts that are generally 75% accurate for the surrounding 20- to 30-mile area (meteorologists don't seem to be much more accurate than that anyway).

Forecasts for the next 12- to 24-hour period are indicated by one of several easy-to-understand weather icons: a sun means clear weather, a sun and clouds for partly cloudy, clouds for overcast weather, clouds with precipitation mean rain or snow, and clouds with rain and lightning warn of thunderstorms.

When a sharp drop in barometric pressure is detected, the Personal Weather Station will warn you of severe storm by flashing the lightning bolts in the storm icon and sounding an alarm. The alarm beeps for one minute, or until you turn it off. If you're not there to hear it the first time, it will beep every three minutes to provide continued storm warnings until the forecast improves. That should make it quite likely that you'll be made aware of approaching bad weather.

The Weather Station turned out to be quite accurate during our early-summer trials. It was on target just about every day. At first, it was a bit disconcerting to wake up to a beautiful, cloudless day and see thunderheads on the weather station's display. But, if it's July in New York, when afternoon thunderstorms are common, you quickly get used to the fact that what appears in the display is not the current weather, but the forecast. And as hurricane/tropical storm Bertha wound its way up the eastern seaboard, the Weather Station flashed its lightning icon and beeped to warn us.

Unfortunately, while it's easy to read the symbols, it's more difficult to interpret them, especially when precipitation is predicted. Will it be a brief thunderstorm? Will the rain come at tonight or tomorrow? Will there be a dusting or a foot of snow? For that sort of information, you'll still have to turn on your radio or TV (or even your computer and Internet account)—and hope that their meteorologists will get the forecast right for a change. ■

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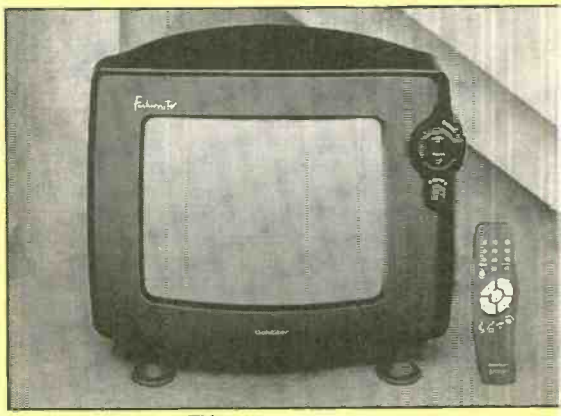
ELECTRONICS WISH LIST

Retro-Style TV

The *Goldstar Fashion TV Model GCT-1375M* from *LG Electronics U.S.A., Inc.* (1000 Sylvan Avenue, Englewood Cliffs, NJ 07632) combines "futuristic 50's tech" styling with 90's circuitry and functionality. The 13-inch set features a black-enamel cabinet and front bezel. Molded handholds make it easy to carry from room to room. Oversized round power/function knobs house a fully programmable digital tuner with red LED displays that strobe up and down when changing channels. The retro contours of the set are echoed in the design of the remote control. An oversized luminescent "dial" on the remote's face affords one-hand control of key functions. The Fashion TV offers audio and video input jacks, on-screen displays, programmable tuning, last-channel flashback, an earphone jack, closed captioning, and a sleep timer. Price: $219.95.



Goldstar Fashion TV

Professional Pager

Motorola's (North American Paging Subscriber Division, 1500 Gateway Blvd., Boynton Beach, FL 33426-8292) *Advisor Gold FLX* is the first alphanumeric pager to use the high-speed FLEX™ protocol, designed by Motorola to significantly increase the efficiency of data transmission. The palm-sized message center has a 30,000 total character message memory (the equivalent of 30 double-spaced pages of text) and a four-line, 80-character scrolling display. Its 43 text and numeric message slots include storage for 19 personal messages, 21 notebook messages, and three information services. Designed for business professionals, its advanced functions and large memory allow users to exchange increased amounts of information, which comes in handy for information services such as news, weather, sports, and stock quotes. To be alerted to incoming messages, the user can choose from eight musical tones or a silent vibration. Any personal message can be converted to an alarm that will sound at the specific time set by the user. Other features include battery life up to four times longer than that of ordinary pagers, a built-in alarm clock, and programmable on/off. Price: $319.

Motorola Advisor Gold FLX Pager

Multi-Mailbox Speakerphone

The *AT&T* (5 Wood Hollow Road, Parsippany, NJ 07054) *Digital Answering System Speakerphone 1841* records voice messages in solid-state memory chips. It offers instant playback; instant forward and repeat, to skip to any message; repeat and review, to play back specific parts of messages; and selective save and delete. Callers can leave messages in up to four different mailboxes, each of which has its own personal announcement. The message-transfer feature allows the answering system to automatically dial the user at another telephone or pager number when a new message is received. The user can then access the message remotely. The AT&T 1845 provides 26 minutes of recording calls for outgoing announcements and incoming messages. It also features a speakerphone, 16-number memory, a time/day stamp, audible message alert, new message playback, and voice prompts to guide the user through the command menu when calling from remote locations. Price: $179.99.

AT&T Speakerphone Digital Answering System

Go-Anywhere CD Players

Kenwood USA Corporation's (P.O. Box 22745, Long Beach, CA 90801) line of portable CD players, including the *Model DPC-761* pictured here, is intended for home, car, and portable use. "Skipping" during playback is virtually eliminated by digital anti-shock circuitry in the form of buffers ranging from three to ten seconds. The DPC-761 features a switchable 5- or 10-second buffer. The CD players provide crisp sound reproduction via dual 1-bit digital-to-analog converters and 8-times oversampling digital filters, and feature 20-track programmable memory and shuffle, scan, and repeat-play modes. All models include over-ear headphones and "lightning recharge" battery systems that, when used with Kenwood NiCd batteries, recharge the CD players in one-third the usual time. Most models also include car-cassette and cigarette-lighter adapters. Price: From $100 to $240.

Kenwood CD Player

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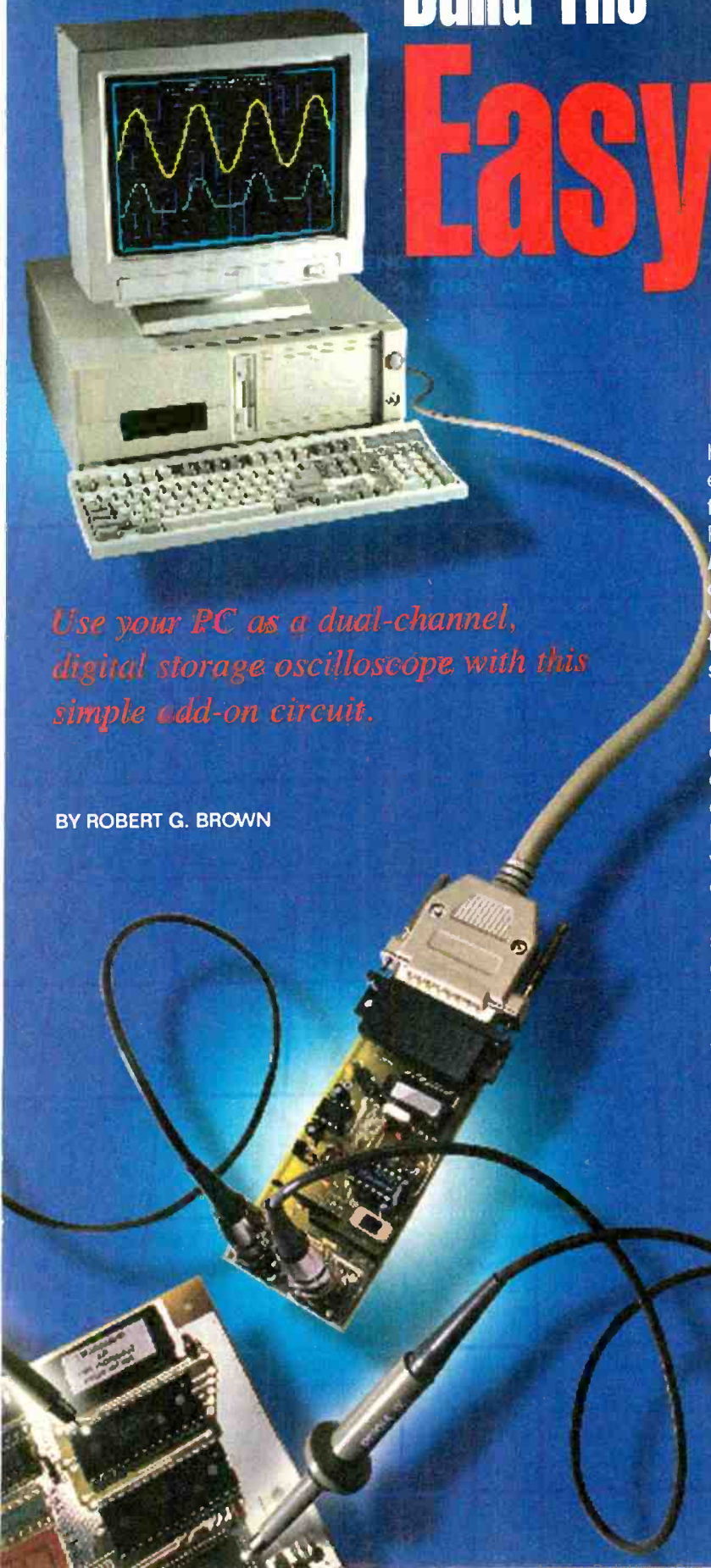
Build The Easyscope



Use your PC as a dual-channel, digital storage oscilloscope with this simple add-on circuit.

BY ROBERT G. BROWN

Most electronics hobbyists would like to have an oscilloscope. However, in most cases it is hard to justify the high cost of such a specialized piece of equipment. Luckily, there is another option for those with IBM-compatible computers. For as little as $85 you can build the *Easyscope* unit described in this article. It's an add-on circuit that you can plug into your PC's printer port, thereby converting the computer into a dual-channel, digital storage oscilloscope (DSO).

DSO Basics. Like an analog scope, a DSO allows you to view electrical signals on a display. But unlike an analog scope, a DSO converts the input signal into digital values by sampling the signal using an A/D converter. That gives a DSO several advantages over the analog scope.

For one, DSOs have the ability to view a single sampling of the input signal. They also have the ability to display the waveform from both before and after a trigger event. In addition, their ability to save data for later viewing or manipulation makes DSOs desirable. (Of course analog-scope proponents will point out that the disadvantage of a DSO is that you do not see what is happening to the input signal between samples.)

Easyscope Features. In some ways the Easyscope is like a typical DSO, but in some ways it's even better. As we mentioned earlier, it attaches to a PC's printer port, and therefore makes use of the host computer's processor and monitor. That way, the easy-to-use software written for the unit can replace a lot of expensive hardware, making

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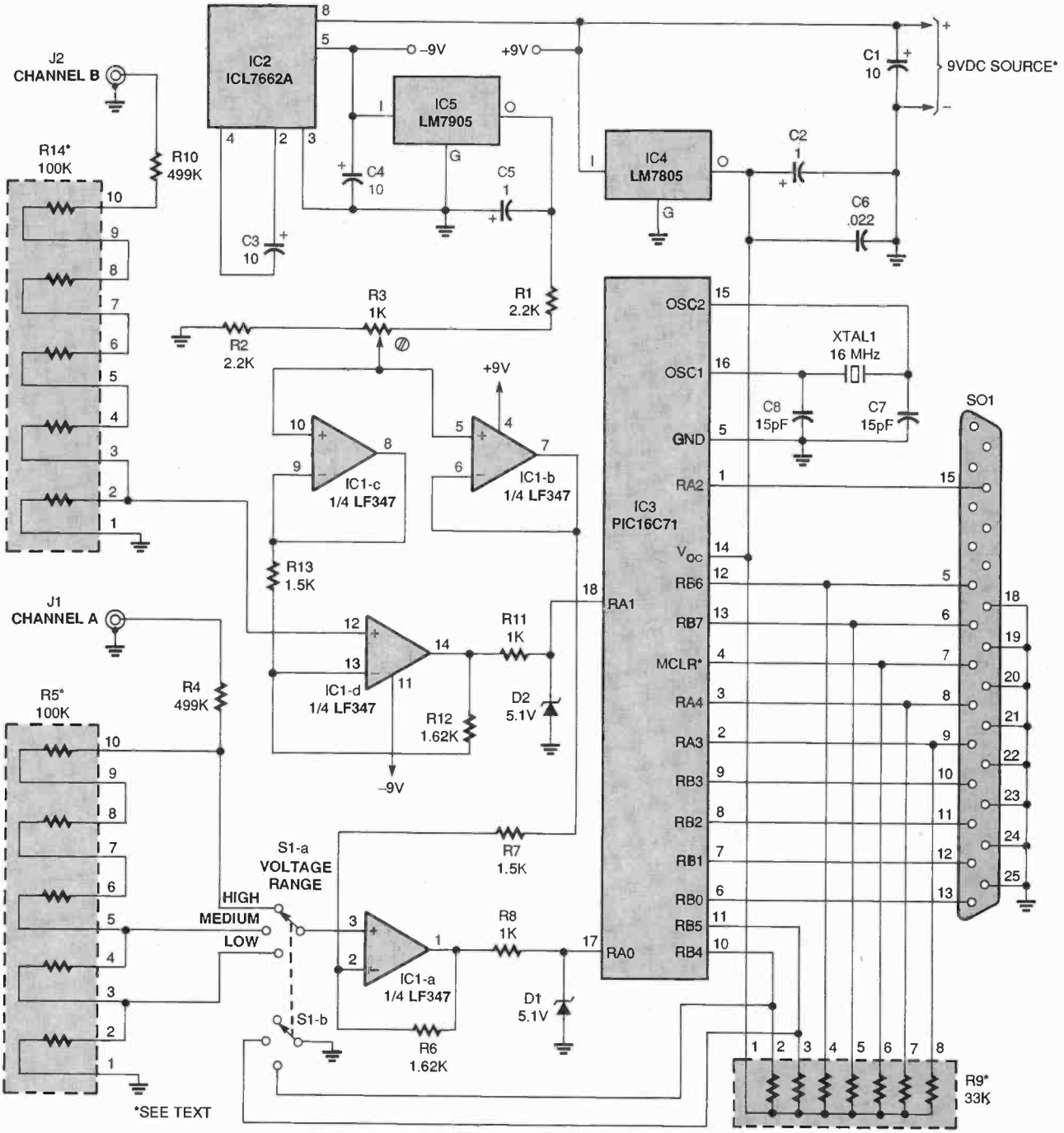

Fig. 1. The schematic for the Easyscope might look complex at a glance, but many of the functions are handled by IC3, a PIC16C71. As a result, this circuit and a PC can replace a complete oscilloscope.

the unit both affordable and easily portable (the board measures only 1.75 × 3.55 inches and can run off a 9-volt battery). If you own a laptop, you can have a completely portable test station.

But what about the Easyscope's actual performance? Here are some of its features: The unit has sample rates of up to 35 kHz, depending on the speed of the host computer. There's also a DVM feature for taking static voltage measurements. The usable voltage ranges are ±2.4, 6, and 12 volts with a 1× scope probe, and ±24, 60, and 120 volts with a 10× scope probe.

Circuit Description. The schematic for the Easyscope is shown in Fig. 1. Power for the circuit is supplied by a 9-volt DC source.

The circuit contains two sections: an analog portion and a digital portion. At the core of the project is a preprogrammed PIC16C71 microcontroller, IC3. The PIC16C71 is more advanced then the PIC16C5x series controllers used in many projects. In addition to the standard PIC features, the PIC16C71 includes a built in A/D converter, which operates in the range of 0 to +5 volts.

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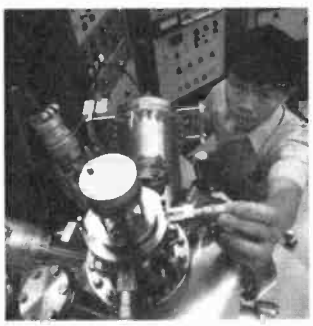

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The Easyscope circuit has two input channels that require signal conditioning before reaching the A/D; jack J1 is the input for channel A, and J2 is the input for channel B. The analog signal conditioning for channel A consists of IC1, an LF347 quad op-amp; a 2P3T switch, S1; and several resistors. The signal must first pass through a 1-megohm resistor divider network, made up of R4 and R5. That signal is picked off the resistor divider at one of three points by S1; those points correspond to an attenuation of 0.5, 0.2, or 0.1 from the original signal. The signal is then fed into pin 3 of IC1-a; the amp is set up in a non-inverting configuration with a gain equal to R6/R7 + 1.

Next, a 2.5-volt offset is injected into the signal. The offset voltage is generated by voltage-inverter IC2, negative-regulator IC5, and several associated passive components. The 9-volt source for the circuit is fed to IC2. That inverter, along with C3 and C4, provides a −9-volt source, which is fed into IC5 to produce a stable −5.0-volt reference voltage. That reference voltage is divided by the resistor network consisting of R1, R2, and trimmer potentiometer R3 to give a reference of about −2.3 volts (which can be adjusted using R3).

The reference voltage is buffered by IC1-b and fed into the inverting input of IC1-a (pin 2) through resistor R7. With a 0-volt input signal, the output of IC1-a at pin 1 should be about 2.5 volts. With a negative input signal, the output would be less than 2.5 volts; and with a positive input signal, greater than 2.5 volts. That output is fed through R8 into the A/D input of the PIC16C71. Zener diode D1 provides over-voltage protection for the A/D input—it prevents the input voltage from going over +5.1 volts and below −0.6 volts.

As you can see from the schematic, the signal-conditioning circuit for channel B is a copy of that for channel A, except that there is no switch to select the range. Channel B is set at the ±12-volt range on the PC board. There are provisions for a jumper block to be installed on the PC board to allow the same range selections as channel A, but more on that later.

The A/D converter within the PIC16C71 is set up to convert the analog voltage at pins 17 (RA0) and 18 (RA1) into the corresponding digital values from 0 to 255. The PIC16C71's internal timer interrupt provides a stable time base for sampling. On each timer interrupt the A/D converter is read, the value stored, and a new A/D conversion is started. If the sample rate is set for 10 kHz, then an A/D conversion must be performed every 100 microseconds. The timer interrupt

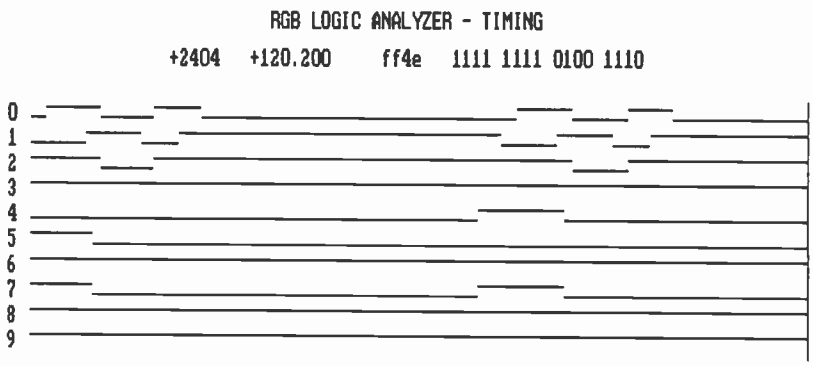

Fig. 2. Here's a timing diagram of the data transfer from the PIC to a PC, in scope mode. For an explanation of the signals, see Table 1.

Table—1

Signal	Purpose	Source	PIC Pin
0	REQ	PC	2 - RA3
1	ACK	PIC	1 - RA2
2	MODE A	PC	12 - RB6
3	MODE B	PC	13 - RB7
4	DATA 0	PIC	6 - RB0
5	DATA 1	PIC	7 - RB1
6	DATA 2	PIC	8 - RB2
7	DATA 3	PIC	9 - RB3
8	MODE C	PC	3 - RA4
9	RESET*	PC	4 - MCLR*

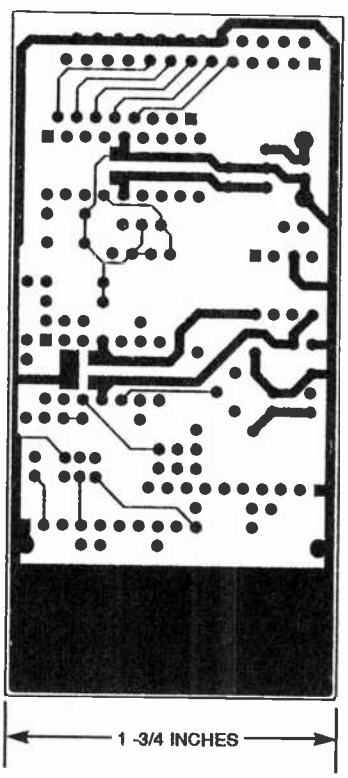

Fig. 3. This is the solder side of the Easyscope board.

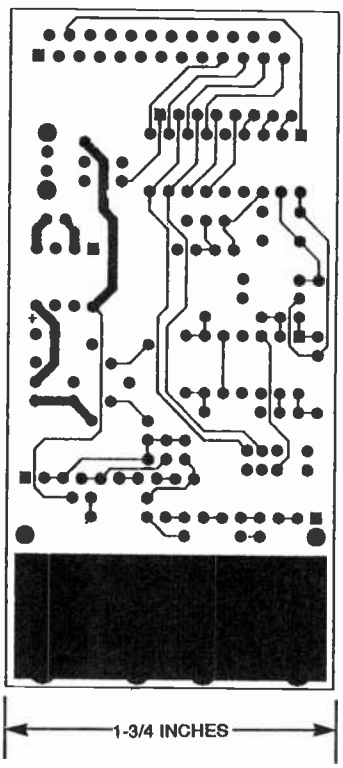

Fig. 4. Here's the component side of the board.

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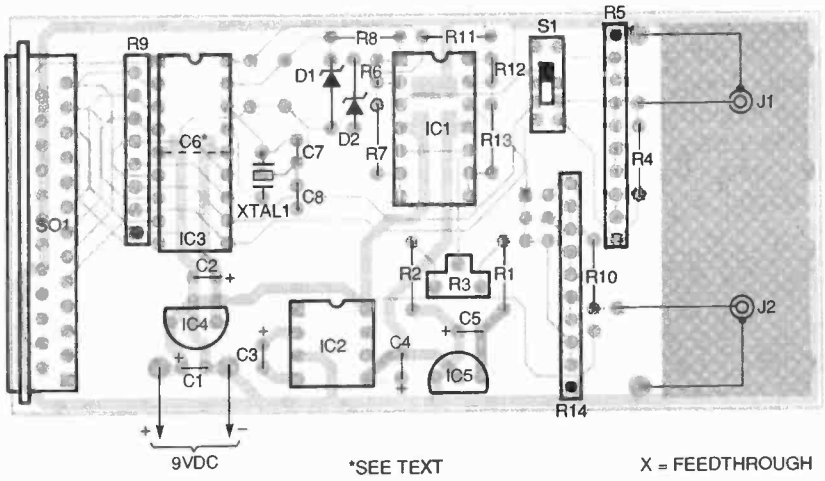

Fig. 5. If you're building the Easyscope on a PC board, use this parts-placement diagram as a guide. Note the feedthrough that must be installed, and also the surface-mounted capacitor, C6, which should be mounted to the solder side of the board.

Listing—1

```
ALTA ENGINEERING EASYSCOPE II Rev 1.0
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F1  - DVM mode
F2  - SCOPE mode : CONTINOUS  Channels 1
F3  - TRIGGER level :  0.00
F4  - TRIGGER slope : +
F5  - TRIGGER position : 4/8
F6  - ACQUISITION period : 100 uS  Frequency 10.00 KHz
F7  - ACQUIRE
F8  - CONFIGURE
F9  - INFO
F10 - exit
```

would be set up to interrupt every 100 microseconds. In between interrupts the data is transferred to the PC over the printer port (through SO1). The transfer occurs 4 bits at a time, using a REQ*/ACK* handshake.

The interface to the PC printer port consists of a total of ten signals: five are driven by the PC (those are inputs to the PIC16C71), and five are driven by the PIC16C71 (as inputs to the PC). One of the signals from the PC controls the PIC's reset pin (MCLR*), allowing the PC to reset the PIC at any time. Three of the signals coming from the PC are designated as MODE control—on a reset the PIC reads the MODE signals to determine what mode to start up in. Those modes include standard-scope, DVM-channel-0, DVM-channel-1, status/load-time-constant, and toggle-all-outputs (debug) modes.

Four of the PIC outputs are designated for data. The remaining two signals are the request- and acknowledge-handshake signals used for data transfers. Figure 2 shows a timing diagram of the data transfer from the PIC to the PC, in scope mode; Table 1 shows what the signals mean. The transfer of each 4-bit nibble starts with the PC asserting the REQ* signal. The * indicates that the signal is active low, so asserting the signal means to make it a logic low.

When the PIC has placed the data

Table—2

Value	Color
0	Black
1	Blue
2	Green
3	Cyan
4	Red
5	Magenta
6	Brown
7	Light Grey
8	Dark Grey
9	Light Blue
10	Light Green
11	Light Cyan
12	Light Red
13	LightMagenta
14	Yellow
15	White

PARTS LIST FOR THE EASYSCOPE

SEMICONDUCTORS

IC1—LF347 quad op-amp, integrated circuit
IC2—ICL7662A or TC7662A voltage converter, integrated circuit
IC3—PIC16C71 (preprogrammed) microcontroller, integrated circuit
IC4—LM7805 5-volt positive regulator, integrated circuit
IC5—LM7905 5-volt negative regulator, integrated circuit
D1, D2—5.1-volt Zener diode

RESISTORS

(All fixed resistors are ¼-watt, 1% metal-film units, unless otherwise noted.)
R1, R2—2200-ohm, 5% carbon-film
R3—1000-ohm trimmer potentiometer
R4, R10—499,000-ohm
R5, R14—100,000-ohm isolated resistor network, 10-pin SIP (contains five internal elements)
R6, R12—1620-ohm
R7, R13—1500-ohm
R8, R11—1000-ohm, 5% carbon-film
R9—33,000-ohm bussed resistor network, 8-pin SIP (contains seven internal elements)

CAPACITORS

C1—10-µF, 15-WVDC, tantalum
C2, C5—1-µF, 6-WVDC, tantalum
C3, C4—10-µF, 15-WVDC, electrolytic
C6—0.022-µF, surface-mount
C7, C8—15-pF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

XTAL1—16.0-MHz crystal
S1—2P3T switch
SO1—DB25 socket, PC-mount
J1, J2—BNC jack
Printed-circuit materials, enclosure, 9-volt power source, DB25 computer cable with two plugs, oscilloscope probes (2), wire, solder, hardware, etc.

Note: The following are available from Alta Engineering (58 Cedar Lane, New Hartford, CT 06057-2905; Tel. 860-489-8003; Web: http://www.gutbang.com/alta; e-mail: alta@gutbang.com): EASYSCII.ZIP software on a disk—$10.00 (postpaid); etched and drilled double-sided PC board—$30.00; preprogrammed PIC16C71—$50.00; complete board kit and switch—$85.00. Add $5.00 for shipping and handling. Connecticut residents please add appropriate sales tax. Visa and Mastercard are accepted.

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on the data pins, it asserts the ACK* signal. That indicates to the PC that the data is ready. After the PC reads the data, it releases the REQ* signal (brings it high) to indicate that the data has been read. Upon sensing this signal, the PIC releases the ACK* signal. The second 4-bit segment of data is transferred in the same manner except that the MODE A signal is set low during the transfer. The timing diagram in Fig. 2 shows the complete transfer of two bytes of data using the REQ*/ACK* handshake.

Construction. Although the Easyscope can be built using any method, to ensure a compact assembly, you should consider using a double-sided PC board with plated-through holes. If you'd like to make your own board, you can use the full-size templates of the solder and component sides shown in Figs. 3 and 4, respectively. Or you can order one from the source mentioned in the Parts List.

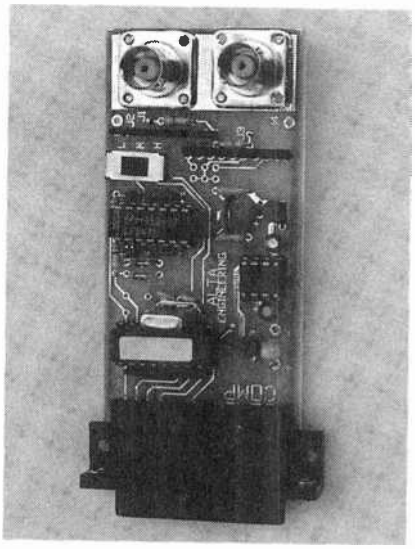
If you are building the unit on a PC board, use the parts-placement diagram shown in Fig. 5 as a guide. Begin by installing all the fixed resistors and capacitors. Both R6 and R12 should be installed vertically. When installing the resistor networks, be careful to note the placement of pin 1 (a dot designates it in Fig. 5). Also note the polarity of the electrolytic capacitors. The surface-mount capacitor, C6, should be installed on the solder side of the board between pin 5 and 14 of IC3, as shown.

Install the feedthrough (designated by an X), next. That can be a tiny piece of resistor lead. Insert it into the hole, and solder both sides. If you'd like to be able to switch the input attenuations of channel B, you can configure a jumper block for the open pads adjacent to the feedthrough. Otherwise, the channel will have a fixed setting, as mentioned earlier.

Go on to install the crystal. Solder trimmer-potentiometer R3 and switch S1 to the board. Then, mount D1, D2, IC4, and IC5, noting the orientation of all of them. Install IC sockets for IC1, IC2, and IC3 at this time as well, but only insert IC2 into its socket for now.

The use of scope probes and BNC connectors with the circuit is optional. If you want to use them, connect J1 and J2 as shown. Otherwise, simply connect clip leads to facilitate test-probe connections.

Next, attach the PC-mount DB25 socket to the board. The PC-mounting pins should plug right into the 25 holes on the board so that the output pins of the socket are at right angles to the board.



A really compact assembly for the Easyscope is possible when you use a double-sided PC board.

Before inserting IC1 and IC3, connect a 9-volt power source (a 9-volt battery will work fine) to the power-supply inputs. Measure the voltage at pin 14 of IC3; it should be +5 volts. Next check the voltage at pin 4 of IC1; it should be the same as the power source. Measure the voltage at pin 11 of IC1; that should read about the same as pin 4, but should be of the opposite polarity. Finally, check the voltage at pin 5 of IC1—it should be about −2.5 volts; adjust that voltage using R3 to about −2.3 volts. Once the voltages are all correct, remove power from the circuit and insert IC1 and IC3.

Of course, IC3 has to be preprogrammed to work with this circuit. You can order a programmed IC from the source mentioned in the Parts List, or, if you have the equipment, can program your own using the firmware available on both the Gernsback BBS (516-293-2283) and FTP site (ftp.gernsback.com).

Setup. In addition to the PIC firmware, you can also download the Easysope PC software (EASYSCII) from both the Gernsback BBS and FTP site. If you don't have a modem, you can get the software from the source mentioned in the Parts List. You will need that program that to let your computer work with the Easyscope.

Once you have the software in your desktop PC, connect the circuit to your computer's printer port using a short (three to six feet) DB25 cable with plugs on both ends. Do not use the Easyscope with a laptop until you have tested the circuit; an assembly error in the Easyscope could damage your laptop's printer port. Connect the power supply to the circuit and start the program EASYSCII on the PC. At first it might display a message indicating it could not find the configuration file. That is not a problem; press any key to clear that message.

A menu should be displayed that resembles Listing 1. Select option F8 (CONFIGURE). Answer the question about which printer port you are connected to (LPT1 or LPT2), with a 1 or 2 followed by an enter. You will then be prompted for color selections for channel A, channel B, and the grid color. Enter the desired color values using Table 2 as a reference. The colors can be changed at any time later.

Next, select option F1 (DVM mode). The program should now display a heading and the A/D reading for channel B, and then the voltage range (2.4, 6, or 12), the A/D reading in hex, and the voltage reading for channel A. Short the channel-A input to ground to give 0.0 volts as an input signal. Change the setting of S1 on the board; the voltage-range display should switch to match. Set the voltage range to 2.4 volts ("L" on the switch). Adjust R3 until the channel-A A/D reading is steady at 7F and the voltage reading is 0.0 volts. If you short the channel-B input to ground, the A/D reading for channel B should also be 7F. You can test the A/D operation for each channel by connecting the inputs to a battery. The reading should change according to the battery voltage. At this point the EASYSCOPE II setup is complete.

Using the Easyscope. During the setup procedure you've already used the DVM mode, so that needs no further explanation. The Easyscope has many more options, though.

The Easyscope's mode is selected by F2 (CONTINUOUS, SINGLE, or NOR-

(Continued on page 43)

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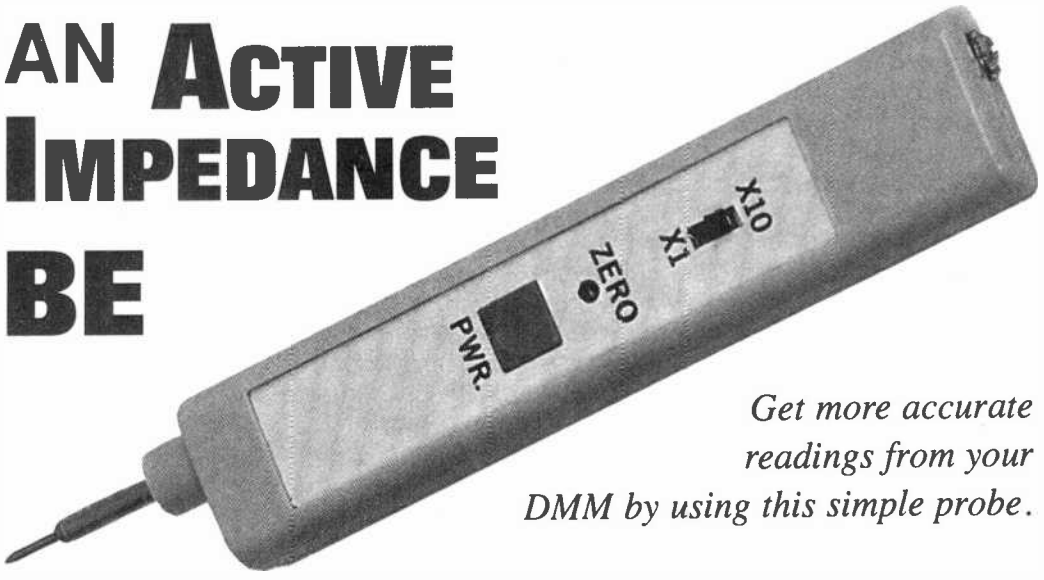
BUILD AN ACTIVE HIGH-IMPEDANCE PROBE



Get more accurate readings from your DMM by using this simple probe.

BY SKIP CAMPISI

It will probably happen, sooner or later: You'll be measuring voltage drops all around a high-impedance circuit, and things will not be adding up correctly. "What's going on?" you might then ask. As it turns out, it's very easy to ignore the high-impedance load present at a DMM's input, as most of the time it will not affect your reading. For that reason, the load is soon forgotten.

Those of us who have "cut our teeth" on old-style analog VOMs remember the load that a meter can put on a circuit; however, we've all been spoiled by the 10-megohm inputs on a modern DMM. When you're making voltage measurements in a circuit at impedance levels of 100,000 ohms or more, though, that 10 megohms in parallel starts adding a significant error to your reading!

The obvious solution to that problem is to raise the impedance at the DMM's inputs. That is exactly what the *Active High-Impedance Probe* described in this article accomplishes. It has an input impedance of 100 megohms, which necessitates the use of "active" circuitry for proper operation, and provides a truly high-tech solution to the circuit-loading problem. If you build the Probe, you will have an instrument capable of 0.5% basic DC accuracy, and a range of about DC to 100 or 200 Hz.

Circuit Description. The schematic diagram for the Probe is shown in Fig. 1. Notice that the circuit is very simple, consisting of only one IC and a handful of passive components.

Power for the Probe is provided by B1, a miniature 12-volt alkaline battery, which is typically used in cigarette lighters and remote controls. The battery will provide up to 1 milliampere of continuous current. With the components specified, current drain is less than 300 microamperes, which should ensure almost shelf-life for B1.

A TLC2254 quad CMOS op-amp (manufactured by Texas Instruments) was specially selected for use as IC1 in this application. (There are other types of op-amps that can be substituted when high performance is not necessary, but more on that later.) The parameters exhibited by the TLC2254 that are required for high performance in the Probe are its: input bias current of 1 picoampere, input offset

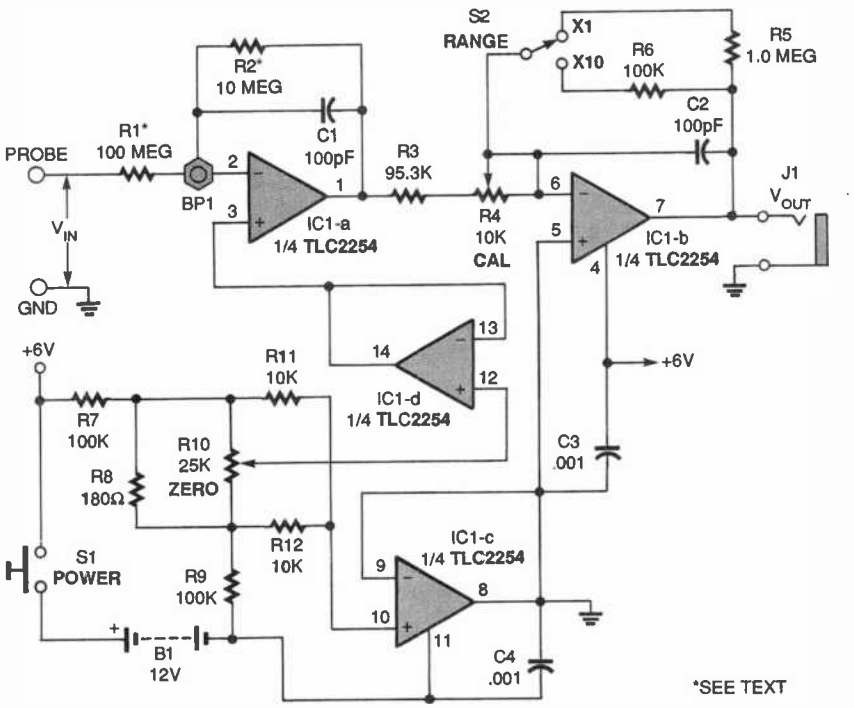


Fig. 1. Here's the schematic for the Active High-Impedance Probe. Note the placement of BP1 near pin 2 of IC1. That Teflon-insulated standoff will greatly help keep the circuit error free.

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voltage of less than 1 millivolt, rail-to-rail output voltage swing, stable output at capacitive loads of up to 1000 pF, and supply current of less than 200 microamperes.

Section IC1-a is configured as an inverting amplifier having a gain of −0.1, and IC1-b is an inverting amplifier having switch-selected gains of −10 ("×1") and −1.0 ("×10"). The overall gain of the circuit is then +0.1 at ×10 or +1.0 at ×1, which allows readings of up to ±60 volts peak with a fresh battery.

Section IC1-c of the op-amp provides the zero-volt ground reference to the circuit, and IC1-d allows the output to be nulled via R10, over a range of about ±5 millivolts. Trimmer potentiometer R4 is used for DC calibration.

Construction. The first step in building the Probe is to select its enclosure. The author's prototype was built into a standard logic-probe-type plastic case; however, you might want to use a shielded enclosure if you will be working in areas containing excessive RFI or 60-Hz line interference. Input impedances this high make excellent "antennas"; you might also want to increase the values of C1 and C2 from 100 pF to 1000 pF to further dampen noise pick-up.

The actual layout and technique used to build the circuit board is not critical to its performance; use any method that you prefer. The author's prototype was assembled on a 1- × 2¾-inch piece of perforated board, using point-to-point wiring. Whatever method you use, begin by mounting a 14-pin socket for IC1, as the chip is a CMOS device that's sensitive to electrostatic discharge (ESD). By drilling holes in the case and aligning the board, you can mount the two switches right on the circuit board.

The only critical "node" in the circuit is pin 2 of IC1, which will be processing signals in the lower nanoampere range. Those low currents can easily leak across a circuit board or through flux residue, and cause severe errors. The only insulators to be trusted at these levels are "air" and Teflon. (Interestingly, below about 10 picoamperes, man-made sapphire is used!) To avoid any errors, install a Teflon-insulated solder terminal (BP1) onto the board, near IC1. Wire it to the circuit as shown in the schematic.

Begin installing the resistors and capacitors at this point. Note that R1 (100 megohms) in the author's prototype is a composite resistor made up of 10 separate 10-megohm resistors connected in series. Metal-film resistors are the best choice here for temperature stability; however, standard ¼-watt, 5%, carbon-film units can be used successfully if they (and also R2) are all from the same lot and manufacturer. If you'd like to use a single resistor for R1, you can order a 100-megohm resistor from MECI (348 East 1st Street, Dayton, OH 45402; Tel. 800-344-4465); the unit is part number 490-0881, and only costs 20 cents. MECI also carries a 10-megohm resistor that you can use for R2; that's part number 490-1641, and costs 39 cents. Both MECI resistors are 1%, ¼-watt, metal-film units.

Resistor R1 should be suspended in the air between BP1 and the probe needle (labeled "probe" in the V_IN inputs shown in Fig. 1). If you're using 10 resistors for R1, make sure the resistor bodies are isolated from each other and everything else. One lead from R2 and one lead from C1 also go to BP1; make sure those components are also suspended off the board. Attach one end of a piece of Teflon-insulated hookup wire to BP1, and terminate the other end with one female pin from a "break-away" type SIP socket. Make the lead just long enough to reach from BP1 to pin 2 of IC1.

Select R6 (100,000 ohms) to be exactly 10% of R5 (1.0 megohm) for best accuracy. Capacitors C1 and C2 should be polystyrene units. When you're done installing all the passive components, double-check your wiring.

Solder a type-N-cell battery holder to the circuit. Then attach two short wires to the circuit to allow for connection to J1, the output jack. Install the board with the probe needle and battery holder into the enclosure. Mount J1 to the case and connect it to the two wires you installed.

It is now time to install IC1. As mentioned earlier, the TLC2254 chip will provide a great amount of accuracy. If you'd like to try substituting a different op-amp, *with a possible loss of accuracy*, here are some National Semiconductor parts you can use: LMC6024, LMC6044, and LMC6064. Texas Instruments also manufactures two other chips that can be used; those are the TLC27M4 and TLC27L4 op-amps. All the preceding ICs have the same power requirements and pinouts as the TLC2254 chip; however, you should still make it a habit to always check data sheets whenever making a substitution.

Keep in mind when making a substitution for IC1 that most of the preceding ICs have higher input-offset voltage specifications. For that reason it might be necessary to increase the zero-adjustment range of the Probe. To accomplish that, simply increase the value of R8 (which is specified as

PARTS LIST FOR THE ACTIVE HIGH-IMPEDANCE PROBE

RESISTORS

(All fixed resistors are ¼-watt, 1%, metal-film units, unless otherwise noted.)

R1—100-megohm (see text)
R2—10-megohm (see text)
R3—95,300-ohm
R4—10,000-ohm trimmer potentiometer, single-turn
R5—1.0-megohm
R6—100,000-ohm
R7, R9—100,000-ohm, ¼-watt, 5%, carbon-film
R8—180-ohm, ¼-watt, 5%, carbon-film
R10—25,000-ohm trimmer potentiometer, single-turn
R11, R12—10,000-ohm, ¼-watt, 5%, carbon-film

ADDITIONAL PARTS AND MATERIALS

IC1—TLC2254 quad CMOS op-amp, integrated circuit (see text)
C1, C2—100-pF polystyrene capacitor
C3, C4—0.001-μF monolithic ceramic capacitor
S1—Pushbutton switch, normally-open
S2—SPDT miniature slide switch
J1—2.5-mm phono jack
BP1—Teflon-insulated standoff, with solder terminal
B1—12-volt alkaline battery, type 23 (RadioShack 23-144 or equivalent)
Perforated board, logic-probe-type enclosure with needle, type-N-cell battery holder (RadioShack 270-405 or equivalent), 2.5-mm phono plug (should match J1), dual stackable banana plug, RG174 or similar coaxial cable (or twisted-wire pair; see text), wire, solder, hardware, etc.

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180 ohms)—doubling the resistor's value will double the adjustment range, etc.

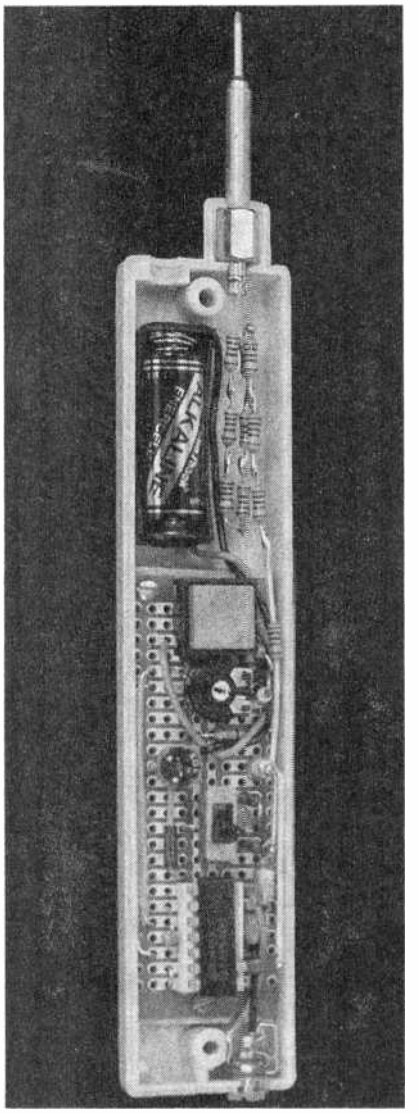
Also, most of the substitutes just mentioned will only be marginally stable when driving a coaxial output cable (more on that cable in a moment). To correct that you will have to build an output cable made up of a twisted pair of wires, rather than using the coaxial cable specified later. As you can see, substituting IC1 might be asking for more trouble than it's worth. However, the option is being provided for those who might have an easier time getting one of the other chips.

Prepare IC1 (remember, it's ESD sensitive) as follows: Carefully bend out pin 2 from the IC until it is at a right angle to the rest of the pins. Insert the package correctly into the socket, then slip the female pin attached to the wire from BP1 onto pin 2.

The circuit is now complete. You only need to install the battery in the holder and prepare the output cable. If you are using the TLC2254 IC, make the cable from a two-foot length of flexible coaxial cable (such as RG174). Terminate one end of the cable with a 2.5-mm phono plug, and the other end with a dual "stackable" banana plug. Keep in mind that if you use one of the substitutes for IC1 you will have to use a twisted pair of wire instead of coaxial cable.

Calibration and Use. With your DVM only, measure a voltage source of between 1- to 5-volts DC, and note the reading. Now connect the Probe to your DVM. For your Probe's ground lead, use your DVM's existing ground test-probe lead, "stacked" in the dual banana-plug ground terminal. (This stacked ground lead represents the V_{IN} input labeled "GND" in Fig. 1).

Short the ground lead to the probe needle, set S2 (the range switch) to ×1, and turn on the power by holding down S1. Adjust R10 (the zero adjust) for an output reading of 0.0 millivolts. (Note: As battery voltage decreases through usage, it may be occasionally necessary to readjust for zero mV.) Remove the ground lead from the needle, and apply the needle and ground lead to the 1- to 5-volt source. Hold down S1 and adjust R4 (the calibration trimmer potentiometer) for an output voltage equal to the value measured with the DVM alone. Set S2 to ×10 and the reading should be exactly 10% of the reading at the ×1 setting.



As this internal view of the Probe shows, the project can be assembled quite neatly within a standard logic-probe-type case, using perforated board and point-to-point wiring.

In actual use, the Probe is accurate, simple to operate, and fairly indestructible. Just plug it into any DMM, and apply the needle probe and ground lead to any DC or low-frequency voltage source within its range. Push in S1 and set S2 for the appropriate range: the ×1 setting yields a ±6-volt-peak range, and the ×10 setting provides a ±60-volt-peak range.

Make your reading, and multiply it by 1.0 or 10, depending on your setting of S2, the range switch. It is a simple matter to test the battery voltage itself, which will indicate your maximum input (and output) swing as the battery ages. Simply apply the Probe to a DC voltage greater than 6 volts in the ×1 range: the output will indicate 50% of the battery voltage and thus, the maximum output swing.

The Probe circuitry is fully protected from ESD damage, overvoltage on either range, and power-off conditions via the 100-megohm input resistance. For your own safety, do not attempt to use this instrument on line-operated equipment or high-voltage DC circuits; the maximum input should not exceed ±100-volts peak to avoid a potential shock hazard. ■

EASYSCOPE

(Continued from page 40)

MAL). That key also selects the number of active channels ("1" = A only; "2" = both A and B). In CONTINUOUS mode, the Easyscope will continuously sample the input signals and update the display; the trigger is not used. In SINGLE sweep mode, the unit will acquire and display a single sampling of the input signals using the trigger. In NORMAL mode, the Easyscope will acquire and display data using the trigger, like a sweep-triggered analog scope.

The F3 key allows you to set a trigger voltage level. Key F4 allows you to set the trigger slope as + or −. Pressing F5 allows you to select the position of the trigger in the acquired data in increments of ⅛. A selection of ⅝ means that all the displayed data will be from after the trigger (just like an analog scope). Selecting ⅜ means that ⅜ of the data displayed would be from before the trigger and ⅝ would be from after the trigger. With a little bit of practice it is easy to set up the Easyscope to acquire the waveforms of interest.

Option F6 allows you to set the acquisition period in microseconds. Key F7 starts the scope mode; the data is displayed on the graphics screen. To exit from the DVM or ACQUIRE mode just press the ESC key.

The Easyscope is an inexpensive and flexible test tool. The author welcomes questions and suggestions; contact him by telephone at 860-489-8003, or e-mail at alta@gutbang.com. ■

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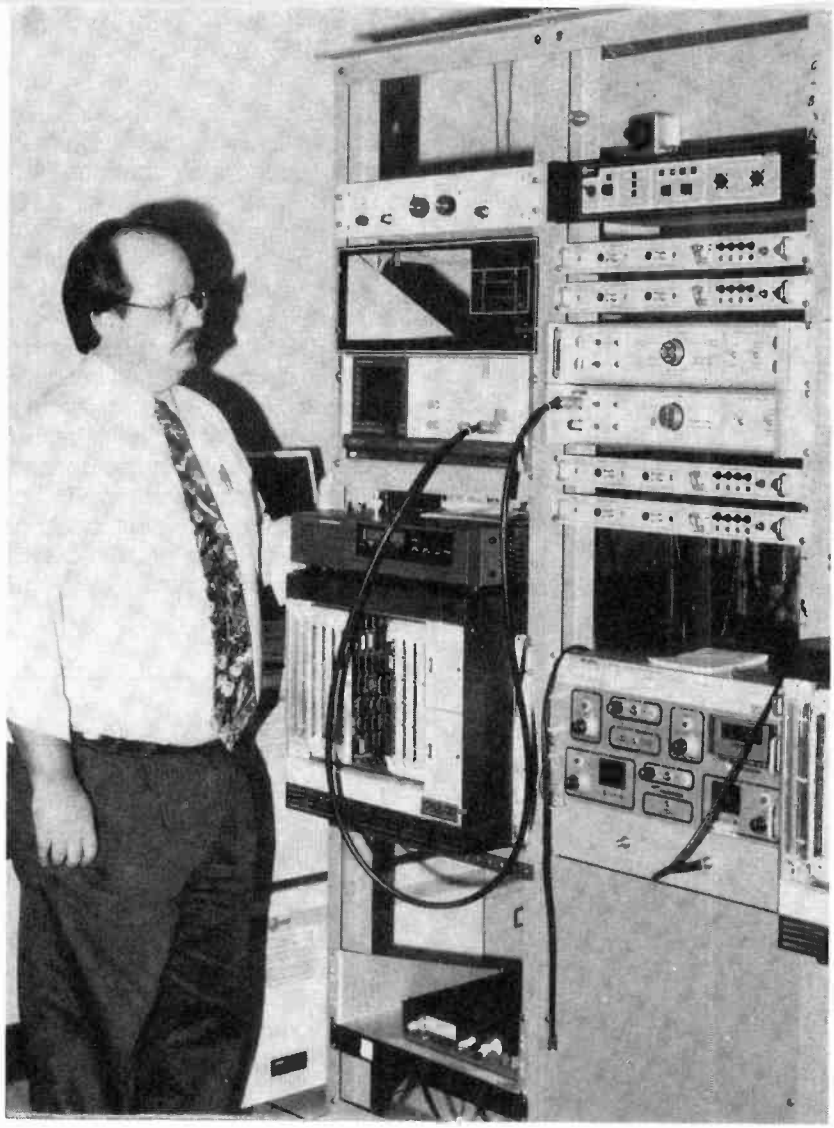

BECOMING AN ELECTRONICS ENGINEER

Here are some tips to keep in mind when planning your career.

BY LYLE RUSSELL WILLIAMS

So you want to be an electronics engineer? Or, maybe you are one, but you haven't looked far enough into the future. The rewards of the profession are numerous, especially the personal satisfaction of accomplishment only the *creator* of a gadget, product, or system can truly enjoy. Nevertheless, to every utopian vision there is a down side. The question you should be addressing is, "Should I be, or should I continue as, an electronics engineer?" The answer is a very complex one that considers your current economic status, your future goals, the industry's needs, and your ultimate retirement goals. During the period of your income-producing life span, there's the considerations of getting married, raising a family, pursuing hobbies, and having social interaction with the world about you. Can all the questions be answered here? Hardly, but you can become aware of stumbling blocks between you and your career goal, and actions you may consider somewhere down the yellow brick road.

What is an EE? An electronics engineer (EE) is usually a professional person who has a bachelor of science degree (BS) in electronics or an electrical engineering degree (BSEE) from a recognized college or university. An electronics technician is someone working in the electronics professions who has less than a BSEE degree. (There are associate degrees, certification programs and licenses for technicians, but that is beyond the scope of this article). Many engineers start their professional careers as technicians. Some end their careers as an electronics technician when age, obsolescence, and diminishing job availability take their toll.

Electronics engineers create and direct the manufacture of computer systems, cellular phones, computers, wrist watches, industrial controls, aircraft guidance systems, weapons systems, and a myriad of other devices. Through such activities, EEs affect our everyday life.

Getting Through College. Some schools combine electronics and power engineering into one degree called electrical engineering. Other schools offer separate degrees, one of which is in electronics engineering. If you are only interested in electronics, the electronics engineering degree is preferred. Both degrees are called BSEE.

The minimum scholastic requirement for an electronics engineer is a BSEE degree. The degree is awarded after the completion of a four-year program at most engineering colleges and a five-year program at others. The four-year college program is preferred considering the cost of tuition. It would be wise to choose a school with a good reputation in engineering. Types of engineering degrees other than electrical/elec-

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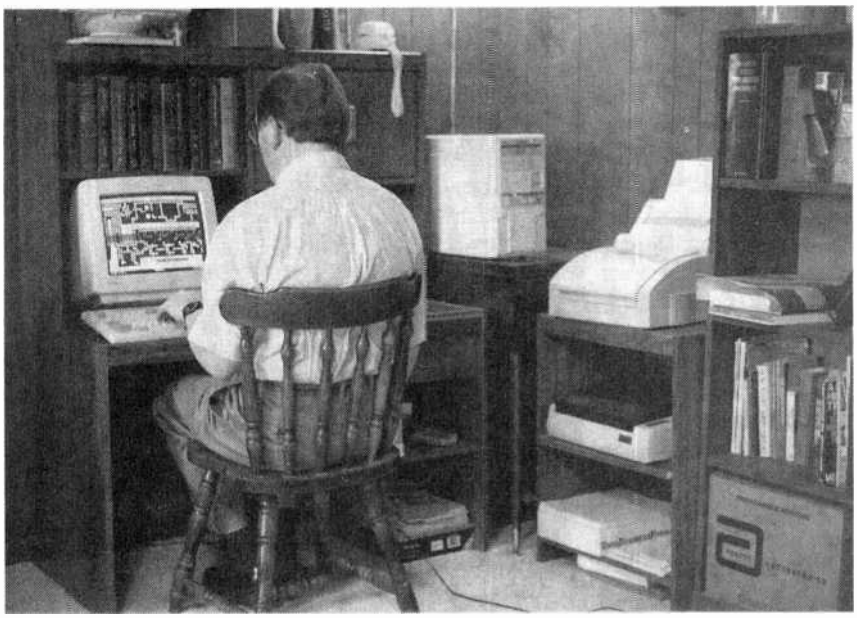
tronics include civil, chemical, computer, mechanical, petroleum, aeronautical, mining, metallurgy, etc. The various engineering departments are grouped together within universities and usually called the "College of Engineering."

College tuition has become very expensive in the last several years—a trend that is consistent with tuition increases since World War II. State universities usually have reasonably good engineering programs and the one in your state is likely to offer you the lowest tuition. Some schools have a better financial-aid program than others and that is a point to consider. If you have ample funds, choose one of the prestigious schools like Massachusetts Institute of Technology (MIT), CalTech, or Georgia Tech.

While some college courses are not much more difficult than senior-year high-school courses, engineering and science courses at most engineering colleges are more difficult than the standard college fare and require increased effort and time on the part of the student. Engineers usually take a heavy course load of 18 to 21 credit hours per semester. They have 4 to 6 hours of classes per day and need to study at least 4 to 6 hours per day not counting weekend study. That 10 to 12 hours of school activity per day doesn't leave much time for a job while in school. You can work during the summer break (2 to 3 months per year) provided you do not elect to take summer courses. Social activities such as hearing guest lecturers, going to concerts, or watching a stage play are an important part of the college experience, but for the engineering student they have to be limited to a few hours per week.

A correspondence college sends you lessons through the mail that you complete at home. Many employers don't accept correspondence degrees. Laboratory courses have to be excluded from these programs, because you don't have access to a library and you never have the supervision of teachers. You miss the social aspect of resident colleges that prepares you for working with college-educated people after graduation. On the other hand, if correspondence school is the best you can afford, and you plan to be self-employed throughout your career, it is unlikely that your customers will care or ask where you got your engineering degree.

After College. How much money will you make when you graduate? At present, starting salaries for electronics engineers are about $36,000 per year. Experienced engineers who do not go into management earn as high as $70,000 per year. For managers and executives there is no limit. The CEOs of a majority of electronics companies have electronics-engineering degrees. Most have additional advanced degrees in business and economics.



Electronics engineers who work at home rely heavily on personal computers for circuit simulation and analysis, integrated software design, programming application-specific integrated circuits, designing schematics and PC boards, and other uses. Shown here is the author working on a PC-board design.

What are the working conditions for an electronics engineer in the commercial realm? Though you will be paid for a 35-40-hour week, you will be expected to work a considerably longer work week. Working in commercial design is often high pressure, particularly at times when a product is going into production and problems have to be solved quickly. Government jobs are often lower key.

Job security in electronics engineering is not what most people believe it is. The electronics industry is what economists call a "cyclic" industry. The fortunes of the industry go through cycles that roughly follow the cycles of the national economy. When the economy is good there may be a shortage of engineers, and getting and keeping a job is easy. When the economy is in recession, it is very hard to get a job and you are in jeopardy of losing the position you have.

Although management and personnel people won't tell you, companies hire engineers for a defined project rather than for lifetime employment. When the project is over, the engineers are laid off. The average job length for an engineer is about seven years. Keep in mind the word "average." There are exceptions, but they are few and far between!

Currently, electronics engineering is in a modest recovery from the last recession period. Many "rock-solid" established companies like IBM and Digital Equipment downsized and laid off engineers. The defense industry remains in a state of economic depression with the end of the cold war. Nevertheless, there has been enough growth in industry as a whole that engineering unemployment is on a decline.

It is true that no job is entirely secure. There are professions such as acting where job security is nonexistent. Average unemployment among lawyers is greater than that for engineers. But for a profession that requires a college degree, engineering job security is

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unusually treacherous. Engineers, like most employees, depend upon their employers for health insurance, sick pay, and retirement benefits. The pattern of frequent unemployment leaves the engineer's family life and retirement plans in peril.

Another pitfall of engineering is obsolescence. As a hypothetical example, suppose that you are designing hard-disk drives for a hi-tech company. The "flash" memory now used in laptop computers is smaller and uses less power than hard disk-drives, but it is a much more expensive storage alternative. Some time in the future the cost of flash memory may become cheaper than hard-disk drives. Your skill in designing hard drives will no longer be wanted. No one will want to retrain you for another skill because that is expensive considering the training period you will require. Companies will hold out for months to fill an open position for an experienced person rather than retrain someone who has experience in a similar, but not exactly the same, skill.

Considering the aforementioned, it is an impossible task for the engineer to predict what technology will be on top in the future. The engineer should school himself in new fundamentals, and seek employment in a growing environment before the current position terminates.

The public image of engineers reached a peak during the 1960s due to the tremendous national pride in our space program. Lately engineers have fallen victim to the "nerd" or "geek" stereotype that is depicted by the teenage TV character Steve Erkle. The presumption is that all smart people are weird and socially inept. None of the engineers that I know fit the nerd stereotype. The majority of them are good-natured and friendly people who happen to be good at math and science.

Many engineers express dissatisfaction with their jobs. But because they like having a job in which learning is a continuing process, and they love the sense of accomplishment that comes with creating new electronic devices, they accept a job that has poor working conditions, low public image, and financial insecurity. Some engineers plan ahead for frequent unemployment and make good use of the time when it comes. Engineers are not alone. A majority of physicians and lawyers are expressing dissatisfaction with their professions. If you enter engineering knowing what to expect, you can practice your profession without resentment.

Engineering Alternatives. So far, the facts in this article might make the outlook for a career in electrical engineering look grim. However, there are strategies for avoiding many career problems that face electronics engineers today.

The author is shown here testing a shortwave-receiver prototype in the lab of his one-person business.

If you like power engineering, you can work for an electric power-utility company. These companies are somewhat immune to the usual economic cycles. They make money even in a recession, and they need to keep employees to maintain their enormous grid of electrical power lines and equipment. It is a maintenance-type job and is not very creative. Power companies may hire a few electronics people to install and maintain the microwave links that are used to switch and monitor equipment at remote locations. Much the same can be said about working for a telephone utility company—relatively stable, but dull.

You can become a college teacher. Although the work can be hectic around the end of a semester, the job is usually low key. Teachers spend around four hours a day in class and some additional time grading papers, counseling students, preparing lectures, etc. Teachers are off three months of the year, a month at Christmas and two months in the summer. With your free time you are sometimes expected to either do research or write and publish. These activities bring prestige to your learning institution. Writing and research are creative activities and can be very pleasant. Writing can bring you extra income in the form of book and magazine royalties. The work is secure with layoffs being rare. The down side is that the salaries are lower than you can make in industry and you need an advanced degree, preferably a Ph.D., in order to hold this job.

The next degree higher than a BSEE is a master's degree (MSEE) which requires one or two years of study beyond a bachelor's degree. The highest degree, the doctorate (Ph.D. or Sc.D), requires an additional two years (eight years total) of college training. When you earn a doctorate, you can use the title Doctor (Dr.) before your name.

If you plan to work in industry, some companies encourage advanced degrees. You can nearly always earn more money with an advanced degree, but in industry the job security for Ph.D.s is no better than for BSEEs. So if you are going for an advanced degree, do so with a job in mind where the advanced degree will be appreciated. In bad economic times an advanced degree can be an impediment to obtaining a position. You will be considered over-qualified for many positions.

Self-Employment. Another alternative to the usual engineering problems is to start your own one-person business. When you get your degree, take a job in industry for several years, then resign and go on your own. The hardest part is finding out what to do in your business. You might have to try a few things before you find something you like that will be profitable. Manufacturing a complex product is generally not possible for a small company. You might go for a service contract with a larger company, but it is often desirable to do a combination of several scaled-down activities. That way if one activity is not productive,

(Continued on page 49)

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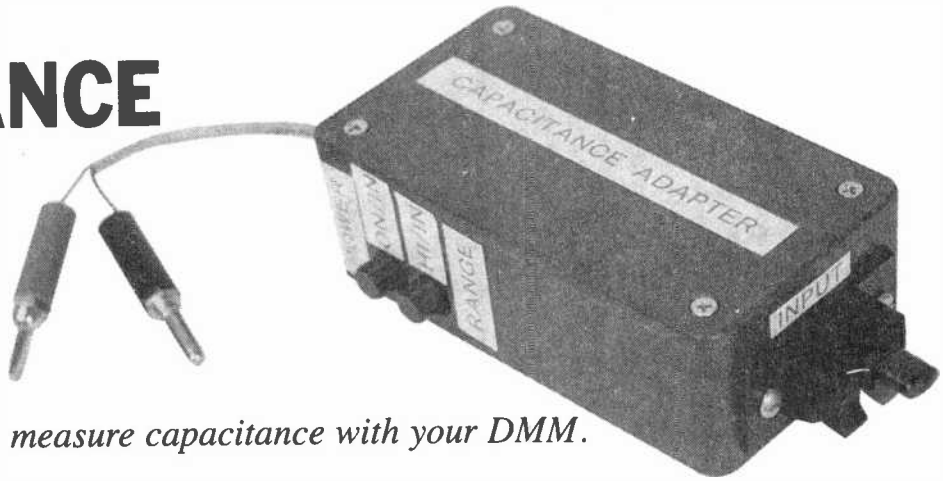
BUILD A CAPACITANCE METER ADAPTER



This simple circuit lets you measure capacitance with your DMM.

BY MARC SPIWAK

If your budget limits your test gear to a suitable digital multimeter (DMM), then you might want to consider adding a home-brew adapter to increase its adaptability. One such budget gadget is the *Capacitance Meter Adapter* described in this article. It's an affordable little circuit that will enable your DMM to measure capacitance at a fraction of the cost of commercial units. As a matter of fact, depending on what parts you have on hand, the circuit could cost you only pennies to build!

The Adapter lets your DMM measure values from 2.2 pF to 2.2 µF. That measurement range isn't as restricted as it sounds—most capacitors you'll work with are within those values, except for larger value capacitors that are usually clearly marked with a value.

When the Adapter is connected to a capacitor and DMM, a DC voltage is fed to the meter; the resulting readout indicates the capacitance value. However, the readout on the DMM will not show pF or µF; it will simply give a value you have to interpret depending on which range the Adapter is set to (it has two ranges). The only other caveat is that your DMM has to have a fixed input impedance of at least 1 megohm, which should cover about 99 percent of the DMMs on the market. An analog meter cannot be used because it will load down the circuit due to its relatively low input impedance, and thereby give inaccurate results.

Circuit Description. A schematic diagram for the Capacitance Meter Adapter is shown in Fig. 1. Power is supplied by a 9-volt battery, B1. When power-switch S1 is in the ON position, a LM7805 regulator (IC2) provides a 5-volt source to the circuit.

Switch S2 is used to select between the high and low capacitance ranges. The circuit measures from 0 to 2200 pF in its low range and from 0 to 2.2 µF in its high range. The Adapter outputs one millivolt per picofarad in the lower range and one volt per microfarad in the higher range. Those are the voltages that would be displayed on a DMM, and which would have to be read as capacitance values (more on that later).

The most "exotic" component of the Adapter is a 74HC132 quad Schmitt

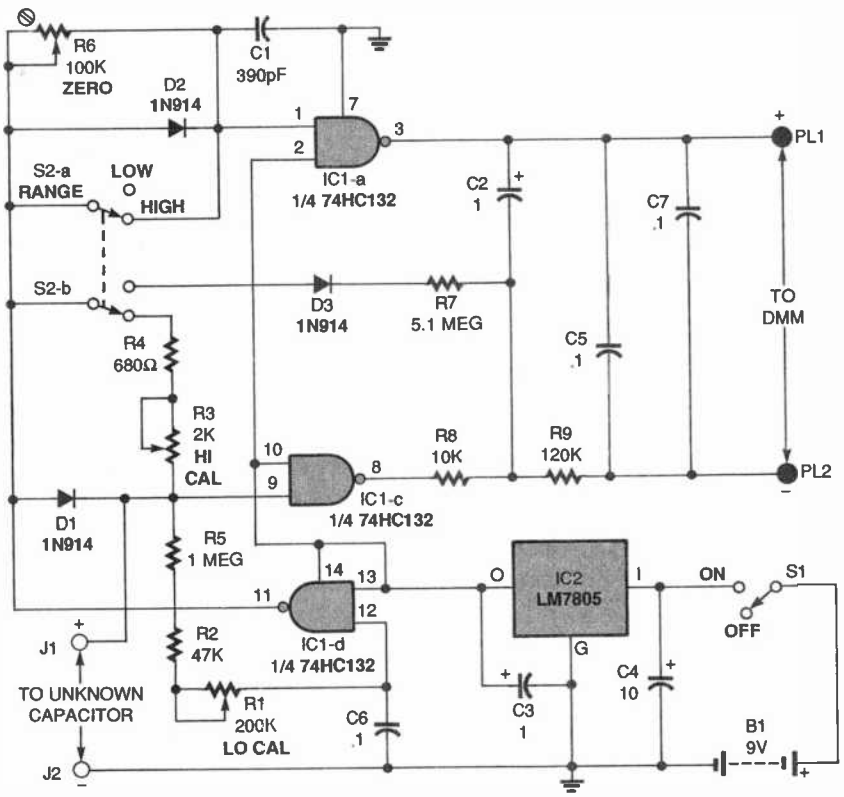


Fig. 1. Here's the schematic for the Capacitance Meter Adapter. The circuit outputs one-millivolt per picofarad in the LOW range setting of S2, and one-volt per microfarad in the HIGH range.

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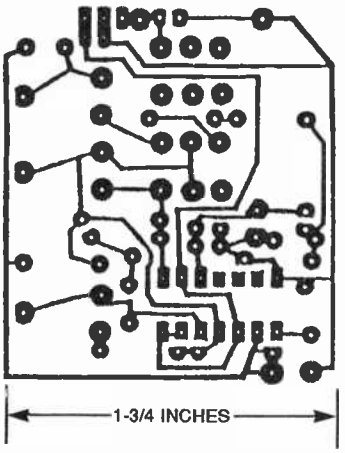

Fig. 2. If you'd like to build the Adapter on a PC board, use this foil pattern to etch your own.

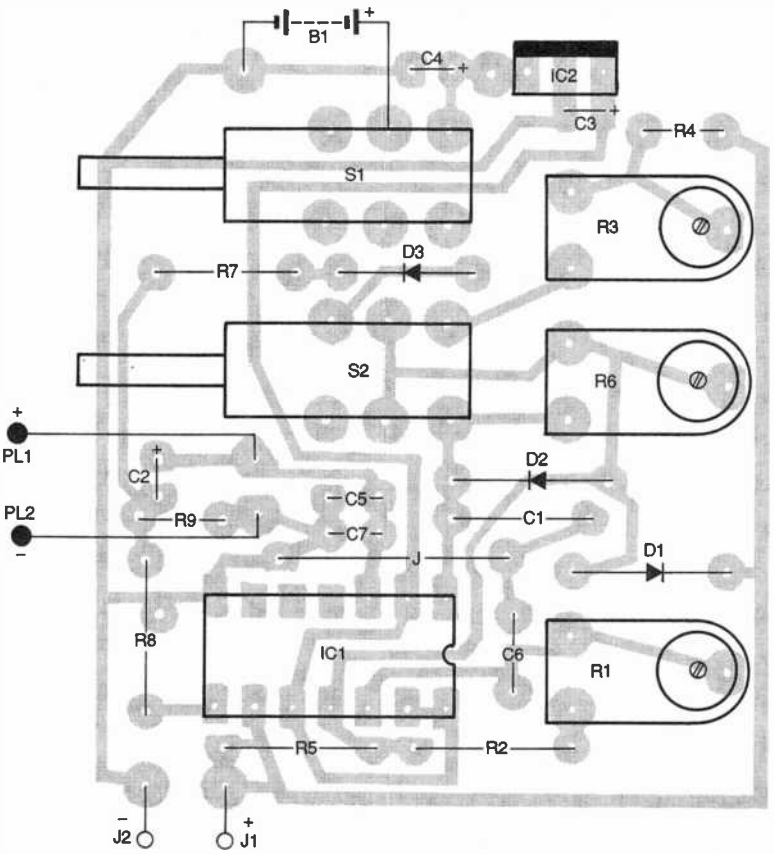

Fig. 3. Use this parts-placement diagram as a guide when building the Adapter on a PC board.

trigger NAND gate (IC1). Only three gates in the package are used. Gate IC1-d is configured as a free-running oscillator whose frequency is determined by the setting of potentiometer R1. The output of IC1-d, pin 11, is a square-wave voltage that's fed to the other two gates configured as inverters (IC1-a and IC1-c).

A capacitor with an unknown value (we'll call it C_X) is connected across input-terminals J1 and J2. Note that the positive lead of a polarized capacitor must be connected to J1. The capacitor under test charges through diode D1 on positive half-cycles and discharges through R5 on negative half-cycles in the low range, or through R3, R4, and R5 in the high range. In the high range, the square-wave output from IC1-d is fed directly to the inputs of the other two gates.

With no capacitor connected to J1 and J2, the outputs of IC1-a and IC1-c are identical, inverted versions of the input signal. The average voltage across the outputs of the gates at pins 3 and 8 in this case is zero. With C_X in place, and depending on its value, the input voltage to IC1-c, pin 9, stays higher longer than the input to IC1-a, pin 2. The output pulses from IC1-a and IC1-c are filtered and smoothed by R8, R9, C2, and C5. The average DC voltage across the outputs is then proportional to the value of C_X.

The circuit is a bit different in the low range, because compensation must be made for stray capacitance. In the low range, the output from IC1-d is fed to pin 1 of IC1-a through diode D2, which also charges C1. Capacitor C1 charges quickly and discharges slowly through potentiometer R6. The charge on C1 holds the input to IC1-a higher for slightly longer than it normally would be. That causes its inverted output to be low for slightly longer and conversely high for slightly shorter. Stray capacitance across input terminals J1 and J2 does the same thing to IC1-c, holding its input higher for slightly longer than it would if there were none. Potentiometer R6 is adjusted so that the discharge time of C1 matches that of the stray capacitance, and so the effect of stray capacitance is canceled out. In the low range an offset voltage is applied to the negative output terminal via D3, R7, and R8 to prevent the gates from locking together with such close trigger points.

Construction. The Capacitance Meter Adapter circuit is simple enough to build using point-to-point wiring. However, if you'd like to use a PC board to assemble the circuit you can either order a kit that comes with one (see the source mentioned in the Parts List), or etch your own using the template shown in Fig. 2.

If you build the project on a PC board, use the parts-placement diagram shown in Fig. 3 as a guide during assembly. Begin by mounting a socket for IC1. Then mount the smaller components—the resistors, capacitors, and diodes. Be sure to double-check the polarity of the polarized capacitors and the diodes. Solder the jumper in place next.

Continue by mounting the switches and potentiometers. Solder the 9-volt battery connector to the board next, paying attention to the polarity. Cut two short, insulated wire leads and attach them to the board to facilitate connections to J1 and J2. Then cut two longer wires and solder them to the board where PL1 and PL2 are indicated. Attach banana plugs to those long wires. All that's left of on-board assembly at this point is to install IC2, and insert IC1 into its socket.

Choose a suitable plastic or aluminum case for the circuit. Mount spring-loaded jacks for J1 and J2 to the case. Those will allow you to conveniently connect capacitors to the circuit for measurement. Attach the short leads intended for J1 and J2 to the jacks.

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PARTS LIST FOR THE CAPACITANCE METER ADAPTER

SEMICONDUCTORS

IC1—74HC132 quad Schmitt trigger NAND gate, integrated circuit
IC2—LM7805 positive 5-volt regulator, integrated circuit
D1–D3—1N914 silicon diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—200,000-ohm trimmer potentiometer, 1-turn, PC-mount
R2—47,000-ohm
R3—2000-ohm trimmer potentiometer, 1-turn, PC-mount
R4—680-ohm
R5—1-megohm
R6—100,000-ohm trimmer potentiometer
R7—5.1-megohm
R8—10,000-ohm
R9—120,000-ohm

CAPACITORS

C1—390-pF, monolithic
C2, C3—1-μF, tantalum electrolytic
C4—10-μF, electrolytic
C5–C7—0.1-μF, monolithic

ADDITIONAL PARTS AND MATERIALS

S1—SPDT switch, PC-mount
S2—DPDT switch, PC-mount
J1, J2—Spring-loaded jack, or equivalent
PL1, PL2—Banana plug
B1—9-volt alkaline battery
Printed-circuit materials, project enclosure, battery connector, 1000-pF and 1-μF calibration capacitors, wire, solder, hardware, etc.

Note: The following is available from Marlin P. Jones & Associates, Inc. (P.O. Box 12685, Lake Park, FL 33403-0685; Tel. 800-432-9937): Capacitance Meter Adapter kit (including everything except a battery, case, and banana plugs)—$12.95 plus $4.50 shipping and handling. Florida residents please add appropriate sales tax.

Then, cut holes in the case to provide access to the switches, and a way to pass through the PL1 and PL2 wires.

Calibration and Use. After carefully checking your work for solder shorts and other faults that could cause your circuit to fail, connect a 9-volt battery to the battery clip. Use S1 to turn the circuit on.

To calibrate the circuit you'll need a 1000-pF capacitor and a 1-μF capacitor. If possible, use calibration capacitors that you have already measured to exact values. Connect PL1 and PL2 to the DMM's 2-volt scale. Then set range-switch S2 to the LOW position and adjust R6 for a reading of zero on the voltmeter. Connect the 1000-pF capacitor to the Adapter's input terminals and adjust R1 for a reading of 1.000 volt. Next connect the 1-μF capacitor to the input terminals and put range-switch S2 in the HIGH position. Then adjust potentiometer R3 for a reading of 1.000 volt.

Once it's calibrated, the Adapter is used in a similar fashion to test capacitors of an unknown value. Connect the Adapter to your DMM and set the meter's range switch to the 2-volt range. When you connect a capacitor to J1 and J2, the display on the DMM will be in picofarads when the Adapter is in the low range and microfarads in the high range.

You now have a simple way of quickly determining the ballpark values of unknown capacitors. While it might not be the most accurate instrument in the world, the Adapter could be the least expensive. It will let you measure the values of capacitors close enough to use them in circuits, sort unlabelled parts, ferret out bad parts, and match capacitor values to one another. ■

ELECTRONICS ENGINEER

(Continued from page 46)

you still have other activities on which to fall back.

Try to avoid borrowing money, which is easier said than done. Start small and build up your capital and liquid assets as you go. Your business activities might include making PC boards, restoring old radios, writing for publication, lecturing, silk screening electronic equipment panels, making name plates, selling electronic kits, buying and selling electronic parts, teaching at all levels, writing computer shareware programs, doing repair work, or consulting, to name a few.

A consultant is someone considered an expert whom companies will hire on a short-time basis at a high fee for a very specific purpose. Most consultants acquire advanced degrees to use as part of their credentials. The trick to consulting, however, is to be good at what you do and to sell yourself. Scholastically less-qualified technicians have been known to serve as consultants because their specialized knowledge in a defined subject is superior, and using such a consultant is still less expensive than hiring a full-time technician or even an engineer who would have to be trained.

Why a one-person business? It is assumed that you want to practice engineering with a minimum of distraction from business activities. If you hire even one employee you are then involved in payrolls, income tax and FICA deductions, workman's compensation, OSHA regulations, employee health insurance, employee retirement, minimum-wage regulations, and so on, *ad nauseam*. If you like these things, you will do well as a traditional business professional and you don't need to become an electronics engineer.

Manufacturing involves another set of government hassles as well as possible stiff competition from "dollar-a-day" workers in third-world countries. There are some small companies that manufacture relatively simple devices for ham radio operators or other small market niches. Offering the device in kit form involves fewer business complications and competition and is something that you might want to consider doing.

In a one-person business you contract-out anything you can't do yourself to other one-person or larger businesses. Being a one-person business doesn't mean that you have to stay small. Some one-person businesses have assets in the millions. More than likely, though, you won't make as much money on your own as you could make in industry. But the working conditions are whatever you impose upon yourself, you can do whatever you like to do, and you can set it up to be very financially secure during your retirement years.

Of the many books published about one-person businesses, the one I like best is *The Incredible Secret Money Machine* by Don Lancaster who is an electronics engineer and a columnist for **Popular Electronics'** sister publication, *Electronics Now*. In spite of the piquant title, Lancaster's book is a no-nonsense source of practical information. ■

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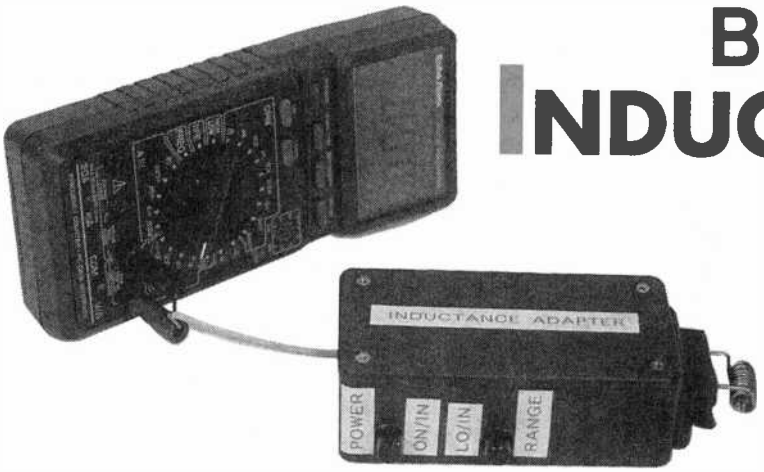

BUILD A INDUCTANCE METER ADAPTER

Measure inductance with this add-on circuit and an ordinary DMM.

BY MARC SPIWAK

An inductance meter could be a valuable test instrument for a hobbyist to own. However, few people own them because of the high price tags found on such instruments. That's about to change.

The *Inductance Meter Adapter* described in this article is a circuit that, when connected to digital multimeter (DMM), lets you measure low-value inductances. The project can be built for a couple of dollars, or less, depending on what parts are in your junk box. Or you can buy a kit of parts including a PC board from the source mentioned in the Parts List.

The range of the Adapter is actually quite impressive. It allows your DMM to measure inductance from 3 microhenries to 7 millihenries in two ranges. Basically, when the Adapter has an inductance connected at its input terminals, it develops a DC voltage at its output terminals that your DMM can measure and display as a calibrated inductance measurement. An analog multimeter cannot do the job because its input resistance is below the minimum 1-megohm required for the Adapter's proper operation.

The Adapter certainly can't replace a fine piece of test gear, but it's a handy little instrument for sorting unlabeled parts, screening out bad or out-of-spec parts, and matching inductors to one another. Another great feature of the Adapter is that you can have it working in less than an hour, with or without the kit.

Circuit Description. The schematic diagram for the Adapter is shown in Fig. 1. The circuit is powered from a 9-volt battery, B1, and a LM7805 regulator, IC2, provides a regulated 5-volt source for the rest of the circuit. Switch S2 turns power on and off.

The heart of the circuit is a single 74HC132 quad Schmitt NAND-gate IC1. The first gate in the package, IC1-a, is configured as an oscillator whose frequency is determined by the RC components (including trimmers R6 and R7) in its feedback loop; IC1-b is a buffer/inverter. One input of both IC1-c and IC1-d is tied to +5 volts, with both sections configured as inverters. The square-wave output from IC1-b is fed to the pin-9 input of IC1-c, and pin 9 also connects to J1, one of the test-inductor input terminals.

When an inductor is connected across J1 and J2, the voltage input to IC1, pin 9 stays higher for a longer period, depending on the value of the inductor. With the output of IC1-c feeding IC1-d, the resulting average DC voltage across the output terminals (J3 and J4) is directly proportional to the unknown inductance. Potentiometers R6 and R7 calibrate the circuit for the high and low ranges, respectively, and potentiometer R1 sets the zero point on the DMM. When the circuit is calibrated with a known

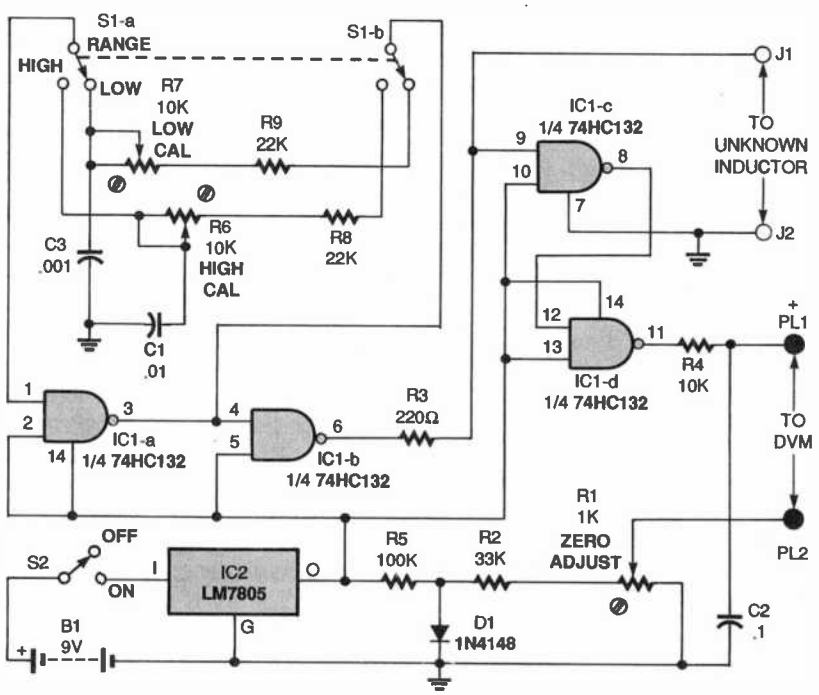

Fig. 1. With this simple Adapter circuit and an ordinary DMM you can measure inductances from 3 μH to 5 mH.

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inductance and properly zeroed out, the output voltage can represent inductance. Switch S1 selects the Adapter's range; the circuit will measure from 3 µH to 500 µH in the LOW range and from 100 µH to 5 mH in the HIGH range.

Construction. The Adapter circuit is simple enough to build using point-to-point wiring. However, if you prefer to use a PC board, you can etch your own from the foil pattern shown in Fig. 2, or order the kit from the source mentioned in the Parts List.

If you're using a PC board, refer to the parts-placement diagram shown in Fig. 3 when building the circuit. Begin by mounting a socket for IC1; be sure to match the orientation shown. Install the resistors and capacitors.

Solder the switches to the board. Then go on to mount the diode and potentiometers, making sure they are oriented properly. Install wire-jumper JU1 and a battery-snap connector for B1. Then solder insulated wire leads for the connections to J1, J2, PL1, and PL2. Keep the leads to J1 and J2 as short as possible, as they could affect the readings given by the unit. The leads for PL1 and PL2, on the other hand, should be somewhat long; that will make it easier to connect the Adapter to a DMM. Solder banana-plugs PL1 and PL2 to the leads. To complete on-board assembly, mount IC2 and insert IC1 into its socket, being sure to check the polarity of both.

The next step is to prepare the enclosure for the Adapter. Any enclosure of a suitable size can be used. Mount jacks for J1 and J2 to the case first. To make it easier to temporarily connect unknown inductors to the circuit, use spring-loaded terminals for J1 and J2 (they come with the kit). Drill holes in the case to accommodate the switches and the PL1 and PL2 wires. Mount the PC board.

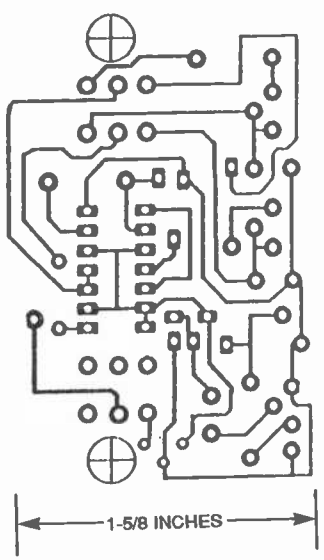

Fig 2. If you'd like to etch your own PC board for the Adapter, use this foil pattern.

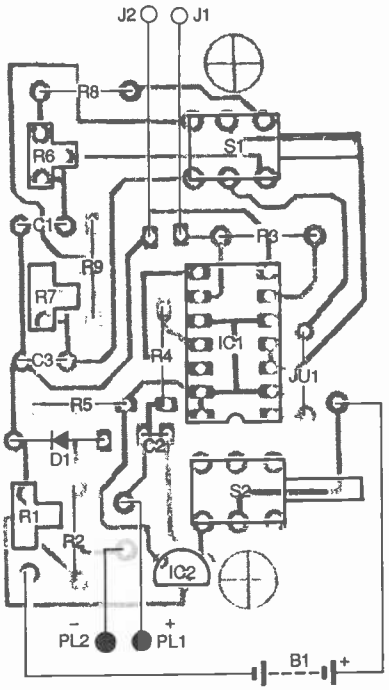

Fig 3. Use this parts-placement diagram as a guide when assembling the Inductance Meter Adapter.

Calibration and Use. After checking your work, connect a 9-volt battery to the battery clip and set S2 to ON. To calibrate the circuit, you'll need a couple of inductors with known values, preferably values equal to or near 400 µH and 5 mH. If possible, measure the value of the inductors you use with an accurate meter to determine their exact values. Connect output leads PL1 and PL2 to a voltmeter set to the 200-millivolt scale and place a short piece of wire directly across terminals J1 and J2. Set range switch S1 to LOW and adjust R1 for a reading of zero on the meter.

Now set the DMM to the 2-volt range. Remove the wire from J1 and J2 and connect the 400-µH inductor (or whatever value you have that's closest). Adjust R7 so that the voltage displayed on the DMM is the absolute value of the inductance. For example, a 400-µH inductor will give a reading of 0.400 volt. Now connect the 5-mH inductor and set the range switch to high. Adjust R6 so that the voltage displayed on the meter is the same as the inductance value. A 5-mH inductor should read 0.500 volt on the DMM.

To use the Adapter, connect it to your DMM and set it to the 2-volt range. In the low range you can measure from 3 to 500 µH, and the display will read between 0.003 and 0.500. Remember to disregard the decimal point. In the high range, measure from 100 µH to 5 mH and the display will read from 0.001 to 0.500. ■

PARTS LIST FOR THE INDUCTANCE METER ADAPTER

SEMICONDUCTORS
IC1—74HC132 quad Schmitt trigger NAND gate, integrated circuit
IC2—LM7805 positive 5-volt regulator, integrated circuit
D1—1N4148 diode

RESISTORS
(All fixed resistors are ¼-watt, 5%.)
R1—1000-ohm trimmer potentiometer
R2—33,000-ohm
R3—220-ohm
R4—10,000-ohm
R5—100,000-ohm
R6, R7—10,000-ohm trimmer potentiometer
R8, R9—22,000-ohm

CAPACITORS
C1—0.01-µF, monolithic
C2—0.1-µF, monolithic
C3—0.001-µF, monolithic

ADDITIONAL PARTS AND MATERIALS
S1—DPDT switch, PC-mount
S2—SPDT switch, PC-mount
J1, J2—Spring-loaded terminal
PL1, PL2—Banana plug
B1—9-volt alkaline battery
Printed-circuit materials, project enclosure, battery connector, 400-µH and 5-mH (or similar-value) calibration inductors, wire, solder, hardware, etc.

Note: The following is available from Marlin P. Jones & Associates, Inc. (P.O. Box 12685, Lake Park, FL 33403-0685; Tel. 800-432-9937): Inductance Meter Adapter kit (including everything except a battery, case, and banana plugs)—$14.95 plus $4.50 shipping and handling. Florida residents please add appropriate sales tax.

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BY TED ROWEN

BUILD A Surround-Sound SWITCHBOX

Control where your home-theater or stereo system's audio is coming from and add surround sound with this handy little device.

Would you like a simple way to select which speakers in your audio setup are on? Better yet, would you also like to control those speakers in such a way as to produce a type of surround sound? If so, you should consider building the *Surround-Sound Switchbox* described in this article. It's a one-evening project that can make a great difference in the way you experience audio at home.

The Switchbox is designed to accommodate a stereo pair of speakers in the front of your listening room, and another "surround" pair in the rear of the room; that means you don't have to buy a truckload of speakers to use the unit. Also, while we're on the topic of buying, the components used in the author's prototype are readily available and inexpensive; in fact, depending on what materials you have on hand, you should be able to build this project for under $20.

The Switchbox is based on the surround-sound effect popularized by David Hafler. Basically, that is when a rear pair of speakers responds to the differential of stereo signals presented to a front pair. Those A+B and A−B signals are not apparent from speakers connected in a normal, parallel configuration. You'll probably be surprised to find that the Hafler effect can produce quite a startling audio ambiance. That is because a Hafler circuit extracts signals that are already present to create surround sound.

Circuit Description. The schematic diagram for the Switchbox is shown in Fig. 1. Because all components are passive, no power supply is required; only audio connections are made to the circuit. (To keep project cost down, a terminal strip was used to make many of the connections shown in the schematic. For that reason, there is only one jack shown.)

The circuit gets its audio input from the left and right outputs of a stereo amplifier. Those signals are fed to two terminals of a switching, stereo phono jack, J1. If headphones are inserted into J1 the audio from the amp will bypass the Switchbox and be fed directly to the headphones. An attenuator will need to be used with the latter (more on that later).

If no headphones are inserted into J1, the left signal is fed to two sections, S1-a and S1-b, of a 4P3T switch. The right signal is fed to the other two sections, S1-c and S1-d. When S1 is set to FRONT, the left and right audio signals will be sent to front-right and -left speakers that are connected to the Switchbox. Setting S1 to REAR will connect the audio signals to rear-right and -left speakers. Finally, the BOTH setting of S1 activates all four speakers.

When the circuit is set so that all speakers are working, another audio option is available from switch S2. Setting S2 to NORMAL will cause the rear speakers to work just like the front ones. However, the HAFLER setting on S2 connects the negative signals of the rear speakers to each other via a 50-ohm potentiometer, R1. Adjusting R1 allows for a variable, Hafler surround-sound effect.

Construction. Because all the components used in the Switchbox are panel-mountable, no circuit board was used in the author's prototype. You can easily do the same.

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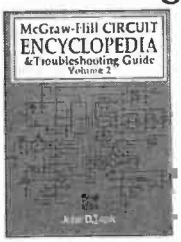

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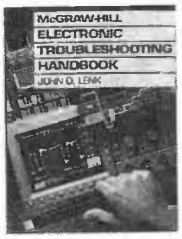

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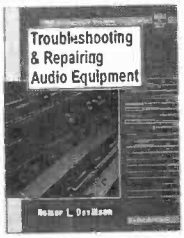

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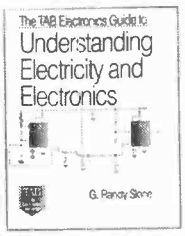

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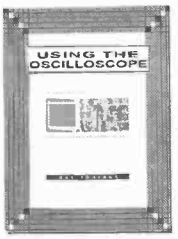

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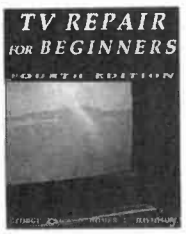

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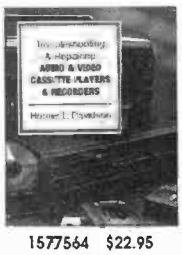

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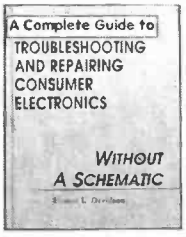

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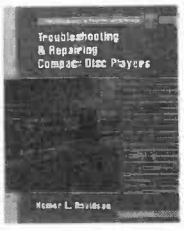

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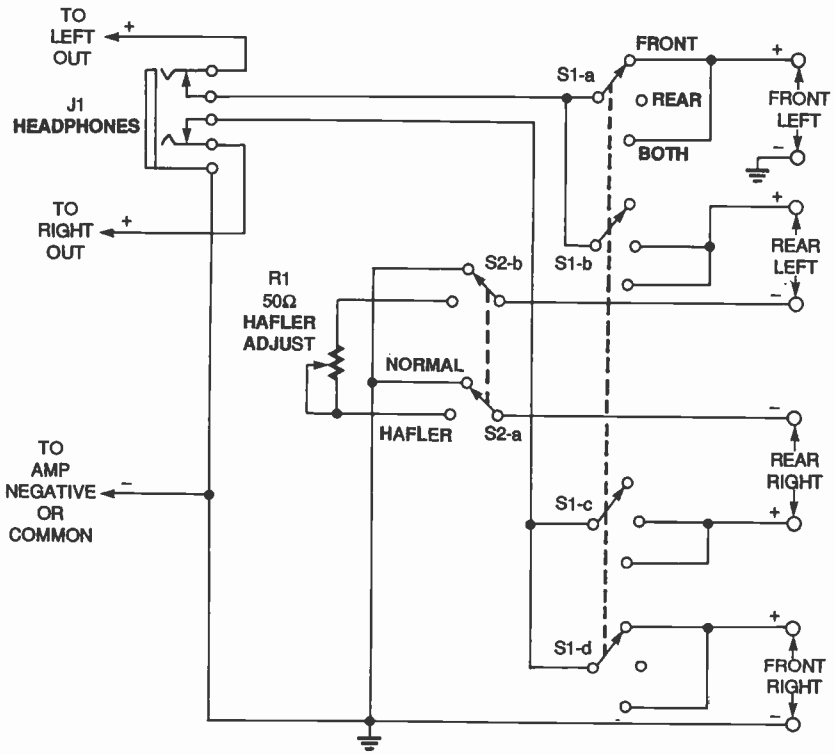

Fig. 1. The circuit for the Surround-Sound Switchbox requires no power source. It passively creates the Hafler effect using existing sum and difference signals.

Begin by finding a suitable enclosure. Drill holes in the panel of the case for the two rotary switches, potentiometer, and stereo jack. Then, mount the components.

Using different-colored lengths of insulated wire, carefully make the connections between the components shown in the schematic. Try to keep the wires as short as possible. In the author's prototype the connections to the speakers and amplifier were made using a twelve-terminal connecting strip. If you wish to do the same, make all the connections between the other components and the strip, and then fasten the latter to the case. The author's prototype used an open-back enclosure that allows easy access to the connecting strip. Depending on the case you use, you might need to make an opening for the strip.

Another option is to use RCA jacks for all audio connections, although that does increase the cost of the project. Depending on how much money you wish to spend, and on how often you will be connecting and disconnecting your Switchbox, you will need to decide if you wish to use jacks.

Before you close up the case, double-check your wiring. It's very easy to make mistakes when making so many point-to-point connections. If you have one, use a DMM that has an audible or visual continuity-tester mode. Connect the leads to various points across the switches and listen for the tone or watch for the needle movement that indicates the switches do what they are supposed to do.

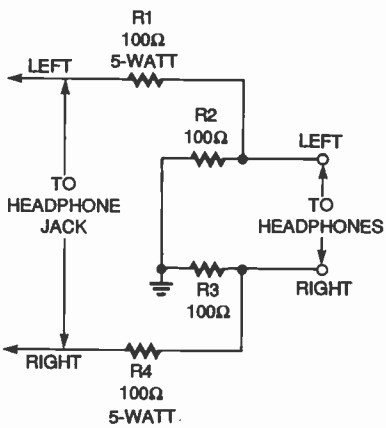

Fig. 2. To use most headphones with the Switchbox you will need an attenuator. Here's a simple add-on you can build in a few minutes.

PARTS LIST FOR THE SURROUND-SOUND SWITCHBOX

R1—50-ohm potentiometer, wirewound
J1—Stereo phono jack, switching type
S1—4P3T rotary switch
S2—DPDT rotary switch
Suitable enclosure, knobs, twelve-terminal connecting strip, rubber feet, wire, solder, hardware, etc.

Now, before you can use the circuit, you might need to build an add-on. If you recall, it was mentioned earlier that you will need an attenuator to use most headphones with the Switchbox. Commercial attenuators are available from sources such as Radio Shack; however, you can also build your own.

Figure 2 shows a simple circuit you can use. To build the attenuator, you have two options. You can either buy a jack and a plug and wire the resistors between them. Or, if you have a pair of headphones you'd like to use only with the Switchbox, you can simply cut the headphone wires and solder the four resistors in place. Be sure to insulate each connection and the entire assembly when you're done.

Using the Switchbox. If you are adding speakers to your system, which is probably the case with the rear ones you'll be using, make sure your amplifier can handle them. Remember that the actual load seen by the amplifier depends on the size and the phase of the signal. For the most part, using four 8-ohm speakers is your best bet. Avoid the use of 4-ohm speakers in the rear circuit as they will result in a 2-ohm load (which is too low) when connected in parallel.

Do not turn your amplifier on while your speakers and the Switchbox are not connected. Also, make sure you do not accidentally connect positive and negative leads from the amplifier together.

To use the Switchbox, turn the volume down on your amplifier and turn on its power. Then, turn S1 to each of its settings. As you do so, increase the volume and make sure each setting is activating the appropriate speakers. Finally, leave S1 on BOTH.

Turn S2 to the HAFLER setting. Adjust R1 to see how it varies the Hafler effect. With a little experimentation, your home-theater or listening room will definitely never be the same again. ■

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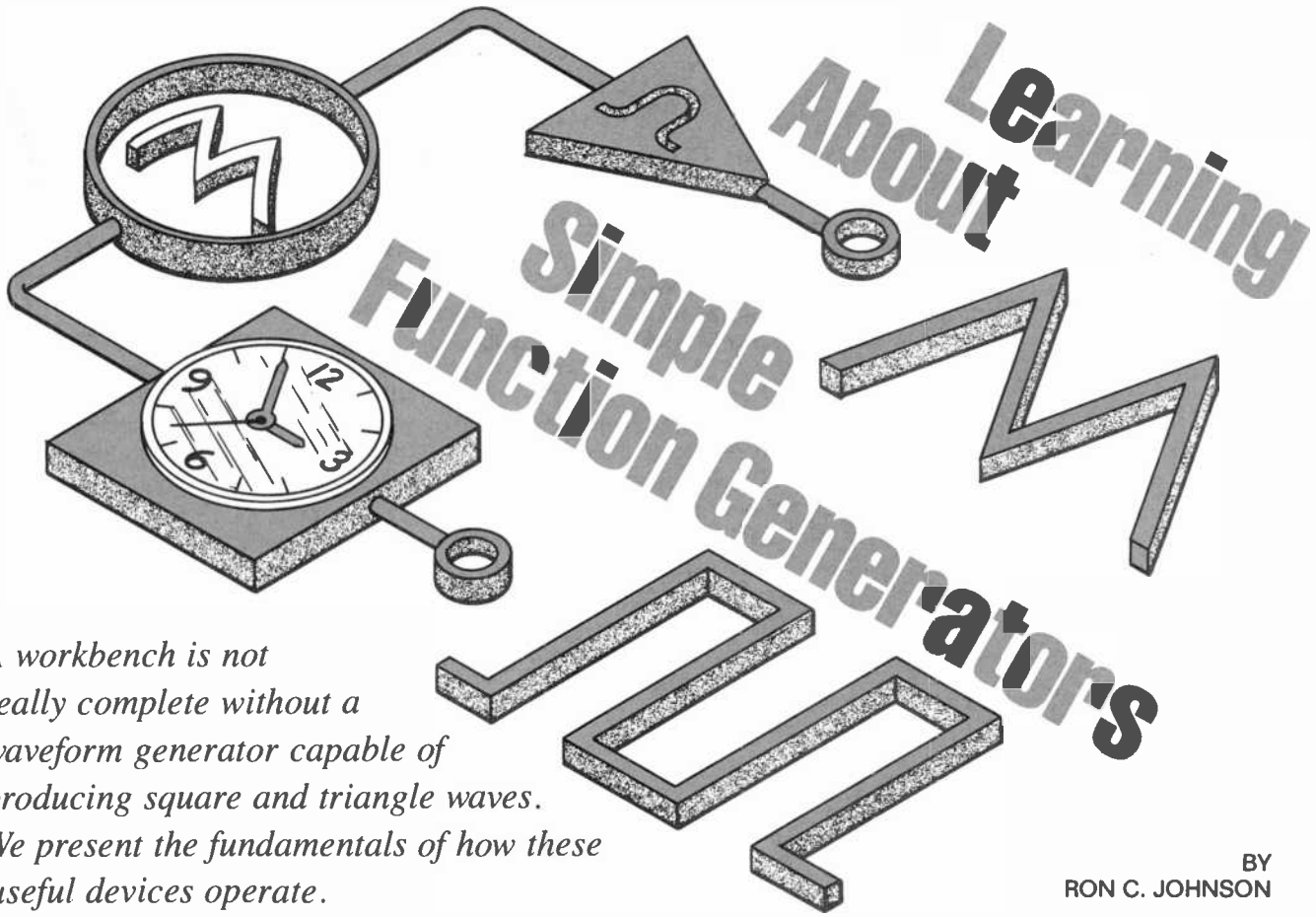

Learning About Simple Function Generators

A workbench is not really complete without a waveform generator capable of producing square and triangle waves. We present the fundamentals of how these useful devices operate.

BY RON C. JOHNSON

Sinewave oscillators can be handy to have on your electronics workbench, especially for testing audio equipment. Unfortunately, you will also likely need a source of square, pulse, or triangle waves for other kinds of applications. Those waveforms are generally categorized as "non-sinusoidal" and are commonly needed in a wide range of applications from radio and TV to computers and industrial control. In this article we will check out some simple non-sinusoidal oscillators, how they work, and how to put a couple of them together.

Terminology. Figure 1 shows several waveforms, the first of which (Fig. 1A) is a square wave. You'll note that a square wave is a voltage waveform that switches between two voltage levels at a constant frequency and is symmetric—it spends an equal amount of time at both levels. We say it has a duty cycle of 50% because it is "on" (at the higher voltage) for 50% of the time. In some cases (like when the square wave is used for audio purposes), the square wave oscillates above and below zero volts as shown.

When a square wave is used in digital circuits it is usually similar to the one in Fig. 1B; its lower voltage level fixed at zero and the higher voltage level set at some standard value.

We could think of it as a "pulse waveform," except that we generally accept that pulse waveforms may not be symmetrical. Such "asymetrical" waves can be found in computer and communications circuits.

Triangle waveforms (like the one in Fig. 1C) are also generally centered around zero volts, although this need not be the case. The basic triangle wave has symmetric positive and negative slopes that are linear and repeat at some frequency. In some cases the two slopes are not symmetric. If one slope (either ascending or descending) is vertical (see Fig. 1D) we call the waveform a ramp.

Under the heading of non-sinusoidal waveforms we could group specialty waveforms; those are generated with some specific shape for a particular function. For example, television circuits generate a variety of complex waveforms to perform specialized functions.

Let's take a look at just some simple ways that the basic square, pulse, and triangle waves can be generated.

Probably the first thing that will pop into your mind when we consider square-wave oscillators will be the old standard: the 555 timer. We could start our explanation with the 555 and show how to hook up a few external components to create the three other oscillators. However, it would be more instructive to examine an oscillator based on the same principles first. That way you'll get a better feeling for how a 555 timer works.

A Simple Relaxation Oscillator. Figure 2 shows the schematic of a simple square-wave oscillator using a single op-amp, three resistors and a capacitor. The circuit is easy to set up on a prototyping board and should work with practically any op-amp such as a 741 or a 358. The principle of operation here hinges on the RC time constant (determined by the values of R1 and C1) and the operation of the op-amp as a voltage comparator.

When the DC supply is first applied to the circuit, capacitor C1 has no charge and therefore no voltage across it. Because it is connected to the inverting input (−) of the op-amp, the output of

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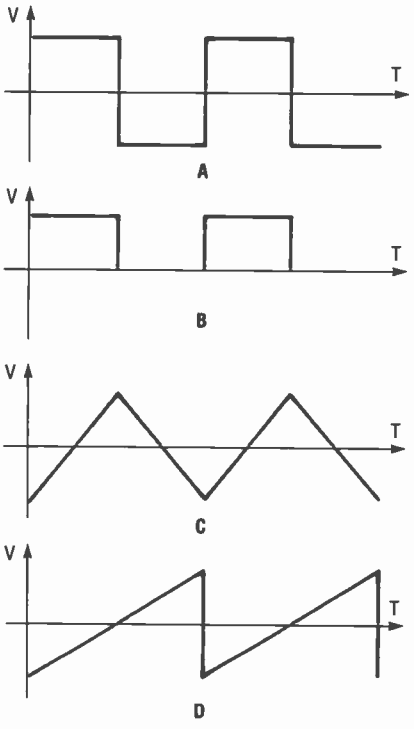

Fig. 1. The basic non-sinusoidal wave family consists of square waves (A), pulsed waves (B), triangle waves (C), and ramps (D).

the op-amp sharply rises to maximum output voltage (which will be the positive power-supply voltage). The output voltage (we'll denote it as V_{out}) causes current to flow through the feedback resistor, R1, charging the capacitor (at an exponential rate) towards the positive power-supply level. The output also sets up a voltage on the non-inverting input (+) via R2. That voltage can be found from:

$$V = V_{out} \times R3/(R2 + R3)$$

Figure 3 shows the waveforms of the voltage across the capacitor (the top graph), and at the op-amp output (at the bottom). The capacitor charges and at some point in time its voltage exceeds the voltage at the non-inverting input. When that happens the inverting input is at a higher voltage, which causes the op-amp output to rapidly change to its maximum negative value (which will be the negative power-supply voltage).

Now the op-amp starts discharging the capacitor through resistor R1 until the capacitor voltage is below the voltage that is present at the non-inverting input. The circuit is considered a form of "relaxation oscillator" because of the charging and discharging action of the capacitor.

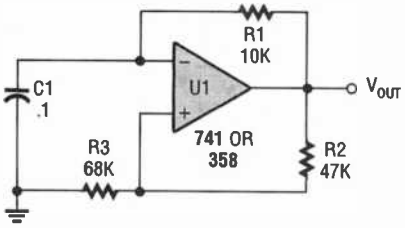

Fig. 2. This is a simple op-amp based square-wave oscillator. Its operating frequency is based on the values of R1 and C1.

If you are in an adventurous frame of mind, try setting up the circuit using the values shown in Fig. 2; it might be handy as a cheap-and-dirty square wave oscillator. By substituting a potentiometer (wired as a rheostat) for R1 you can get some variation in frequency. For a wider frequency range you can use a switch to select between different capacitors that take the place of C1.

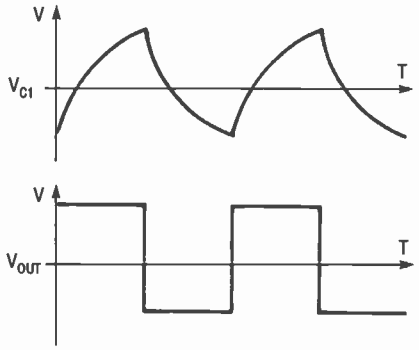

Fig. 3. The square-wave oscillator produces the top-most waveform across the capacitor, and the bottom waveform at the output.

The 555. The 555 timer has become a standard, all-purpose building block (for the hobbyist and professional alike), and is commonly used in low-frequency oscillator circuits. Of course, the 555 has several other useful applications as a one-shot, timer, etc., which are beyond the scope of this article so we won't cover them here.

I won't go into great detail on how to use 555's for designing intricate oscillators. (There are lots of 555 oscillator designs to be found both in this magazine and in other texts.) Instead, let's "poke around" inside one and find out how it works.

Figure 4 contains a block diagram of what is inside a 555. First, look at the voltage divider made up of three 5000-ohm resistors in series connected between V_{cc} and ground. One input of both comparators is connected on either side of the middle resistor. The other two comparator inputs are available to the user via pins 2 and 6 on the IC. If we had a V_{cc} of 15 volts, we would have 5 volts dropped across each resistor. Any time that pin 6, the threshold (non-inverting input of the upper comparator), is above 10 volts, the output of the upper comparator will go high. On the other hand, any time pin 2, the trigger (inverting input of the lower comparator), is below 5 volts the lower comparator output will go high. Those comparator outputs drive the R and S inputs of a flip-flop that drives an output buffer. (The 555 output buffer can sink or source about 200 mA of current.) The flip-flop also drives a transistor that is

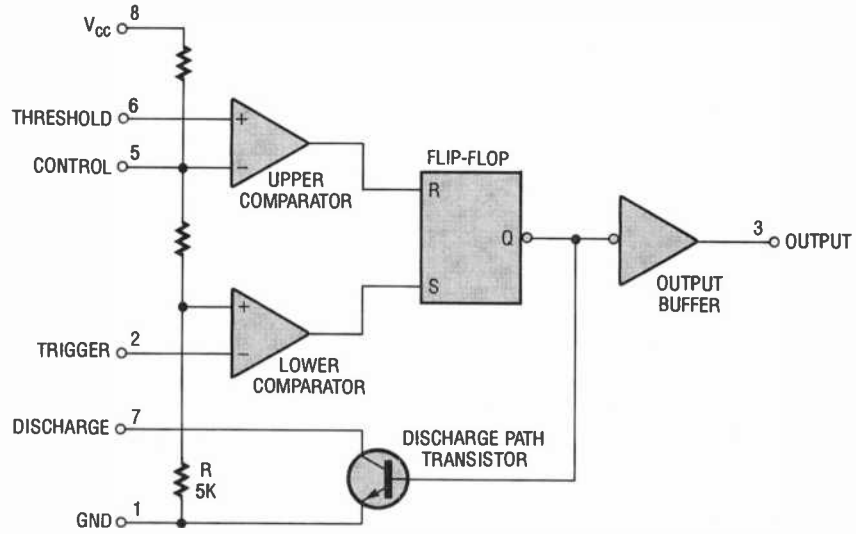

Fig. 4. This internal block diagram of a 555 timer reveals the comparators that operate an R-S flip-flop. They change state when their inputs reach voltage levels programmed by the resistor network.

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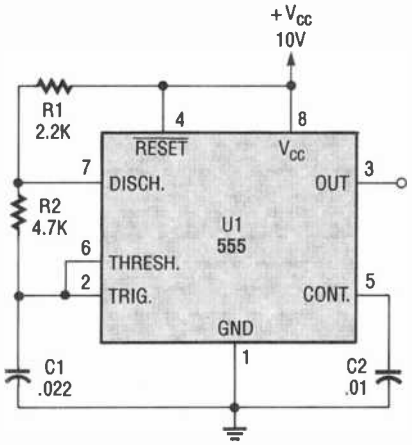

Fig. 5. This 555 is connected for astable operation. The comparator inputs are both tied to the capacitor to monitor its voltage.

used to discharge an external timing capacitor via an external resistor connected to pin 7 (see Fig. 5).

When the 555 is used as a square wave-oscillator, the threshold (pin 6) and the trigger (pin 2) are connected together to sense the voltage across the external timing capacitor. When the capacitor voltage rises above 10 volts (for our example) the upper comparator changes states, resets the flip-flop, and the output goes high. The transistor then discharges the capacitor via R2. When the capacitor voltage falls below 5 volts the lower comparator changes states, sets the flip-flop, and the output goes low. The transistor then turns off, allowing the capacitor to charge up to 10 volts via R1 and R2, and the cycle repeats.

Multivibrators. Multivibrators are another kind of square-wave oscillator. You'll still see them once in a while in older circuits, but today, as is the case with many discrete implementations, circuits using op-amps or specialized integrated circuits have taken their place.

Figure 6 shows a typical "astable" multivibrator. It's called astable because the circuit is not stable in either of its two states, so it oscillates between them. Again, an RC time constant is used to set the frequency of the circuit, as we'll explain.

The circuit consists of two NPN transistors, back to back in a common-emitter configuration. They are biased in such a way that they will either be cutoff (no current flowing) or saturated (maximum current flowing). In other words, they are used as switches.

When power is first applied, one of the transistors starts to turn on first because of base current supplied by R1 or R2. Which one turns on at this time is determined by the actual characteristics of the resistors and transistors, as opposed to their ideal values.

Let's assume Q1 turns on first. That transistor saturates, pulling the voltage at point A almost down to zero. That also pulls the voltage at point C down, robbing the base current from Q2. However, C1 starts to charge up by current supplied through R1. After a period of time, which depends on the RC time constant dictated by R1 and C1, the voltage at the base of Q2 rises to 0.7 volts, forward-biasing the base-emitter junction. When that happens, Q2 turns on and the voltage at point B drops to almost zero. That pulls the voltage at point D down to zero, robbing the base current of Q1 and turning it off. Now C2 charges, just like C1 did, until Q1 is forward biased, completing the cycle.

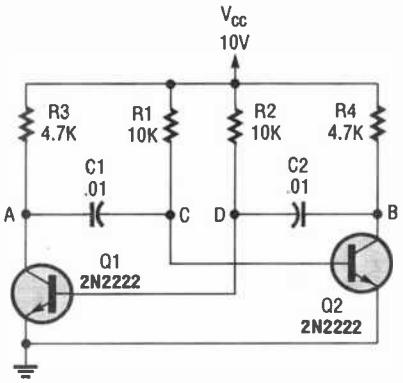

Fig. 6. This astable multivibrator begins to operate because of the minute differences in values between complementary components.

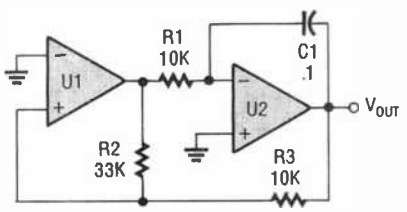

Fig. 7. This triangle-wave generator uses one op-amp as a constant-current source and the other as a comparator.

If we were to observe the voltage waveforms at the transistor's collectors we should see two square waves. They would be out of phase with each other (one high while the other was low and *vice versa*).

This is a pretty simple circuit to play with. If you would like to try it out, use the values shown in the schematic. It is not easy to vary the circuit's frequency continuously because both R1 and R2 would have to be controlled at the same time to keep the waveform symmetrical. On the other hand, if you want a pulse source with a variable duty cycle, the resistors can be varied separately.

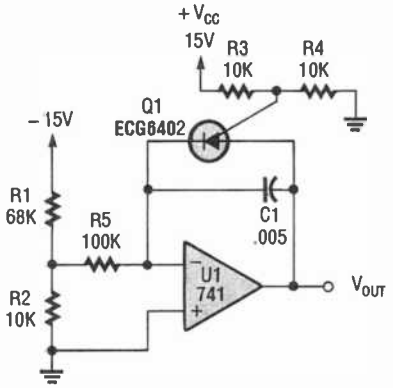

Fig. 8. This ramp generator steadily increases its output voltage until Q1 suddenly cuts it off.

Triangles and Ramps. The circuit shown in Figure 7 is a simple triangle-wave generator. It uses two op-amps (an LM358 would fit the bill here), three resistors, and a capacitor. In the circuit, U1 is used as a comparator and U2 as an inverting DC amplifier.

The capacitor is not charged when power is first applied to the circuit, so U2 has its non-inverting input at ground while the inverting input will go slightly positive, causing the output to try to go low. Because the capacitor cannot change voltage instantaneously (it has to charge up), the op-amp output starts to climb at a linear rate towards the positive power-supply voltage.

Op-amp U1 is set up as a comparator with the voltage divider formed by R2 and R3 determining its upper and lower switching points. When the voltage at the non-inverting input of the comparator exceeds the zero volts on the inverting input, the output of the comparator will go high. As the capacitor charges toward the positive rail, at some point the comparator will change states. That will present a positive voltage to the inverting input of U2, causing its output to go negative. All of this creates the waveform shown back in Fig. 1C.

You could set up the circuit using the resistor values shown in the schematic. It will oscillate at about 3 kHz. Changing

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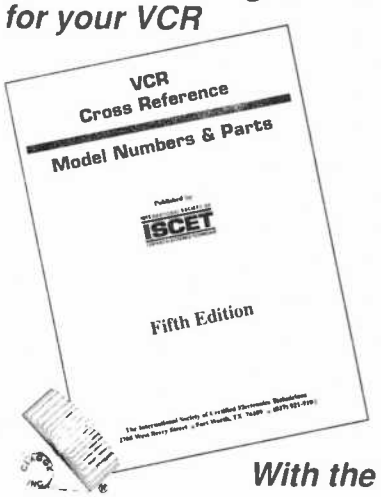

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the values of R1 and C1 would allow you to vary the frequency.

A variation on this type of circuit that would create a ramp waveform is shown in Fig. 8. The circuit uses Q1, a programmable unijunction transistor (or PUT), to discharge the capacitor when it reaches a predetermined voltage. The circuit then starts to charge the capacitor again so the comparator used in the previous design is not necessary.

The PUT is placed across the capacitor and is programmed by a voltage divider that sets the switching voltage at the gate. When the voltage across the capacitor rises to 0.7 volt above the gate voltage, the PUT turns on and discharges the capacitor. When the voltage across the PUT falls below a minimum voltage (about 1 volt), the PUT turns off and the capacitor starts to charge again.

The frequency of operation depends on several factors: the level of the negative voltage applied to R1, the value of the time constant (R1C1), and the characteristic trigger voltage of the PUT's gate.

The values given for the resistors and capacitor would produce a frequency of about 600 Hz. You could use a 741 op-amp and an ECG6402 PUT to set up the circuit for testing.

(and a few other variations). One very useful example is the XR-2206 function generator chip. We are not going to tell you how to build a complete generator with one here. We'll just introduce the chip so that you can experiment with it if you like.

The chip is a sixteen-pin DIP (see Fig. 9) that consists of four functional blocks: a voltage-controlled oscillator, an analog multiplier/sinewave shaper, a unity-gain buffer, and a set of necessary current switches.

The voltage-controlled oscillator, or VCO, is a fairly straightforward section. We don't have to know what is inside it, but it requires an external timing capacitor and a resistor to make an RC time constant around which the oscillator works. If we substitute a potentiometer for the resistor we can obtain variable frequency control.

The chip can actually use two additional timing resistors that it includes in the circuit via the current-switch section, which selects the resistor to be used. The current switches are controlled by an input called the FSK input. It is used in frequency-shift keying applications, which we won't tackle here.

The multiplier/sinewave shaper circuit determines whether the output at pin 2 will be a triangle or sinewave. If you want a sinewave, the chip generates a triangle wave and then reshapes it to get a low-distortion sinewave.

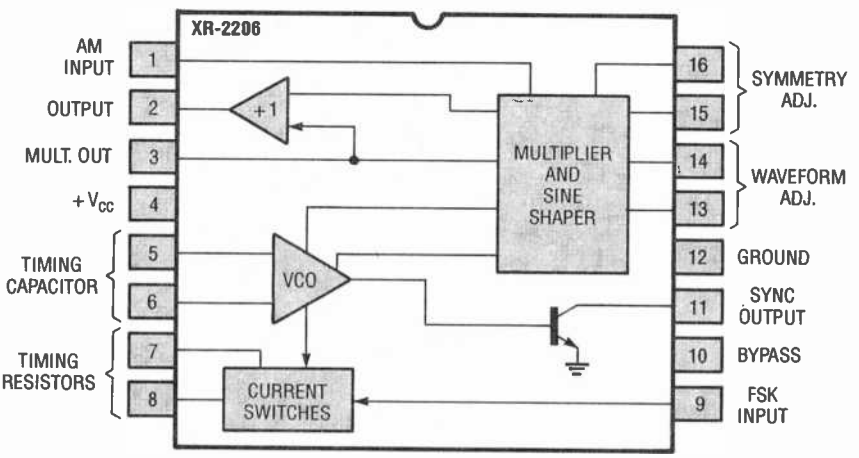

Fig. 9. This is a block diagram of the XR2206 function-generator. Chips like this make building a function generator easy.

A Function Generator. Having said all of the above we now come to something a little more complex: function-generator chips. In the last several years Exar (and some other manufacturers) have come out with a number of integrated circuits that contain the building blocks to generate sine, square, pulse, and triangle waveforms

The buffer amp (marked +1) is just a unity-gain driver to allow the chip to source a reasonable amount of current into whatever load we hang on its output.

We hope this article aroused your curiosity enough to pursue this topic. ■

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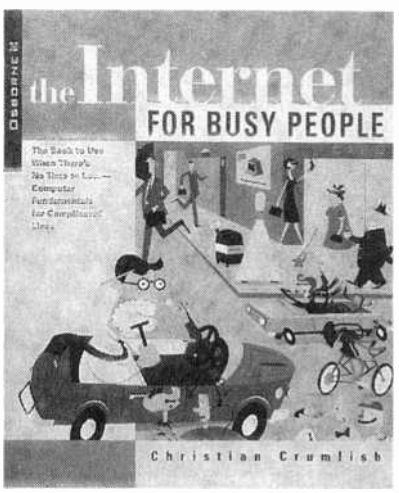


You can set aside an evening or a lunch hour, or just pick up the book whenever you need it. The book is organized for a quick orientation, and features several timesavers. Quick reference sections at the beginning of each chapter demonstrate all the essential commands and features, shortcuts provide accelerated routes to completing a task or solving a problem, and cautions warn of known pitfalls and help you avoid potential trouble spots. Clever definitions help you learn and remember the jargon.

The book explores Windows 95's seamless Internet connection, and shows simple instructions to follow when using other versions of Windows. It helps you master e-mail, mailing lists, and Usenet newsgroups, and discover the power of FTP, Telnet, and Gopher. The book explains how to search the Net and quickly find new sites.

The Internet for Busy People costs $22.95 and is published by Osborne/McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710; Tel. 800-227-0900.

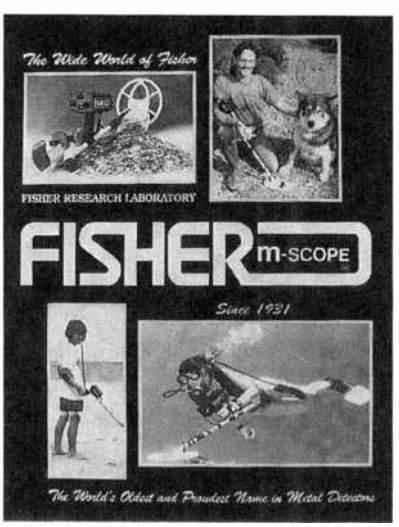
CIRCLE 93 ON FREE INFORMATION CARD

FISHER M-SCOPE CATALOG

from Fisher Research Laboratory

This 16-page catalog describes metal detectors for treasure hunting, underwater searching, gold prospecting, relic hunting, and competition treasure hunting. A full-page "Fisher Features" chart helps consumers compare the features of various models, from optional search coils to push-button pinpoint controls.

Four new models appear in the catalog. The Gold Bug-1 is designed for gold-hunting. The Impulse is a pulse-induction detector for underwater metal detection. The CZ-20 QuickSilver is an underwater version of the popular Fisher QuickSilver target-ID detector, and the CZ-6a is the next-generation QuickSilver metal detector.



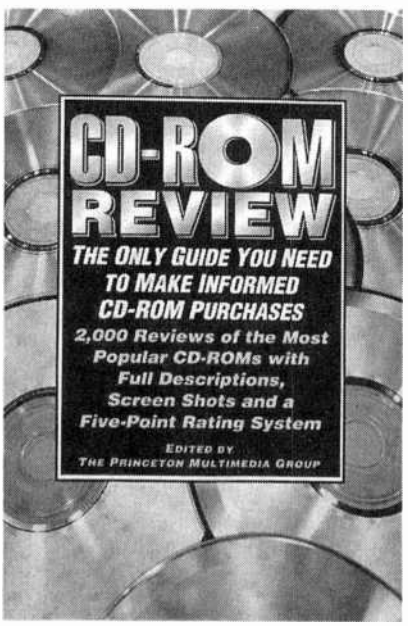
The Fisher M-Scope Catalog is free upon request from Fisher Research Laboratory, Department 6MO, 200 West Willmott Road, Los Banos, CA 93635; Tel. 800-M-SCOPE-1; Fax: 209-826-0416.

CIRCLE 94 ON FREE INFORMATION CARD

CD-ROM REVIEW

edited by the Princeton Multimedia Group

With more than 6000 CD-ROM products currently available, and many more on their way, finding the best CD-ROMs can be frustrating. This comprehensive resource showcases the breadth and depth of the CD-ROM industry and simultaneously helps consumers choose the most appropriate CD-ROM titles for their home or office.



More than 2000 CD-ROMs are evaluated in the book's almost-700 pages. A quick-reference 5-star rating system considers interface, content, sound, graphics, and entertainment value. The guide also looks at the overall CD-ROM experience, rating each program's ease of use, depth of information, and level of challenge.

The book includes alphabetical listings by CD-ROM title, divided into categories ranging from business to health to kids' games. Each category begins with the editors' choice "Top Ten" list. More than 900 screen and package shots accompany the product descriptions.

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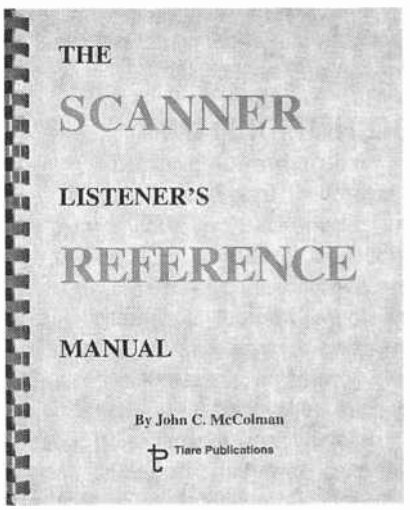
CD-ROM Review costs $22 and is published by HarperPerennial, 10 East 53rd Street, New York, NY 10022-5299; Tel. 212-207-7174; Fax: 212-207-7901.

CIRCLE 95 ON FREE INFORMATION CARD

THE SCANNER LISTENER'S REFERENCE MANUAL

by John McColman

To get the most out of your scanner requires a lot of information that used to be found in a stack of different sources. This book pulls together a huge amount of information needed for successful and efficient monitoring. In one handy reference, you'll find information on emission symbols, non-federal service category codes, federal allocations, station classes, federal government department codes, allocations for the 470–512-MHz band, computer instruction sets, allocations by service category, digitally coded squelch, service pool, CTCSS, and assignments by frequency listing. You'll also find the frequencies for monitoring TV audio, cordless phones, railroads, pagers, Civil Air Patrol, VHF maritime channels, CB channels, amateur radio, aeronautical channels, remote broadcast pickups, mobile telephones, the U.S. military, and distress/emergency calls. The book also includes the FCC Frequency Allocation Table.



The Scanner Listener's Reference Manual is available for $17.95 plus $3 shipping and handling from Tiare Publications, P.O. Box 493, Lake Geneva, WI 53147; Tel. 414-248-4845.

CIRCLE 96 ON FREE INFORMATION CARD

WINDOWS 95 FOR BUSY PEOPLE

by Ron Mansfield

This book helps you spend more time becoming proficient at using Windows 95, and less time shuffling through user's guides. The fun, easy-to-follow book caters to your busy schedule, leaving you with the skills you need to succeed and the time in which to use them.

Organized into short, individual lessons that can be read whenever you have a bit of spare time, the book explains how to use this new interface for fast, accurate results. It discusses Window 95's new networking capabilities and enhanced multimedia powers, explains plug-and-play and Windows Explorer, and shows how to use long file names and improved online help. Time-saving features of the book include quick-reference sections that demonstrate all the essential tasks and features, shortcuts to completing tasks or solving problems, convenient tips and techniques, fast and clever ways to learn and remember the jargon, and warnings about known pitfalls and problems to avoid.

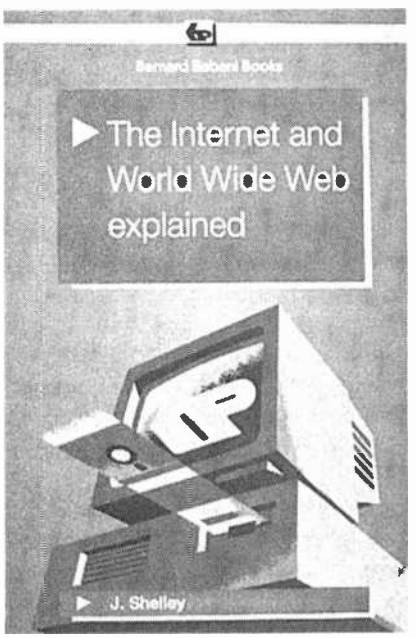
Windows 95 for Busy People costs $22.95 and is published by Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710; Tel. 800-227-0900.

CIRCLE 97 ON FREE INFORMATION CARD

THE INTERNET AND WORLD WIDE WEB EXPLAINED

by J. Shelley

According to hyped-up media reports, we should all be speeding along the Information Superhighway. Yet many people have yet to find an entrance ramp. They're confused by all the technical jargon and have nowhere to turn for answers to their numerous questions.



This book strives to help several different groups of people: Those who are simply interested in or curious about the Internet; those who would like to use it for such tasks as finding information or sending and receiving e-mail; and those who would like to put information on the Internet. Readers will find the answers to many basic Internet questions, written in plain, jargon-free English. They'll learn what the Internet is and what is has to offer them, how they can get in touch with other people with similar interests, how to send e-mail and place merchandise orders over the Internet, how to get connected, and how much it will cost. Technical terms are explained as needed, making the book quite easy to follow.

continued on page 82

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Think Tank

Telephone Circuits

JOHN YACONO
TECHNICAL EDITOR
WINDOWS MAGAZINE

This month we'll examine some telephone circuits sent in by readers, but first I'll continue our discussion of inductance. Last time we discussed inductive kickback; this time we'll show how similar properties of a magnetic field can be put to good use.

In the September column, I mentioned core materials, which concentrate the magnetic field produced by inductors, and allow you to build what would otherwise be a large inductor in a small space. They also provide a useful form to wrap windings on.

Let's look at what happens when two coils share the same form, and one of them is driven by a varying current. As the current in the driven coil increases, that coil generates a magnetic field that increases in strength in step with the increase in current. Because the other coil experiences this varying magnetic field, a voltage appears across its terminals (see last month's column if you're unsure why). If that coil is connected to a load, it'll drive current through the load. If the current in the driven coil decreases, the magnetic field starts to collapse, and the voltage generated at the other coil changes polarity.

As you might have guessed, this describes the action of a transformer. The coil driven by the source of varying current is called the "primary;" the coil generating the output voltage is called the secondary. Typically the core of a transformer is made of iron.

One use for a transformer is to physically isolate two circuits, while still coupling them electrically (or more precisely, electromagnetically). Typically the primary and secondary of an "isolation" transformer have roughly the same number of turns. That makes the output signal look just like the input signal (produced by the drive current); the two signals have the same peak voltage and current.

The ratio of primary-to-secondary turns determines the ratios of input-to-output current and voltage. Specifically:

$$N_P/N_S = v_P/v_S = i_S/i_P$$

where N_P, v_P, and i_P are the number of turns, voltage, and current at the primary, while N_S, v_S, and i_S are those same variables for the secondary. This principle allows you to convert high time-varying voltages or currents to low ones, and vice versa. In fact, that's precisely what a power transformer does: it takes the high voltage from power lines and converts it to the lower voltages common to most semiconductors.

Transformers are used to boost voltage, too (for example, to produce the high voltage needed to operate vacuum tubes). In a Tesla coil, the principles of electromagnetic kickback and transformer operation are combined to produce very-high-voltage output for experimentation. The high voltage is produced by repeatedly interrupting the current through the primary of a transformer that has a very high secondary-to-primary turns ratio.

Well, that's enough on transformers. Let's open that mailbag!

FLASHY IDEA

I have been a fan of Think Tank for years; however, this is my first attempt to submit an idea or circuit. I work as an electrician for Michigan State Industries. Our office phone cannot be heard in the shop, so we've missed lots of calls. That is, until I came up with the circuit in Fig. 1.

My circuit takes advantage of our telephone's built-in flasher. When the phone rings, the flasher turns on and off, causing photocell R1 to conduct. Relay RY1 is then energized, which in turn completes the circuit between the light and the AC line. Thus the light flashes in step with the rings.

—*Yamini Mack, Jackson, MI*

I'll bet the staff is happier. Anyone attempting the project should observe good AC-wiring practices. An interesting change might be to use a full-wave rectifying circuit to reduce the required voltage and cost of T1.

DO NOT DISTURB

While browsing through the September 1992 *Think Tank*, I noticed the "Phone-Use Indicator" circuit you published. It is a nice circuit, albeit with one complication: it requires an external power source. Some time ago, I designed similar circuits that utilize only power from the telephone-company lines. Although I tried several circuit variations, some including Zener diodes or bi-directional LEDs, the circuit I am submitting (see Fig. 2A) was the simplest and most practical.

The device draws current far below the level that would indicate an off-hook condition. I use these indicators

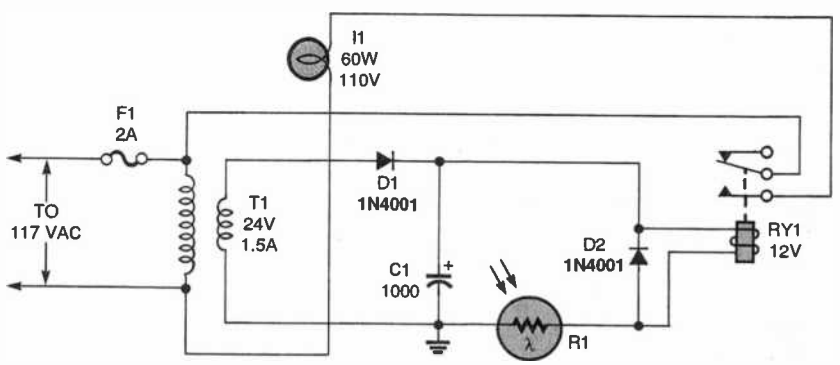

Fig. 1. This circuit uses light-dependent-resistor R1 to sense when a phone with a built-in flasher is ringing. Relay RY1 then closes, lighting lamp I1.

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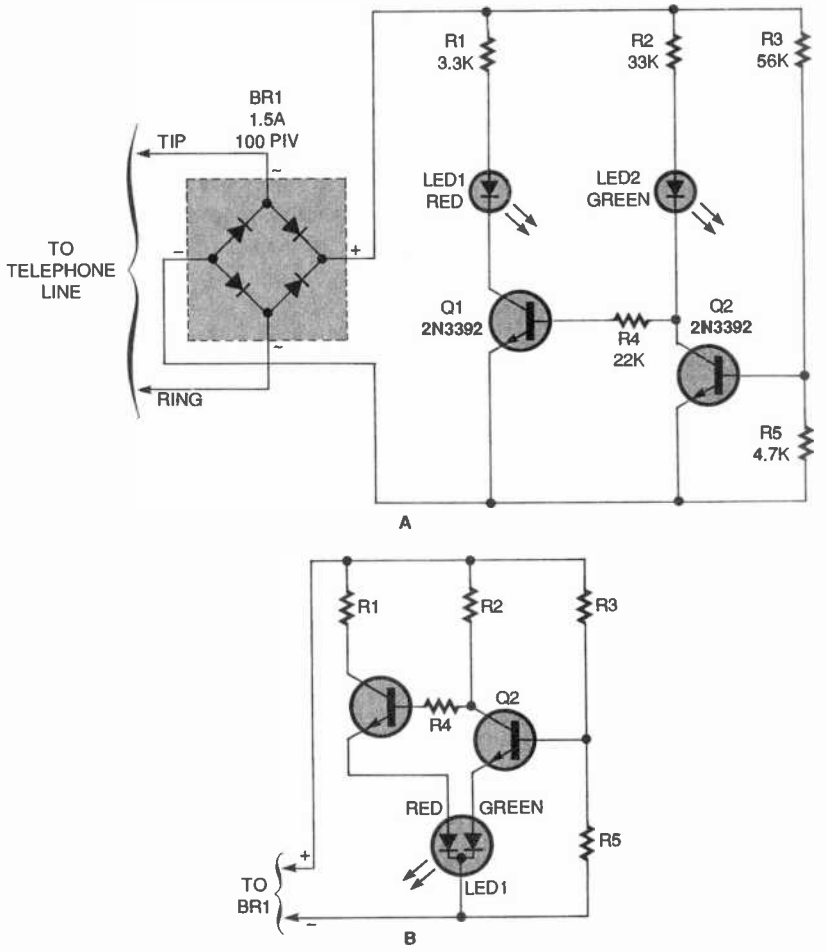

Fig. 2. Tired of having your phone calls interrupted by others picking up the receiver? This circuit (A) will tell others when the phone is in use. If you'd like to experiment with a tri-color LED, check out the optional schematic (B).

on several telephones at the far ends of my house to help ensure uninterrupted conversations.

When all telephones are on-hook, Q2's base is turned on by a voltage-divider circuit consisting of R3 and R5. (The value shown for R5 causes the device to switch over at about 9 volts, and can be changed to facilitate other voltage levels.) Transistor Q2 allows current to flow through R2 and LED2, indicating the phone line is not in use. It also effectively grounds the base of Q1 and forces LED1 to remain off.

When the voltage drops because a telephone goes off-hook, Q2 stops conducting, which allows a little current to flow from R2, LED2, and R4 to Q1's base. When that occurs, Q1 conducts, energizing LED1, while LED2 is deprived of sufficient current to glow. The bridge rectifier compensates for a possible reversal between the "tip" and "ring" wires, and rectifies the ring signal.

I mounted all of the components on a small piece of perforated board, which I was able to mount into a generic, modular telephone-jack box. I connected a 10-inch pigtail, with a modular plug attached that allows the device to be placed in-line with any telephone.

I originally wanted to use a bi-directional LED, so I would only need one LED, but could not find a common-anode device. Interestingly enough, when the telephone rings, both LEDs flash rapidly back and forth.

—*John C. Thomas, Richmond, VA*

Try using a common cathode, three-terminal, bi-color LED and rewiring your circuit to look like Fig. 2B. You might have to play with the resistor values (particularly R3 and R5). I haven't tried it myself, but I think it could just work.

IN-USE INDICATOR

The circuit in Fig. 3 was made to reduce the chances of a family member picking up a telephone extension while someone else is communicating via computer. The local electronics store sells a device that will indicate when a telephone line is in use; however, the price would make most experimenters build their own solution.

The LM741 op-amp is used as a voltage comparator, comparing the telephone line voltage to the battery voltage. The telephone line drops

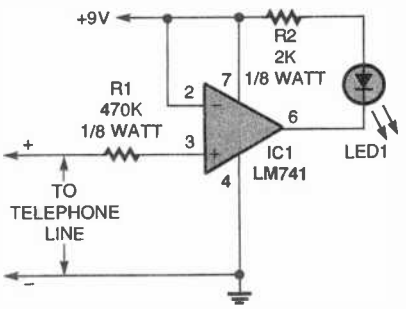

Fig. 3. Use this telephone-in-use indicator if you'd like to be certain of having uninterrupted data transfer.

below 9 volts when it is in use. That drop turns the op-amp on, which lights the LED. Resistor R1 prevents the circuit from loading the telephone line excessively. In my location the in-use circuit drops the line voltage approximately 5 volts. That leaves quite a bit of reserve because a telephone line operates at approximately 40-48 volts. Resistor R2 limits the current to the LED. A 1000-ohm resistor will brighten the LED; however, the total circuit current draw will increase. The circuit as shown consumes 1.15 mA in standby, and 3.80 mA when indicating a line in use.

The circuit is so small compared to the required 9-volt battery that it leaves two installation options. The circuit can be located inside the phone where the connection to the telephone line for voltage sensing can be made. The only outside connection is to the battery. In the second option, the circuit can be built on top of the 9-volt battery connector. The only outside connection is to the telephone line.

The estimated life for the battery is unknown. The breadboard version of the circuit is still in use now, at the time

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of this writing, primarily to determine battery life. It works great and is elegantly simple.

—Fitz Wood, Marietta, GA

Boy, I sure could use one of those. I do a lot of e-mail and remote networking myself, and there's nothing as frightening as having a connection go south while you're administering a server over the phone!

I'd like to slap a 100-PIV diode in line with R1, though. The reverse bias of the ring signal is pretty nasty.

TWO RINGY DINGIES

Sometimes I can't hear the phone ring when I'm working outside my house. So I made two circuits that activate loud 10-inch fire bells when the phone rings. Let's look at each in turn:

The first circuit is shown in Fig. 4A. When a call comes in, the 90-VAC ring signal from the telephone line travels through C1 and C2 to pins 1 and 2 of a 555 (IC1). That signal triggers the IC to supply continuous current to pin 3, which then flows through D1 and R4, triggering SCR1 (RadioShack 276-1067 or equivalent). The SCR conducts ample current to ring the bell, and has a holding current that is cut by the bell's breaker points, which shuts down the system when there are no pulses.

The circuit operates from a 12-volt power supply, and uses little current while waiting for calls. Regulator IC2 (a 7812) protects IC1 from battery-supply over voltage. Select values for C1 and C2 that are just large enough to conduct ring pulses. When the capacitance is low enough, taking a phone on the same line off hook will cause the bell to tap. If the bell won't stop, there is too much capacitance.

This circuit can alternatively light a 12-volt bulb when the phone rings. But to turn off the lamp the SCR's holding current has to be broken with some sort of switch, possibly a thermal one that also causes the lamp to flash.

The other circuit (see Fig. 4B) is based on the "Phone Flasher" circuit from the May 1990 *Think Tank*. When there's no ring signal, the phone line's on-hook voltage (about 50-volts) keeps the triac (RadioShack 276-1001 or equivalent) from switching on, so the optocoupler doesn't conduct. When the phone rings, terminal 4 of the optocoupler feeds pulses through R3 and R4 to the gate of SCR1. The activated SCR connects the bell to the 12-volt supply. Pulses are about 400 Hz so the bell might sound a bit rough. The opening of the bell's breaker points cuts the Thyristor's holding current to stop it from conducting when the gate signal stops. A 12-volt, 2-ampere power supply operates the unit.

Adjust R3 high enough so the SCR is not triggered between rings, but low enough to trigger it when the phone is ringing.

P.S. I was 80 on my last birthday.

—Jay E. Hawthorne, Claresholm, Alta Canada

Both are pretty interesting circuits. Mr. Hawthorne also tells us you can eliminate C2 and D3 in Fig. 4A if desired.

By the way, I feel honored that someone who's been around to see the whole electronics revolution thus far reads this column, and has contributed so many times. Thank you.

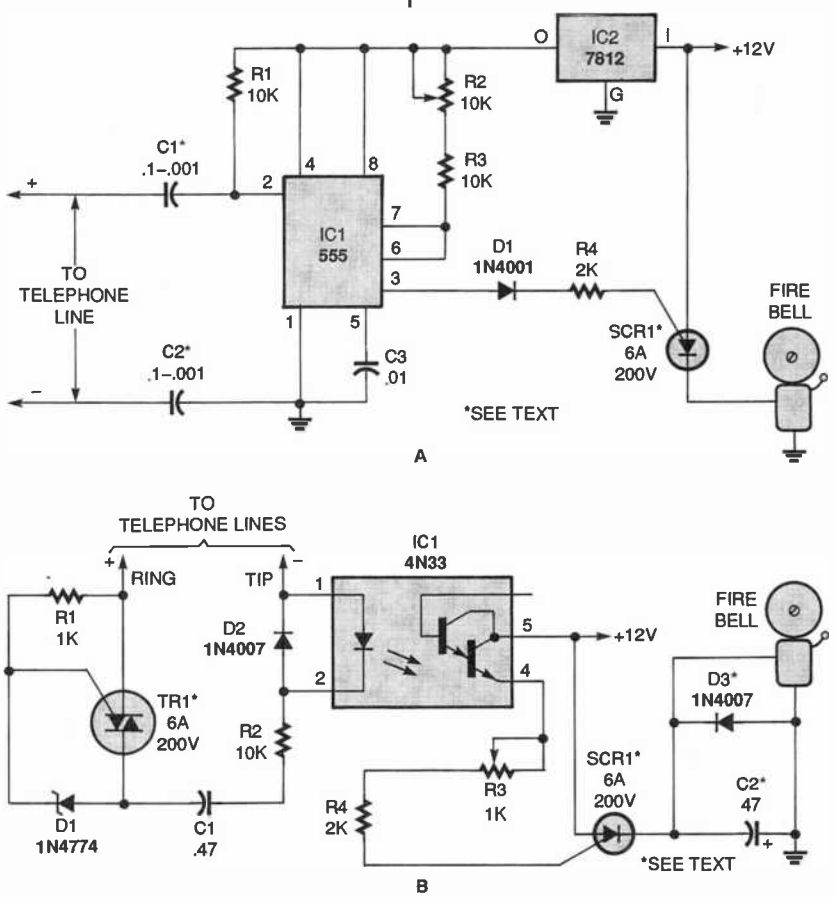

Fig. 4. This circuit (A) senses when a phone rings and activates a loud 10-inch fire bell. Its similar companion (B) features an optocoupler.

REMOTE TEL-BELL RINGER

The low-cost (approximately $20), telephone-line extension bell ringer shown in Fig. 5 will enable you to add a remote ringer in your garage or other area where a ringing telephone cannot be heard. It will also make the ringing sound of a standard telephone more audible. Up to four ringers can be used on a single telephone line, and a remote bell can be used 100 feet or more away from the unit. By substituting a light bulb for T2 and dispensing with the bell, the circuit can be made useful for the hearing impaired.

About 50 to 60 VDC is present between the tip and ring (red and green) wires of an unoccupied telephone line. Capacitor C1 blocks that DC voltage. The MOV just shunts any dialing pulses generated by a rotary phone that might be on the same line.

To make the phone ring, the tip and ring wires deliver an AC signal between 90 and 130 volts to the

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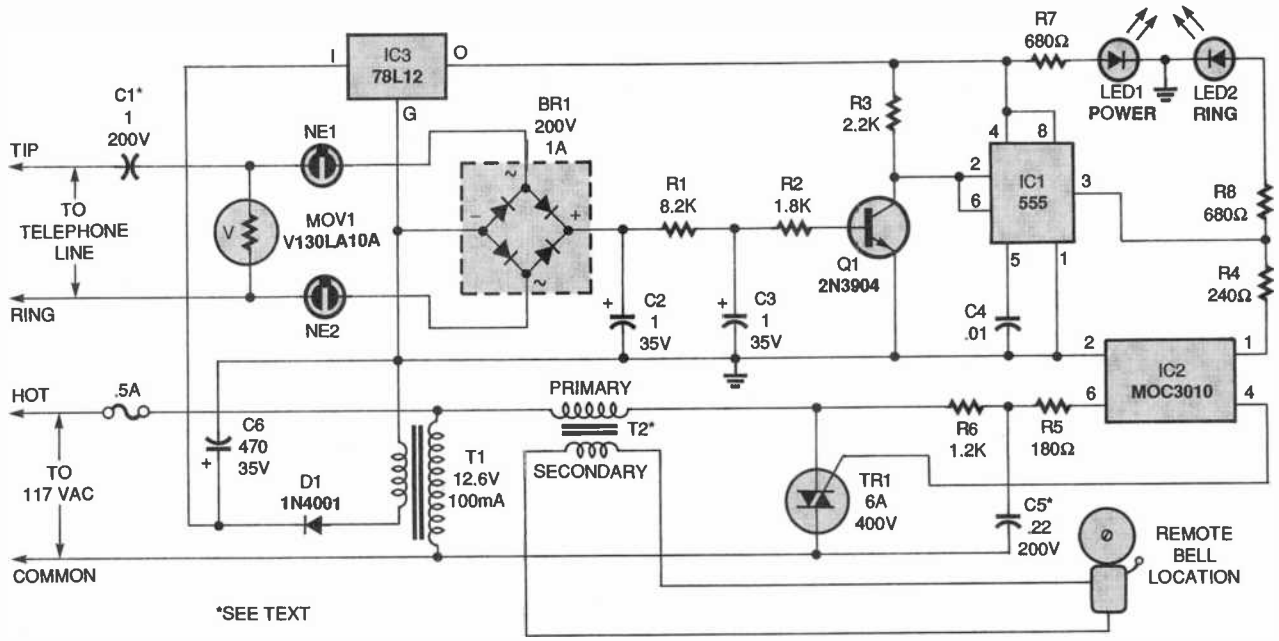

Fig. 5. This low-cost telephone-line extension bell ringer lets you hear your phone ringing in the garage, or in whatever other remote bell location you wish.

phone. That AC signal is coupled through C1 to the two neon lamps, NE1 and NE2 (RadioShack 272-1102 or equivalent). Those neon bulbs provide line isolation between the unit and the telephone line. They also neon fire (ionize) when more than 100 volts are present on the phone line (in other words, during the ring signal). When they fire, they form a three-step voltage divider with the bridge rectifier. The voltage across the bridge is rectified, then filtered by R1, R2, C2, and C3, and causes Q1 to conduct. Then pins 2 and 6 of U1 go low, causing pin 3 of U1 to go high. The optoisolator and triac (RadioShack 276-1000 or equivalent) then turn on, applying power to the remote bell through a doorbell transformer (T2).

The simple circuit can be assembled on a perforated board or a small PC board. Double-check the polarity of the components before soldering them in place. The entire ringer can be mounted within a small plastic enclosure that can be located near the phone, or at some distance away as a remote ringer monitor. Keep in mind that some telephone companies require that you inform them that you are using one of these circuits. Power can be taken from your house's doorbell, allowing you to omit T1 and save space in the box.

Note that C1 is a nonpolarized, 200-WVDC, metal-film capacitor. Capacitor C5 should also be metal film; for that reason, use two 0.1-μF metal-film capacitors in parallel (the capacitors are available from RadioShack as part number 272-1053).

—Craig Kendrick Sellen, Waymart, PA

Pretty thorough conditioning of the incoming phone signal. I suppose if you're tapping voltage off the house bell you could also use one of its chimes as the "announcer," provided the chime is located where you can hear it. You could dispense with the triac-based control circuit, using the optocoupler to complete the circuit between the household's bell transformer (not the one shown) and the extra chime.

TELEPHONE QUESTIONS

In the August 1992 *Think Tank*, do Figs. 1 and 2 show circuits of intercoms? Are those telephones, which are used to make intercoms, connected to regular telephone services, or are they connected to each other?

One more thing. Is it possible to find a caller's telephone number without the help or service provided by the telephone company (such as Caller ID), and can such a thing be done with or without a computer? If the answer is yes, I would be very grateful to you if your can also supply me with a circuit diagram to make such a device.

—Zahid Mehmood, New York, NY

The two devices are regular phones used to form an intercom, but they're only hooked up to the power supply shown, not the phone company's lines.

Sorry, but for Caller ID to work, the phone company must transmit the incoming phone number prior to the first ring signal. Without the phone company's cooperation, the data is not available for processing by any circuit you might build.

That rounds out another month. Write to *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735 if you'd like to take a shot at a free book. ■

MULTIMEDIA WATCH

(continued from page 14)

clopedia. The $49.95 disc is loaded with physical, political, and satellite maps, all with searchable locations. Pictures, video, slide shows, and more, detail this diverse planet.

If you've ever been so fed up that you felt like getting into an armed tank and blasting away at everything around you, then *Assault Rigs* from Psygnosis might be just what you need to calm your aggressions. Real-time 3D graphics take you through 40 levels of hostile, interactive mazes. ■

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COMPUTER BITS

Web Authoring Tools

BY JEFF HOLTZMAN

For the past few issues we've been talking about hypertext in general, and most recently, Windows Help files in particular. Now we will focus on hypertext as it is used on the Internet. In particular, we'll look at tools for creating Web pages. Let's start with some background about what constitutes a Web page.

WEB PAGE BASICS

A Web page is nothing but plain-old 7-bit ASCII text, the *lingua franca* of disparate computer systems. It may refer to binary files in other formats—such as bitmapped graphics—but Web pages themselves contain nothing but ASCII text.

Although a web page contains nothing but ASCII, the file format is anything but simple, because along with the text—the content—of the page are numerous tags that specify document structure and format. For example, there are tags to denote bold and italic type, and other tags to break a page into hierarchically related sections. The way the tags are used is specified by a language called Hypertext Markup Language, or HTML.

As you probably know, HTML is a rapidly evolving specification. It is being driven by companies with intense competitive interests, so there are inconsistencies in the way various features of the language are intepreted, implemented, and even extended. A standards body called the World-Wide Web Consortium (W3C) tries to track and to some extent drive a real standard. The current version is 3.2, with a 4.0 version expected (possibly) by the end of the year. See http://www.w3.org for details on HTML and related technologies.

TOOLS

There are four basic categories of Web-page tools: text editors, save-as-HTML filters, tag helpers, and WYSIWYG editors. We'll discuss products in each category, and examine their relative strengths and weaknesses.

It is possible to create Web pages using just a programming language, but we'll save that for another time. Also, most Windows Help authoring tools are also gaining a save-as HTML feature that allows a fully hyperlinked help system to be recreated as a fully linked set of HTML pages.

TEXT EDITORS

These include things like Windows' Notepad and DOS programs like EDIT and EDLIN, and anything else that can edit plain ASCII files. You can even use a word processor and save as ASCII, although plain text editors tend to allow quicker iteration through the edit-test-edit-test cycle. My favorite product in this category is The SemWare Editor, a descendant of the venerable shareware program, Qedit. TSE is fast, light, and infinitely customizable.

It's interesting to note that a computer-industry trade journal recently published results of a survey of professional WebMasters, over half of whom stated their preference for plain text editors. The main reasons: Poor user interfaces and inconsistent support among authoring tools for various HTML tags.

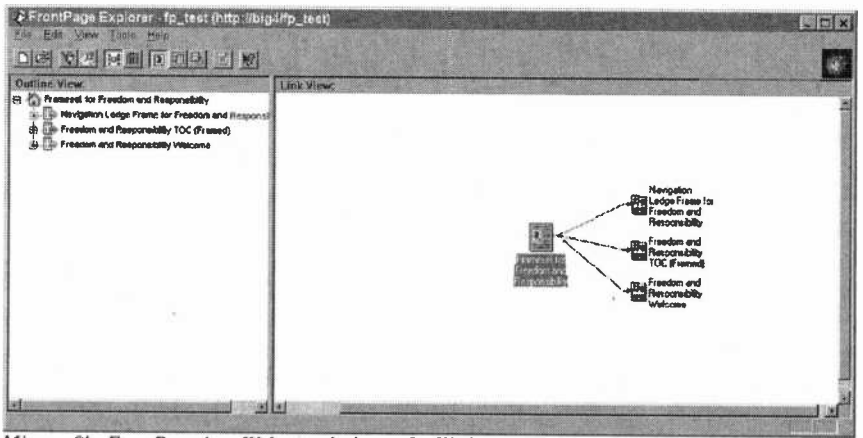
SAVE-AS-HTML FILTERS

One way to allow a standard word processor to create HTML documents is to simply save existing documents in the HTML format. Weaknesses here typically involve bitmap graphics formats and hypertext linking. But you don't have to learn a new program. By installing a free upgrade called the Internet Assistant, MS Word 7 (for Windows 95) gains a save-as-HTML option. I assume most similar programs do as well. IA is available from Microsoft's web site and the major online services. Microsoft also supplies free Internet Assistants for Excel, Access, and PowerPoint.

IA makes Word into a mini-browser that can display Web pages in both source (tagged text) and rendered (as a Web page) formats. If you're a Word user, and have light-duty Web-page authoring needs, IA may be all you need. In the IA mode, Word is classified as a WYSIWYG editor. Incidentally, you can use Word+IA to browse pages stored on your local hard drive. Click the Enter URL button, and enter syntax with the following format, where filename.htm is a valid HTML file in the specified directory:

file:///C:/dir1/dir2/filename.htm

WYSIWYG editors try to hide most or all of the underlying HTML coding, and allow the page developer to concentrate on developing pages. These



Microsoft's FrontPage is a Web site designer. Its WYSIWYG character applies to both individual page designs, and the overall structure of the site as a whole.

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are typically much more elaborate programs, approaching the strength of full-blown word processors or desktop publishing programs. By far the coolest product I've seen in this category is FrontPage, available for $149 from Microsoft (One Microsoft Way, Redmond, WA 98052-6399).

I don't like it because it "hides" HTML. I do like it because it explicitly acknowledges and provides support for the real problems in Web-site design: structure, organization, design, and architecture. In my book, a successful Web site is not the one with the coolest graphics or other effects. It's the most well organized, the one that helps me find what I'm looking for quickest.

I know people who have literally designed hypermedia systems using Post-it notes and kite string. FrontPage puts design back where it belongs, in the computer. FrontPage has several templates and wizards that can help you create a Web-site skeleton, complete with links, in minutes. With an interface called the FrontPage Explorer, it provides both hierarchical and node-based graphical depictions of your site's structure. Thus you can literally see which pages link to which pages, and which elements (such as bitmaps) a page contains.

FrontPage also has the concept of a "bot," defined as "A dynamic object on a web page that is evaluated and executed when the author saves the page to the server or, in some cases, when the reader links to the page." Bots allow you to do things like create includable elements (e.g., a toolbar) that can be used over and over in multiple pages. Another bot automatically builds a table of contents page for a web site. Still another allows the page developer to insert arbitrary HTML codes in a file, even if the FrontPage editor does not support them directly.

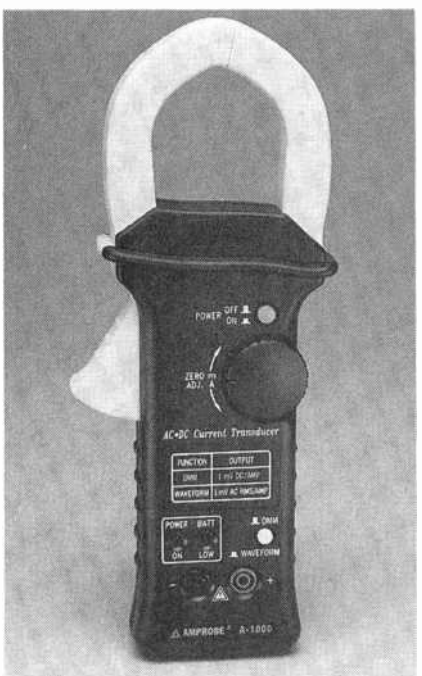
TAG HELPERS

The final category is Tag Helpers, which provide a middle ground between raw text and WYSIWYG editors. Tag editors typically "know" nothing about tags, but provide pushbuttons and well-organized menus to automate the process of inserting HTML tags. There are many, many shareware products in this category. There is little that this type of product can do that a programmable text editor (like TSE or Qedit) cannot be taught to do. And by creating your own HTML editing commands, you'll learn more about both HTML and your text editor.

Next time we'll talk about the right way and the wrong way to create a Web site. ■

NEW PRODUCTS

(continued from page 10



The A-1000, complete with shrouded test leads, shrouded right-angle-to-BNC test leads, carrying case, battery, and user's manual, has a list price of $178.85. For additional information, contact Amprobe Instruments, 630 Merrick Road, Lynbrook, NY 11563; Tel. 516-593-5600; Fax: 516-593-5682.

CIRCLE 86 ON FREE INFORMATION CARD

PHONE-LINE VIDEO CAMERA

The *SECURECam I* from *Marshall Electronics* is a digital color camera that plugs directly into standard commercial telephone lines for remote viewing and storing of video pictures on any personal computer. It allows you to dial up the remote site on your PC and view live images at a rate of four frames per second in a 2×2-inch window. If you freeze the picture, a full-screen, high-resolution (640×480), 24-bit color image appears on the screen. Only a camera and a standard phone line are needed at the remote site. A modem-equipped PC running Windows is the only thing required to view and save the images at the monitoring site. The color digital camera features electronic zoom plus pan and tilt controls.

The SECURECam I provides a cost effective method of remote viewing for applications such as alarm verification, crime-watches, monitoring weather conditions, and traffic or pedestrian control. Business owners can use it to monitor operations from home or office. Its digital technology also allows for remote Internet cameras for future neighborhood-watch programs. We've all seen applications for a camera like this on the Web. There are sites using cameras like this one to display what a landmark looks like at the current moment, what the weather is like in a particular area, and even what a person's aquarium looks like at the current time.

Five or more cameras can be integrated through special adapters that use the same phone line, allowing coverage of large areas. Future adapters will allow security alarms to dial the viewing PC and automatically save pictures into a video database.

The SECURECam I has a suggested retail price of $599. Additional slave cameras, which plug into a multi-cam adapter box, cost $299 each, and the adapter box costs $199. For more information, contact Marshall Electronics, Inc., Optical Systems Division, P. O. Box 2027, Culver City, CA 90231; Tel. 310-390-6608; Fax: 310-391-8926; e-mail: Lmarsgo@ix.netcom.com.

CIRCLE 87 ON FREE INFORMATION CARD

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SCANNER SCENE

Check Out These New Channels

BY MARC SAXON

RadioShack's PRO-50 is a basic, straightforward, 20-channel handheld, well-suited to beginners. It sells for about $150. Even serious monitor-meisters should view the PRO-50 as a relatively inexpensive scanner to use for certain specialized applications. For instance, if you are in the field and are interested in monitoring only a single agency, or only certain maritime channels, or only cordless-phone frequencies, you can use the PRO-50 and leave your expensive handheld home.

This isn't a bare-bones deal, either. The PRO-50 is a good-looking scanner that offers full searching capabilities with a monitor memory channel for temporary storage of a newly discovered frequency. It scans and searches at 16 channels per second. The frequency coverage is the standard 30 to 54 MHz, 137 to 174 MHz, and 380 to 512 MHz. Sensitivity is rated at 1 μV on all frequencies. Selectivity is -6 dB at ±10 kHz, and -50 dB at ±20 kHz. The IF frequencies are 10.7 MHz and 455 MHz.

The PRO-50 offers one-hour memory backup without batteries installed. It requires six AA batteries or any 9-volt DC (negative ground) source, such as an adapter. The antenna is a rubberized type with a BNC connector.

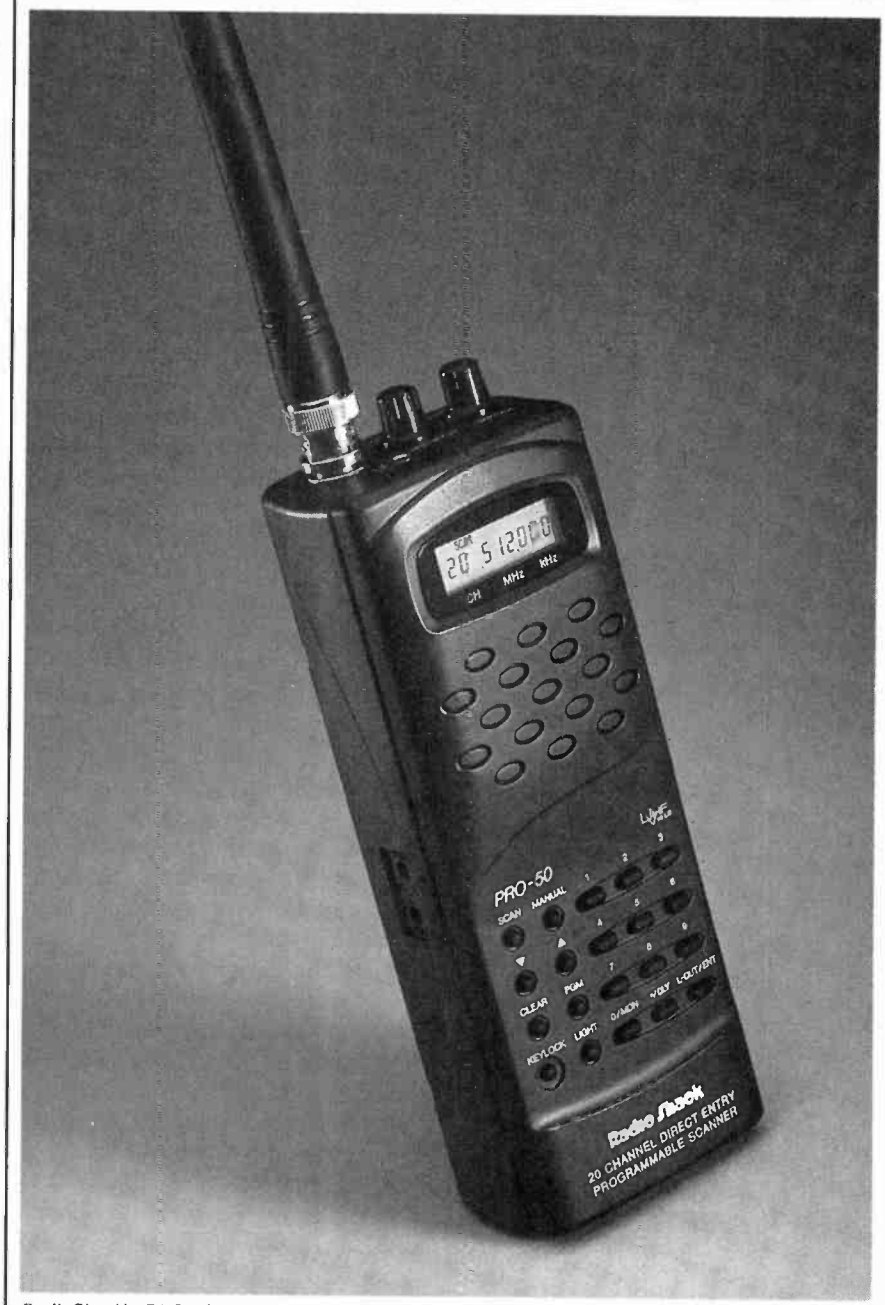
Look for the PRO-50 at any RadioShack store.

NEW FREQUENCIES TO WATCH

The FCC announced its new Emergency Medical Radio Service (EMRS). Some 453-MHz Special Emergency Service Channels will be used by the EMRS, but the big news came in the 220-MHz range.

Medical services, rescue organizations, disaster-relief groups, and beach patrols can use ten new narrowband channels in the 220-MHz band to allow them to communicate with one another while conducting safety-of-life operations. In other words, they are mutual aid channels.

"Narrow-band" means that the channels are closely spaced with only 5-kHz separation. That means that many channels will program into your scanner off the exact frequency by 2.5 kHz. Not to worry. From a mere 2.5-kHz away, you would still be able to copy all transmissions on that channel without noticing the difference. For scanner owners, 5-kHz channel separation means adjacent channel communications would cause interference.



RadioShack's PRO-50 is a trusty, full-function handheld for beginners and an inexpensive on-the-road scanner for more experienced users.

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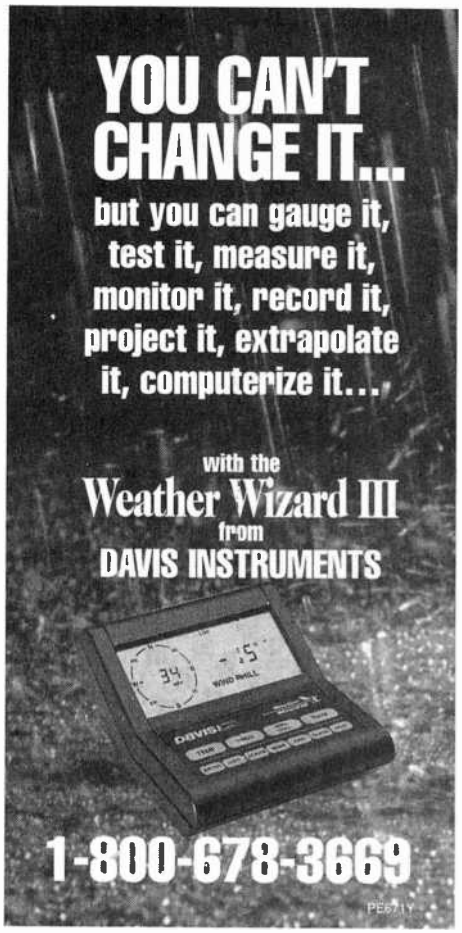

CIRCLE 162 ON FREE INFORMATION CARD

In other FM bands, the usual practice is for assignable frequencies to be more widely spaced.

The new EMRS frequencies in this band are: 220.8025, 220.8075, 220.8125, 220.8175, 220.8225, 220.8325, 220.8375, 220.8425, and 220.8475 MHz. They are called Channels 161 through 170.

URGE TO SURGE

After the interruption in the regulated voltage from your AC power line, even for a few moments, the sudden resumption of power comes in the form of a voltage spike. That spike, known as a *surge*, exists only for a split second, but can push a jolt of more than 6000 volts into all equipment plugged into the building's 120-volt AC power lines.

A surge can seriously damage many types of electrical and electronic devices if they happen to be in use. Certainly, your desktop scanner could be zapped by a surge.

Many people use surge protectors that accommodate six power plugs, and those are okay. But my personal preference is to use individual, single-outlet protectors (RadioShack 61-2133 or equivalent) on my radios. They are inexpensive, dedicated to a single device, and will handle any jolt coming down the "inflammation superhighway."

THINGS ARE LOOKING UP

A letter from reader R. Cinque in New Jersey reports receiving FM transmissions of carrier pulses on 137.85 and 137.855 MHz. Can we provide any guidance?

That band is reserved for satellites. The only one that we could link to the reported frequency is the Russian weather satellite METEOR 2-10, which operates on 137.85 MHz. Try 137.17 MHz for the MARECS A/B communications satellite, as it sometimes produces voice and data. FM voice from the orbiting MIR space lab is often reported on 143.625 MHz.

The other day, a friend called me from an airplane and mentioned that he was using the plane's cellular phone. It's a common misconception that airline phones are cellular, but cellular phones are illegal for use aboard in-flight aircraft.

Nevertheless, airplanes use a full-duplex air/ground telephone communications system that is similar to cellular, and you might like to give it a listen. Full duplex means that both parties can speak at the same time. The business and personal calls that go through sound very much like cellular and cordless calls, yet these frequencies haven't been blocked out in the newer scanners.

There are several competing companies providing air/ground phone service to airlines. Each operates a nationwide network of ground stations, which use the 849–896-MHz band to uplink communications to the aircraft. Airlines contract with specific companies to supply their air/ground service.

Airlines receive the 849–851-MHz band, and their own transmissions are downlinked in the 894–896-MHz band. Here's a major difference from cellular phones: Airline air/ground telephones use AM mode. That's right—forget FM! Also, the assigned channels have been given a weird 6-kHz spacing.

Put your scanner into AM mode, set it at 5-kHz steps, and let it search the 894–896 band to pick up the aircraft side of the communications. Aircraft can be monitored from hundreds of miles away if you have an outside antenna. Then, do the same with 849–851 MHz to see if you are close enough to any ground station to pick them up.

Corporate jets also use air/ground phones. They have a completely different system tied to landline phone companies, and are reminiscent of mobile phones of the pre-cellular era. Telephone companies in certain major cities operate the ground stations. Each ground station is licensed to operate with FM on one or two specific channels out of the 12 in the air/ground telephone band that lies between 454.70 and 454.975 MHz (25-kHz channel spacing).

Aircraft communicating with the ground stations do so exactly 5-MHz higher than the ground station's frequency. If a ground station was using 454.725 MHz, for instance, the plane would use 459.725 MHz.

Write to *Scanner Scene*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

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CIRCUIT CIRCUS

Crystal Sets

BY CHARLES D. RAKES

This month the circus goes on a journey back in time to the early days of radio. Come along with us to the exciting world grandpa experienced in the era of cat whiskers, crystals, grounds, and long wire antennas.

If you have never experienced listening to a free-powered radio read on, because you're in for a special electronic treat. And if you have tasted the fruits of crystal radio, you know there's fun afoot. So stay tuned for some crystal magic.

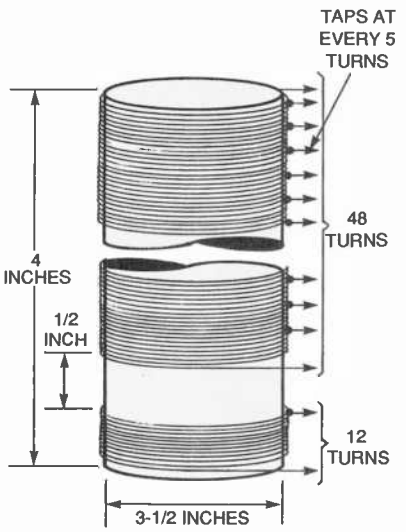

Fig. 1. This small coil is made up of two windings. Note that the 48-turn winding has taps at every five turns. The 12-turn coil will be used for RF coupling.

PARTS AND MATERIALS LIST FOR THE SMALL COIL (Fig. 1)

$3\frac{1}{2}$-inch diameter PVC pipe
19- or 20-gauge, enamel-covered, copper magnet wire

SMALL COIL

To use the crystal receiver circuits in this column, you will have to wind two coils, which we'll refer to as the small and large coils. Both are simple to wind and are not at all critical in their construction. So if you don't have the exact size coil form, feel free to use just about anything you have that is close. Also, if you don't have the same gauge of wire specified, you can use a slightly different wire size (a gauge off in either direction). But in any case, try to use a plastic form to wind your coils on, thereby ensuring the highest Q possible for the coil; PVC works best.

The small coil shown in Fig. 1 is wound on a $3\frac{1}{2}$-inch-diameter piece of PVC pipe cut to a length of 4 inches. Note that the coil is made up of two separate windings. The main coil has 48 close-wound turns of 19- or 20-gauge, enamel-covered, copper magnet wire, with taps at every 5 turns. The small winding consists of 12 turns of the same type of wire, wound a half inch below the main winding.

LARGE COIL

The large coil, shown in Fig. 2, is wound on a 4-inch-diameter PVC pipe. Cut the pipe to a length of about 5 inches. Like the small coil, this large

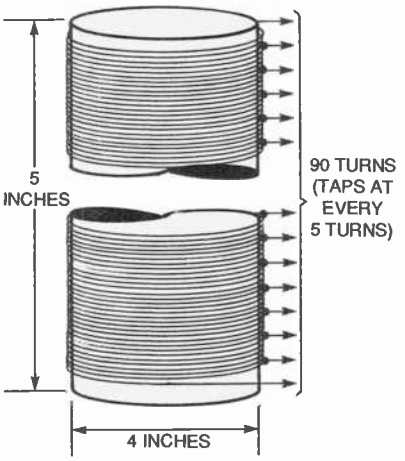

Fig. 2. The large coil has one 90-turn winding with taps at every five turns.

PARTS AND MATERIALS LIST FOR THE LARGE COIL (Fig. 2)

4-inch diameter PVC pipe
19- or 20-gauge, enamel-covered, copper magnet wire

one should be close wound. Use the same type and size wire you used for the small coil. This time, however, wind 90 turns onto the form; the large coil should also have taps at every 5 turns.

That takes care of the two homemade coils used in the receivers described this month. The only other coil you'll need is a factory-made RF choke with a value between 1 and 2 mH.

BROADBAND RF TESTER

Our first crystal-radio circuit, shown in Fig. 3, is a broadband RF test circuit. The circuit contains the store-bought inductor just mentioned (L1), a germanium diode (D1) that can be found at RadioShack and other sources, and a pair of 2000-ohm headphones. This simple receiver will allow you to see how much detectable RF is available at your location, and the effectiveness of your antenna and ground system.

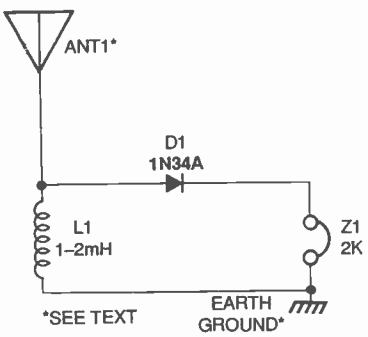

Fig. 3. This broadband RF tester will give you a good idea of the effectiveness of your antenna/ground setup.

PARTS LIST FOR THE BROADBAND RF TESTER (Fig. 3)

D1—1N34A germanium diode
L1—1- to 2-mH RF choke
Z1—2000-ohm headphones
Antenna (see text), earth-ground connection (see text), wire, solder, etc.

A long and high antenna works best for the crystal receiver, but good results, especially in large metropolitan areas, can be had with short and smart antennas. A wire placed around the room near the ceiling will suffice in

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some locations. At times you can receive strong signals by connecting the antenna input to the metal frame of your telephone. Bed springs have always been tried and with fair results in a strong signal area. Window screens, drains, and other ungrounded metal items can be tried. Don't tie on to anything that might have AC voltage present, however.

A good earth ground is essential for efficient crystal-radio operation. That's easier for some than others. For example, if you live in a city building finding a good earth ground several stories up isn't an easy task (but here again you can improvise by running a counterpoise antenna away from your main antenna and connecting it to the ground circuit of the crystal radio). Metal water pipes can make a good ground system if they are actually under the ground at some point.

Those antenna and ground tips should be kept in mind when you build and use any of the receivers in this column. As you'll soon find out, experimenting with antenna and ground systems can be as challenging and rewarding as receiving a weak and distant station.

Once you have an antenna and ground setup, connect the RF test detector to the appropriate points. You should hear a number of AM broadcast stations all coming in at the same time. If so your antenna and ground system is "radio active."

TUNABLE DUAL-COIL

Our first real crystal-radio circuit is shown in Fig. 4. Both of the windings of the small coil (shown here as L1) are used in this circuit. The 12-turn primary winding couples the RF signal from the antenna/ground system to the 48-turn secondary winding. Here C1, a 365-pF variable capacitor, tunes the L/C circuit to the desired radio-frequency signal. A 1N34A germanium diode, D1, detects the audio and feeds it to the headphones (Z1).

The various taps on L1's secondary allow impedance matching of the antenna/ground system and the detector diode, as well as the inductance value needed to tune to the desired RF signal. Here's where you can hone your receiver for its best performance by experimenting with the various taps.

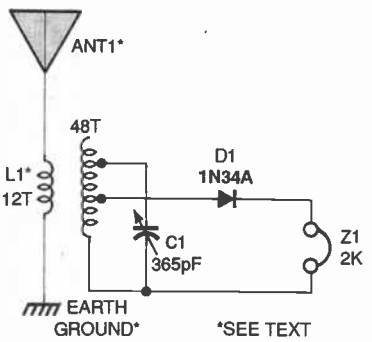

Fig. 4. Both windings of the small coil are used in this dual-coil receiver.

PARTS LIST FOR THE TUNABLE DUAL-COIL (Fig. 4)

D1—1N34A germanium diode
C1—365-pF variable tuning capacitor
L1—Small coil (see Fig. 1)
Z1—2000-ohm headphones
Antenna (see text), earth-ground connection (see text), wire, solder, etc.

A good tap selection for starting out with your receiver would be to connect C1 across the full secondary of L1. Connect the germanium diode to the middle tap.

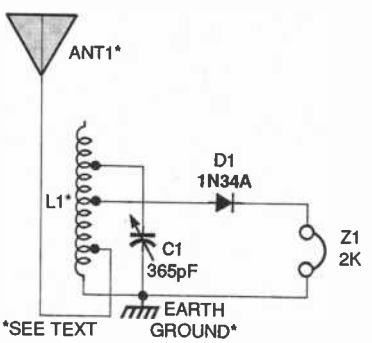

Fig. 5. This single-coil receiver can be tuned by varying the tap points and by adjusting C1.

PARTS LIST FOR THE TUNABLE SINGLE COIL (Fig. 5)

D1—1N34A germanium diode
C1—365-pF variable tuning capacitor
L1—Large coil (see Fig. 2)
Z1—2000-ohm headphones
Antenna (see text), earth-ground connection (see text), wire, solder, etc.

TUNABLE SINGLE COIL

Our second receiver, see Fig. 5, places the large coil described earlier in a single-coil circuit. The key to this receiver's success is its tapped coil. By experimenting with various tap combinations you can make the circuit very selective and sensitive.

A starting setup for this circuit is as follows: Connect the antenna to the second tap up from the bottom of the coil (that's the end of the coil that's connected to ground). The diode should connect to about the fourth tap up from the bottom, and C1 should be attached to the seventh tap or so up from the bottom. Those tap position might not be the best starting point for your antenna/ground arrangement. That doesn't matter, however, because to obtain the best results with the receiver at your location you should experiment with all variables anyway.

FINE TUNER

Our next receiver's tuned circuit (see Fig. 6) is in some ways similar to an antenna-matching device used by amateur-radio operators to impedance match their receiver/transmitter input/output circuitry to the impedance of the antenna for maximum signal transfer.

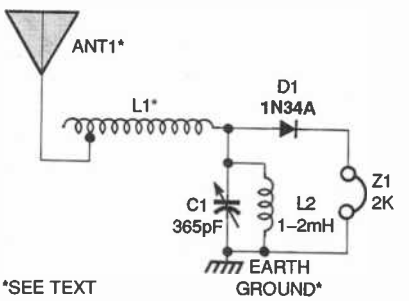

Fig. 6. While an effective crystal receiver, this circuit resembles an antenna-matching device used by amateur-radio operators.

PARTS LIST FOR THE FINE TUNER (Fig. 6)

D1—1N34A germanium diode
C1—365-pF variable tuning capacitor
L1—Large coil (see Fig. 2)
L2—1- to 2-mH RF choke
Z1—2000-ohm headphones
Antenna (see text), earth-ground connection (see text), wire, solder, etc.

Inductor L2 gives a DC-signal return path for D1's output. The inductance of L2 is too large to affect the circuit's tuning function. This is a very fine crystal radio receiver. Build it, fine tune it, and you'll agree.

continued on page 77

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Baluns and Other Broadband Transformers

BY JOSEPH J. CARR, K4IPV

One of the necessary tasks of antenna construction is impedance matching. There are a number of schemes used for impedance matching, but one of the more common is to use either a balun transformer, or one of its relatives. As you might expect, there are a number of different transformers used for impedance matching in antenna systems.

The term balun is used extensively by ham operators, and it comes from *BALanced-UNbalanced*. When it is used correctly, the term balun refers to a transformer that matches a balanced load (*e.g.* a dipole antenna feedpoint) to an unbalanced load (*e.g.* coaxial cable). However, it has become a common (if erroneous) practice to use "balun" in a generic sense to refer to any broadband transmission-line transformers. Some of these are balanced-balanced types that we might call bal-bal, and others are an unbalanced-unbalanced configuration and might be called un-un. I suppose that balun sounds more like a real word than bal-bal or un-un. (Note: Some antenna and accessories catalogs do use these terms correctly, but the erroneous use is frequently seen.)

One of the earliest forms of balun transformer is the coaxial cable balun shown in Fig. 1. Both pieces of coaxial cable used in this balun transformer are of the same type (75-ohm coax). When connected in this configuration, the balun transformer produces a 4:1 impedance transformation. This means that a 300-ohm balanced antenna (a folded dipole) will look like a 75-ohm unbalanced load. The coax to the ham rig or receiver can be any convenient length. The balun section, however, must be half wavelength (keeping in mind the velocity factor). The length of the balun section is found from:

$$l = 492v/f$$

Where l is the length is in feet, v is the velocity factor (0.66 for polyethylene coax, and 0.80 for polyfoam), and *f* is the frequency in megahertz (Mhz).

Calculations using this equation usually come up with fractional values. For example, for 7150 kHz using polyfoam coax, the length is 54.76 feet. To convert the fractional part to inches, multiply by 12. For example, 0.76 ft × 12 = 9.1 inches. The overall length of the 54.76-foot antenna is 54 feet, 9.1 inches.

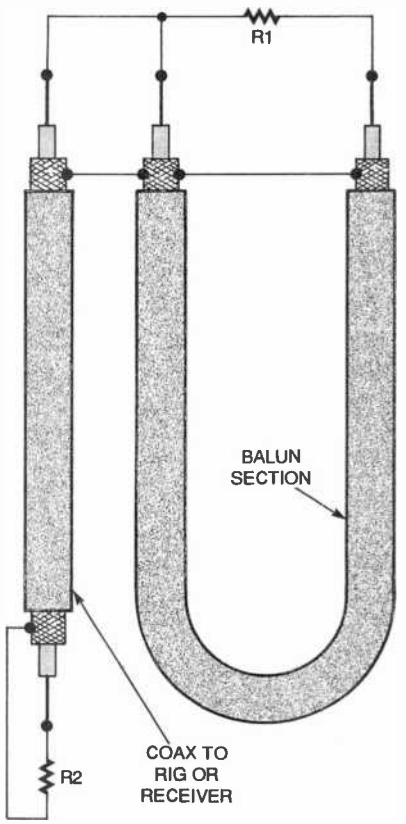

Fig. 1. A coaxial cable 4:1 balun transformer is made from 75-ohm coax cable.

A BOX FOR THE BALUN

A connection box for making the coaxial balun is shown in Fig. 2. This box is intended for mounting on the antenna center insulator. It should not be used to support the antenna unless eye bolts or other more rugged fixtures are provided at the left and right ends. The balanced antenna feedpoint is connected to a pair of five-way binding posts, while the coaxial cable for the run to the rig or receiver and the balun sections (B1 and B2) are connected to SO-239 coaxial connectors.

The coaxial balun is designed for a specific frequency, and will work over a small distance to either side of the design frequency (typically one HF ham band can be accommodated). But for wideband operation, you might want to build a broadband transformer such as those shown in Fig. 3. Note that some of these transformers only show one core symbol (as in Fig. 3A). These transformers have all windings on the same core. The dots show the phase sense of the windings, and indicate the same end of the winding.

The two most common forms of balun transformer are those in Figs. 3A and 3B. The version in Fig. 3A has no impedance transformation, and is usually referred to as a 1:1 balun. The transformer in Fig. 3B, on the other hand, offers a 4:1 impedance transformation. It is equivalent to the coaxial balun shown in Fig. 3A. The transformers in Figs. 3C and 3D are both

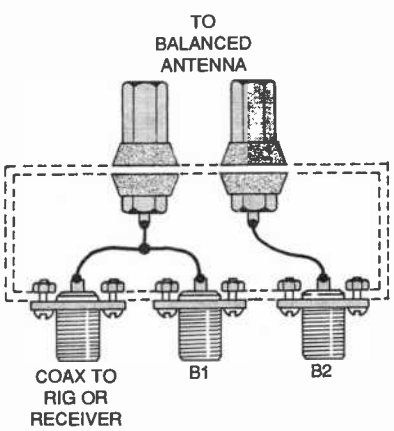

Fig. 2. Here's the connection box for making a 4:1 coaxial balun. It is intended for mounting on the antenna center insulator

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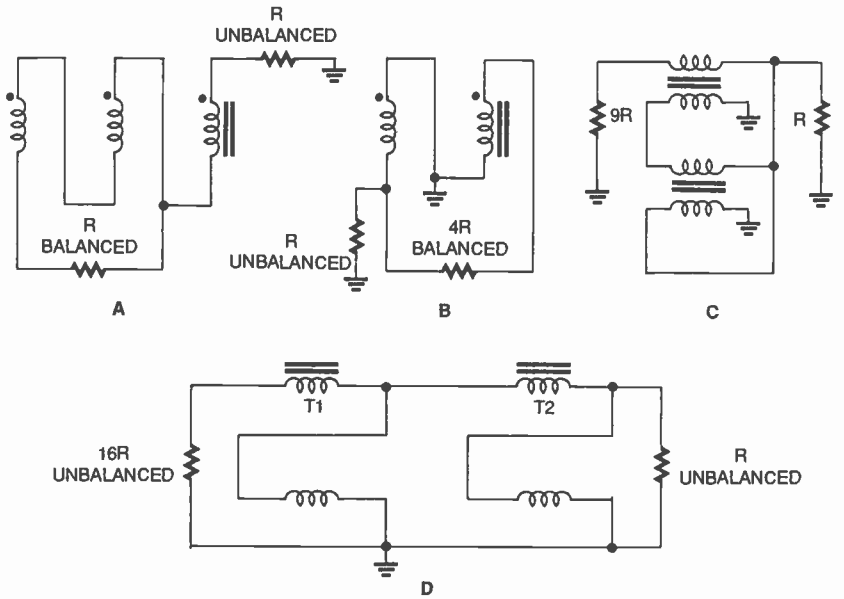

Fig. 3. There are several types of impedance-matching transformers: 1:1 balun (A), 4:1 balun (B), 9:1 un-un (C), and 16:1 un-un (D).

un-uns. The configuration in Fig. 3C produces a 9:1 impedance transformation, while that in Fig. 3D produces a 16:1 transformation.

The construction of coil baluns and broadband transformers is shown in Fig. 4. The transformer shown in Fig. 4A is wound on a toroid core made of either powdered iron or ferrite. The toroid is doughnut shaped. Since it has the interesting attribute of containing the magnetic field to its own geometry, it has little interaction with its environment. This means that it will work like the book says more often than certain other transformer core configurations.

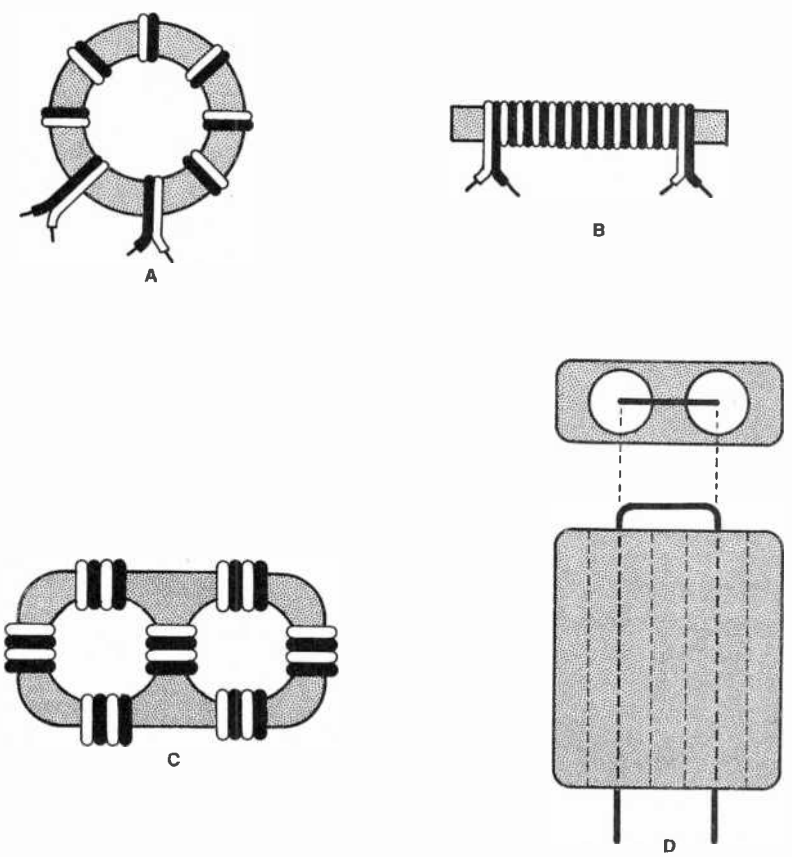

Fig. 4. Shown here are construction details for the most common types of transformers: toroid (A), solenoid (B), bazooka–end view (C), and bazooka–top view (D).

WINDING THE TOROID

Note how the wires are wound on the toroid core. They are kept paired and lie next to each other. In this manner they are wound together as if they were only one piece. When two wires are used, this form of winding is called bifilar. When three wires are wound together in this manner a trifilar winding is produced. The bifilar method is used to wind the coils shown in Figs. 4A and 4B, while trifilar winding is used for the one in Fig. 4C.

The solenoid winding method is shown in Fig. 4B. The core can be either air (in which case a coil form is needed), or a ferrite rod (as shown). Again we see the use of either bifilar or trifilar winding, depending on the nature of the transformer being made.

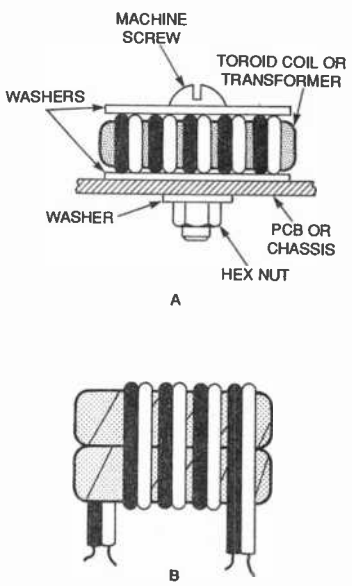

Fig. 5. Here's how to mount a toroid transformer to a PC board (A). Stack baluns where higher power levels must be handled (B).

The so-called bazooka balun core is shown in Figs. 4C and 4D, using two different winding styles. In Fig. 4C, the wire is passed through both holes to form a loop (internal winding). Counting the number of turns is a little different than one might suppose. The case shown in Fig. 4C is one turn, even though many people erroneously

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assume that it is half a turn. If one end of the wire is passed through both holes one more time, then there are two turns present. Both the primary and secondary windings can be wound in this same manner, laying one over top the other (the primary is usually laid down first). The case shown in Fig. 4D shows an end view of the bazooka balun core. Here, several turns are wound in both the internal and external winding styles. These two styles can be intermixed on the same form, but wherever possible you should use the internal winding mode as the preferred mode.

Figure 5A shows how a toroid-core inductor or transformer is mounted on either a printed-circuit board or metal chassis. Fiber or nylon washers are used to secure and protect the toroidal core, and nylon or other non-metallic fasteners (machine screw and hex nut) are used to keep it in place. Use non-metallic fasteners to keep from interfering with the operation of the transformer. Only in the case of the largest toroids (>5- or 6-cm diameter) are metal fasteners usable, and even then they should be avoided.

The scheme in Fig. 5B is used on transmitter antenna tuning units and similar applications where the power is higher. Two or more 5-cm or larger toroids are stacked one on top of the other. Each toroid core is first wrapped with fiberglass tape to insulate it from the other core. After the cores are wrapped with tape and stacked on top of each other, you should add a final layer of tape to keep the whole assembly stable. The bifilar or trifilar windings are then laid down on the stacked cores.

A number of manufacturers offer baluns, bal-bals, and un-uns, in both voltage and current configurations. Some are designed to replace the center insulator of an antenna such as the dipole. Others are intended for mounting elsewhere.

That's all for now. I can be reached by snail mail at P.O. Box 1099, Falls Church, VA, 22041, or by e-mail at carrjj@aol.com. ■

CIRCUIT CIRCUS

(continued from page 74)

IMPEDANCE MATCHER

Our next circuit, see Fig. 7, uses three inductors to increase the receiver's selectivity and sensitivity. Components L2 and C1 are used in an antenna impedance-matching circuit, while L1 and C2 operate in a series-tuned low-output impedance circuit that matches the impedance of the diode detector. A 1- to 2-mH inductor (L3), as in the previous circuit, offers DC continuity to the detector circuit.

Here, again, experiment with various taps on each inductor for the greatest amount of audio output with good selectivity. When the circuit is adjusted for maximum audio output, the selectivity will suffer, but if you are tuned to the strongest RF signal it probably won't make any difference. In any case the key word is "experiment."

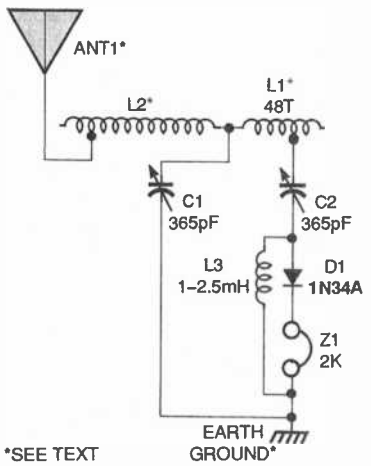

Fig. 7. This three-inductor receiver provides for impedance-matching of the antenna and diode detector.

PARTS LIST FOR THE IMPEDANCE MATCHER (Fig. 7)

D1—1N34A germanium diode
C1, C2—365-pF variable tuning capacitor
L1—48-turn winding of small coil (see Fig. 1)
L2—Large coil (see Fig. 2)
L3—1- to 2-mH RF choke
Z1—2000-ohm headphones
Antenna (see text), earth-ground connection (see text), wire, solder, etc.

RECTIFYING DETECTOR

Our last receiver circuit (see Fig. 8) uses both homemade coils in a full-wave-rectifier detector circuit. This receiver can supply up to twice the audio output of a single-diode circuit.

The 12-turn coil of L1 couples the RF signal to the large coil, L2. Connect the center tap of L2 to ground, the fourth tap up from the center to diode D1, and the fourth tap down from the center to diode D2. The combined audio output drives the headphones (Z1).

If you change tap positions, keep the same number of turns on each side of center. That will balance the RF that feeds each detector diode.

The circuit's sensitivity and audio output can be increased by placing L1 inside of L2 (the forms specified for the coils should make that possible). For maximum selectivity, L1 should be loose-coupled to L2.

This dual-diode receiver can drive a high-impedance speaker to fill a small room with audio. You can make your own high-impedance speaker by taking a 1000-ohm to 8-ohm audio-output transformer and connecting it to the receiver circuit. Replace the headphones with the 1000-ohm transformer winding and connect an 8-ohm speaker to the transformer's output. That should give you free enjoyment radio night and day.

Looks like we've run out of time. So until the next circus, travel back in time and enjoy the magic radio of yesteryear. ■

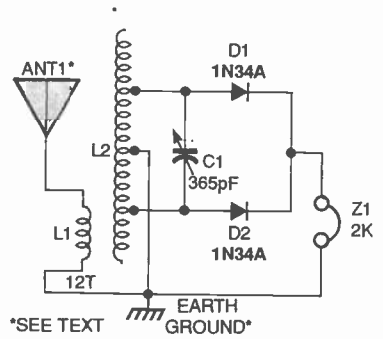

Fig. 8. This dual-diode receiver can supply up to twice the audio output of a single-diode circuit.

PARTS LIST FOR THE RECTIFYING DETECTOR (Fig. 8)

D1, D2—1N34A germanium diode
C1—365-pF variable tuning capacitor
L1—12-turn winding of small coil (see Fig. 1)
L2—Large coil (see Fig. 2)
Z1—2000-ohm headphones
Antenna (see text), earth-ground connection (see text), wire, solder, etc.

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ANTIQUE RADIO

Back to the Star Roamer

BY MARC ELLIS

Back in the September issue, we started to work on a Knight Kit (Allied Radio) *Star Roamer* that a sharp-eyed friend of mine plucked from a trash can (along with an auxiliary RF amplifier and Q-multiplier), saving it from an ignominious burial in a landfill. For those of you who just joined us, this was a "starter set" for beginning SWLs or hams—the mid-60's equivalent, perhaps, of the Hallicrafter's S-38 that was so popular in the previous decade. The attractively styled four-tubes-plus-rectifier set has five bands covering 200-400 kHz (marine/aircraft beacon), 550-1800 kHz (broadcast band), 1.8-4.8 MHz, 4.8-12 MHz, and 12-30 MHz.

This ad from Allied Electronics shows how the Star Roamer kit was originally sold.

Described fully in September, the set has a full complement of the controls you would normally expect to find on a "serious" shortwave receiver, including bandspread, automatic volume control (AVC), noise limiter, antenna tuning, and "s"-meter calibration. It sold for $39.95.

Last time, we popped the cover of the set and gave it a cursory inspection. Cosmetically, we found the radio to be pretty good, except for some corrosion in the plating on the top of the chassis. The "CW Practice" key had been removed to make room for an added jack for the Q-multiplier or RF preamplifier, and a BFO pitch control that was supposed to be there was nowhere to be seen. The four tubes were checked, and all tested as good.

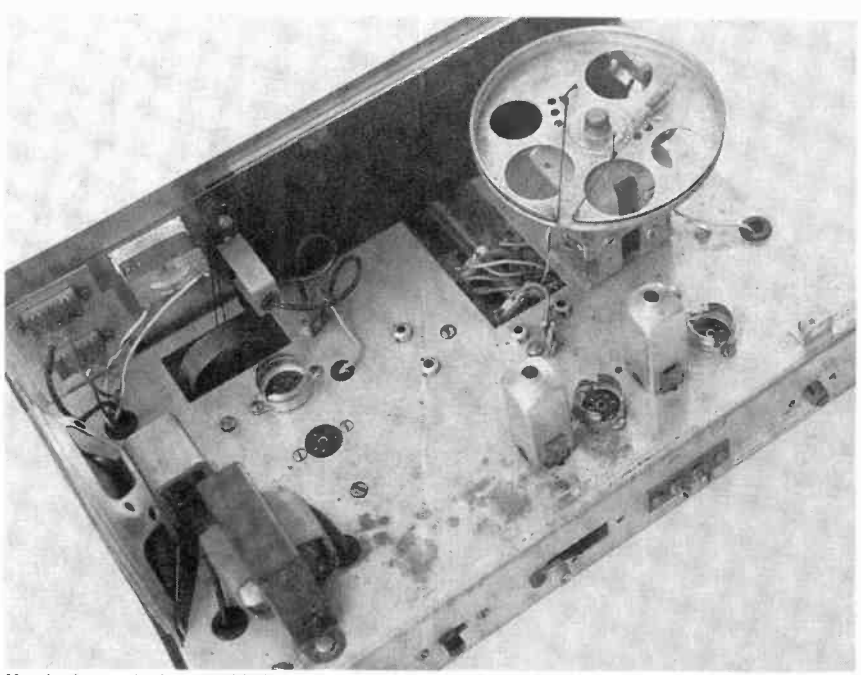
Disconnecting the B-plus line, we switched the set on and found that both the plate and filament windings of the power transformer were delivering power. Then it was time to put away the tools and test instruments until the next session.

COMPONENT REPLACEMENT

My next step in restoring a radio of this era would normally be to replace the electrolytic filter capacitors in the power supply and the electrolytic capacitor (if present), bypassing the cathode of the audio-output stage. Electrolytics dry out and deteriorate with age, and should not be considered permanent parts of the receiver. When they fail, they might very well cause short circuits that destroy other components such as rectifier tubes and power transformers.

All wax-coated paper capacitors are also replaced. Those absorb moisture over the years and—like electrolytics—are prone to deterioration and leakage, if not total failure. Replacing those wholesale will save you a lot of troubleshooting time (and possible damage from short circuits) after you power up the set. To preserve authenticity, many restorers apply heat to remove the innards of the old wax-coated capacitors and install modern caps inside the casings.

As it happens, the Star Roamer is new enough so that all capacitors (except the electrolytics in the filter and cathode bypass circuits) are ceramic discs. Those are far more reliable than the old paper jobs, and are normally not replaced unless found to be defective. The set is also new enough to have a selenium-stack diode rectifier instead of the rectifier



Here's the partly disassembled chassis after cleaning. The dark spots to the right of the power transformer are areas where the finish is corroded.

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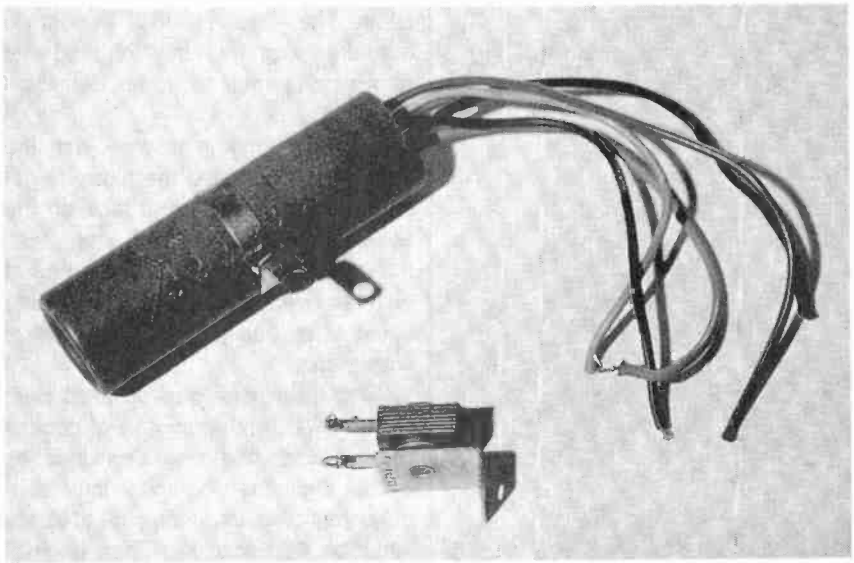

The multi-section electrolytic and the selenium stack rectifier were replaced before powering up the set for the first time.

tube we usually deal with in antique-radio power supplies.

Selenium rectifiers are also prone to fail. When they do, they are apt to release God-knows-what into the environment, causing a nasty smell suggestive of something having died in the walls. I definitely wanted to replace that baby with a modern (and trouble-free) silicon diode.

REBUILDING THE POWER SUPPLY

Prior to this month's work session, I picked up a suitable silicon diode at RadioShack and ordered replacement electrolytics from Antic Electronic Supply. The Star Roamer's multi-section tubular electrolytic, now all-but-impossible to replace, contained four individual capacitors with a common negative terminal. There was the audio-output cathode bypass (50 μF at 25 volts) and a triple 30-μF filter unit.

I had to smile when I saw how carefully the voltage ratings of the 30-μF units had been matched to their positions in the voltage-divider/filter circuit (consisting of two series-connected resistors). There was a 300-volt unit to be used at the input to the filter, a 200-volt unit for connection to the junction of the two resistors, and a 150-volt unit to be used at the output of the filter. Was it really possible to make such subtle voltage distinctions in electrolytic capacitor design?

In any case, considering the relatively limited range of electrolytic sizes available today, there were distinctions I certainly would not be able to make in selecting replacements. I ordered three individual 33-μF, 350-volt units to replace the filter capacitors and a 47-μF at 50-volt unit to replace the bypass.

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was involved, where it was destined and where it was bound. It did concede in 1986 that the incident was classified as among its

Handler of Greenpeace, said their research had established that many othe

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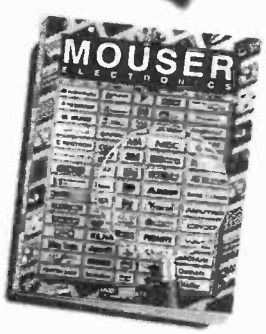
syn. see **Mouser Electronics**



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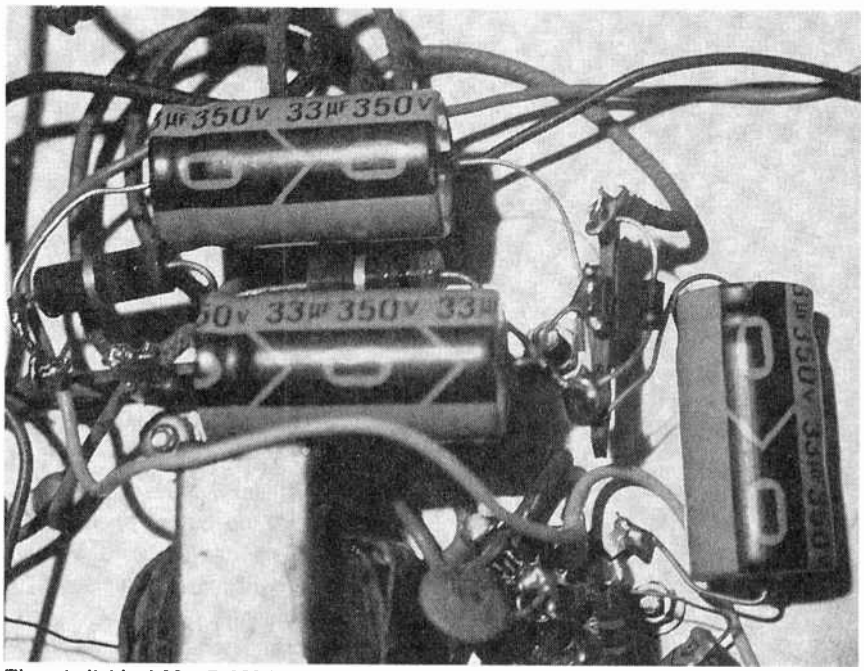

Three individual 33-μF, 350-WVDC electrolytics replace the filter capacitors in the old multi-section unit.

Removing the selenium stack, I used its mounting hole to install a terminal strip to be used for wiring up the diode and providing a ground connection for the replacement electrolytics. Then, one at a time, I disconnected the wires from the original multi-section electrolytic, replacing each section with an individual capacitor.

FIRST POWER-UP TEST

Normally, I don't power up a new set—even after making all necessary capacitor replacements—until I've done some housekeeping, including treating all potentiometers and switches with contact cleaner. Like a leaky capacitor, a poor contact in a switch section or other control can cause mystifying symptoms that might be hard to isolate. However, I was curious. I therefore decided to do a preliminary test before removing the set's built-in antenna (probably not original), rear panel, and tubes to facilitate cleaning.

Flipping on the power switch, I waited ... and waited ... and waited. The set's twin pilot lamps had come on, but there wasn't a sound from the speaker. Not even a quiet hum! Unplugging the set, I examined the wiring under the chassis and quickly spotted the reason. The built-in speaker switch on the headphone jack was bent and stuck in a permanently open position. Furthermore, someone had tried, rather incompetently, to wire around the problem, and in the process had disconnected the speaker. Making a temporary direct speaker connection, I turned on the set again and this time I was pleased to hear the expected hum.

Tuning around on the broadcast band, I heard a few stations, but sensitivity and volume were poor. Though the "s"-meter had swung down toward the left end of its scale (as is normal) after the set had warmed up, it did not budge when tuning through a station. That suggested to me that perhaps something was amiss in the AVC circuit.

Connecting the set to a short outside antenna, I tried the long-wave band and the three shortwave ones. Not a peep on any of them—not even a bit of static! Not too encouraging a beginning, but it looks as if there might be some interesting problems to work on!

HOUSEKEEPING

The underside of the Star Roamer's chassis was quite clean—almost mint looking, in fact. So was the front panel. The rear apron was clean but slightly rusty. The top of the chassis was coated with the usual gummy household grime, which could be removed. But the plating, here and there, had corroded slightly, showing ugly dark spots. There wasn't much I could do but take the grime off, which I did with a rag dampened in some detergent solution.

But before going to work with the detergent, I removed the tubes to get them out of the way and took off the fiberboard ventilation back along with the loopstick antenna mounted on it. I also removed all of the knobs so that I could more easily clean the panel of fingerprints.

With the clean-up complete, I went to work with my spray can of contact cleaner. Each of the slide switches, as well as the sensitivity- and volume-control potentiometers, got a shot of cleaner inside its enclosure. Then each of those controls was worked through its range several times to give the cleaner a chance to work. The band-switch was a type I had never seen before, its contacts being enclosed and seemingly inaccessible. But I sprayed the cleaner around some likely looking openings in the housing, hoping that some would get inside, and worked the control through its range.

WHAT'S NEXT

Next time, I'll probably start by checking the wiring against the schematic to make sure that the kit builder made no mistakes. I'll also take voltage readings at several points. If everything looks okay, I'll then check the tuning of the IF amplifier, proceeding from there to a realignment of the set's front end.

Until then, I'd like to hear from you! Send your comments and questions to *Antique Radio*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

"He's either making an oscilloscope or a laser death ray cannon."

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DX LISTENING

The "Other" Time Standard—WWVH

By Don Jensen

It's hard to miss the omnipresent 24-hour-a-day WWV standard time and frequency shortwave "radio clock" broadcasts from Fort Collins, CO. Not so well known, though, nor as well heard in much of the United States, is its sister station, WWVH on Hawaii's island of Kauai.

Both are operated by the U.S. Department of Commerce's National Institute of Standards and Technology on standard frequencies of 2,500, 5,000, 10,000, and 15,000 kHz. While that means interference for listeners in many parts of North America, at times WWVH can be heard "through" WWV's signal. The Hawaiian time ticker, with announcements by a woman, is easily distinguishable from the male voice of WWV.

WWVH went on the air in November 1948 from the island of Maui. Initially its transmissions did not include voice time announcements. Those were added in 1964.

In July 1971, the station moved to a modern $1.2 million 30-acre transmitter complex on the island of Kauai, near Kekaha on Kokole Point. In 1974, the time announcements were changed from Greenwich Mean Time to the new, but essentially identical Coordinated Universal Time.

WWVH keeps incredibly precise time, thanks to three atomic frequency standards at the Hawaiian site, accurate to one millionth of a second a month. Variations are kept within five microseconds of the NIST's UTC primary time standard in Boulder, CO.

The station also has a number of special announcements, including Pacific weather warnings. These announcements are programmed automatically into the broadcast format.

The 2,500-kHz transmission is aired by a 2.5-kilowatt transmitter, feeding a monopole antenna. The signals on 5,000, 10,000 and 15,000 kHz are broadcast by 10-kilowatt transmitters through modified half-wave-dipole phased arrays.

If your vacation travel takes you to Hawaii, you're welcome to visit WWVH during normal working hours. SWLs who do their traveling by radio, can obtain a WWVH QSL card by sending their reception reports to NIST Radio Station WWVH, P.O. Box 417, Kekaha, HI 96752.

ELWA: THE END?

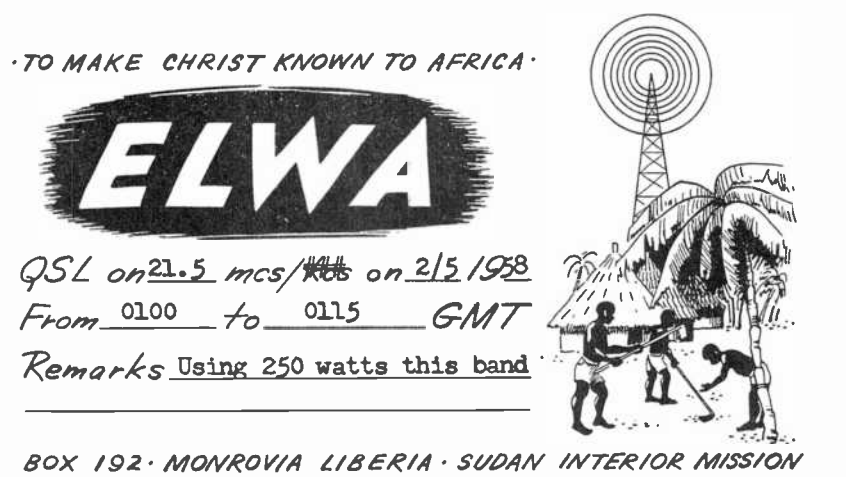
As of this writing, ELWA, the Sudan Interior Mission's shortwave outlet near Monrovia, Liberia, is off the air, a victim of the terrible civil strife in this west African country that resumed earlier this year. The radio station and hospital at the missionary complex on the Atlantic coast, a few miles outside Monrovia, was overrun successively by several groups of rebel soldiers, and was stripped and destroyed. Fortunately, the missionaries and Liberian staff members escaped without harm.

ELWA also was a victim in the 1990 civil war. In the half dozen years since it was first destroyed, the station was rebuilt and improved. This time, however, the SIM may have had enough. Shortly after this year's attack on the SW station, Jonathan Shea, SIM director for the West African Field Station, said, "The future of ELWA now looks worse than in 1990... We fear this is again the end of the radio facilities, but there are no regrets. Every minute we were on the air. . . .is worth what we put into them."

ELWA began shortwave broadcasts in March 1955, airing religious and educational programming to West Africa. Two years later, the station began a once-per-week broadcast to North America, since a number of the missionary staff were Americans. Its 10-kilowatt transmitters usually were well heard by SWLs. Now, it looks like another familiar old SW voice is off the air for good.

FEEDBACK

"I can fill you in a bit about the



Here's a vintage verification card from ELWA, a station forced off the air for the second time by civil strife in Liberia.

CREDITS—Brian Alexander, PA; Jim Clar, NY; Bob Fraser, MA; Anita Glockner, PA; Jack Jones, MS; Marie Lamb, NY; Mark Mohrmann, VT; North American SW Association, PA.

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Canadian station, CFVP, 6030 kHz, mentioned in *DX Listening* in March," writes Carl Stone of Claresholm, Alberta. CFVP and its medium wave counterpart, CFCN, 1,060 kHz, now CKMX, have been in Calgary for many years, but, Carl notes, the original site was High River, Alberta.

"It was the first radio station built in Canada west of Halifax. The experimental station was built to keep watch for prairie fires. It was constructed from scratch by W.W. Grant. Using parts, some of them special ordered from England, he built both the transmitter and receiver for the station.

"The Voice of the Prairies had a 10-watt transmitter. It was believed in those days that radio waves would not go beyond mountains and hills, which is why High River, on a flat prairie, was chosen as the site of the station. However, Grant was able to work many states, ships at sea, as well as Japan and Hawaii.

"Later, two men at the station began playing the fiddle and piano on the air. They became known as the CFCN Old Timers, a program that continued for 60 years. The programs on CFVP, 6,030 kHz, were the same as on the medium-wave station. The shortwave station had regular listeners in Europe in the old days and its antenna used to be a guy wire for the CFCN tower.

"I was here when W.W. Grant came to High River. My memory is good, and I have his hand-built Voice of the Prairies 'peanut' radio receiving set. I also happen to be a ham, VE6PR."

A fascinating story about one of North America's pioneer shortwave stations! Thanks, Carl, for sharing your memories.

DOWN THE DIAL

Here are some SW listening targets to try for.

AUSTRIA—13,730 kHz. Radio Austria International English programming noted at 1150 UTC with "Time Out For Art," a program on an exhibition featuring the works of Claude Monet.

BOLIVIA—6,025 kHz. Radio Illimani in the Bolivian capital of La Paz has been logged with Spanish programming at 0930 UTC. This has been heard with a government public health announcement and identification, followed by music.

BOSNIA HERCEGOVINA—7,105 kHz. Radio Bosnia Hercegovina can be heard on this frequency between about 0100 and 0200 UTC, broadcasting in Bosnian. This has been heard with popular and folk music. A 5-pip time signal marks the hour.

BRAZIL—4,875 kHz. Radio Roaima was noted at 0030 UTC with a live sportscast of soccer—called *futbol* in Brazil—in Portuguese. It's a real listening experience when one of the teams scores and the announcer bellows out a prolonged shout:

"Gooooooooooooooal!"

CANADA—17,725 kHz. Radio Canada International broadcasts in English from 1900 to 2000 UTC for Canadian peacekeepers in Bosnia. It operates in parallel at this hour on 15,275 kHz.

ECUADOR—4,950 kHz. Radio Bahai operates here at 1030 UTC with programming in Quechua, an Andean Indian language, and Ecuadorian music.

ISRAEL—9,435 kHz. Kol Israel noted in English at 2000 UTC, with news broadcast about anti-terrorist meetings.

LITHUANIA—5,910 kHz. Radio Vilnius is heard at 0055 UTC with English-language news, identification, and music.

PERU—6,115 kHz. Radio Union broadcasts here in Spanish during the early morning hour of 0800 UTC. This one has Andean melodies and identifies as "Radio Union" or "Union La Radio."

ZANZIBAR—11,735 kHz. Radio Tanzania Zanzibar is a very nice catch, broadcasting from the tiny spice island off Tanzania's East African coast. Look for this one with local programming around 2000 UTC. ■

ELECTRONICS LIBRARY

(continued from page 63)

The Internet and World Wide Web Explained (order number BP403) is available for $6.95 plus $3 shipping and handling from Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.

CIRCLE 98 ON FREE INFORMATION CARD

INSTANT JAVA

by John A. Pew

Written by a Java instructor for Sun Microsystems, this book teaches programmers and nonprogrammers alike to instantly create exciting Web pages filled with sound, animation, and interactivity. The book provides applets—including audio, multiple simultaneous animations, image maps, and ticker tapes—and shows users how to easily plug them into existing Web pages. The applets are designed to be as flexible as possible. You can customize as few or as many settings as you wish to create, with very little effort, creating personal and unique applets.

The book provides detailed, step-by-step instructions on how to customize the applets on the included CD-ROM to suit specific needs. The CD-ROM also includes the source code for all the applets in the book and the Java Developer's kit, as well as HTML sample pages that show exactly how to embed the applets into your Web page. The CD-ROM requires Windows 95, Windows NT, Solaris 2, or Macintosh System 7.5.

Instant Java costs $29.95 including CD-ROM disk and is published by The SunSoft Press, Prentice Hall PTR, Order Processing Center, P.O. Box 11071, Des Moines, IA 50336; Tel. 800-811-0912 or 515-284-6751; Fax: 515-284-2607; e-mail: orders@prenhall.com; Web: http://www.prenhall.com~. ■

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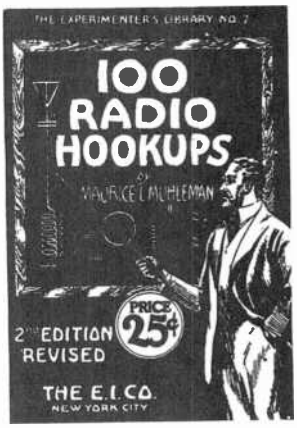
First published in May, 1923 this popular booklet went into reprint editions nine times. It is packed with circuits, theory, antenna installation and tips on consumer radio receivers that were popular in the early 1920's. Antique radio buffs and those inquisitive about the early days of radio will find this booklet an exciting, invaluable and excellent reference into the minds of early-day radio listeners. Sorry, we cannot honor the original 25-cent cover price.



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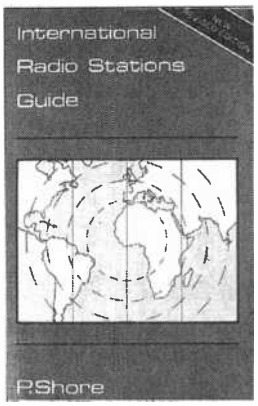

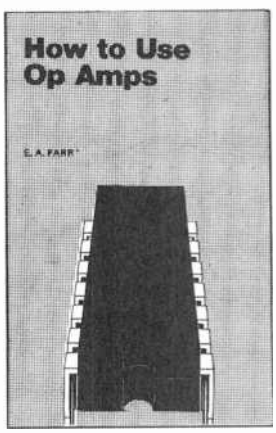

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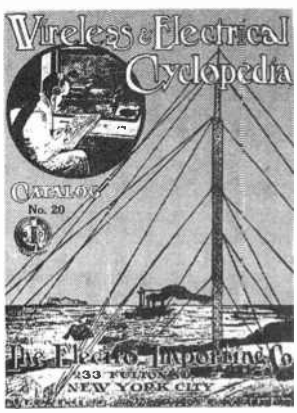

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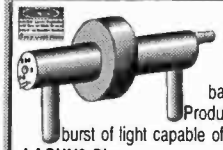

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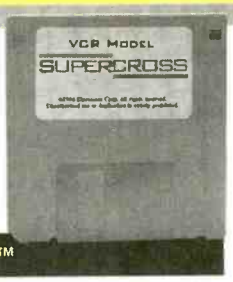

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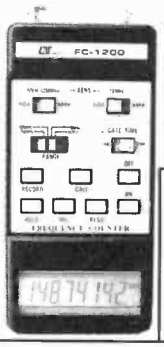

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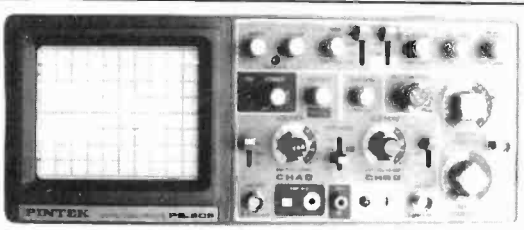

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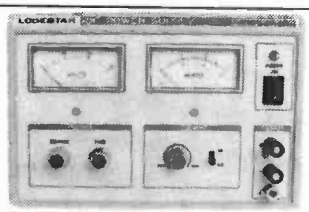

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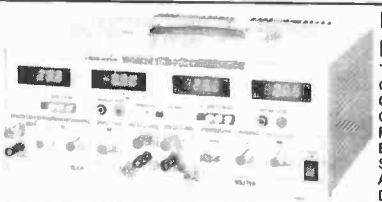

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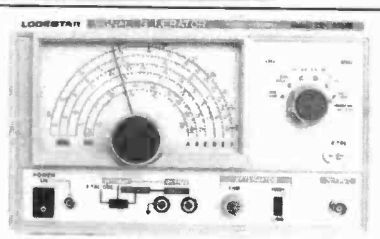

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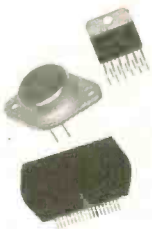

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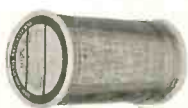

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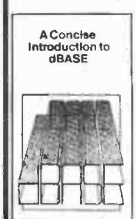

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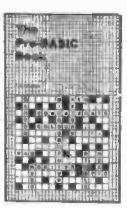

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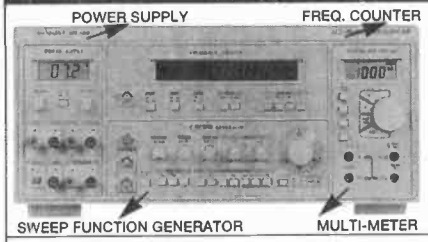

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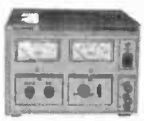

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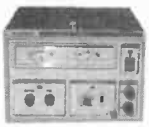

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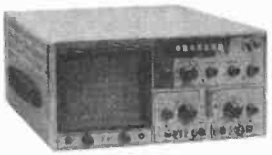

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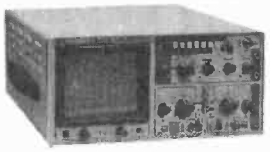

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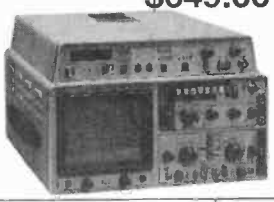

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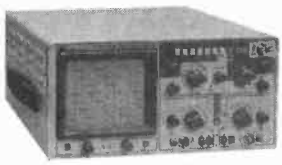

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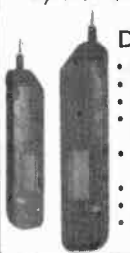

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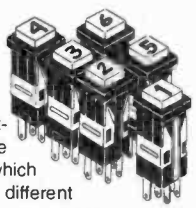

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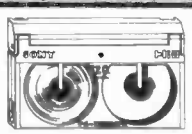

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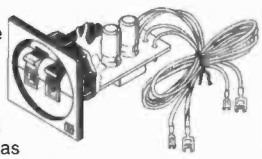

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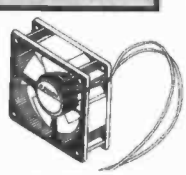

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CONDUCT A PROFESSIONAL SEARCH...ANYTIME...ANYWHERE!

Every newspaper and magazine article and every radio and TV story discussing some new episode involving "Bugging" devices, continues to increase the ever growing demand for electronic Counter-Surveillance "sweeps" and equipment. The very limited supply of competently trained and equipped Counter-Surveillance specialists has created a situation where "sweep" rates exceeding $250 per hour are now considered reasonable and appropriate.

This is an exciting, immensely interesting and profitable field that you can enter with a minimum investment. Two hours actual practice with the CSD-18 will have you "reading" and "clearing" telephones and rooms with professional ease and competence. The average fee for "debugging" a single telephone is over $200.00 It requires about 45 minutes to complete the job and once it gets around that YOU can provide this service, you'll quickly have more clients than you can handle. Even if you choose to provide "sweeps" for only a small number of friends and associates, your initial investment will quickly be returned many times over.

FREE WITH ORDER!

SUBMINIATURE "BODY WIRE" DETECTOR!

If you fear the possibility of being overheard and/or recorded during private conversations and require "silent" notification, we've also included our SBD-5 (regularly $225) as a FREE GIFT! Only 3" x 2" x 1", this exciting new development in micro-miniaturization will instantly detect hidden body wires at ranges up to 10 ft and alert you via a silent vibration.

BIG MONEY OPPORTUNITIES!

Also, complete information describing the fantastic opportunities now open to trained Counter-Surveillance technicians and how a number of individuals are reaping a Bonanza in this booming business! You'll learn exactly how the ever increasing use of Electronic Listening Devices by investigative agencies, government agencies, jealous suitors and unscrupulous business competitors, etc. has created huge demand for this service.

FASCINATING HI-TECH INFORMATION PACKAGE!

A detailed analysis of a variety of extremely fascinating hi-tech devices and procedures used for ultra-sophisticated audio and video eavesdropping including micro-wave and laser device monitoring; new methods for listening thru walls; all about scramblers, voice changers and exactly how neighbors eavesdrop. How missing persons are found, confidential data banks are broken into, lie detectors deceived and much more!

A comprehensive information package JAM-PACKED FULL of some of the most exciting and fascinating reading imaginable. Reads like a James Bond novel, with one important exception...IT'S NOT FICTION!

THE ONE "BUG" TO FEAR MOST!

While most individuals are now somewhat guarded in their telephone conversations, they still rather naively feel secure in the "privacy" of their own home or office. However, the most common type of "tap" presently used by eavesdroppers now picks up ALL SOUNDS AND CONVERSATION WITHIN A ROOM ... WITH THE TELEPHONE STILL ON THE HOOK!

Due to this devastating capability, this "Infinity" tap (variously referred to as Infinity Transmitter, Hookswitch Bypass, 3rd Wire, Harmonica Bug, etc.) has become the "bug of choice".

In flagrant violation of federal law prohibiting their use and sale, these devices in various forms are openly advertised in many technical publications for as little as $30. Literally thousands of these devices are now in the hands of unscrupulous individuals all over the country!

In response to this ever-growing threat, a uniquely engineered feature of the CSD-18 now also detects Infinity type devices anywhere "down the line".

In other words, if ANYONE ... ANYWHERE ... is utilizing the telephone tip and/or ring wires to monitor your private room conversations while your telephone is on the hook, you'll immediately be made aware of it via a flashing LED!

100% POSITIVE INDICATION

The CSD-18 also flawlessly detects "Series" and "Parallel" telephone transmitters and "Telephone Recording Devices". And, a separate feature silently indicates when extension phones are picked up or being used. The CSD-18 completely eliminates all doubt and guesswork.

EXCLUSIVE "LISTEN-IN" FEATURE!

The CSD-18 will even allow you to "listen-in" to exactly what the eavesdropper is surreptitiously monitoring. And, without the eavesdropper ever becoming aware that he has been detected! We are unaware of ANY other detection equipment having this combined capability AT ANY PRICE!

MAXIMUM PROTECTION

The CSD-18 detects and locates ALL major categories of surveillance equipment including:
BUMPER BEEPERS,
"BODY" TRANSMITTERS
TELEPHONE RECORDING DEVICES
SERIES & PARALLEL PHONE TRANSMITTERS
"INFINITY", MICRO-WAVE AND "LASER" BUGS
& ALL TYPES OF CONCEALED TRANSMITTERS
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CSD-18 **$495** Complete

Includes headphones, antenna/probe, all plugs and adapters, batteries, the Free SBD-5 & Info Packages.

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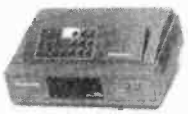

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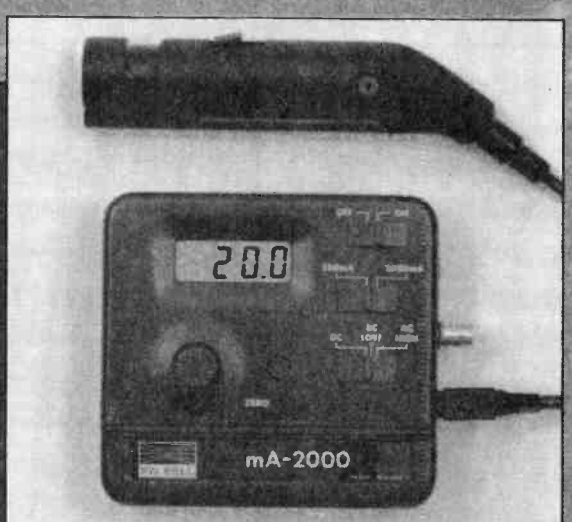

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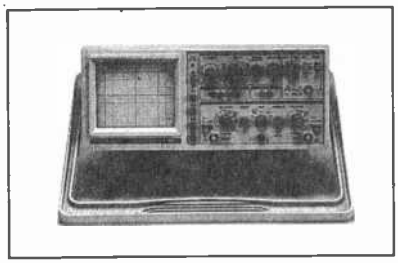

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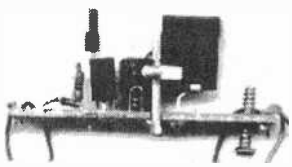
92L031 **7.95 each**



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Current limiter module. Very tiny and easy to use. Schematic included.

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3.125" square by 1" thick.

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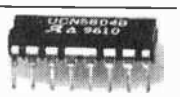


STEPPER MOTOR DRIVER IC

UCN5804. Drives a unipolar stepper in one of three operating modes: single phase, two phase or half step. Up to 1.25 Amps per phase. Step and direction input. Drive with a 555 oscillator, parallel port, etc. Build your own robot turntable for model trains, anything that requires precision positioning.

93I002 **$4.50 each**

• Above, packaged with 5V stepper motor (92M010) and schematics.

93I003 **$9.95 each**

LONGWAVE ULTRAVIOLET LAMP

This pocket-sized longwave ultraviolet light may be used for detecting invisible inks, minerals in rocks, etc. It's the size of a pocket pager and even has a belt clip to keep it handy. Runs on two "AA" batteries (not included). 3.25"W x 1.75"H x 1"D. Use with felt tip pen with UV/fluorescent ink (96U002).

95L007 **$7.95 each**

SPY STUFF!

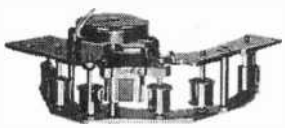
Send secret messages to your friends! Identify your own stuff! This pen writes in "invisible ink" that becomes visible with our "Magic Light" (95L007).

96U002 **$2.99 each**

COMBO PRICE

Two each Longwave UV Lamp (95L007) and "Spy Stuff" pen (96U002).

96Z001 **$19.95**



STEPPER-DRIVEN TAPE MECHANISM

5-1/2" rollers on 3/16" ball bearings. 5V, 200mA, 1.8° stepper, with 10 pitch shaft, 1/2" travel.

96M003 **$3.95 each**

EPROM BLOWOUT! Erase & Save $$$!

2708 (92I003)	**$.25**
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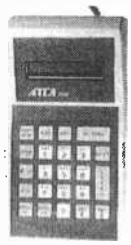
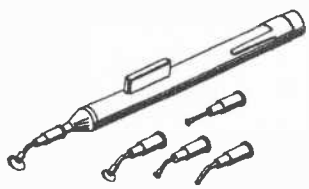


Better than Caller ID! This device detects an incoming call. If you subscribe to caller ID, the unit will automatically receive and display the caller's telephone number. If not, the unit will ask the caller to enter their telephone or personal ID number. The device will then display and compare this telephone or personal ID number to a memory bank of numbers that you've installed. If the system finds a match your phone will ring. If the system does NOT find a match, the caller will be directed to leave a message. All messages are digitally recorded. No tape or answering machine necessary. New, in factory cartons, with documentation.

96U001 **$59.95 each**



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This pen-style vacuum tool is delivered to you with five different size vacuum cups - ideal for handling and manipulating various components during assembly or placement operations, and it's *guaranteed ESD-safe.*

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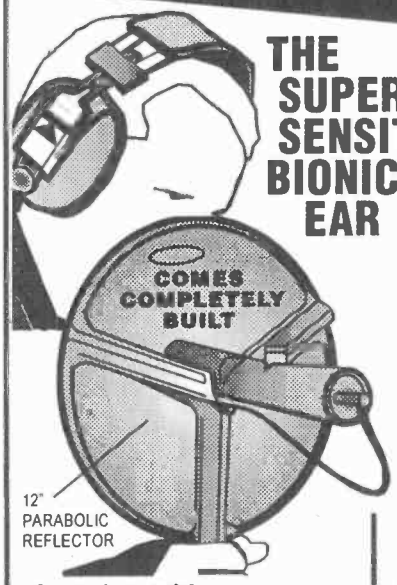

Complete with
- **Professional headset**
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- **12" parabolic reflector.**

- Individual volume controls for each ear.
- Auto Safety Circuit shuts sound off at 95 decibels for your ear protection.
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- Hear mere whispers at incredible distances.
- Record those sounds with your own recorder.

BE-1 BUILT $149.95

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With it's new and improved design it will not only test your radar detector... BUT it's tuned to the amateur radio band.

- While your out on American highways personally test yours and your fellow travelers radar detectors.

The "ZAPPER II" is a 10.450 GHz to 10.550 Transmitter

KIT $39.95 BUILT $49.95

WIRELESS FM MICROPHONE

Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-2 kit is a buffered wireless mike that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. 6 to 12v DC. SIZE: 1.25" x 1"

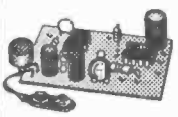
WM-2 KIT $14.95

STROBE LIGHT

Do you need an attention getter, warning light,or flashing light for model airplanes? Then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate. Power requirement 6 or 12v DC . Size 3.5"x1.9"

ST-1 KIT $11.95

SUPER SNOOPER BIG EAR



Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. Power requirement 6 to12v DC. SIZE:1.75"x 1"

AA-1 BUILT $29.95 KIT $10.95

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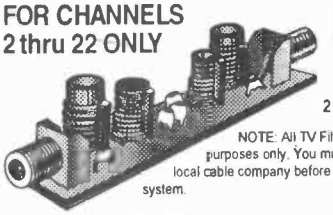


Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a beep beep beep. Works on cable channels 2 thru 22) only.

NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.

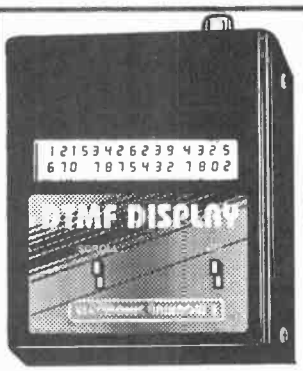
DF-222 KIT $14.95

MICRO-MINIATURE WIRELESS MIKE

So small you could hide this one on some real bugs! It's the smallest we've ever seen. With it's super sensitive mike it transmits a whisper or a room of conversation to an FM radio, tunable from 88 to 108MHz FM. With a proper antenna it transmits about 1/2 mile. The kit is made with surface mounted parts, we have already mounted these parts. You install the leaded parts. Power requirement 6 to 12v DC. Size .35"x.9"

MMWM5 KIT $34.95

Record every number dialed on your phone



Okay. Caller ID's tell you what number is calling you. But what about the calls made from your phone? Now, return from work or vacation and know the answer. The new DTMF Recorder electronically logs and saves every number dialed. This is the same high-tech magic used by detectives and government spies. Now yours. Does your wife or husband make expensive long -distance calls and then deny it? Does your son or daughter call that low-life you forbade them to talk to? Now know.

- Decodes digits 0 thru 9, #, *, A, B, C, on a 2 line 16 character LCD display.
- Clicks into your phone or extension in seconds, with no special wiring or hassles, or jack it to the incoming service panel in your garage.
- Records all numbers dialed, including local numbers that don't appear on your bill.
- Records credit card numbers entered through your phone key-pad.
- Records Voice mailbox, answering machines, and modem access numbers.
- Records Cellular or repeater phone numbers heard over your phone. Even hook to a scanner, and learn scores of emergency phone numbers. Also decodes tones stored on a tape recorder. Never before has such sophisticated gear been available to the public. And not at this price.

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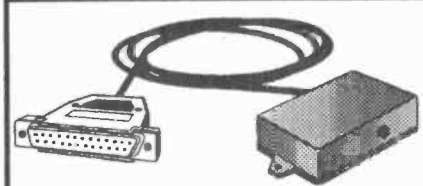

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Rubber Boot Included

Our Best Offer Ever on a High Quality Full Sized DMM

General

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%
Temperature Ranges:
Operating: 0°C to 40°C (32°F to 104°F)
Storage: -10°C to 50°C (14°F to 122°F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
Dimensions: 188mm long x 87mm wide x 33mm thick
Net Weight: 400g

$19.00 any qty

DC Voltage (DCV)

Range:	*Resolution:*	*Accuracy:*
200mV	100µV	
2000mV	1mV	
20V	10mV	±(1%rdg+2dgts)
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	*Resolution:*	*Accuracy:*
200µA	100nA	
2000µA	1µA	±(1.2%rdg+2dgts)
20mA	10µA	
200mA	100µA	
10A	10mA	±(1.2%rdg+2dgts)

Overload Protection: mA Input, 2A/250V fuse.

AC Voltage (ACV)

Range:	*Resolution:*	*Accuracy:*
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

Resistance (Ω)

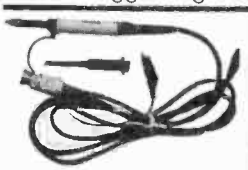
Range:	*Resolution:*	*Accuracy:*
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test
Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

hFE Test
Measures transistor hFE.

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00



Switchable Scope Probe Sets

(Selectable X1/Ref/X10) These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP9060) or 150MHz (model HP9150). Both sets include a handy storage pouch and include an IC test-hook adapter for the probe. The BNC connector rotates to avoid cable tangle or kink. Cable length is 1.4 meters.

CAT NO	DESCRIPTION	PRICE EACH 1	10	100
HP-9060	Scope Probe Set DC~60MHz	$16.49	$14.49	$11.58
HP-9150	Scope Probe Set DC~150MHz	24.95	21.95	18.62

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 185mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 185mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 185mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30

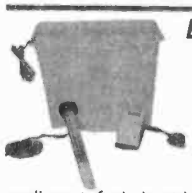
Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

Developer This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50



Etching Tank This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

Desoldering Pumps

These powerful plastic body desoldering pumps are designed for easy one hand operation for fast, efficient desoldering. Double O-ring piston seals for maximum suction.

CAT NO	DESCRIPTION	PRICE EACH 1	5	10
08-366S	Large Desoldering Pump	$15.89	$13.49	$11.95
08-366E	Regular Desoldering Pump	10.89	8.59	7.39
08-366TIP	Replacement Tip	1.95	1.95	1.95

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Electronic Soldering System

Here's the ideal solution when **Temperature Control** is required. Easy to use slide control allows user to set system from 300°F to 840°F. Voltage to iron from control unit is 24V Iron heating power is 48W. Replaceable 5.3mm tip is standard. Replacement Irons and tips are available.

AS LOW AS $50.00

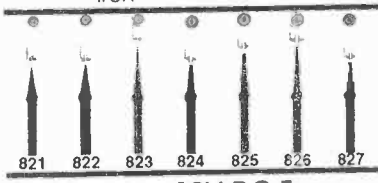
CAT NO	DESCRIPTION	PRICE EACH 1	5
SL10	Temp Controlled Soldering Iron	$56.00	$50.00
SL24V	Spare 24V Soldering Iron	10.50	7.50

Electronic Soldering System with LED Display

Deluxe temperature controlled system with LED display for maximum accuracy. Temperature is adjustable from 160°-480°C (320°-900°F). Iron heating power is 48 Watts. Runs on 24V from controller unit. Replacement irons and tips are available. Tip size is 5.3mm.

AS LOW AS $75

CAT NO	DESCRIPTION	PRICE EACH 1	5
SL30	Deluxe Soldering System w/LED	$86.00	$75.00
SL24V	Spare 24V Soldering Iron for SL10 or SL30	10.50	7.50

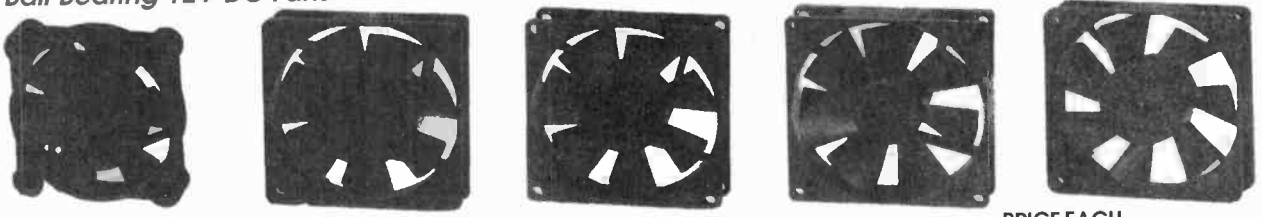


Replacement Tips for SL10/SL30

We now offer a variety of replacement tips for the SL10/SL30 soldering stations.

CAT NO	DESCRIPTION	PRICE EACH 1	5
821	1/32" Pencil Tip	$1.39	$1.19
822	1/32" Pencil Tip	1.39	1.19
823	1/64" Pencil Tip	1.39	1.19
824	1/16" Chisel Tip	1.49	1.29
825	1/8" Chisel Tip	$1.49	$1.29
826	3/64" Chisel Tip	1.49	1.29
827	3/64" Pencil Tip	1.59	1.39

Ball Bearing 12V DC Fans



These High Quality Fans feature Ball Bearings and Brushless DC Motors. All of them are designed to meet UL, CSA & VDE Standards. Design these fans into power supplies, computers or other equipment requiring additional air flows for heat removal. These fans are regular Circuit Specialists stock items — they are not surplus.

INDUSTRY BEST PRICING!

CAT NO	PRICE EACH 1	10	25	100
CSD 4010-12	$ 9.88	$ 6.38	$5.48	$4.87
CSD 6025-12	9.38	5.91	5.41	4.71
CSD 8025-12	8.88	5.85	5.19	4.49
CSD 9225-12	8.95	6.14	5.29	4.59
CSD 1225-12	11.45	8.96	7.82	6.85

Specifications

CAT NO	DIMENSIONS (MM)	RATED VOLTAGE (V)	START VOLTAGE (V)	INPUT CURRENT (A)	AIR FLOW (CFM)	STATIC PRESSURE (INCH-H_2O)	SPEED (RPM)	NOISE LEVEL (dB)	WEIGHT (g)
CSD 4010-12	40x40x10mm	12	7	0.06	5.1	0.19	5,500	26	20
CSD 6025-12	60x60x25mm	12	5	0.13	13.7	0.165	4,500	28	65
CSD 8025-12	80x80x25mm	12	5	0.16	37.8	0.177	3,000	31	80
CSD 9225-12	92x92x25mm	12	5	0.32	42	0.18	2,800	37	95
CSD 1225-12	120x120x25mm	12	5	0.35	62	0.180	2,500	42	135

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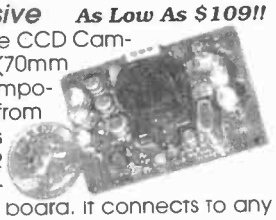
CAT NO	DESCRIPTION	PRICE EACH 1	10	25
RH60-1	1-lb. Spool, .031", 60/40	$ 6.90	$ 5.96	$ 5.30
RH63-1	1-lb. Spool, .031", 63/37	6.95	6.10	5.41
RH60-4	4.4-lb. Spool, .031", 60/40	24.00	21.90	17.92
RH60-TUBE	6-oz. Tube, .031", 60/40	.99	.89	.79

CCD Camera - IR Responsive *As Low As $109!!*

This black and white monochrome CCD Camera is totally contained on a PCB (70mm x 46mm). The lens is the tallest component on the board (27mm high from the back of the PCB) and it works with light as low as 0.1 lux. It is IR Responsive for use in total darkness. It comes with six IR LED's on board. It connects to any standard monitor, AUX or video input on a VCR or through a video modulator to a TV. Works with a REGULATED 12V power supply (11V-13V). Hooks up by connectiong three wires: red to 12V, black to ground (power & video) and brown to video signal output.



CAT NO	DESCRIPTION	PRICE EACH 1	5
CA-H34A	PCB Mounted IRCCD Camera	$125.00	$109.00

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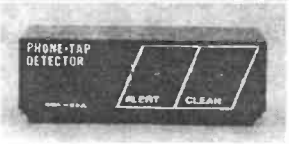

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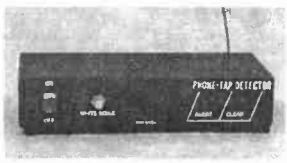

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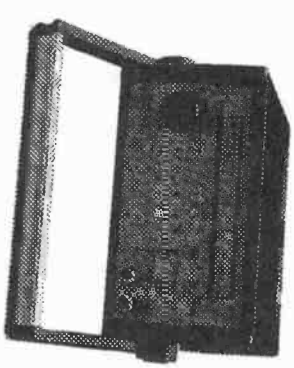

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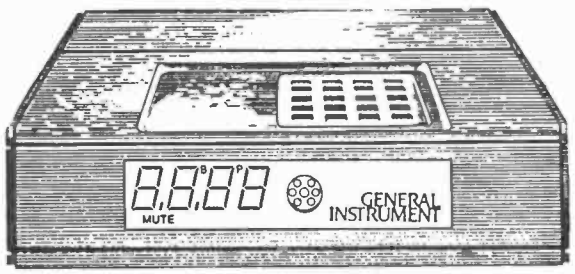

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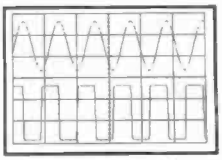

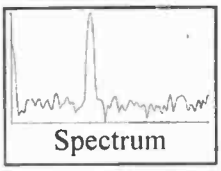

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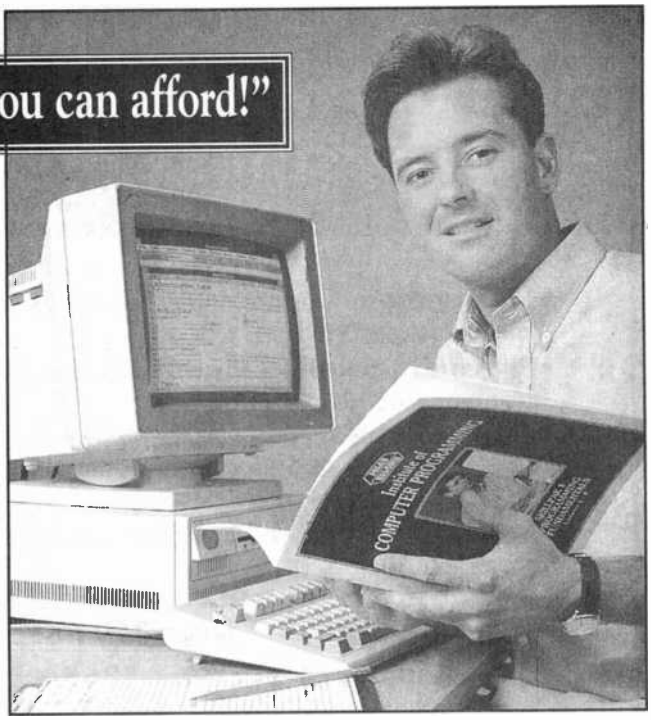

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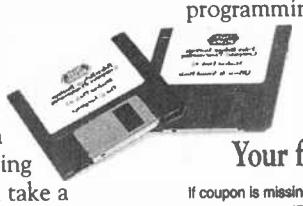

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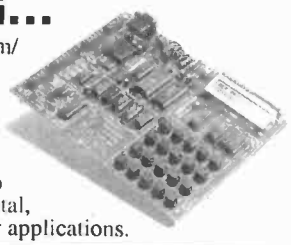

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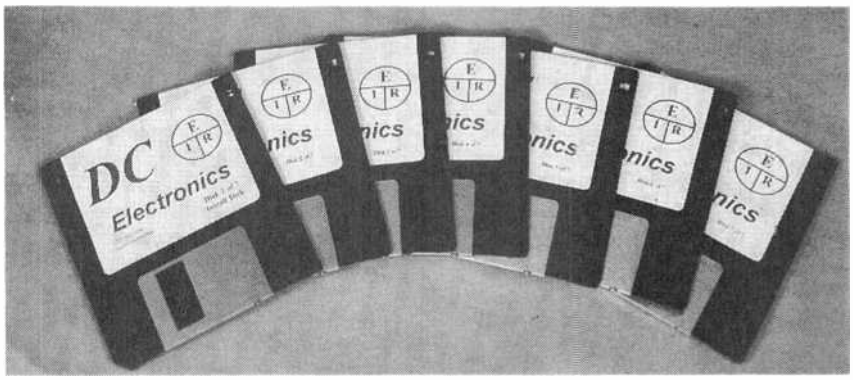

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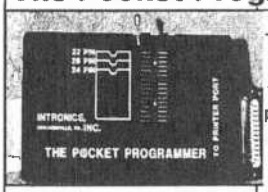

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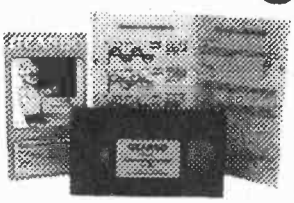

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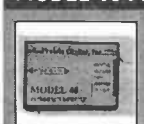

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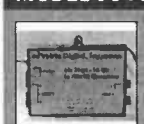

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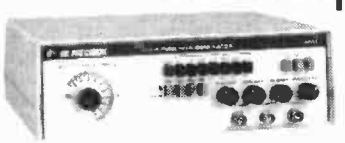

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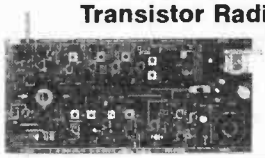

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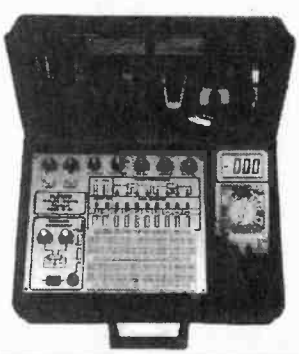

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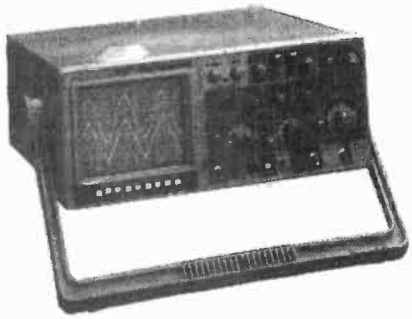

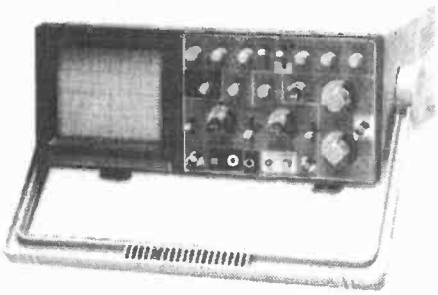

60MHz

DS-603 $1350
- Analog / Digital Storage
- 20MS/s Sampling Rate

S-1365 $795
- Analog w/ Cursors

S-1360 $759
- Analog with Delayed Sweep

40MHz

S-1345 $569
- Analog with Delayed Sweep

S-1340 $489
- Analog

2 Year Warranty

25/30MHz

DS-303 $1095
- Analog / Digital Storage

S-1330 $439
- 25MHz Analog
- Delayed Sweep

S-1325 $335
- 25MHz Analog

OSCILLOSCOPE SELECTION CHART

ANALOG

Model	Bandwidth MHz	Sensitivity (max)	No. of Channels	Sweep Rate Max ns/div	Delayed Sweep	Video Sync	Component Tester	Beam Find	Time Base
S-1365	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1360	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1345	40	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1340	40	1mV/div	2	10ns/div	No	Yes	No	No	1
S-1330	25	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1325	25	1mV/div	2	10ns/div	No	Yes	No	No	1

DIGITAL STORAGE

Model	Bandwidth MHz	Analog Sen (max)	No. of Channels	Sampling Rate	Memory Channel	Internally Backed Up	Pretrigger %	Output
DS-303	30	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232
DS-603	60	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232

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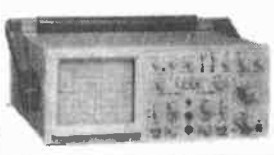
2125 - $539.95
Delayed Sweep



Model 1541C
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Dual Trace

60MHz with Cursors readouts and Dual Time Base
Model 2260
$1225

Model 2160
60MHz Dual Trace
$949
Dual Time Base • Delayed Sweep

Model 2190A
100MHz 3 Channel
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Dual Time Base • Delayed Sweep

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HACKING FAX MACHINES

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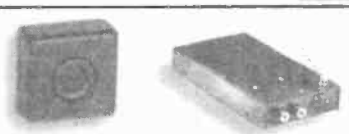

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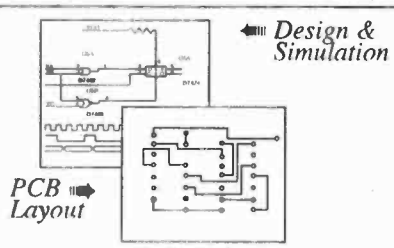

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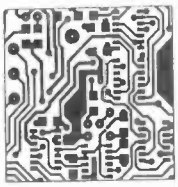

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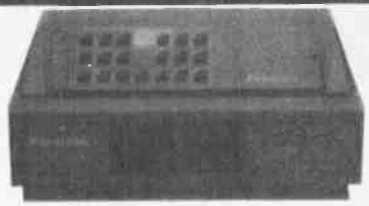

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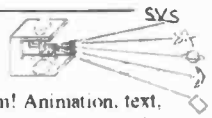

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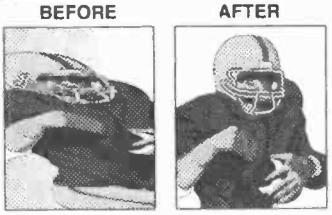

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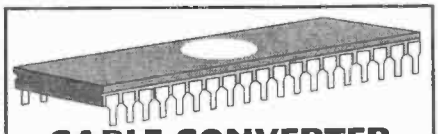

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We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but, in all cases, full payment must accompany your order.

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The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $1.75 per word. Minimum charge is $26.25 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues. **Sorry, no discounts on credit-card orders. Boldface (not available as all caps),** add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad,** add 25%. **Tint screen plus all boldface ad,** add 45%. **Expanded type ad,** add $2.25 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. POPULAR ELECTRONICS is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in POPULAR ELECTRONICS is limited to electronics items only. All ads are subject to the publishers approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $1.75 per word, Minimum $26.25

Send you ad payments to:
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190 – Cable TV	360 – Education	540 – Music & Accessories	710 – Telephone
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21 - $36.75	22 - $38.50	23 - $40.25	24 - $42.00
25 - $ 43.75	26 - $45.50	27 - $47.25	28 - $49.00
29 - $50.75	30 - $52.50	31 - $ 54.25	32 - $56.00
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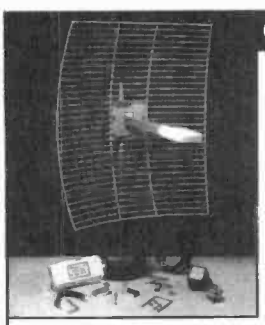

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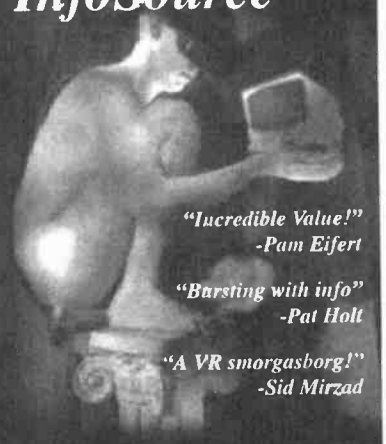

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Popular Electronics does not assume any responsibility for errors that may appear in the index below.

Free Information Number		Page
25	Ace Communications	112
—	AES	102
26	Alfa Electronics	86
28	All Electronics	90
—	Allison Technology	99
—	Allstar Electronics	111
27	Alltronics	94
—	AMC Sales	111
—	American Innovations	98
—	Andromeda Research	102
—	Basic Electrical Supply	100
30	Bel-Merit	89
32	C&S Sales, Inc.	106
—	Cable Discount	112
—	Circuit Specialists	96
—	CLAGGK, Inc.	60
—	Cleveland Institute of Electronics	37
—	Command Productions	98
—	Comtrad Industries	CV3, 9, 13
—	Consumertronics	108
139	Dalbani	87
162	Davis Instruments	72
—	DC Electronics	103
—	Desert Cable	104
148	Electronic Rainbow	95
—	Electronic Technology Today	83, 88
158	Fluke Corp.	7
—	Foley-Belsaw	101
—	Forest Electronics	108
—	Fotronic Corporation	93
—	General Device Instruments	103
—	Grantham College of Engineering	4
—	Great Southern Security	91
—	Greenleaf Electronics Inc.	100
—	Home Automation Systems	112
—	I.E.C.	110
—	Information Unlimited	84
13	Interactive Image Technologies	CV2
—	Intronics, Inc.	103
140	Jensen Tools	116
—	Kableworks	110

Free Information Number		Page
—	KDE Electronics	92
—	Learn Inc.	32
153	MCM Electronics	85
—	Mega Electronics	113
152	Mendelson's	104
—	Mental Automation	110
157	MicroCode Engineering	5
—	Millennium Enterprises	115
—	Modern Electronics	110
15	Mouser	79
—	NRI Schools	19
—	Ohio Automation	111
43	Optoelectronics	CV4
—	Orion Electronics	115
150	Parts Express	104
149	Phillips Tech	115
47	Prairie Digital Inc.	104
46	Print	99
45	Print	92
—	Quality Entertainment	108
14	Radio Shack	15
—	Silicon Valley Surplus	111
—	Skyvision Inc.	105
—	Smithy Company	115
—	Synergex Scientific	110
—	T.C. Tronics	99
—	Tab Books	11, 55
—	Tecma Maquila Services	3
—	Tech Serv	102
155	Telulex	98
151	UCANDO Videos	104
—	US Cyberlab	100
—	Virtual Reality Publishing	117
—	Vision Electronics	111
—	Visual Communications	113
—	Weeder Technologies	112
—	Windjammer Barefoot Cruises	72
—	World College (Div. of C.I.E.)	22
—	WPT Publications	111
134	Xandi Electronics	109

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