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February 1997

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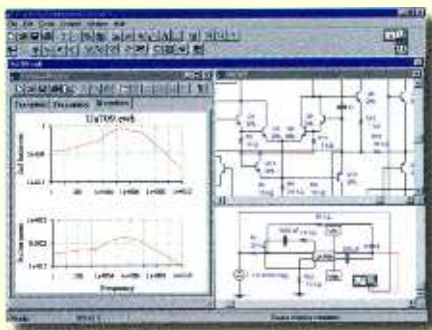
NEW VERSION!

Electronics Workbench Version 5 with analog, digital and mixed A/D SPICE simulation, a full suite of analyses and over 4,000 devices. Still the standard for power and ease of use. Now ten times faster. Still the same low price.

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High-End Features

TRUE MIXED ANALOG/DIGITAL	YES
FULLY INTERACTIVE SIMULATION	YES
ANALOG ENGINE	SPICE 3F5, 32-BIT
DIGITAL ENGINE	NATIVE, 32-BIT
GMIN STEPPING	YES
TEMPERATURE CONTROL	EACH DEVICE
PRO SCHEMATIC EDITOR	YES
HIERARCHICAL CIRCUITS	YES
VIRTUAL INSTRUMENTS	YES
ON-SCREEN GRAPHS	YES
ANALOG COMPONENTS	OVER 100
DIGITAL COMPONENTS	OVER 200
DEVICE MODELS	OVER 4,000
MONEY-BACK GUARANTEE	30-DAY
TECHNICAL SUPPORT	FREE

Powerful Analyses

DC OPERATING POINT	YES
AC FREQUENCY	YES
TRANSIENT	YES
FOURIER	YES
NOISE	YES
DISTORTION	YES

30-DAY MONEY-BACK GUARANTEE
VERSION 5.0 FOR WINDOWS 95/NT/3.1.
Upgrades from previous versions \$79.

FEATURES OF ELECTRONICS WORKBENCH VERSION 5

WHAT'S NEW

Now 10 times faster! Handles 4 times larger circuits. More and better device models. New thermal modeling. New on-screen graphs. New analyses (Fourier, Noise and Distortion). 25 new components including vacuum tubes, diodes, solenoids, 50 new ICs. Improved accuracy, improved schematic editor with zoom and grouping, pages, interactive wiring, improved filter, improved waveform, redesigned word generator and logic analyzer.

GENERAL

Integrated Tool: Fully integrated schematic editing, SPICE simulation and waveform generation and analysis. Supports modifications to the circuit during simulation. Circuit analysis through virtual test instruments. Six analyses listed below.

Simulation Engine: Interactive, 32 bit SPICE 3F5 enhanced with true mixed digital and mixed analog/digital support. Automatic interior of signal transition interface. Supports multiple usage of hierarchical blocks. GMIN stepping for better convergence. No power limitation circuit size or complexity.

Schematic Capture: Click and drag interface. Hierarchical workspaces. Automatic wire routing with automatic reference designations. Schematic size independent instrument for quick and simple analysis. Six analyses for on-screen graphs and more (see table below).

Simulation: All design information, including simulation SPICE parameters setup and execution of all models, saved in a design file to be reloaded into a new simulation.

Post-processor: SPICE post-processor with other simulators or to create timing diagrams. Imports manufacturers' models and creates interchangeable Electronics Workbench components. Exports to standard PCB layout packages such as OrCAD, Protel and Tango.

ANALYSES

DC Operating Point: Calculates DC operating point and assigns voltage and current mode.

Transient: Circuit voltages and currents over time at any number of nodes. Specify start and stop times.

AC Frequency Sweep: Small signal gain and phase over range of AC frequencies at any number of nodes. Sweep range, type, decade, octave or linear and resolution (number of steps) of frequency sweep.

Fourier: Magnitude and phase of DC and Fourier spectral components of transient response. Specify fundamental frequency and an unlimited number of harmonics.

Noise: Resistor and semiconductor noise distribution reported as RMS sum. Specify device of interest and reference nodes, start and stop time and resolution of frequency sweep.

Distortion: Small signal of steady-state harmonic and intermodulation products over a range of frequencies. Specify any number of nodes and sweep range, type and resolution. Operates on individual devices on an individual basis.

VIRTUAL TEST INSTRUMENTS

Digital: 1-bit, 2-bit, 3-bit, 4-bit, 8-bit, 16-bit, 32-bit, 48-bit, 64-bit, 80-bit, 96-bit, 112-bit, 128-bit, 144-bit, 160-bit, 176-bit, 192-bit, 208-bit, 224-bit, 240-bit, 256-bit, 272-bit, 288-bit, 304-bit, 320-bit, 336-bit, 352-bit, 368-bit, 384-bit, 400-bit, 416-bit, 432-bit, 448-bit, 464-bit, 480-bit, 496-bit, 512-bit, 528-bit, 544-bit, 560-bit, 576-bit, 592-bit, 608-bit, 624-bit, 640-bit, 656-bit, 672-bit, 688-bit, 704-bit, 720-bit, 736-bit, 752-bit, 768-bit, 784-bit, 800-bit, 816-bit, 832-bit, 848-bit, 864-bit, 880-bit, 896-bit, 912-bit, 928-bit, 944-bit, 960-bit, 976-bit, 992-bit, 1008-bit, 1024-bit, 1040-bit, 1056-bit, 1072-bit, 1088-bit, 1104-bit, 1120-bit, 1136-bit, 1152-bit, 1168-bit, 1184-bit, 1200-bit, 1216-bit, 1232-bit, 1248-bit, 1264-bit, 1280-bit, 1296-bit, 1312-bit, 1328-bit, 1344-bit, 1360-bit, 1376-bit, 1392-bit, 1408-bit, 1424-bit, 1440-bit, 1456-bit, 1472-bit, 1488-bit, 1504-bit, 1520-bit, 1536-bit, 1552-bit, 1568-bit, 1584-bit, 1600-bit, 1616-bit, 1632-bit, 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Diodes: Diode, Zener Diode, LED, Shockley Diode, Diac, SCR, Triac and Full Wave Bridge Rectifier.

Transistors: NPN and PNP BJT, N- and P-Channel JFET, 3 and 4 Terminal Enhancement and Depletion N- and P-Channel MOSFET.

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Control: Differential Integrator, Gain Block, Transfer Function Limiter, Multiplex Divides and Summer.

Other: Fuse, Locus and Locusless Transmissor Limiter, Virtual DC motor, Vacuum Tube and Buck and Boost Converter.

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Vol. 14, No. 2



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COVER STORY

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Is the performance of your car stereo lacking in some areas? Are your road trips just not as entertaining as they could be? Put some real power into your vehicular audio system with this amplifier that looks small but actually sounds big. Best of all, it costs less than \$20 to build—*Gary Clifton*

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In many states, if your car's windshield wipers are on, the law requires you to turn on the vehicle's headlamps too. With this circuit you'll never have to remember to do that again. Just switch on your vehicle's wipers and let the Control module do the rest for you—*Anthony J. Caristi*

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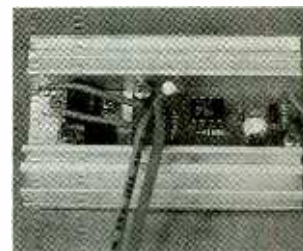
Join us for a look at LowFERS and MedFERS, the most unusual ham frequencies that you can explore. Learn what signals lurk in those regions of the spectrum, and what equipment you can use to hear them —*Karl T. Thurber, Jr.*



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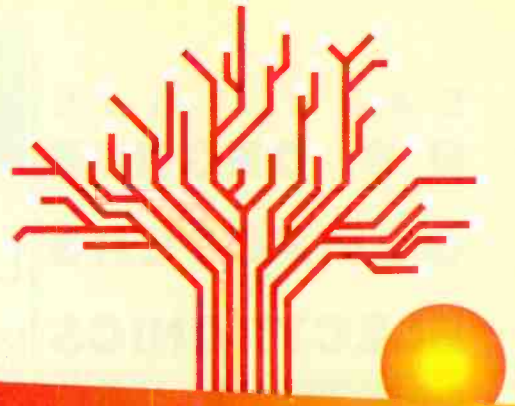
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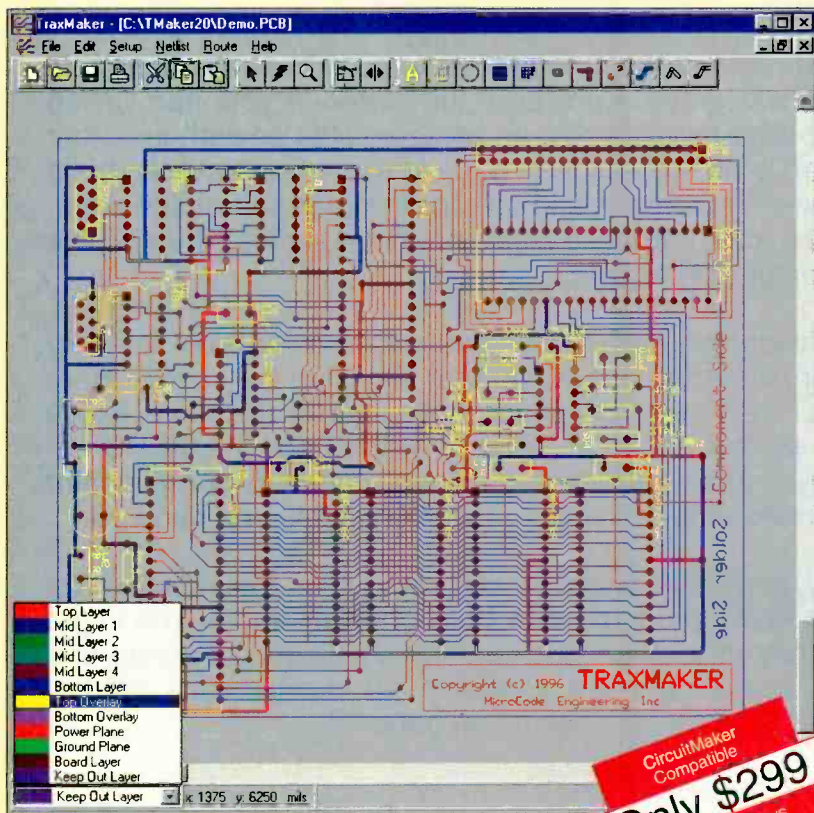
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EDITORIAL

Listening Pleasure

Let's face it, most of us spend a lot of time driving. Whether you travel to work or school, or live a good distance from your sweetheart, you might be spending an hour or more in your car each day. Shouldn't that experience be a pleasant one?

To make road travel more enjoyable, a lot of drivers turn to (or turn on) their car stereos. But if the sound system within your car isn't quite up to par, you won't be all that happy with those hours spent behind the wheel. Instead, you'll probably find yourself wishing you were home listening to music the right way.

This month we're happy to present you with a truly affordable way of boosting the power of the stereo in your car. Called the 22-Watt Amplifier, it's an amazing little powerhouse that you can build for less than \$20. At that price, you can build two, one for the front and one for the rear pair of speakers. You'll be quite surprised at just how loud such a setup is! The story begins on page 27.

Also this month, we've got some great non-musical listening tips for all of our ham readers. In "Cruising the Lowest Ham Bands" we'll give you an idea of some of the more exotic things there are to hear in the LowFERS and MedFERS frequency ranges, and even show you the kind of equipment you'll need to tune them in. The story begins on page 39.

Finally, for any audiophiles with computers, this month's *Net Watch* explores the current state of digital audio. You might be surprised to learn just how many CD-quality songs and movie audio clips are available for downloading off the Internet. The column begins on page 16.

Happy listening!

Dan Karagiannis
Editor

Why pay for cellular phone service if you only want it for emergency use?

The SOS Phone offers a 24-hour call center to connect you with your emergency roadside service, 911 service or family members in the event of an emergency.



Press the Tow button and your emergency road service will be dispatched to tow your automobile.

To tell you the truth, I am not interested in owning a cellular phone...except for use in an emergency. What would I do if my car broke down on the interstate or ran out of gas on some deserted back road? How would I get help? Like most women, I have the safety of my children to consider.

Last month, I inquired about cellular phone service. I was surprised to find out how expensive it was, even for the most basic calling plans! I just couldn't justify spending that much for something I may never need. Then a good friend told about a product she thought would solve my problem. It's the SOS Phone—a cellular phone service designed exclusively for emergency use!

What does it do? With the touch of a button, the SOS Phone will connect me to a roadside emergency service, a 911 service or a trained SOS operator, 24 hours a day. If I ever need help, I know it's just a phone call away.

Emergency assistance. By pressing the "tow" button, I'll be connected with my emergency roadside service provider. Or, if I don't have one, the SOS operator can recommend one to me and dispatch them immediately.

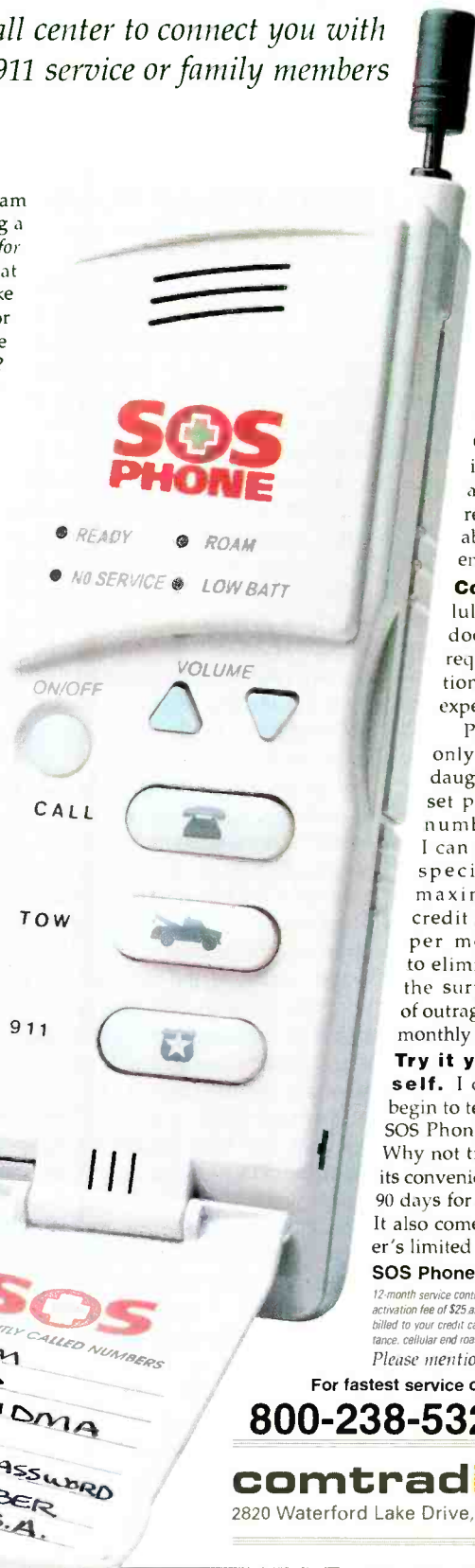


The 911 button will connect you to 911 police or other emergency services, and the call is absolutely free!

The "911" button will connect me to the 911 emergency service in my area—best of all, the call is absolutely free!

Personalized service. Each SOS Phone has a serial number that is recorded at the Call Center, so each time I use my phone, the operators will know that it is me calling, and will greet me by name. Plus, my SOS Emergency Record will appear instantly on the computer screen and the operator will connect me with the person or emergency service I need.

Not just for emergencies. If I just want to call home to tell



my husband that the kids and I are running late, I can! By pressing the "call" button, I'll reach an operator. When I ask the operator to call home, I'll be connected automatically. And because the Call Center has my list of 10 most-used phone numbers, I don't even have to recite the number!

Great for teens. The SOS Phone is also a great thing to have around for my stepdaughter. I can rest assured that she'll always be able to get in touch with us (or an emergency service) if she needs to.

Cost control. Unlike ordinary cellular phone plans, the SOS Phone doesn't have any minimum usage requirements or any other stipulations that could change the price I expect to pay each month.

Plus, without my password, the only non-emergency calls my stepdaughter can make are to our 10 pre-

set phone numbers. I can even specify a maximum credit limit per month to eliminate the surprise of outrageous monthly bills! **Try it yourself.** I can't







Use the Call button to talk to an SOS operator or be connected to someone on your preset list of numbers.

begin to tell you how much confidence the SOS Phone has given me and my family. Why not try it yourself? If you don't enjoy its convenience and security, return it within 90 days for a "No Questions Asked" refund. It also comes with a three-year manufacturer's limited repair or replacement warranty.

SOS Phone \$99 \$12 S&H
12-month service contract required for this price. Requires a one-time non-refundable activation fee of \$25 and a monthly charge of \$9.95. Calls made on the Call button are billed to your credit card at \$1.45 per minute. (That rate includes all local, long-distance, cellular and roaming fees.) For outgoing calls only.
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LETTERS

Thanks for the Info!

I NEEDED THAT

Just a quick note to thank you for Lyle Russell Williams' article, "Becoming an Electronics Engineer," which ran in the November 1996 issue of **Popular Electronics**. This is just the sort of information that I am looking for as I make the transition from technician level to engineering. It was very interesting to see what could be waiting for me on the other side of graduation from engineering school.

How about printing similar articles in the future on how to use our electronics skills to make money. The "hobby" end of electronics is great, but one can only have so many home-made gadgets cluttering up the home!

B.L.M.

Albuquerque, NM

Thank you for writing. While we are primarily a hobbyist magazine, we would be open to publishing more articles on how to make money using electronics skills. After all, who wouldn't love to make money doing what he or she likes?—Editor

NEW TESTING POLICIES

The readers of **Popular Electronics** might be interested to hear about some sweeping policy changes announced recently by the International Society of Certified Electronics Technicians (ISCET). The changes allow other organizations to administer ISCET tests, and allow the ISCET-issued test and certificate to bear the name and logo of the participating organization. A portion of the test fee will go to the certifying organization.

In addition, ISCET has agreed to accept the Electronics Technicians Association (ETA) Associate Test in lieu of the ISCET Associate Test requirement to qualify to take any one of the ISCET Journeyman exams. ISCET would also be willing to work with ETA to develop a common Associate exam question pool.

ISCET is recognized as the leading electronics and appliance technician-certification agency, having certified

more than 41,000 technicians, most of whom hold Associate certification.

B.R.

ISCET

Fort Worth, TX

PARTS POLICY, PLEASE!

I have read **Popular Electronics** for about 45 years. Lately, however, I have been disappointed to see companies writing articles and then offering to sell the key part at *extremely* high prices. In the November issue, for instance, the PIC CPU for the "Easyscope" costs about \$2; they are selling it for \$50. That's quite a markup!

Popular Electronics has held my attention over the years because it offered projects that hobbyists could build. I now look at the parts list before reading any construction article. Today, when the average electronics engineer or technician (let alone experimenter) doesn't own a PIC programmer, I believe the magazine should establish a policy to keep its projects accessible to its readers.

I would like to suggest that all construction articles use parts that are readily available from more than one source. All source code should be available through **Popular Electronics** for anyone to use with no royalty of other charge. If a printed-circuit board is made available, the magazine should print the film with drill centers. If a PC board is mandatory for the project to work properly, the article should explain how to make the board.

I am an electronics engineer who got into the field largely because of **Popular Electronics** and Don Lancaster. I credit my good grades in college to my experience building the projects presented each month in the pages of your magazine.

Years ago, I wrote an article that **Popular Electronics** published (and reprinted). I could write a construction article every month that would use a programmed microcontroller, offer to sell the chip for \$50, and make a lot of money—but I feel that is wrong. It prohibits other young experimenters from

building projects that would help them learn more about electronics.

Thanks for listening!

A.M.

We received a reply from Robert G. Brown in which he states that at the time he prepared the article, the unprogrammed PIC he uses was over \$20. He and many readers still feel, however, that the cost of the complete kit—\$85—is a great value.

*I have to add, in response to your other comments, that we do provide source code, free of charge, for every PIC project we run in **Popular Electronics**. The files were posted in the past to our BBS, and will now be posted to our FTP side (<ftp.gernsback.com>). Also, we always provide PC-board templates when a project uses them, as well as any special assembly procedures necessary to make the boards.*

Hope this answers your concerns; thanks for writing.—Editor

HAVES & NEEDS

I am seeking a manual for an oscilloscope: Model Conar 255, manufactured by Conar Instruments in Washington D.C. Thank you for your help.

DUKE HOLY

1125 Shoreview

Englewood, FL 34223

Popular Electronics is a unique magazine. When my copy arrives each month, I can't wait to turn to my favorite columns (*Circuit Circus* and *Think Tank*). I love building projects and servicing television, audio, and VCR equipment—which, fortunately, is my profession.

I am interested in corresponding with other people around the world who share my interest in electronics, and who would like to exchange ideas on this important field.

JOSEPH ANIE

Port Fire Service

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DYCAM 10-C DIGITAL CAMERA



*Forget film and developing;
take still pictures electronically
with this digital camera.*

The principles behind photography haven't changed much in the past hundred years or so. Basically a light-sensitive substance, usually some compound of silver on a flat surface, is exposed to a scene of interest through the aperture of a pinhole or lens. From that point on it's all chemical, not electronics. Color photography adds fancier chemicals to the mix, but the principles are the same.

Now photographic chemicals and related products are relatively expensive, so that's why you can pay a lot for film and its developing. One way around this is the charge-coupled device, or CCD. A CCD is a solid-state device that "sees" light and outputs an electronic representation of what it sees. There are CCDs of varying quality and sensitivity, and of course, price.

Video cameras contain a CCD. These cameras convert an image—actually a series of them—into an electronic signal that is transferred to video tape. When the tape is played back, the recorded signal is converted into the type of signal that a television set requires. NTSC is the TV signal format used in the United States and many other countries. The problem is, the resolution of an NTSC TV picture is rather poor compared to a pho-

tograph. If you've ever seen an image captured from NTSC video you can see how much detail is missing. You don't really notice the lack of detail while watching TV, but if you get up close to the screen you can actually see the spaces between color pixels. This is why people are anxious for HDTV to become available, because it will have at least double the resolution of NTSC, and a wider picture as well.

Clearly then, CCDs of much better quality must be used in still cameras. This is one reason why electronic still cameras have been high in price. Another problem is that images from an electronic still camera must be viewed on a monitor, or printed. And affordable color printers just didn't exist only a few years ago. But thanks to advancements in technology, home computers, and color printers, electronic still cameras are breaking new ground, and fairly advanced ones can now be purchased for under \$1000.

The advantages to a digital camera are many. There's no expensive film involved, no development costs, and your PC becomes your own personal photo studio. Pictures in electronic form can instantly be e-mailed anywhere in the world. A photographer/reporter up in a helicopter

documenting some sort of disaster can send pictures via wireless e-mail or modem to a publisher as the pictures are taken. Internet users can upload pictures immediately after taking them without having to scan them in first.

Dycam 10-C Digital Camera. The Dycam model 10-C truly is a camera of the '90s. This digital color zoom camera features a power zoom with a close-up mode, automatic focus, automatic flash, virtually unlimited storage with add-on memory cards, and outputs pictures in a maximum 640 x 480 resolution.

The 10-C is nearly identical to a handful of other digital cameras, as well it should be; all of them are made by Chinon. The unique thing about the Dycam 10-C is that this is the only one with a threaded collar around the lens, so you can attach accessory lenses and filters. The 10-C also sells for a bit less than the others, with a list price of \$998. That price includes the camera, a serial adapter cable, four AA batteries, user's guides, and software on diskette. The camera is powered from four AA batteries—lithium, alkaline, or Ni-Cd batteries can be used. A battery-level indicator tells you when you should change the batteries. Images are retained even

Fifteen years of micro-electronic research makes 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 on local broadcast networks!

Technology corner

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

Bandwidth of TV Signal

1 2 3 4 5 6



Spectrum system:
Precision tuning

Other systems:
Non-precision tuning

■ 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.

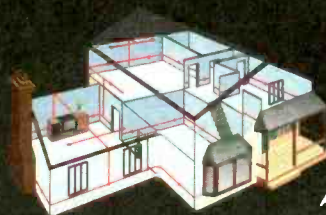
How does Spectrum use a home's electrical wiring as an antenna?

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.

Acting Antenna



Before



After

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 display a sharp, focused picture thanks to Spectrum's advanced "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 12 of the best antenna configurations.

Parallel 75 ohm resistance
For minimum loss of signal

Signal search control
For selecting multiple antenna configurations

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

Dual outlets with surge protection

For plugging in additional TV/stereo equipment, guarding against damage and surges

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.

Rural areas. If you live in a rural area you may need to enhance the incoming signal—most rural areas signals are weak, making them harder to fine tune. The "Gain Booster" is a high-frequency signal booster designed to increase the output level of the signal entering your television. It delivers a 10-fold greater signal which will bring richer color and a noise-free picture. By using the "Gain Booster," all of the Spectrum's fine tuning controls will function better, giving the Spectrum Antenna a stronger signal to fine tune. It also works in conjunction with your outdoor antenna.

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.

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 can get great reception on all your TVs!

Spectrum Antenna \$39 \$4 S&H
Additional antennas just . . . \$34 S&H free
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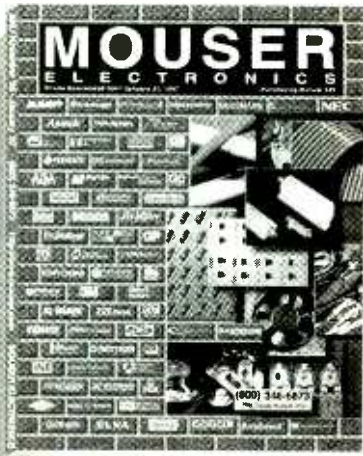
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CIRCLE 162 ON FREE INFORMATION CARD



One year old Daniel doesn't mind having his picture taken with the Dycam 10-C digital camera. This shot shows the best resolution the camera can provide.

with the batteries removed, but the camera's built-in clock will fail three minutes after removing them.

An AC adapter is available from Dycam for \$79, and this eliminates the need for batteries, but it also ties you to an AC outlet. The AC adapter is fine for studio work, and useful when transferring pictures from the camera to computer, as this operation consumes a lot of power. The camera turns on when the flash is pulled out to the side, and it shuts itself off after 60 seconds to conserve power if it's not being used.

You don't need a computer to use the camera, although you do need one to import the pictures and view them on. The camera can be used with a PC or Mac. A PC must be a 486 or better, running Win 3.1 or higher, have at least 8 MB RAM, a high-density floppy drive, and about 10 MB of free hard-disk space. A Mac must have a 68020 processor or higher, System 7.0.1 or later, 8 MB of RAM, a high-density floppy drive, and about 10 MB of free hard-disk space.

Using the 10-C. The Dycam 10-C is very easy to use. Its internal memory can hold 40 pictures in the normal resolution, 10 pictures in fine resolution, and 5 pictures in super-fine resolution. The normal resolution consists of 320 X 240 pixels stored in a compressed form that has some loss of

detail associated with it. The fine resolution pictures contain basically the same level of picture detail with the same lossy compression scheme, but at 640 X 480 pixels—double the size of the normal-resolution pictures. The super fine pictures are also 640 X 480, but these are stored using a lossless compression scheme that retains as much detail as possible.

In actual use, however, you'll see very little difference between the fine and super-fine pictures. Resolution modes can be "mixed and matched," so that you can select the resolution that best suits a particular image, while still squeezing the most out of the camera's memory.

The Dycam 10-C also accepts standard PCMCIA add-on memory cards to increase the number of pictures you can take before downloading them to a PC. Dycam sent us a 4-megabyte card that increases the camera's capacity to 172 normal-resolution pictures, 43 fine-resolution pictures, or 21 super-fine-resolution pictures. Dycam sells this card for \$349. Cards with larger and smaller capacity are also available. While a reporter might need more memory in the camera, most users will be fine without one.

Seasoned photographers will feel comfortable with the Dycam 10-C in their hands. It looks and feels like

(Continued on page 57)

**NEW
Xplorer**

It's a receiver a counter, a recorder, a decoder...



•Two-Line LCD display. First line displays frequency. Second line switches between either CTCSS, DCS, DTMF, Signal Strength, or Numerical Deviation.

NMEA-0183 GPS Interface, -Connect your GPS to the Xplorer for Mapping applications. (GPS and Mapping Software not included)

The New Xplorer Test Receiver. Ideal for any two-way communications testing or monitoring. The Xplorer is a value packed performer integrating the functions of a CTCSS, DCS, and DTMF Decoder, Frequency Recorder, Nearfield Receiver and more into one hand-held unit. No more guessing when programming a frequency for monitoring-the Xplorer captures nearfield frequencies off the air from 30MHz - 2GHz in less than 1 second. The New Xplorer; providing the power of handheld portability with state of the art functionality and performance.



•Built-in Speaker. All frequencies received are demodulated for instant monitoring.

and the last instrument you will ever NEED.

Features & Specifications

- Frequency Lock Out, Manual Skip, and Auto or Manual Hold
- Internal Speaker, Audio Earphone/Headphone Jack
- Built-in PC Interface, PC Connection Cable and Download Software included
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- Optimum Maximized Sensitivity for increased nearfield distance reception
- Tape Control Output with Tape Recorder Pause control relay and DTMF Encoder for audio data recording
- High speed FM Communications Nearfield Receiver, sweeps 30MHz - 2GHz in less than 1 second
- Two line LCD displays Frequency and either CTCSS, DCS, DTMF, Deviation or Signal Strength
- NMEA-0183 GPS Interface provides tagging data with location for mapping applications
- Frequency Recording Memory Register logs 500 frequencies with Time, Date, Number of Hits and Latitude/Longitude. (Latitude & Longitude coordinates are only displayed in memory when used with GPS)
- Real-Time Clock/Calendar with lithium battery back-up
- Built-in Rapid Charge NiCad Batteries with 5 hour discharge time and Power Supply included
- Numerical Deviation Display with 1-10kHz and 10-100kHz ranges
- Telescoping Whip full range Antenna included



•Easy touch control pad. F1 & F2 keys control all Xplorer functions. Hold, Skip, Store and Lockout all enabled through the keypad.

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PRODUCT TEST REPORT

AudioSource MCSW 1 Powered Subwoofer

BY STEPHEN A. BOOTH

Bass—the lower frequencies of the audio spectrum—is the underlying foundation for most music. Yet it's the place where many loudspeakers reveal their shortcomings.

To sound these deep registers with accuracy and volume, a loudspeaker must push large volumes of air that recreate the long waveforms in the 20- to 200-cycles-per-second range. Most speakers carry the melody fine through the mid-range and treble frequencies, but begin to "roll off" or attenuate the bass signals long before plumbing their depths.

The size of the woofer or bass-speaker driver, cabinet volume and style, and available wattage all play a role in low-frequency response. Typically, small speakers of the bookshelf type, those bundled with mini-stereo systems or built into TVs, just run out of gas. It's not that they don't deliver bass below their stated cutoff—but they don't reproduce it accurately. If, for example, the speaker promises flat frequency response down to 100 Hz, the vibes below that point will be muddy, from distortion. Instead of a tight, distinct kettle-drum roll, you'll hear a tubby sort of rumble.

A dedicated subwoofer can restore the bottom to music or special effects. It's a speaker whose only job is to handle the lowest bass. A crossover in the subwoofer or elsewhere routes sounds above a given frequency to the main stereo speakers. Often, the subwoofer has its own source of amplification, sometimes built-in. That's the case with the MCSW 1 from AudioSource.

The Burlingame, California-based manufacturer offers this compact, powered subwoofer as an affordable add-on to sound systems that might be a bit anemic in the range below 180 Hz. This is frequently true of today's popular "shelftop" or mini-stereo systems. Though they have nice features and performance otherwise, and usually some kind of electronic bass-boost circuitry, their necessarily small speakers

can't reproduce the deepest notes of a pipe-organ or the earth-shaking sound effects found in many movies.

With amplification up to 50 watts and a variable crossover that may be adjusted to work smoothly with a wide variety of speakers, the MCSW 1 complements a shelftop stereo nicely. Size-wise, it's also a nice match. The 8-inch speaker is housed in a 12-inch black cube that won't overpower a room or the main system.

TEST RESULTS

Except for one *peccadillo*, the MCSW 1 got passing grades in electrical measurements performed at the Advanced Product Evaluation Laboratory (APEL), an independent testing facility in Bethel, Connecticut.

Actually, the one slip-up the lab detected has more to do with the manufacturer's claims than the subwoofer's performance.

Although AudioSource rates the power output of the MCSW 1's amp at 50 watts, this maximum is achieved only at the 50 Hz frequency. So, if the subwoofer's crossover were set to operate at higher frequencies (up to its 180 Hz limit), power output would not be as great at these points. This is not a bad thing—the horsepower is most needed at the lower point—merely a clarification of the builder's specs.

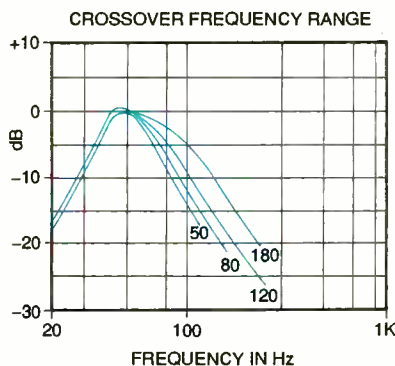


Fig. 1. This diagram shows how the MCSW 1 subwoofer performs in its four crossover frequency ranges.

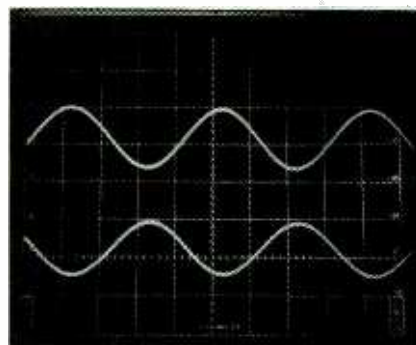
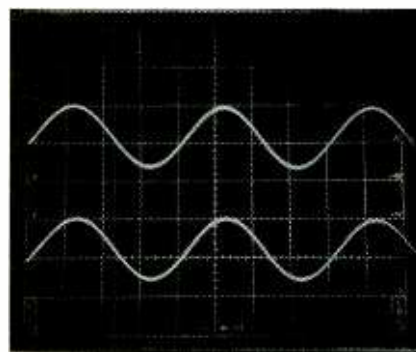


Fig. 2. As you can see from these scope screenshots, the subwoofer is capable of both accurately reproducing (top) and reversing (bottom) the phase of an audio signal. The original input signal in each screenshot is shown as the top wave, and the subwoofer's is shown as the bottom wave.

Otherwise, the MCSW 1 performs as advertised. As shown in Table 1, signal-to-noise ratio (92.5 dB) is very decent at maximum output. Also at top-power, distortion is inaudible at the low 50-Hz point. In fact, distortion is not a factor at any of the four crossover frequencies (see Fig. 1).

Regarding phase (see Fig. 2) the MCSW 1 replicates an input signal accurately—and can reverse it accurately. Why would you want to? This is a matter of speaker placement and your hearing.

IN-USE EVALUATION

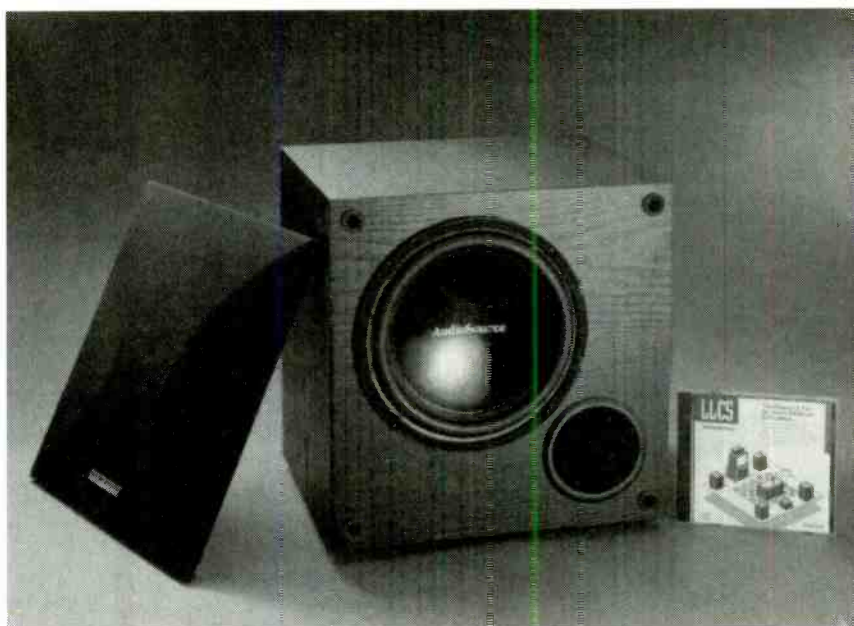
Normally, you should operate the MCSW 1 with its rear-mounted Phase switch in the "0-degrees" mode—that is in-phase with the main stereo speakers. But because the subwoofer

is not in the same cabinet as these, and might be located quite differently, AudioSource notes that it's possible the subwoofer frequencies will arrive at your listening position "out of phase" from the other speakers.

If this were the case, some sound-waves in the upper bass and lower midrange might be canceled, making the music seem audibly hollow. Raising the subwoofer's volume (through its level-control) would not improve the sound. AudioSource suggests setting the Phase switch to the "180-degrees" position (and thereby reversing) to compensate for the cancellation effect, and restore balanced sound.

The Phase reversal switch is a very useful and thoughtful feature, so the very minor annoyance it raises will seem petty: The MCSW 1 has no remote control for those rear-mounted switches and dials.

It's no big deal when adjusting the crossover frequency, which should be a one-time operation. If a check of your main speakers shows that they're flat down to, say, 70 Hertz, you'd set the crossover around 80 Hz to let the sub



Don't put up with a lack of bass reproduction from your sound system. Add the AudioSource MCSW 1 powered subwoofer shown here and really experience music and movies.

handle the bass from that point down. But it would be convenient, for example, to be able to adjust subwoofer volume and phase from your listening position. Ditto for turning the subwoofer

on and off—just to hear the difference.

And what a difference the MCSW 1 does make. For a listening evaluation, the powered subwoofer was added to a typical shelftop mini-stereo, with the

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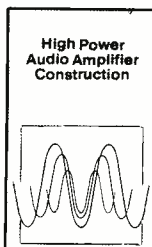
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TABLE 1—TEST RESULTS

The following test results were furnished by the Advanced Product Evaluation Laboratory, an independent testing facility located in Bethel, CT.

Brand: AudioSource
Model: MCSW 1 Powered Subwoofer
Price: \$250

Maximum Power Output (@ 50 Hz): 50 watts
Distortion (@ 50 Hz): 0.18%
Signal-to-Noise Ratio: 92.5 dB

Crossover Network:
Frequencies (@ 1 watt)
50 Hz
80 Hz
120 Hz
180 Hz

Distortion
0.16%
0.90%
0.005%
0.005%

Crossover Frequency Range: See Fig. 1

Phase Shift (0-deg./180-deg.): See Figs. 2 and 3

Other Measurements:
Speaker Size: 8-inch Round
Speaker Impedance: 8 ohms
Dimensions (inches): 12.125 × 12 × 11.25
Weight: 19.75 pounds

very demanding Pierre Verany "Digital Test" CD set (PV.788031/788032) played as source material.

On a recording of fireworks, the MCSW 1 clearly reproduced the receding echoes or reverberation of the explosions. Without it, you could hear only the boom of the initial reports—even with the mini-stereo's bass-boost at the maximum level. Likewise, during a performance by a Dixieland band, you'd never know there was a bull-fiddle (a.k.a., double bass, bass viol, contrabass) on stage until the MCSW 1 kicked in. Ditto for the lowest pipes in Louis Vierne's "1st Organ Symphony."

More important, the difference between accurate bass reproduction and mush was most clearly audible during the fourth movement of Rimsky-Korsakov's "Scheherazade." Whereas a volley on the kettle drums had a fuzzy, tubby quality when heard through the mini-stereo alone, with the MCSW 1 the individual baton strokes were distinct against their ascending rumble.

When it was connected to a more sophisticated stereo system and speakers, the effect of the MCSW 1 was less dramatic, but still a profound improvement. You could expect similar results by adding the bass cube to a surround-sound home theater setup. Just hooking it up to a stereo TV did wonders for the boob-tube's under-achieving full range speakers.

The MCSW 1 might not have remote control convenience, but it operates in a standby mode where it powers up automatically when it senses an input signal from the connected source unit. And, conveniently, versatile inputs and outputs enable connection to different types of equipment. These include line-level RCA jacks, which you'd use to route an unamplified signal through the crossover from audio equipment with a preamp-out or a dedicated subwoofer output.

For audio gear that lacks a preamp out (for example, many mini-stereos), the MCSW 1 also has high-level inputs and outputs of the speaker-terminal clamp type. You'd use these to receive an amplified signal from an audio component's speaker output terminals, and relay the signal on through the subwoofer's crossover to the input terminals of the stereo speakers.

Overall, the MCSW 1 provides a satisfying way to make an existing sound system more satisfying—and it's a less expensive upgrade compared to replacing amps and speakers. ■

FOR MORE INFORMATION

AudioSource
1327 North Carolan Avenue
Burlingame, CA 94010
Tel. 415-348-8114

CIRCLE 72 ON FREE
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How to make your car invisible to radar and laser...legally!

Rocky Mountain Radar introduces a device guaranteed to make your car electronically "invisible" to speed traps—if you get a ticket while using the product, the manufacturer will pay your fine!



■ **The Phazer will "jam" both radar and laser guns, preventing police from measuring your speed.**

If your heart doesn't skip a beat when you drive past a speed trap—even if you aren't speeding—don't bother reading this. I can't tell you how many times that has happened to me. Driving down the interstate with my cruise control set at eight miles over the limit, I catch a glimpse of a police car parked on the side of the road. My heart skips a

beat and for some reason I look at my speedometer. After I've passed the trap, my eyes stay glued to my rear view mirror, praying the officer will pass me up for a "bigger fish."

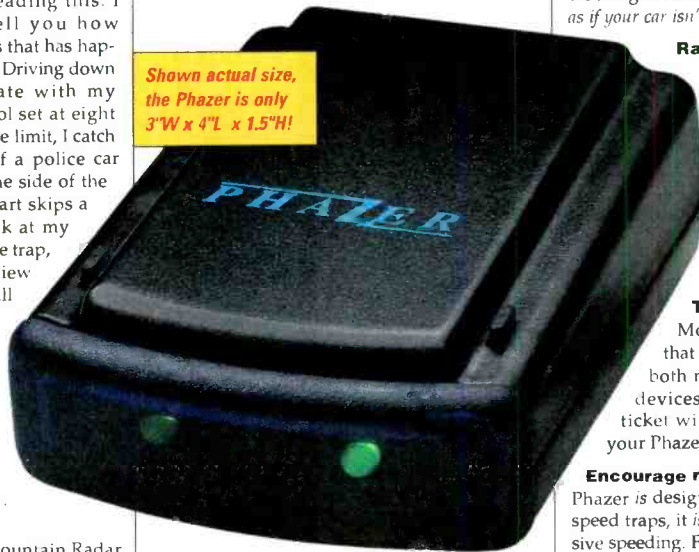
It seems that as speed-detection technology has gotten more and more advanced, speeding tickets have become virtually unavoidable. And although devices exist that enable motorists to detect these speed traps, they are outlawed in many states... including mine.

The solution. Today, Rocky Mountain Radar offers drivers like me a perfect solution—the Phazer. Combining a passive radar scrambler with an active laser scrambler, the Phazer makes your automobile electronically "invisible" to police speed-detecting equipment.

The radar component works by mixing an X, K or Ka radar signal with an FM "chirp" and bouncing it back at the squad car by way of a

waveguide antenna, effectively confusing the computer inside the radar gun. The laser component transmits an infrared beam that has the same effect on laser Lidar units.

Shown actual size, the Phazer is only 3"W x 4"L x 1.5"H!



Perfectly legal.

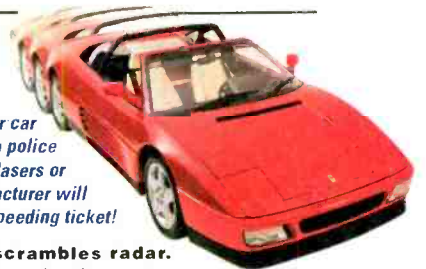
Some radar devices have been outlawed because they *transmit* scrambling radar beams back to the waiting law enforcement vehicle. The Phazer, however, *reflects* a portion of the signal plus an added FM signal back to the police car. This, in effect, gives the waiting radar unit an electronic "lobotomy."

Best of all, unless you are a resident of Minnesota, Oklahoma or Washington, D.C., using the Phazer is completely within your legal rights.

HOW TO MAKE YOUR CAR DISAPPEAR

Radar and laser scramblers are devices that foil speed traps by making vehicles electronically "invisible" to police radar. Radar scramblers mix a portion of the radar signal with background clutter and reflect it back to the squad car. This technique, pioneered by Rocky Mountain Radar, creates an unreadable signal that confuses the computer inside the radar gun.

The laser scrambler in the Phazer works in a similar manner. It transmits a special infrared beam with information designed to scramble the laser signal. The result? Readouts on police radar and laser guns remain blank. As far as the police officer is concerned, your vehicle is not even on the road.



■ **The Phazer makes your car invisible to police radar and lasers or the manufacturer will pay your speeding ticket!**

How it scrambles radar.

Police radar takes five to 10 measurements of a vehicle's speed in about one second. The Phazer sends one signal that tells the radar the car is going 15 m.p.h. and another signal that the car is going 312 m.p.h. Because police radar can't verify the speed, it displays no speed at all. *To the radar gun, your car isn't even on the road.*

Works with laser, too! The Phazer also protects your vehicle from Lidar guns that use the change in distance over time to detect a vehicle's speed. The Phazer uses light-emitting diodes (LEDs) to fire invisible infrared pulses through the windshield. Laser guns interpret those pulses as a false indication of the car's distance, blocking measurement of your speed. *Again, it's as if your car isn't even on the road.*

Range up to three miles.

The Phazer begins to scramble both radar and laser signals as far as three miles away from the speed trap. Its range of effectiveness extends to almost 100 feet away from the police car, at which point you should be able to make visual contact and reduce your speed accordingly.

Ticket rebate program. Rocky Mountain Radar is so confident that the Phazer will protect you from both radar and laser speed-detection devices that if you do get a speeding ticket within the first year while using your Phazer, they will pay your fine!

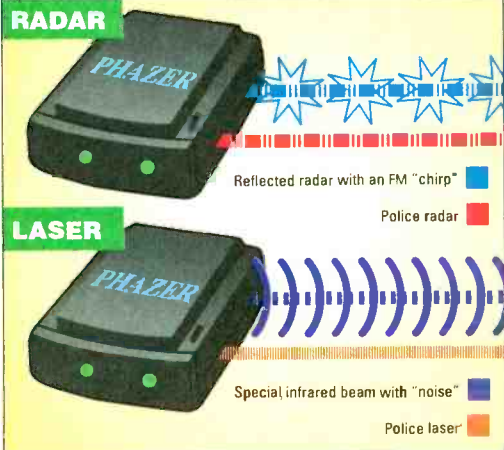
Encourage responsible driving. While the Phazer is designed to help you (and me) avoid speed traps, it is *not* intended to condone excessive speeding. For that reason, the manufacturer will only pay tickets where the speed limit was not exceeded by more than 30%, or 15 miles per hour, whichever is less.

Risk-free. Thanks to the ticket rebate program, speed traps don't make my heart skip a beat anymore.

Try it. Your car will be invisible to police radar and laser, or the manufacturer will pay your fine! It's backed by our risk-free trial and three-year manufacturer's warranty. If you're not satisfied, return it within 90 days for a full "No Questions Asked" refund.



■ **The Phazer is a completely legal way to protect yourself from speed traps (except in OK, MN and Washington DC).**



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NET WATCH

The State of Digital Audio

BY DAN KARAGIANNIS

Every little corner of cyberspace shouldn't look and sound the same. That's been the unwritten motto of most Net-site creators, and for this reason multimedia on the Net was born. In fact, cyberspace sights and sounds are so common now that I'm sure anyone with a SLIP/PPP connection who has been to even a handful of sites with a graphical Web browser has experienced them.

Even in its simplest forms, multime-

dia adds a lot to cyberspace. Pages with animated burning torches, or moving little cartoon characters are always more interesting to look at than the usual gray pages with a picture here or there. The same goes for sound—clicking on something and hearing a bit of digital audio only enhances one's experience as well. It's this latter type of digital technology we'll be looking at this month.

With the information in the column, and a few minutes of download time, you'll be equipped to hear some amazing sounds, all right off the Net. And for the audiophiles out there, yes I do mean CD quality!

files as you download them. But anyone who's tried version 2.0 of the software knows that RealAudio files are not all that clean. Forget about CD, tape, or even FM-radio quality. The files tend to sound more like a weak AM station at best. (RealAudio 3.0 is better, but you need an ISDN connection to hear CD quality audio.) Currently, the most practical way to hear good-sounding audio is to download it first. But those files tend to be large.

when the transfer and playback is completed. Now to make things worse...

Due to the fact that most simple compression techniques can only do so much (read "very little") to a sound file, most digital audio has to be made smaller in other ways. That's where the other three factors come in to play.

The sample rate is one of the biggest factors to determine a file's clarity and timbre. Audio CDs use a 44.1-kHz rate, which is the industry standard (although DAT recorders now record up to 48 kHz). Files of this quality tend to get large real fast (we'll look at just how large in a moment), so 22- or 11-kHz (or lower) rates are often used. The result? While dividing the rate also divides the size of the audio file, you often end up with a sound that resembles a transistor radio playing in a tin can.

The sample size of digital audio is also an important quality-determining factor. The best available in high-end audio samplers is 18 bits. In sound cards, you probably won't find a size that's higher than 16 bits (no, any sound card with the number "32" in its name does not work with 32-bit samples; that number refers to "voices," which is out of the scope of this column). Audio CDs use 16-bit audio, which sounds great. But, just like a high sampling rate, a high sampling size also adds up those megabytes quite quickly. As a result, a lot of files are 8-bit, which makes the file half as large and sound only half as good.

So far, to keep the size of a file down, we end up with a tinny bit of audio that sounds almost full of static. Now let's consider stereo vs. mono. Stereo means you have two separate tracks of audio in a file. As you might have guessed, stereo therefore means you have a file that's twice as large. Therefore, most .wav files on the Net are mono, which takes out any bit of life left in an already horrible file.

Now that we've looked at all the factors, let's get an idea of what the term "large" meant in all the paragraphs you just read. If you record a standard-length pop song, which is about three-



Winplay3 seems to be the best .mp3-file player available. You'll swear you were listening to a CD!

Why? The reason for that lies in four factors of digital audio: the compression, sample rate, and sample size used in a file, and whether it is stereo or mono.

The first one, compression, is a factor in the computer world that no one should be a stranger to by now. The most common use of compression is in the creation of .zip files, which allow several regular files to be grouped into one file and shrunk to a percentage of their size. But when it comes to digital audio files, this type of compression doesn't do much (try zipping up a .wav file and you'll see what I mean).

The type of sound-file altering done by programs like RealAudio tends to be a bit "lossy." In other words, the file gets damaged by compression. Because of that, no matter how good the file is to begin with, it won't sound quite so good

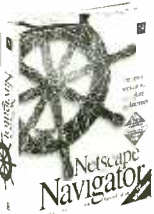
COMPRESSION, SAMPLING, AND STEREO

In the past we've explored RealAudio, which lets you listen to audio

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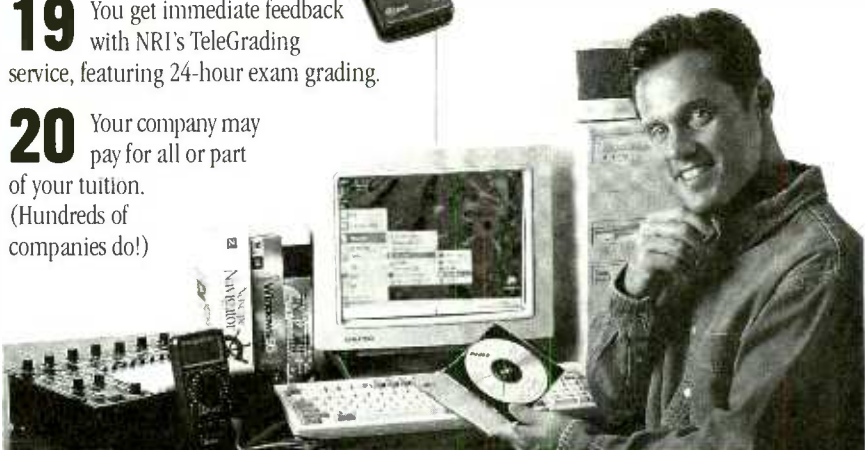


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Bongo's Big Site O' Hell holds more great-sounding digital audio files than you'll ever have time to download.

and-a-half-minutes long, at CD quality (44.1 kHz, 16 bit, stereo), you'll eat up 36 megabytes of space! That's one large .wav file, and one which would take you so long to transfer that your connection would probably disconnect (ever notice how connections seem to go down only when you're more than halfway through downloading a file?).

So it's pretty clear that .wav files, which are mostly uncompressed, will never provide a good way of putting digital audio on the Net. But what if there was a format that let you take a three-and-a-half-minute song, record it at CD quality, and have it take up less than 3 megabytes?

LAYER-3 AUDIO

The need for data reduction of video pictures and sound has been recognized for some time, and as a result a standard for compression was developed: MPEG. Using the latest level of MPEG audio coding—layer-3—you can shrink down CD audio by a factor of 12, without losing any timbre, clarity, or overall clarity.

Our first site this month is probably the best place to visit to get started with layer-3 audio, or .mp3 files. It's name is a bit deceiving, as it's called MPEG Layer 3 Sounds. Actually it contains sounds *and* teaches you .mp3 basics.

You'll find a few useful section links at the top of the page. What is MP3? teaches you in a non-technical way

about the technology. There are links to an FAQ if you want more information.

How Do I Play the MP3 Sounds Archived Here? is probably the most useful section. Here you'll find links to software that lets you listen to .mp3 files on your computer. The best seems to be Winplay3. There's a link to a version with a 20-second limit, and one to a version without limits.

How Do I Encode My Own MP3 Files? gets you started on the slightly annoying process of making your own digital-audio files. I call it annoying because it's not a graphical-interface procedure, and let's face it: Windows has spoiled all of us!

Links to Other People's Pages is definitely worth checking out too. Here you'll find an assortment of places to go if you're looking for song files, movie sound clips, etc. Speaking of movie clips, though, there are plenty right at the MPEG Layer 3 Sounds page.

The files at this site are pretty neat. There are high-quality *Star Wars*

HOT SITES

MPEG Layer 3 Sounds

<http://www.eskimo.com/~miyaguch/mp3.html>

Bongo's Big Site O' Hell

<http://bongo.dorms.tamu.edu/>

Digital-Audio Newsgroups

alt.binaries.sounds
alt.binaries.sounds.music

Trilogy, *Jurassic Park*, and even *Simpsons* clips.

Another site worth mentioning is Bongo's Big Site O' Hell. Despite its non-serious-sounding name, this large hot spot is actually a major archive of .mp3 and other multimedia files. It's even configured to play .mp3 audio right over the Net, but you'll need a 128-kbps ISDN connection to listen to it. Considering most of us don't have that, we'll have to download the files first and hear them.

What kind of files? Well, in addition to movie audio you'll find all types of music, including quite a few popular songs. We won't even get into whether this is legal or not; just think of it as listening to a *powerful* radio station, with a digital tape recorder running.

Before we leave the topic of .mp3, let me just mention one other resource on the Net for obtaining files of this type. Use your USENET news reader to access any of the alt.binaries.sounds newsgroups (especially alt.binaries.sounds.music). Most of the files posted there are layer-3 audio. Here's where you'll learn firsthand about another great feature of layer-3 files. If you want to, you can download just one part of a multipart .mp3 file, decode it, and take a listen. Then, if you like what you hear, download the rest. This isn't possible with multipart, posted .wav files.

REALAUDIO 3.0

In the spirit of fairness, I just want to give a brief update to the current status of RealAudio software. The latest version of the software, 3.0, gets a bit closer to broadcast quality than 2.0 did. But keep in mind, this isn't really supposed to compete with .mp3 for quality. After all, RealAudio does something unique. It lets you hear audio as it downloads, and not after.

If you have an ISDN connection, you can take advantage of this software (just like you could with streaming layer-3 files) by having it provide you with almost-CD-quality sound as it comes off the Net. I won't go any deeper into the product again, but do want to stress that for what it does it's probably the best available.

That just about does it for this month. If you'd like to drop me a line, send e-mail to peeditor@gernsback.com, and snail-mail to *Net Watch*, Popular Electronics, 500 Bi-County Blvd., Farmingdale, NY 11735.

MULTIMEDIA WATCH

My New Favorite PC

BY MARC SPIWAK
TECHNICAL EDITOR
WINDOWS MAGAZINE

I've got a new favorite PC—for the next month or so, anyway. That's how often newer and faster systems seem to come out. It's hard to believe the kind of PC the average guy can buy these days, and not for an astronomical figure, either. Micron's new Millennium Pro Plus is fueled by two Pentium Pro 200 MHz CPUs. It comes with 64 MB of RAM and a 512K pipeline burst secondary cache. While I'm talking about a Micron system, you

SCSI adapter card features an external connector for hooking up external SCSI peripherals. That's the fastest way to connect an extra CD-ROM drive, a CD-R drive, a tape backup, and so on. And any portable SCSI device will absolutely blow away a parallel-port based cousin in performance. The system also came with a Sound Blaster 16 sound card.

Naturally the system includes a 17-inch monitor. But it also comes with the

any version of Windows will run at warp speed on a Pro. However, you absolutely need NT to take any advantage of having two CPUs. Windows 95 really can't do anything with two CPUs, and for that matter it doesn't even know there are two CPUs.

I don't have a problem with NT being different than Win 95. As a matter of fact, NT 4.0 has the Win 95 front end, so anyone familiar with Win 95 will have no trouble navigating through NT 4.0. For that matter, anyone familiar with Win 3.1 wouldn't have any trouble using NT 3.51. The real difference is that any flavor of NT has a lot more features built in than Win 95 or Win 3.1, especially in the security department. My problem is that NT is not what I want for multimedia.

Any software designed to run under Win 95 was supposed to work in NT as well, but it just didn't turn out that way. Many programs just don't work right, and NT 4.0 is an entirely new animal with entirely new incompatibilities. I actually wiped out the NT 4.0 installation on my hard drive by trying to install CD Creator 2.0, which supposedly runs fine under NT 3.51. Fortunately I had already tested the system. I later found out that there is a known incompatibility with CD Creator under NT 4.0. That's some incompatibility! But none of that really matters because Win 95 is definitely the preferred platform for multimedia, and that's what this column is all about.

The problem is that Win 95 contains some 16-bit legacy code for backward compatibility, and that's not really what you want for NT. There is some performance penalty when running Win 95 on a Pentium Pro, but the penalty really goes to the processor rather than the software. Pros run best when they don't have to stumble across 16-bit code. But the truth is that Win 95 runs great on a Pentium Pro, and it seems to run faster on a Pro 200 than on any Pentium. It's a fact, though, that Win 95 can't take advantage of two processors, period.

Software that can take advantage 21



My dual-processor Pentium Pro 200 is more than twice as fast as a Pentium 200, but only with software that can take advantage of the two processors.

can be sure that any dual Pentium Pro system is going to be radically powerful. One thing I noticed is that a dual-processor system generates a lot of heat. The system is cooled by a total of four fans, and it heats up my office in no time.

The Millennium Pro Plus uses all SCSI components: a Seagate 2GB Ultra SCSI hard drive, a Plexstor 8× CD-ROM drive, and an Iomega 1 GB jaz drive. A jaz drive is basically a hard drive with removable cartridges. It's nearly as fast as a conventional hard drive, and each cartridge holds a gigabyte. The cartridges are great for transporting tons of data or for use as an ultra-fast backup system. One nice thing about a SCSI system is that the

fastest graphics accelerator I've ever tested—Number Nine's Imagine 128 Series 2. I can play Video CD movies using software MPEG alone, and play them at full-screen size without dropping any frames. That card will allow any reasonably fast Pentium to do that, and I'm not even sure yet what it can do with two Pentium Pro CPUs. The fact is, there's not much you can do yet with two processors, as not much software can take advantage of them. Let me explain:

The system came loaded with Windows NT Workstation 4.0 and a Microsoft Office CD—you need 32-bit software for NT, so Office fits the bill. You also need NT to take full advantage of a Pentium Pro CPU, although



Kurzweil Voice 2.0 voice-recognition software lets you control Windows and many Windows-based programs by voice and type by voice.

of the two processors better watch out, though. According to a Wintune benchmarking score, a program free for anyone to download from the *Windows Magazine* Web site (www.winmag.com), the dual Pentium Pro system burned through 833 million instructions per second (MIPS). A single-processor Pentium 200 system (not a Pro) recently scored 361 MIPS, so you can see how fast this system really is. An Access database benchmark test that I have used was completed in 1 minute 7 seconds on the dual-processor system. For that to be impressive you must understand that the same test took nearly 2-1/2 minutes on a single-processor Pentium Pro 200, and about 26 minutes (!) on a 486 DX2/66. My guess is that it would take about 3 minutes on a regular Pentium 200, although I haven't tried it yet.

If I were buying a system today, I would buy a dual-processor Pentium Pro—if I could afford one. The Micron system comes to a total of about \$5500. If I couldn't afford it, I'd make it a single-processor Pro. That alone subtracts around \$700 from the price. I could certainly do with half the memory for another few hundred dollars saved. Doing away with the jaz drive chops off another \$500 or so, as does settling for a less luxurious graphics accelerator. Then you're looking at a \$3500 barnstorming system, and probably well under \$3000 by the time you read this.

NEW STUFF

I recently felt like Scotty in the movie, *Star Trek: The Voyage Home*, when he's in the acrylics factory giving away the formula for transparent aluminum. He picks up the mouse like a microphone and says "Computer." I feel the same way when I use *Kurzweil Voice 2.0*. That's a voice-recognition software which lets you control Windows and many Windows-based programs by voice. You can also type by voice. Typing by voice is easy, and you never have to worry about spelling errors. The software will run on a 486 DX4/75 or faster, although a Pentium is recommended. Anyone who can't type can now, although fast typists still beat the software. In addition to recommending a Pentium, the program requires 35 MB of disk space and 16 MB of RAM for a 30,000-word vocabulary or 24 MB of RAM for a 60,000-word vocabulary. A Telex Nomad microphone is included with the software.

You have to train the program to recognize your speech. You do that by pronouncing lots of words and numbers in a process that takes about half an hour. The software then learns more and more as you go. You give system commands using continuous dictation, speaking without pauses between words—"Filemenu," "Saveas," and so on. You dictate with a sharp pause between each word as if you were reading words separated by periods. Punctuation marks and numbers are spoken in as you would say them, and letters are entered in a special mode (Alpha, Bravo, Charlie, etc.). The program also recognizes spoken letter combinations and acronyms such as AC, DC, and SCSI.

Kurzweil Voice displays your words as you speak. If it gets something wrong, or if you say something wrong, you say "Correct That" or "Delete That." You can also pick words from a list of numbered suggestions by saying "Take 1" to accept the first word, "Take 2" for the second, and so on. You can always type it in yourself whether it's on the list or not, but it's best if you do everything by voice so that you train the software as much as possible. It seems that Kurzweil Voice 2.0 lets you dictate as fast as you can speak, as long as there's the pause between each word. You just have to shell out \$695 for the software. But if you can make money by typing, and can't real-

WHERE TO GET IT

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Los Angeles, CA 90025
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Broderbund Software
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Novato, CA 94948
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INFORMATION CARD

Discovery Channel Multimedia
7700 Wisconsin Avenue
Bethesda, MD 20814
CIRCLE 62 ON FREE
INFORMATION CARD

E.M.M.E. Interactive
1200 Summer Street
Stamford, CT 06905
CIRCLE 63 ON FREE
INFORMATION CARD

Kurzweil Applied Intelligence, Inc.
411 Waverly Oaks Road
Waltham, MA 02154
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Maris Multimedia
4040 Civic Center Dr., Suite. 200
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ly type, Kurzweil will pay for itself.

I've got a bunch of new software from Activision this month. MechWarrior 2 fans will certainly like the Win 95 version of the *MechWarrior 2 Expansion Pack: Ghost Bear's Legacy* (\$29.95), with 15 new 'Mechs, 30 new missions, and a dozen new weapons. As out of place as it might seem, Now is the time that Activision also releases *NetMech* for MS-DOS (\$14.95), which allows eight MechWarriors to compete in battle with modem or network connections. *The Elk Moon Murder* is a live-action game that turns you into a detective investigating a brutal murder. You must visit the crime scene, question people, gather evidence, and search the town for clues and suspects before it's too late.

If you like to drink exotic beers from around the world or just are interested in beer, then take a look at the *World Beer Hunter* CD-ROM from Discovery Channel Multimedia. Renowned British beer connoisseur Michael Jackson (not the singer) takes you around the world on a beer run. You'll find maps, audio, video, profiles on pubs and breweries, and plenty of information on hundreds of beers. This one sells for \$34.95.

Origins of Mankind, from Maris Multimedia, is a study of man's past and how we got where we are today. Rich animations, 3D graphics, computer-generated landscapes, and more, show the path that life has taken over the past 70 million years or so. Morphing technology even lets you watch evolution in action. This interactive textbook on human evolution costs \$39.95.

Thor Heyerdahl is a legendary explorer who believes that the Pacific Islands were populated by ancient Peruvians, Egyptians, and Sumerians; and years ago he set out to prove it. *Kon-Tiki Interactive* details how, nearly 50 years ago, Dr. Heyerdahl sailed from Peru to Polynesia in 101 days on a waterlogged balsa raft named Kon-Tiki. The disc also covers the Ra I and II Expeditions across the Atlantic, and many of Dr. Heyerdahl's other expeditions as well. You can get this one from The Voyager Company for \$39.95.

The *3D Talking Globe* from Now What Software is an interesting disc that presents you with a global atlas that you can quickly move around on. It's much like moving a real globe except that you do it with a hand-shaped mouse pointer. Three-million

place names are stored in a look-up database and you can hear 3000 of them spoken in the native language. Among many other neat features there's an adjustable magnifying glass and a tape-measure-like mileage meter that tells you how far it is from one point to another. This disc sells for \$34.95.

If you enjoy shooting paintballs at your friends, then you'll enjoy the CD-ROM game *Lemmings Paintball* for Windows 95 from Psygnosis. This game puts you in charge of a Lemmings tribe on a weekend mission to capture the other team's flags. You're armed with a pump-action paint gun and tons of paint balls.

People who enjoy solving puzzles will probably be interested in *Brainstorm!* from Simon & Schuster Interactive. Your powers of spatial relations and abstract visuals are tested to the limits with 3D animations, brain teasers, strategy games, puzzles, and more. This title has a suggested retail price of \$34.95.

E.M.M.E. Interactive is an international developer of education/entertainment CD-ROMs, with something interesting for everybody. I recently had the pleasure of sampling such titles as *Voyage in France*, *Greatest Moments of Our Time*, *Michelangelo*, and *The Great Myths and Legends*. If any of these titles interest you, contact E.M.M.E. for a complete list of them.

I have four new children's titles from Broderbund Software for this month. Intended for ages 4-7, *Gregory and the Hot Air Balloon* is an animated storybook adventure featuring Gregory Chuckwood and his pet Lizard, Newt. *Darby the Dragon* takes kids ages 5-8 on a multimedia adventure with Darby, the friendly Dragon Prince. Two other animated multimedia titles are for kids ages 8-12. *Write, Camera, Action* teaches reading and writing in a fun way, and *Reading Galaxy* builds comprehension and problem-solving skills with excerpts from many kids' books.

Kids of all ages will want to play *Piper* from Splash Studios. The game features Jason David Frank from the *Mighty Morphin Power Rangers* TV show. Piper battles Mephisto, King of the Rats, in a race to discover the Lost Cavern of Gold. There are different levels for different age groups, as well as puzzles, jokes, hidden treasures, songs, videos, and four rat-whacking games.

You can Build Gadgets! Here are 3 reasons why!

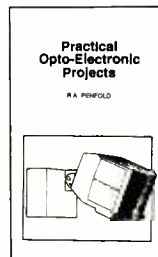


BP345—GETTING STARTED IN PRACTICAL ELECTRONICS \$5.95

If you are looking into launching an exciting hobby activity, this text provides minimum essentials for the builder and 30 easy-to-build fun projects every experimenter should toy with. Printed-circuit board designs are included to give your project a professional appearance.

BP349—PRACTICAL OPTO-ELECTRONIC PROJECTS \$5.95

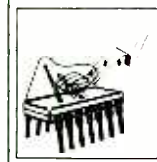
If you shun opto-electronic projects for lack of knowledge, this is the book for you. A bit of introductory theory comes first and then a number of practical projects which utilize a range of opto devices, from a filament bulb to modern infrared sensors and emitters—all are easy to build.



Practical Electronic Music Projects

BP363—PRACTICAL ELECTRONIC MUSIC PROJECTS \$5.95

The text contains a goodly number of practical music projects most often requested by musicians. All the projects are relatively low-in-cost to build and all use standard, readily-available components that you can buy. The project categories are guitar, general music and MIDI.



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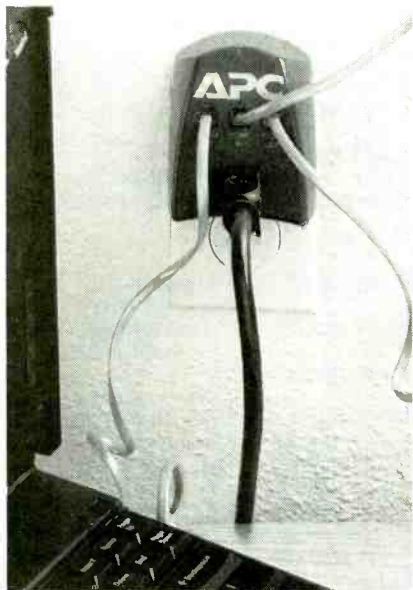
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NEW PRODUCTS

NOTEBOOK SURGE PROTECTOR

Aimed at mobile computer users who rely on notebook PCs for critical tasks while on the road, *American Power Conversion's SurgeArrest Notebook* is a compact, travel-size device that provides telephone-line and AC-power line protection against damaging power surges and spikes. A thermal fuse disconnects the AC line in the event of a sustained overvoltage. Also the device carries a lifetime warranty and a \$3500, three-year equipment-protection policy.



With three phone jacks, the SurgeArrest Notebook protector makes hotel-room laptop use more convenient than ever. Users no longer have to climb behind or around furniture to unplug the telephone line from the phone and the wall to link to the notebook computer. One telephone line can be plugged into the notebook PC while still retaining the use of the telephone. The surge protector can also be used to protect fax machines.

The SurgeArrest Notebook protector costs \$29.95. For additional information, contact American Power Conversion, P.O. Box 278, 132 Fairgrounds Road, West Kingston, RI 02892; Tel. 800-877-4080; Web: <http://www.apcc.com>.

CIRCLE 80 ON FREE INFORMATION CARD

DIGITAL DICTAPHONE

The *Voice It Manager* is a cross between a dictation machine and a personal organizer. The pocket-sized, digital device is available in two models with recording capacities of 22 or 45 minutes. Voice data is stored directly onto a computer chip, allowing individual messages to be instantly accessed and played or erased. Messages are stored in memory until purposely erased, so there is no danger of inadvertently recording over important notes. The Voice It Manager's "flash" memory chip is designed to retain messages even when battery power is lost.

Digital recording technology also allows messages to be sorted and organized. Notes can be categorized into any of five channels or "files." A library of 20 icons allows users to customize files by popular subject headers such as "things to do," "expenses," "memos," and "meetings."



A calendar and scheduling feature allows users to program certain messages to play automatically as audible reminders. Recurrent reminders can be recorded once and scheduled to play back regularly by day, week, month, or year. An LCD readout furnishes information on which channel is in use; the number of notes in the channel; and the time, day, and date of recording.

The Voice It Manager's contact file can store up to 100 names with three phone numbers per name. Voice notes

with addresses or other information can be appended to the names in the contact file. Phone numbers appearing on the LCD can be automatically dialed by holding the unit's speaker next to a telephone mouthpiece.

The *Models VM-15* (with 22 minutes of recording time) and *VM-30* (45 minutes) have suggested retail prices of \$129.95 and \$169.95, respectively. For more information, contact Voice It Worldwide, 2643 Midpoint Drive, Suite A, Fort Collins, CO 80545; Tel. 970-221-1705; Fax: 970-221-2058.

CIRCLE 81 ON FREE INFORMATION CARD

DIGITAL MULTIMETER

Extech's Model 380760 digital multimeter provides 30 ranges and eight functions, including DC/AC voltage, DC/AC current, resistance, diode test, and audible continuity test. Designed to meet IEC-1010 standards, the DMM provides $\pm 0.5\%$ basic DC voltage accuracy. An oversized one-inch LCD readout offers 1999 counts with two or three updates per second. Over-range, polarity, and low-battery indications are featured, along with auto power off and data-hold functions. Four input jacks with overload protection are provided. The multimeter comes complete with test leads,



a 9-volt battery, and a protective holster with a dual-position tilt stand.

The Model 380760 digital multimeter costs \$39. For additional information, contact Extech Instruments Corporation, 335 Bear Hill Road, Waltham, MA 02154; Tel. 617-890-7440; Fax: 617-890-7864; e-mail: extech@extech.com; Web: <http://www.extech.com>.

CIRCLE 82 ON FREE INFORMATION CARD

FIELD-SERVICE SOLDERING IRONS

Two soldering irons from *M.M. Newman* are designed for industrial and electronic field service, as well as automotive, marine, and hobby applications. The *Antex Model G/3U* miniature soldering iron heats up and recovers instantly and operates from 115 volts AC for in-plant or field-service use. The *Model MLXS* soldering iron is powered by any standard 12-volt automotive or marine battery. For optimal thermal efficiency, both irons feature heating elements placed directly under their tips.



Both models are available with a variety of specialized, interchangeable slide-on tips. The Model G/3U heats up to 800°F in 45 seconds, while the MLXS takes two minutes to reach that temperature. The Model G/3U has a six-foot cord and a three-prong plug, while the 12-volt iron has a 15-foot cord with two alligator clips for mobility.

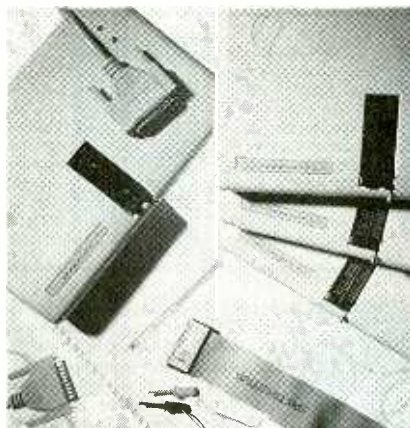
The *Antex Model G/3U* miniature soldering iron has a list price of \$19.95, and the *Model MLXS* 12-volt iron costs

\$34.65. For further information, contact M.M. Newman Corporation, 24 Tioga Way, Marblehead, MA 01945; Tel. 617-631-7100; Fax: 617-631-8887.

CIRCLE 83 ON FREE INFORMATION CARD

PC-BASED PROGRAMMERS

ICE Technology's PC-based programmers offer low-cost solutions for a wide range of programmable devices. Varying in levels of device support, the programmers are all-inclusive, requiring no add-on modules or adapters to support any parts up to and including 40-pin dual in-line packages. Socket adapters available optionally expand support to SOIC, PLCC, PGA, QFP, and TSOP packages.



The *Speedmaster 1000+* supports EPROMs, EEPROMs, Flash, Serial PROMs, BPROMs, 8748/51 micros, GALs, and erasable PALs. The *Speedmaster LV* adds support for Bipolar PALs and complex programmable logic, as well as for low-voltage devices. The *Micromaster 1000+* is a universal programmer that can also program more than 180 microcontrollers, including PICs, COP8 series, Motorola 68HCxxx series, TMS370, Z8, 87Cxxx, and more, all without any additional software or modules.

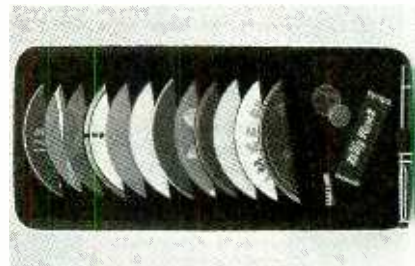
The *Speedmaster 1000+* costs \$495; the *Speedmaster LV* costs \$595; and the *Micromaster 1000+* costs \$695. All three models are compatible with ICE's built-in ROM/RAM emulator upgrade options, priced starting at \$175, which feature built-in 8- or 16-bit ROM/RAM and chip testing for TTL, CMOS, DRAM, and SRAM. Free software upgrades on all programmers are available on ICE Technology's ftp site. For more information, contact ICE Technology, Inc., P.O. Box 1438,

Henderson, NC 27536; Tel. 800-624-8949 or 919-693-0678; Fax: 919-693-0681; Faxback: 919-693-1509; Web: <http://www.icetech.com>.

CIRCLE 84 ON FREE INFORMATION CARD

MOBILE MUSIC STORAGE

With car CD players becoming increasingly popular, more drivers are discovering a need for safe and convenient disc storage space in their vehicles. Case Logic's CDV-12 CD Visor meets that need: neatly organizing CDs, keeping them at the driver's fingertips and yet safely out of sight—behind the sun visor.



The CD Visor holds 12 compact discs securely in soft protective slots. Hook-and-loop straps adjust to fit any car or truck visor, and allow the CD holder to be easily moved to provide access to the vanity mirror, without detaching the unit. A mesh accessory pocket and elastic pen loop allow drivers to also store pocket change, gas cards, tire gauges and the like behind the visor.

The CDV-12 CD Visor costs \$9.95. For additional information, contact Case Logic, 6303 Dry Creek Parkway, Longmont, CO 80503; Tel. 800-447-4848 or 303-530-3800; Fax: 303-652-1091; Web: <http://www.caselogic.com>.

CIRCLE 85 ON FREE INFORMATION CARD

PIC MICROPROCESSOR DEVELOPMENT SYSTEM

Sirius microSystems' PIC-MDS is a complete development system for the inexpensive Microchip PIC family of RISC microcontrollers. It consists of a development board, a programmer, a cross-assembler, and a detailed training text. Specifically designed to make it easy to learn how to program and use microcontrollers, the PIC-MDS provides step-by-step examples to guide users from writing and testing simple programs to keypad, LCD, A/D, serial I/O,

continued on page 72

Hobbyist's Paperback Budget Books



BP80/98—Popular Electronic Circuits—Books 1 and 2...\$11.90. Contains a wide range of circuits which are accompanied by text giving a brief introduction, circuit description and special notes on construction and setting-up that may be necessary.



#160—Coil Design and Construction Manual...\$5.95. A complete book for the home builder on how to make RF, IF, audio and power chokes and transformers. Practically every possible type is discussed and calculations are explained in detail.



BP271—How to Expand, Modernize and Repair PC's and Compatibles...\$7.75. All the practical information you are likely to need to upgrade your PC and compatible. Also contains useful information and illustrations to help you with repairs.



BP276—Shortwave Superhet Receiver Construction...\$6.95. Provides construction details, including coil winding, of a number of advanced-design receivers which should have performance levels at least equal to commercial sets of similar complexity.



#223—50 Projects Using IC CA3130...\$5.00. One of the more practical and useful operational amplifiers (opamp), the CA3130 integrated circuit chip is the heart of several easy-to-assemble projects covered in the book. The projects are divided into five categories: audio projects, RF projects, test equipment, household projects and a catch-all miscellaneous group. Ideal for all skill levels.



BP122—Audio Amplifier Construction...\$5.75. Practical designs are featured and include circuit diagram and description, Veroboard or printed-circuit board layout and construction notes. The text is divided into two parts. The first deals with many types of preamplifiers. The second covers power amplifiers from a simple low-power battery type to a 100-watt DC-coupled amplifier using four MOSFETs in the output stage.



BP107—30 Solderless Breadboard Projects—Book 1...\$5.95. Each project is designed to be built on a "Verobloc" breadboard and is presented with a brief circuit description, circuit diagram, component layout diagram and components list. Notes on construction and applications are provided. Wherever possible, the components are common to several projects to keep project costs down.



BP266—Electronic Modules and Systems for Beginners...\$7.25. Shows the reader how to build a number of simple analog and digital circuit modules, all suitable for battery operation, and all based on only 1 or 2 transistors or ICs.



BP329—Electronic Music Learning Projects...\$6.25. A beginner's book that will assist you in assembling such projects as the Elexylophone, Gildaphone, Melody Ranger, Cordmaker, Appealing Handbells, Electronic Sol-Fa, Tune-up Box and more.



BP319—Making MS-DOS Work For You...\$6.50. What you need to know first, comes first, however the text is written in a circular style so that the reader can start anywhere in the text. This book is relevant to all versions of both MS-DOS and PC-DOS.



BP303—Understanding PC Software...\$6.95. Covers main types of PC software, giving details of typical uses, the basics of how they are used and their limitations. Each chapter covers popular software and programs of a similar type.



BP105 Aerial (Antenna) Projects...\$5.50. In this book the author has considered practical antenna designs, including active, loop and ferrite antennas which perform well and are relatively simple and inexpensive to build. The complex theory and mathematics of antenna design have been avoided. Also included are construction details of a number of antenna accessories including a pre-selector, attenuator and filters.



BP33—Electronic Calculator Users Handbook...\$5.75. The book eliminates the mysteries of the calculator and offers unique ideas for the simplest to most complex calculators. Covers the basic functions plus trigonometric, hyperbolic, logarithms, square roots and powers. Included are formulas and data for VAT, discounts, and mark up, currency conversion, interest, binary and octal numbers, and much more!



BP125—25 Simple Amateur Band Antennas...\$5.50. Plans to build antennas that are simple and inexpensive to construct and perform well. From the simple dipole to beam, triangle and even mini-rhombic types made from four TV masts and about 400 feet of wire. After the antenna discussion you will find a complete set of dimension tables that will help you "tune" an antenna on a particular frequency.



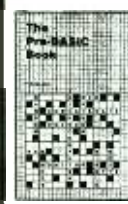
BP263—A Concise Introduction to dBASE...\$6.95. The most popular data-base program, dBASE, is difficult to master without help. This book helps you spend your time using dBase, not setting it up. A user's guide that covers all the basics up to dBase IV.



PCP104—Electronics—Build and Learn...\$9.95. Construction details are given to build a circuit demonstrator that is used throughout the book to introduce common electronic components and how these components are built up to useful circuits.



BP302—A Concise Users Guide to Lotus 1-2-3 Release 3.1...\$6.25. Written to help existing spreadsheet users upgrade to 1-2-3 Release 3.1, which has the ability to work 3-dimensionally with both multiple worksheets and files.



BP146—The Pre-BASIC Book...\$6.95. Another book on BASIC but with a difference. It concentrates on introducing technique by looking in depth at the most frequently used and more easily understood computer instructions.

Just What the Project Builder Is Looking For!

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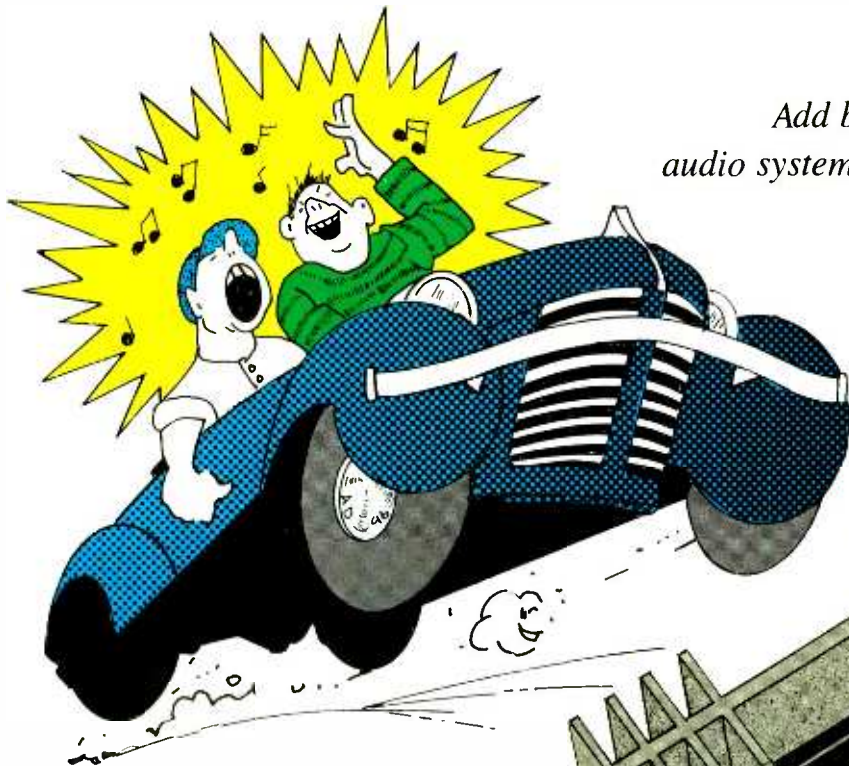
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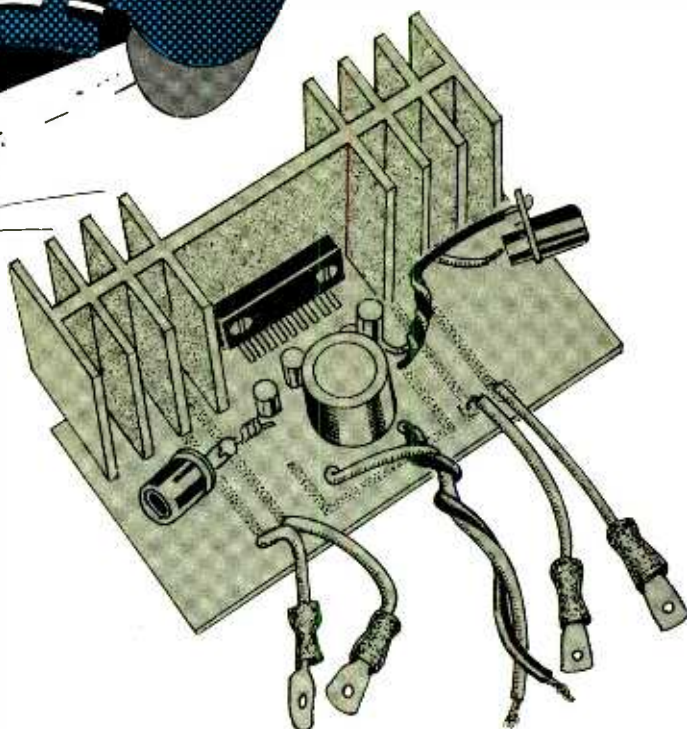
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Add big stereo sound to your car's audio system without spending big bucks.

BY GARY CLIFTON



BUILD A 22-WATT AMPLIFIER



Is your car stereo missing something? Do the speakers that accompany you to and from work each day really put out all that they can? Let's face it; our car audio systems are the only entertainment we have while on the road. And if those systems aren't up to par, you'll feel it. So why not breathe some new life into your car's sound system?

The 22-Watt Amplifier described in this article will deliver up to 22 watts-per-channel into a pair of four-ohm loudspeakers. Best of all, you can build it for under \$20. That means you can build one Amplifier for the front speakers in your car, a second one for the rear speakers, and have 44 watts of pure audio power, all without breaking the bank.

The TDA1554. Whether you're a beginner at electronics or an experi-

enced hobbyist, be prepared for a pleasant surprise: The low parts count of this project means you can easily assemble the Amplifier in an evening. Such a low parts count is possible because of the TDA1554 integrated amplifier, which is found at the heart of the circuit (see Fig. 1; the amplifier chip is IC1).

A number of factors made the TDA1554 IC an ideal choice for this project. First of all was the cost—the chip is relatively inexpensive for what it does. Second, the TDA1554 was designed primarily for automotive applications. It runs on a +12- to +15-volt supply capable of delivering up to 5–10 amperes. Therefore, using the chip eliminates the need for a separate power supply.

The TDA1554's other features include a mute/delay circuit to eliminate turn-on pop; and thermal, ESD

(electro-static discharge), and load-dump protection. Input impedance is typically 30,000 ohms in BTL (bridge-tied-load) applications, with gain typically at 26 dB. The power bandwidth runs from about 20 Hz to 20 kHz. Output power is typically 17 watts at 0.5% THD (total harmonic distortion) and 22 watts with up to 10% THD in the BTL configuration.

Inside the TDA1554 are four independent amplifiers, a mute/standby switch, and some protective circuitry. Each amplifier can drive up to 11 watts into a 2-ohm load, or amplifiers can be paired to drive up to 22 watts into 4-ohms using the BTL configuration; the latter is used in the Amplifier project. The mute/standby switching circuit is used to eliminate loudspeaker turn-on pop by providing a slight delay and a gradual turn-on. Both the inverting and non-inverting inputs are

available for each of the four amplifier sections.

As just mentioned, the chip uses a BTL output configuration to get 22 watts out of a nominal 12-volt DC system. This circuit is sometimes referred to as a "bridge" or "bridged output" where neither side of the load (in this case loudspeaker) is tied to ground. Instead, two amplifiers operated 180° out-of-phase are tied together or bridged at the load. While one side is moving high, the other side is moving low. No phase-shifting circuitry is involved to obtain the 180° shift. The audio inputs are fed to the inverting input of one amp and the non-inverting input for the other amp in each stereo pair. The result is typically twice the power (into the load) either amplifier could deliver into a single-ended load (which is when one side of the loudspeaker is connected to the amplifier and the other side is connected to ground).

Circuit Description. The schematic for the 22-Watt Amplifier is shown in Fig. 1. Power for the circuit (+12 volts) is provided by a connection to the host vehicle's battery. A connection is also provided for the vehicle's ground. Capacitors C1 and C2 provide decoupling of any signal riding on the supply voltage, while capacitor C3, working in conjunction with IC1, provides ripple rejection.

The incoming audio signal is coupled to IC1 by capacitors C4 and C5. Those 10- μ F capacitors are used to avoid rolling off of the low audio frequencies. Resistor R1 and capacitor C6 feed the mute switch circuit (included in IC1), providing the delay that eliminates turn-on pop. Their R/C time constant is about 1.4 seconds. None of the component values external to IC1 are critical, but major value substitutions should not be made.

Pin 14 (the mute switch) of IC1 must have at least 8.5 volts for the amplifier to be on, or be held below 3.3 volts to ensure the chip stays in the mute condition. Current requirements at this pin are on the order of 40 μ A in the on condition, and 100 μ A for standby. The R1/C6 combination used here (47 μ F and 39,000 ohms) provides enough delay to eliminate turn-on pop without having an excessive wait for normal operation. In addition to this slight delay, pin 14 gradually comes up

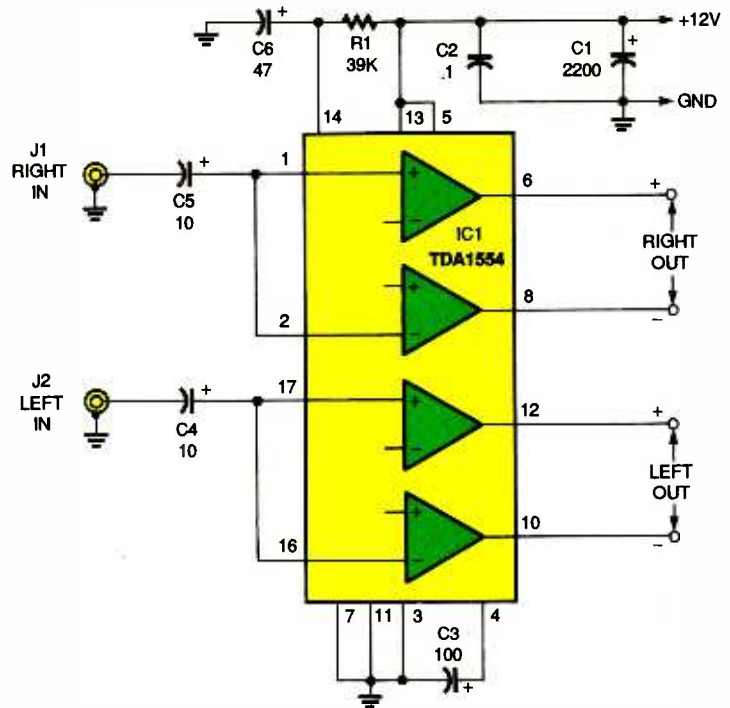


Fig. 1. The heart of this 22-Watt Amplifier is the TDA1554 IC. Four internal amplifiers in that chip can be connected as two bridges to drive two four-ohm speakers.

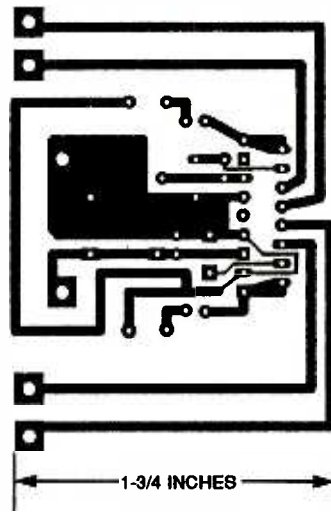


Fig. 2. Here's a full-size foil pattern that you can use to make your own PC board.

above the 8.5-volt threshold as C6 charges up, rather than coming on instantly as it would if a simple switch were used.

Values for C6 and R1 aren't critical, but R1 should be no larger than 100,000 ohms and the R1/C6 time constant should be on the order of a second or two. Too short a time constant may not eliminate the turn-on pop; too long a time constant does no harm except causing an irritating delay.

Power and Heat. Before we get to how to actually build the Amplifier, a few things about its power consumption and heat production need to be brought up. If it's driven to the full 22-watts-per-channel output with a continuous 1-kHz sine wave, total current consumption for this project is on the order of five amperes. However, if you're listening to music with the volume turned up until the peaks just begin to clip, the Amplifier will consume about two amperes or less. This is due to the dynamic range inherent in music—not every sound is at peak volume and there are slight pauses, often between beats.

Consider the difference between a softly strummed harp and a bass drum, for instance. Most of the power peaks are also short transients rather than continuous tones. For that reason current consumption isn't really an issue if you use one of these amplifiers in an automotive applications. However, using two or more amplifiers at high volume may drain the battery if your car's engine isn't running. For in-home use, each Amplifier should have at least a three-ampere supply available to handle transitory peaks adequately.

Now, on to heat production. The TDA1554 IC has a worst-case power

dissipation of around 25 watts. This represents heat that has to be carried away from the die inside the IC package. There is a thermal resistance between the die and the IC package itself, between the IC package and the heatsink, and finally between the heatsink and the surrounding air. The end result is that this amplifier requires a heatsink with a thermal resistance of 2.8° C/W or lower. Inadequate heat-sinking results in thermal shutdown or intermittent, erratic operation as the die heats and cools.

For this reason, use a thermalloy extrusion #11096 heatsink; it has a thermal resistance of 2.1° C/W for a 3-inch-long section, which is better than the calculated requirement. The prototype circuit was tested with a 2-inch

PARTS LIST FOR THE 22-WATT AMPLIFIER

CAPACITORS

- C1—2200- μ F, 25-WVDC, electrolytic
 C2—0.1- μ F, ceramic monolithic
 C3—100- μ F, 25-WVDC, electrolytic capacitor
 C4, C5—10- μ F, 16-WVDC, electrolytic
 C6—47- μ F, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

- IC1—TDA1554 two-channel audio amplifier, integrated circuit
 R1—39,000-ohm, 1/4-watt, 5% resistor

- J1, J2—RCA jacks, panel mount
 Printed-circuit materials, metal or plastic enclosure (minimum 3 x 3 x 4 inches) with ventilation holes, 2-inch heatsink (thermal extrusion 11096 or equivalent; see text), heatsink compound, two 6-32 screws and nuts, 7/16- to 10-ampere in-line fuse and holder, shielded audio cable, 18- and 20-gauge insulated stranded wire, solder, hardware, etc.

Note: The following is available from DC Electronics (2334 N. Scottsdale Rd, Scottsdale, AZ 85257; Tel. 800-467-7736): complete kit of parts (S1554 Kit) including the heatsink, TDA1554 IC, etched and drilled PC board, and all on-board components—\$19.95; TDA1554 IC—\$8.95; heatsink (11096-2)—\$3.49; PC board—\$10.95. Shipping and handling is \$4.00; Arizona residents please add applicable sales tax.

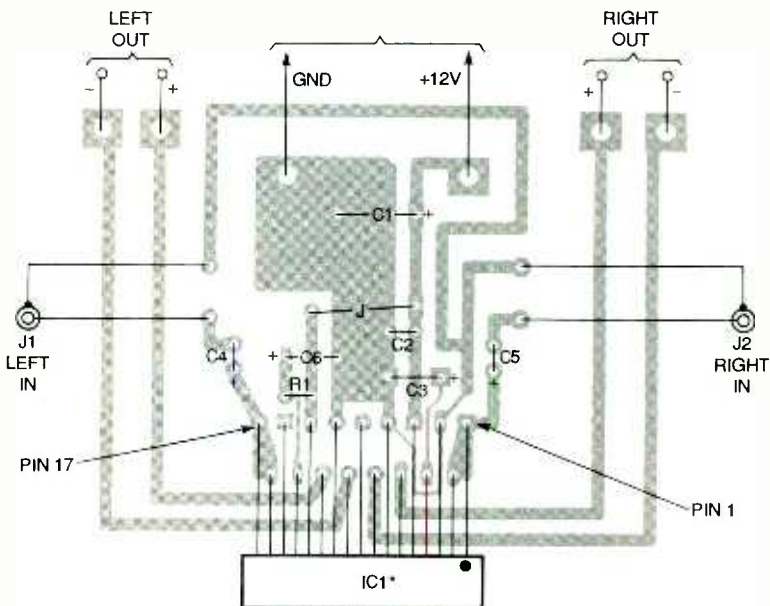
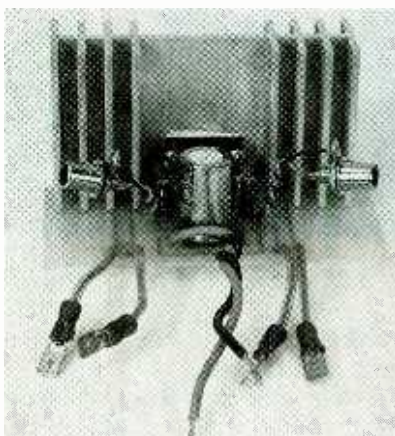


Fig. 3. Use this parts-placement diagram as a guide when building the Amplifier. Note that IC1 is an in-line SIP; therefore its pin numbers are numbered consecutively from pin 1 at the marking to pin 17 at the other unmarked end of the IC.



As you can see, the assembled 22-Watt Amplifier is dwarfed by the aluminum heatsink.

length of this extrusion, and it was found that a 2-inch piece is adequate for a music load, but only marginally acceptable for continuous operation at 5 amperes. If the Amplifier is going to be installed in the trunk of a car in a warm climate (like the desert), a bigger heatsink will be required to cope with the higher ambient temperature that can build up in such enclosed, unventilated volumes.

Construction. The prototype for the 22-Watt Amplifier was built on a printed-circuit board. If you'd like to do the same you can either make your own PC board using the foil pattern shown in Fig. 2, or order one from

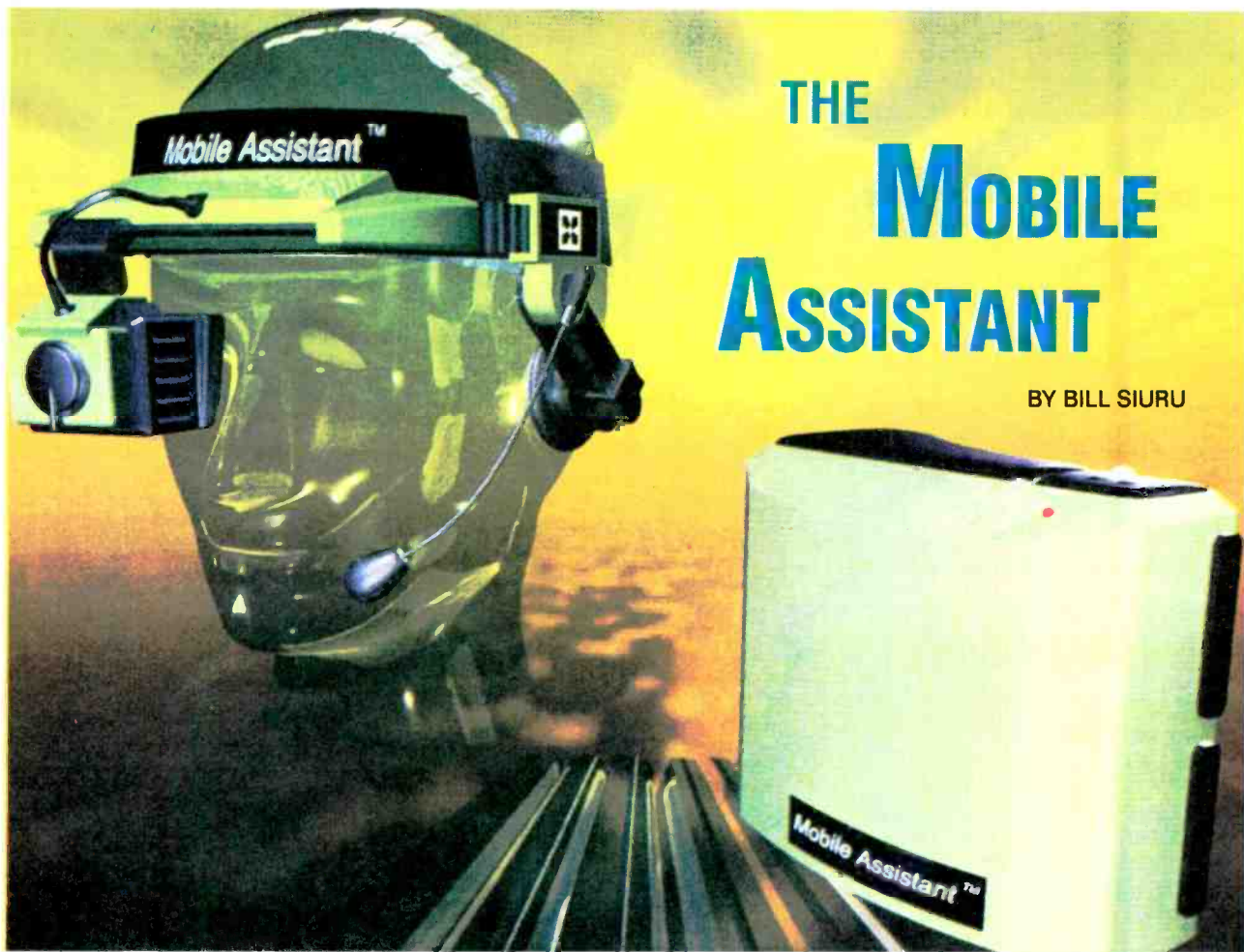
the source mentioned in the Parts List. PC-board assembly is recommended for most audio projects.

If you're using a PC board, use the parts-placement diagram shown in Fig. 3 as a guide. Begin assembly by installing C1. Solder it into place and save one of the snipped leads to use for the jumper, which should be installed next. Install R1 (standing up) by doubling back one lead so both leads are parallel. Next, install the remaining capacitors and check polarity before soldering.

Attach to the circuit board wire leads of ample length for the speaker, power, and ground connections shown. For power and ground leads an 18-gauge, or heavier, insulated, stranded wire should be used. Stranded 20-gauge wire is fine for speaker leads. Select different-colored leads to avoid confusion.

Audio input signals should be routed in through shielded cables to minimize hum, alternator whine, and other extraneous noises. Attach those cables at this time; then connect standard RCA phono jacks (J1 and J2) to them.

After everything else is soldered into place, install IC1 onto a heatsink before soldering the IC onto the PC board. As we mentioned earlier, use a thermalloy extrusion #11096 heatsink or its equivalent (one is available from
(Continued on page 56)



THE MOBILE ASSISTANT

BY BILL SIURU

Here's a look at an advanced portable computer that you can wear!

Computers are an integral part of an ever increasing number of occupations. This includes not only white-collar office workers, but also blue-collar technicians who use computers while troubleshooting and repairing complex equipment like aircraft, computers, power-generation systems, and automobiles, to name a few.

More and more technical data used for diagnosis and service is being transferred from bookshelves full of manuals to much more compact computer databases, which are accessed via laptop or notebook computers. While this trend reduces the time required in looking up the needed information, schematic diagrams, troubleshooting test points, visual inspection hints, and other data, there is still a lot of wasted effort. For instance, the technician has to move to the computer, use a keyboard or mouse to search for and retrieve the information they need,

perhaps print it out, and then move back to the job site.

Unlike office employees who work in computer-friendly environments, technicians often have to work in cramped quarters, outdoors in all types of weather, and perhaps 30 to 40 feet above ground on a wooden utility pole. Even small notebook computers are too cumbersome in such environments. What then is a tech to do?

A Mobile Solution. One answer is for the technician to wear a computer that has input/output peripherals, which can be used hands-free. This is the whole idea behind the *Mobile Assistant* now offered by *Computer Products and Service Inc.*, an information and systems integrator located in Fairfax, VA. Indeed, the inspiration for the *Mobile Assistant* came while watching Army technicians juggling technical manuals and simultaneously trying to make repairs.

The patented *Mobile Assistant* took six years to develop. It's a 6- x 5- x 3-inch IBM-compatible, belt-worn computer that looks a bit like a canteen and weighs 2.75 pounds. The specifications on the preliminary basic computer include a 486 processor operating at 50 MHz with clock doubling, a 340-MB internal hard drive, internal analog/digital conversion, 4 MB of RAM, and a PCMCIA reader.

The computer is pre-loaded with MS-DOS 6.2 or Microsoft Windows 3.1 software plus speech recognition and synthesis hardware and software. Windows 95 or SCO/UNIX can be loaded as an option. There are I/O ports for standard serial, parallel, and keyboard peripherals, including external disc drives, printers, and CD-ROMs.

Cards for cellular phones, FAX/modems, RF communication devices, and interfaces with equipment-specific diagnostic setups can be plugged into the dual PCMCIA slots. For video conferencing there is an op-



With more accessories than a Japanese camera, the Mobile Assistant can be adapted to virtually all kinds of tasks in the field as well as in workshops.

tional Integrated Video Kit that includes a miniature head-mounted camera with 24-bit capture, plus associated image processing, JPEG compression, and basic voice-control capability. Expansion upgrades available include additional RAM (4 MB, 8 MB, 16 MB or 32 MB) and an 810-MB hard drive. The computer is designed to withstand a 3-foot drop, has passed FCC class A certifications, and is even splash-proof.

The Mobile Assistant uses a miniature monochrome VGA heads-up display mounted on a sliding frame so it can be moved and viewed by either the right or left eye. Located a few inches in front of the eye, it can be used with eyeglasses and can be tilted and rotated. Unlike an occlusive display used in virtual-reality applications, the monocular, single-active matrix liquid crystal display (AMLCD) fills only a small portion of the field of view.

Called an *augmented reality display*, the AMLCD allows users to see both the computer image and the outside world simultaneously without distortion. The image actually appears to float in front of the user, filling a viewing area that is equivalent to a 15-inch desktop monitor with comparable resolution. The 0.7-inch diagonal VGA, supplied by Kopin of Taunton, MA, has 640- × 480-pixel resolution and weighs about 8 ounces. There are controls for focusing and adjusting brightness for viewing in even bright sunlight. For safety's sake, there is no high voltage near the user's head.



The Mobile Assistant is currently in use in the military, where critical field work must be performed without the availability of volumes of technical manuals. Data can be called up and viewed on a miniature heads-up display that can be slid over either eye



The Mobile Assistant allows for complete "hands-off" operation as this technician follows a visual test/repair procedure on complicated military equipment.

Power Packed. The system is powered by a rechargeable lithium-ion battery that weighs 1.8 pounds and is also worn on the belt. It has a 3- to 4-hour capacity between recharges. There is an optional AC power supply, or a disposable lithium-battery pack that offers 14 hours of operational life.

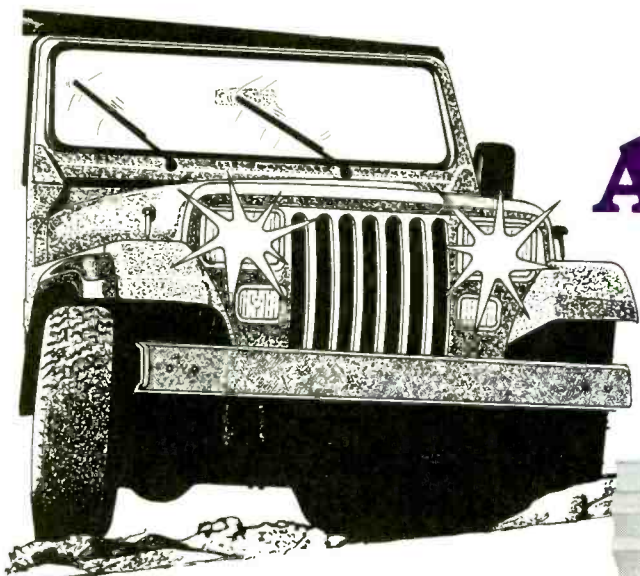
Users can access the system and navigate through the various databases using several options. First, there is a mouse built into the computer. Both a miniature keyboard or a wrist-worn keyboard are optional. However, for complete hands-off operation, there is headset-mounted microphone for the speech-recognition system. Voice-recognition hardware and software is now rapidly maturing, and is expected to become a mainstream technology over the next few years. In all fairness, current voice-recognition systems still require very precise and clear verbal commands—no mumbling or thick accents allowed.

Applications. Computer Products and Service Inc. envisions many uses for the Mobile Assistant. For instance, technicians can work while viewing a needed schematic, or even watch a video clip showing how to complete the repair at hand. A novice or apprentice technician could communicate with an experienced expert who could not only talk, but visually guide him or her through a complicated procedure.

The Army is now testing the Mobile Assistant in conjunction with the Intelligent Fault Locator used to diagnose and repair subsystems on the AH-64A Apache helicopter. Here the belt-worn computer is used to read trouble codes and perform diagnostic tests, as well as to access the Interactive Electronic Technical Manual (IETM). The IETM replaces hard-copy manuals that take no less than three trucks to transport!

In the civilian world, AIL Eaton Corporation has adapted the Mobile Assistant for use in servicing gas burners and power plants. Other applications include law enforcement, firefighting, medical diagnostics and treatment, and more.

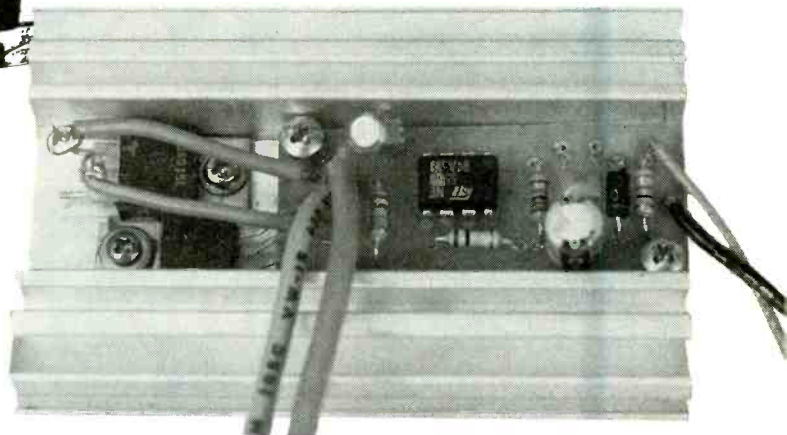
Another example is in the routine inspection of incoming materials. The
(Continued on page 52)



BUILD AN AUTOMATIC HEADLAMP CONTROL

BY ANTHONY J. CARISTI

Let this circuit switch on your vehicle's headlamps whenever you turn on your windshield wipers. Use it to help prevent accidents, and, in some places, to obey the law.



Circuits like the *Automatic Headlamp Control* described in this article will eventually be part of many vehicles manufactured in the United States. In fact, this type of system is already standard equipment on at least one line of domestic luxury cars. The purpose of such units is to ensure that the headlamps of a vehicle are automatically lighted whenever the windshield wipers are operating.

About 16 states already have a law on the books that requires drivers to have their vehicle's headlamps on during inclement weather, and other states are sure to follow. Also, studies have shown that the accident rate is substantially reduced when automatic headlamps are on during daylight hours.

Of course, it is easy for the driver to turn on the headlamps when required, but there are several important reasons to build and install this electronic module. First, it is completely automatic. There is no need to remember to manually turn on or off any switch. As a result, the driver al-

ways obeys the law, and there will never be an occasion where the battery goes dead when the headlamps are inadvertently left on after parking the vehicle.

Second, the Control circuit provides enough current to the headlamps to make them visible to other drivers, but does not deliver full power. This is accomplished without the use of bulky, heat-producing power resistors. Using pulse modulation, the circuit operates the headlamps at about a 30% duty cycle, which minimizes the load on the alternator and battery, and has virtually no effect on headlamp filament life.

With the Automatic Headlamp Control, you will never be given a summons when you forget to turn on your lights, and its automatic feature can help avoid an accident. Those reasons alone should prompt you to build and install this low-cost circuit.

Some other features of the Control circuit are its relatively small size (which allows you to place it anywhere in the engine compartment of your vehicle), and the fact that it has

no operating controls or adjustments. Once installed, the Control has no effect on normal headlamp operation except to automatically illuminate the lamps whenever your windshield wipers are on.

Circuit Description. The schematic for the Automatic Headlamp Control is shown in Fig. 1. At the heart of the circuit is IC1, a 555 timer chip that is operated as an astable or free-running multivibrator. The frequency of operation, about 40 Hz, is determined by the values of R2, R3, and C2. The duty cycle of the oscillator is set to about 70% by the ratio of R2 to R3.

The 555 is operated by the 12-volt DC power source that appears across the windshield-wiper motor assembly. Thus, the circuit oscillates only when the windshield wipers are turned on. Components R1, D1, and C1 protect the circuit from voltage transients that may appear on the power line of the vehicle.

A P-channel power MOSFET transistor, Q1, is used to deliver current to the headlamps. Power-diode D3 iso-

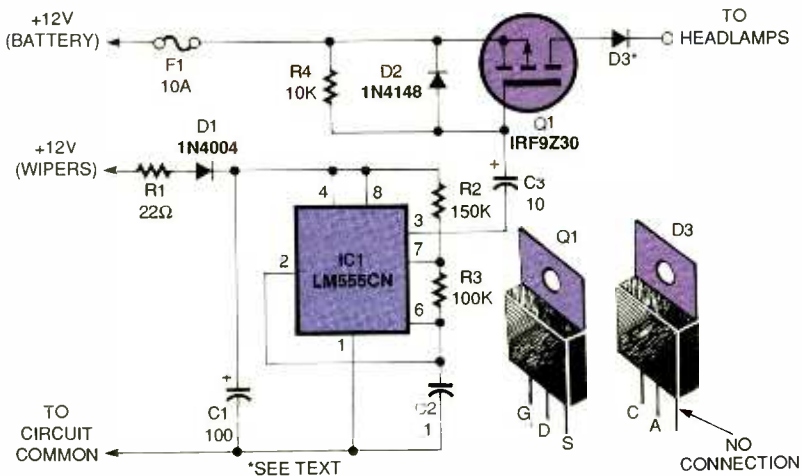


Fig. 1. Here's the schematic for the Automatic Headlamp Control circuit. Note the pinouts of MOSFET Q1 and power-diode D3.

lates the Control module from the normal headlamp circuit of the vehicle. As we'll see later, both Q1 and D3 need to be placed on a small heatsink to dissipate the amounts of heat that they generate.

When the windshield-wiper motor is at rest, the oscillator circuit is dormant, and Q1 is biased off by R4. Once the wiper motor is turned on, IC1 oscillates producing a waveform that is coupled to the base of Q1 through C3. As a result, Q1 turns on with a 30% duty cycle. During the time Q1 is forward biased, battery voltage is present at the anode of D3. Pulses of current then flow into the low-beam headlamps, illuminating them to somewhat less than full brightness.

A 10-ampere fuse, F1, protects Q1 and D3 from any possible excessive current. Such conditions can arise as a result of short circuits or malfunctions in the vehicle's electrical system.

Construction. The author's prototype for the Automatic Headlamp Control consists of a single-sided printed-circuit board mounted to a small heatsink. Any heatsink may be used as long as it contains a flat mounting area that's large enough to accommodate the PC board and the two TO-220AB-size semiconductor components, Q1 and D3.

If you wish to build the circuit on a PC board, you can either etch your own using the full-size template shown in Fig. 2, or order an etched and drilled board from the source mentioned in the Parts List. Alternatively, you can hard wire the circuit on a perforated board, making sure

you keep the board compact enough to fit on your chosen heatsink. Excellent project-building techniques must be used, though; it's a harsh environment under the hood of a vehicle.

For those building the circuit on a PC board, a parts-placement diagram is shown in Fig. 3. Before starting, clean the copper side of the PC board with steel wool to remove any

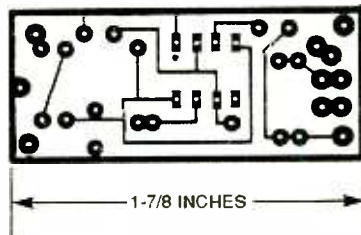


Fig. 2. If you'd like to etch your own PC board for the Control module, use this full-size template.

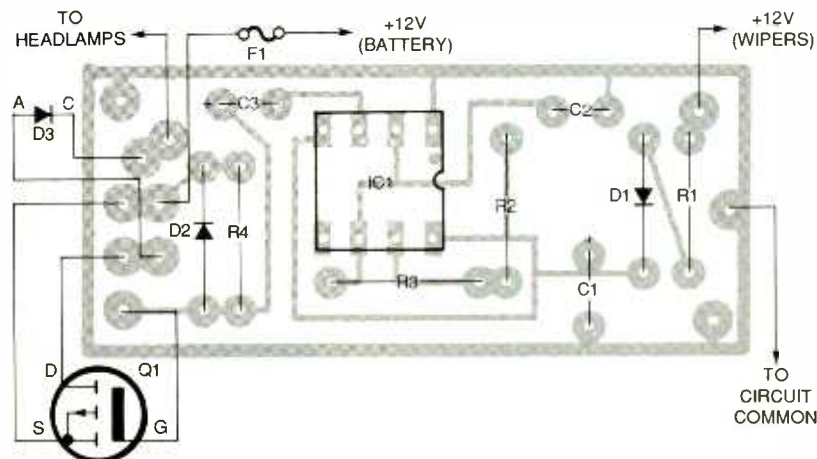


Fig. 3. Use this parts-placement diagram as a guide when assembling the Control board. The pins of Q1 and D3 are labeled to make off-board assembly easy.

dirt, oxidation, etc. When the board's thoroughly clean, begin by installing the resistors. Then solder the capacitors to the board, observing correct placement of the electrolytic units.

Solder four insulated, 18-gauge stranded wires (about 12-inches long) to the board next to facilitate connections to the vehicle (the wires will also make bench testing easier). You should use different-colored wires to prevent confusion.

Mount diodes D1 and D2 next, as shown in the diagram. Then connect D3 and Q1 to the board, using the pinouts shown in Fig. 1 and the labeled points shown in Fig. 3, as guides. You can simply bend the leads of Q1 and solder them to the board, but you will need to use short, insulated, 18-gauge stranded wire leads to connect D3 (as you can see in Fig. 3, the pads are not adjacent). Carefully bend up the anode and cathode wire terminals of the diode before soldering them to the leads. Be sure the wires and solder connections do not short out each other or anything else.

The last component to install is IC1. Do not use a socket for this part. Instead, solder it directly to the board for reliability, because the circuit will be subjected to the vibration and harsh environment of the engine compartment of your vehicle. Before soldering the IC, be absolutely sure it is properly oriented as shown in Fig. 3. Be careful; it is difficult to remove a multi-pin IC from the board once it has been soldered in place.

When the printed-circuit board is completed, examine it very carefully for opens, short circuits, and bad sol-

der connections, which may appear as dull blobs of solder. Any solder joint that is suspect should be redone by removing the old solder with desoldering braid, cleaning the joint, and carefully applying new solder. It is far easier to correct problems at this stage rather than later on if you discover that the circuit does not work.

Figure 4 provides drilling information for the heatsink used in the author's prototype. Two holes are used to mount the printed-circuit board, and the other two are used to mount Q1 and D2. The location of mounting holes, used to secure the heatsink to the vehicle's chassis or sheet metal, are left up to the discretion of the builder.

PARTS LIST FOR THE AUTOMATIC HEADLAMP CONTROL

SEMICONDUCTORS

- IC1—LM555CN or equivalent timer, integrated circuit
- Q1—IRF9Z30 P-channel MOSFET
- D1—1N4004 or equivalent silicon diode
- D2—1N4148 or equivalent silicon diode
- D3—Silicon power diode, 15-ampere, 200-volt (Mouser 519-D2015L or equivalent)

RESISTORS

- (All resistors are 1/4-watt, 5% units.)
- R1—22-ohm
- R2—150,000-ohm
- R3—100,000-ohm
- R4—10,000-ohm

CAPACITORS

- C1—100- μ F, 25-WVDC, radial electrolytic
- C2—0.1- μ F, ceramic-disc
- C3—10- μ F, 25-WVDC, radial electrolytic

ADDITIONAL PARTS AND MATERIALS

- F1—10-ampere slow-blow fuse
- Printed-circuit materials, heatsink, fuse holder, machine screws and matching hex nuts, fiber shoulder washer, mica insulator, wire nuts, test lamp, electrical tape, 18-gauge stranded hookup wire, solder, hardware, etc.

Note: The following parts are available from A. Caristi (69 White Pond Road, Waldwick NJ 07463): etched and drilled PC board—\$9.95; IC1—\$2.50; Q1—\$9.50; D3—\$4.75. Please add \$5.00 postage and handling.

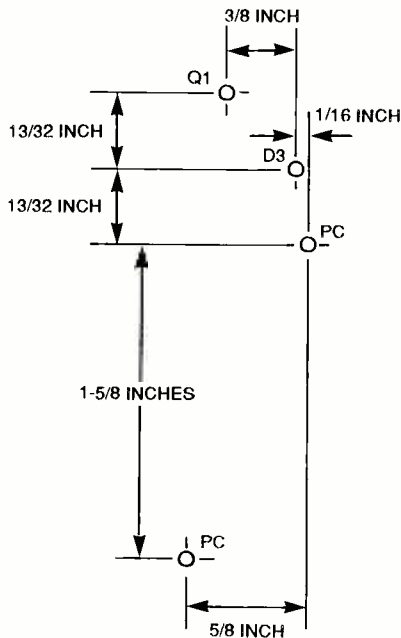


Fig. 4. This heatsink drilling template was used to make the author's prototype.

Make sure the transistor and power diode will lie flat on the heatsink. Then mount the PC board to the heatsink using suitable hardware and two plastic spacers, about 1/16- to 1/8-inch thick to prevent the circuit from shorting out to the metal. Small spacers can be fabricated by cutting a 1/4-inch-long spacer in half.

It is important that proper mounting hardware, including plastic spacers and a mica insulator, be used to mount Q1. Figure 5 illustrates how the insulating shoulder washer, mica, and transistor are assembled. Power-diode D3 is an isolated component and no insulation is required. However, heatsink compound should be used on both semiconductor parts to maximize heat transfer to the metal.

Do not attempt to install the circuit board in the vehicle at this time. It must first be tested to ensure that it is working properly.

Preliminary Test. To perform the ini-

tial test a 12-volt DC source is required. You'll also need a DMM. If available, an oscilloscope may be used to display waveforms. A small 12-volt automotive-type lamp such as a number-1157 unit can be used as a test load to simulate the headlamps of the vehicle. Be sure the DC power source is capable of driving the required lamp current. Figure 6 illustrates the preliminary test setup you need to assemble.

Before applying power, take a resistance reading between the metal tab of Q1 and the heatsink to verify that the resistance reading is infinite. If not, check and correct the assembly according to Fig. 5.

Connect the negative side of the power supply to circuit common. Then attach the positive side of the supply to both the +12-volt battery and wiper connections. Finally, connect the test lamp between the cathode of D3 and circuit common. Turn the power supply on.

The lamp should be lighted with less than normal brightness. This can be verified with a DMM, which will indicate an average voltage of about 3 volts across the lamp.

Disconnect power from the +12-volt wiper wire only. The lamp should be extinguished.

If the circuit performs as indicated, the preliminary test is completed. Otherwise, troubleshoot the circuit to locate and repair the fault. Visually inspect the board for shorts again, then double-check the orientation of all semiconductor components, and of C1 and C3.

If no fault is found with the assembly, connect an oscilloscope probe to pin 3 of IC1 to ascertain that it is oscillating. If not, try a new chip. If IC1 is operating, replace Q1.

When the board is operational as described, it is ready to be installed into the vehicle. Let's take a look at how to do that.

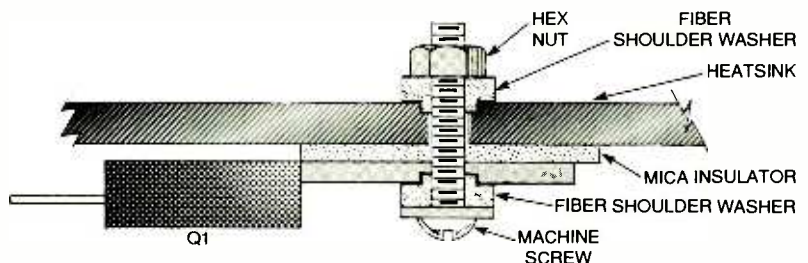


Fig. 5. MOSFET Q1 must be mounted to the heatsink as shown here.

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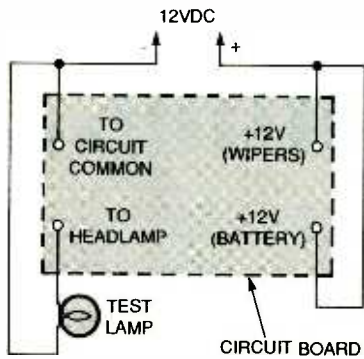


Fig. 6. Here's how to wire up the Control board so that you can perform a preliminary test without connecting the circuit to your vehicle.

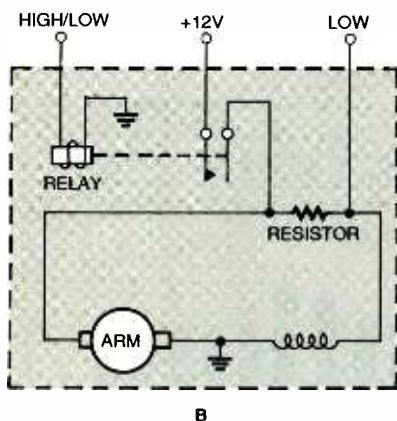
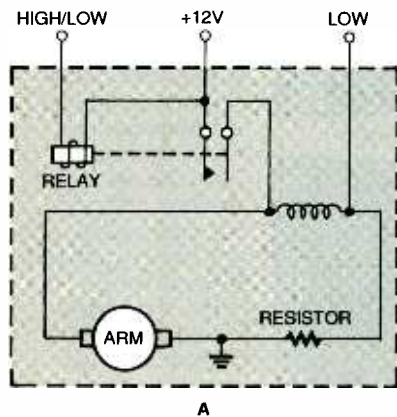


Fig. 7. Your vehicle's windshield-wiper circuit could work either by ground-control (A) or +12-volt switching (B).

Installation. You will need some more 18-gauge wire, preferably of matching colors to the leads you already attached, to make the connections between the Control module and your vehicle's electrical system. Wire nuts may be used if desired.

A fuse holder should be soldered to the wire that leads to the +12-volt battery connection. You can obtain

an inline fuse holder, as well as a 10-ampere slow-blow fuse, from an electronics supply house or automotive parts dealer. Insert the fuse at this time.

In order to accommodate all vehicles with electric windshield wipers the installation wiring is accomplished in either of two ways. The method you use will depend upon whether the dashboard switch in your vehicle controls the ground return for the wiper-motor relay coil or if it controls +12 volts.

Figure 7A illustrates a typical wiper

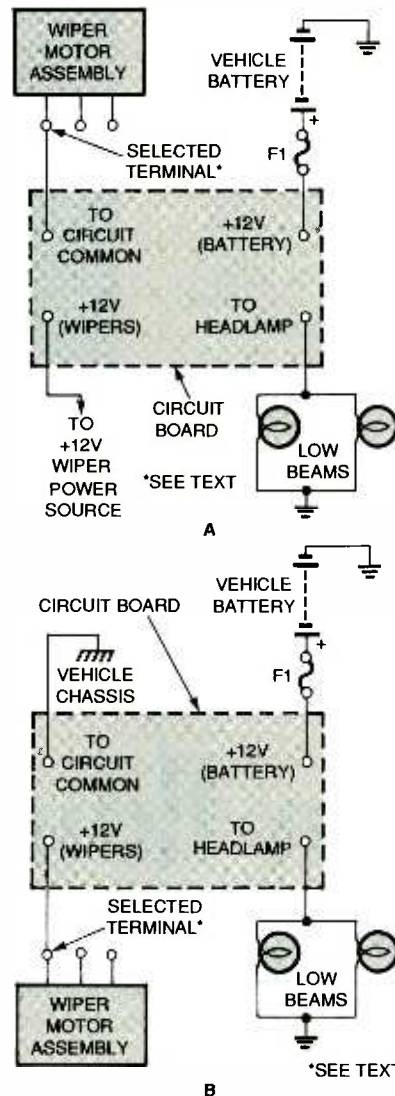


Fig. 8. If the wire you choose for connecting the wiper assembly (see text) is at +12 volts potential with the motor off, and zero volts when it is on, use the connection diagram shown in A to install the Control module. If the selected wire is at zero volts with the wipers off, and at +12 volts when they are on, use the diagram shown in B.

circuit that uses ground-return control. The dashboard panel switch provides the ground return for the relay coil, and a second pair of contacts shorts out the high-speed resistor that is placed in series with the shunt field of the motor.

Figure 7B illustrates a +12-volt switching system. Here the panel switch controls power to the relay coil, and a second pair of contacts is used to short out the high-speed resistor when low speed is selected.

Notice that in both circuits the relay coil wire changes voltage level when the wiper motor is operated at either speed. This is the wire that must be identified.

To determine which circuit is applicable to your vehicle, take a DC voltmeter and check the potential of all wires leading to the wiper motor assembly. Make sure the ignition is on, and set the dashboard wiper switch to each position, including off.

Figure 8A should be used as a guide when installing the Control module if the selected wire is at +12 volts potential with the motor off, and zero volts when it is on. Figure 8B should be used if the selected wire is at zero volts with the wipers off, and at +12 volts when they are on.

If necessary, refer to a shop manual or ask a qualified automotive technician or the dealer to determine which circuit is applicable to your vehicle. That could save you some trouble if you're not sure.

Before starting the actual installation, disconnect the negative (chassis) wire from the vehicle's battery. This will ensure that no inadvertent short circuit occurring during installation will cause damage.

The module should be placed at a location in the engine compartment of the vehicle where it will be protected against damage and dirt. Extra heat dissipation may be obtained by securely mounting the heatsink to any metal part of the vehicle, using heatsink compound to attain maximum heat transfer. If desired, a plastic cover may be placed over the assembly to protect it against grime and grease. It is preferable that the assembly be mounted near the front of the vehicle where it is close to the headlamps. Be sure to choose a location for the project that is protected
(Continued on page 56)

CRUISING THE LOWEST HAM BANDS

BY KARL T. THURBER, JR.

Must the higher frequencies always be "better" frequencies? While technology dictates the exploration and use of ever-higher frequencies, there still is considerable interest in the other end of the electromagnetic spectrum. By the "other end," we mean the basement: longwave (LW) and mediumwave (MW).

In this article, we'll explore the two lowest ham bands: the Federal Communications Commission (FCC) "Part 15" no-license frequency allocations of 160 to 190 kHz and 510 to 1705 kHz. Allocations in those ranges are referred to as LowFERS (Low Frequency Experimental Radio Station) and MedFERS (Medium Frequency Experimental Radio Station). Sometimes, you'll see hobbyists who focus on those bands referred to as LowFERS or MedFERS (both with a lowercase "s"). The terms were coined by Ken Cornell, W2IMB, who for years operated the LW beacon "KEN" on 187.5 kHz, and who now operates the MW beacon with the same ID on 1652 kHz.

You'll find LowFERS and MedFERS pursuits fun and technically rewarding. And, if you keep emissions within the band, you can try all sorts of modulation methods and transmission modes. Has this been a limited area of exploration? Not exactly. While many experimenters also are licensed hams, many others are not.

But before we get to the exploring of the bands, let's examine the rich history in LW and MW for LowFERS and MedFERS. We'll begin with a look at LW in the "good old days" of radio.

Longwaves. Much radio pioneering was on LW. That spectrum below the AM broadcast band is where wireless

originated. For a long time, the view was that higher frequencies, the so-called shortwaves (SW) lying above the AM standard broadcast band (BCB), were useless terra incognita (see the "Electromagnetic Spectrum" box). This is explained largely by technology—it then was much easier to generate radio frequency (RF) energy at longer wavelengths than at shorter ones.

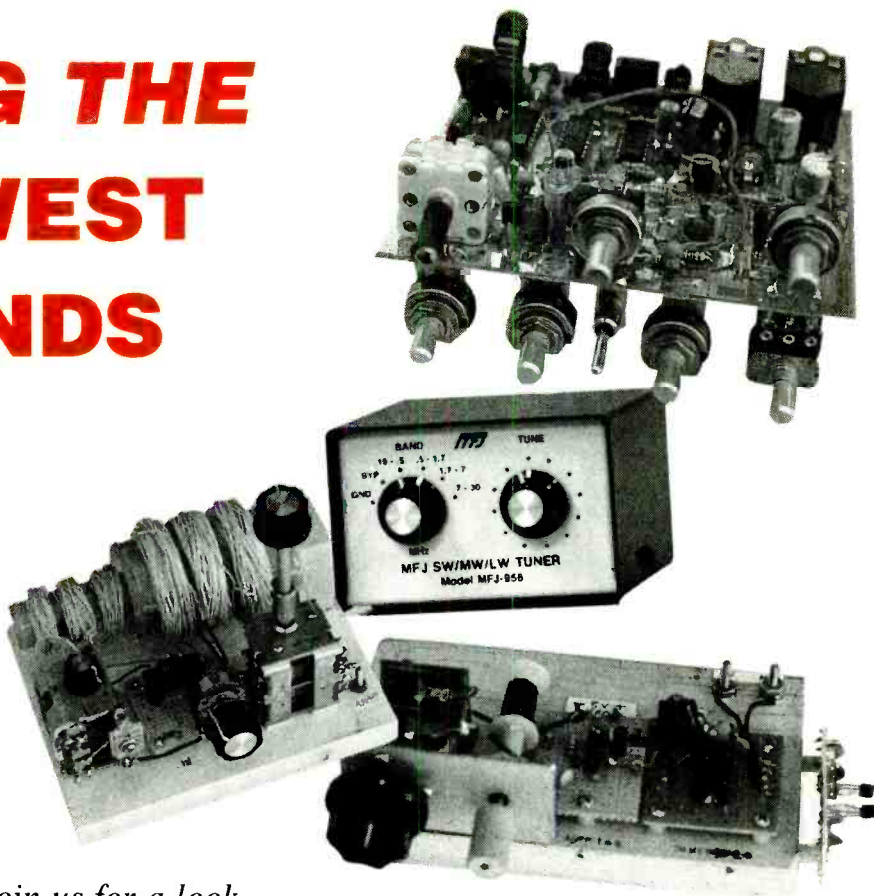
LW frequencies were the place to be until the early 1920s, when radio amateurs moved ever-higher to escape interference from commercial stations. Amateurs made an important discovery: the higher the frequency, the greater the communications range. When that word got out, most hams rushed to the higher frequencies.

Then, LW went into a decline that only began to be reversed after World War II; even today, LW is largely neglected by shortwave listeners (SWLs). LW's renaissance is due in part to recognition of propagation charac-

teristics that actually make LW superior to SW for some tasks such as radio determination, military emergency communications, and time-keeping and frequency transmissions.

Longwave Inhabitants. You're probably familiar with MW, especially the AM BCB, now 535–1705 kHz. But LW, from 30 to 300 kHz, offers listening largely unknown to SWLs. The heart of the LW region has plenty of activity. There you'll find signals from time and frequency stations, broadcasters, military and emergency communications, unlicensed but legal experimenters (more on them later), radioteletype stations, radio determination (radiolocation and radionavigation), and some unusual signals (see Table 1 for both LW and MW frequency allocations).

The 150-285 kHz band is a popular broadcast band in Europe, North Africa, the Middle East, and Asia, where LW broadcasters use high-power transmitters and large antennas to



*Join us for a look
at the most unusual ham bands—LowFERS and
MedFERS—and the equipment used to explore them.*

TABLE—1

Band (kHz)	Service
30-70	Fixed stations and maritime mobile
59-61	Standard frequency stations (WWVB at 60 kHz)
70-90	Fixed stations/radiolocation/radionavigation
90-110	Radionavigation (LORAN-C at 100 kHz)
110-130	Fixed stations/maritime mobile/radiolocation
130-150	Fixed stations/maritime mobile
150-285	Foreign broadcasting (but not in the U.S.)
160-190	Fixed and 1750-meter "Part 15" band (U.S.)
190-435	Aeronautical and marine beacons (radionavigation)
200-285	Aeronautical mobile stations
285-325	Marine radionavigation
325-405	Aeronautical and marine radionavigation/aeronautical mobile
405-415	Marine radionavigation (including 410-kHz radio directionfinding)
415-490	Maritime mobile (maritime coast and ship telegraphy)
490-510	Mobile (500-kHz distress and calling frequency)
510-525	Aeronautical radionavigation/marine radionavigation/512-kHz ship calling/coastal stations/beacons/NAVTEX
510-1705	Experimenters' Part 15 "Top End" band in U.S.
525-535	Traveler's Information Service (TIS)/Highway Advisory Radio (HAR) on 530 kHz
535-1605	Standard AM Broadcast Band (in the U.S.)
1605-1635	Traveler's Information Service/Highway Advisory Radio stations
1605-1705	Extended AM Broadcast Band (in the U.S.)
1705-1800	Radiolocation
1800-2000	160-meter amateur-radio band

make their signals as strong as possible. As a result, station range is much greater than on the MW BCB, which tends to be almost useless at night because of mutual interference.

There are few LW broadcast enthusiasts in the United States. This is primarily because relatively few receivers cover LW, and it's hard for U.S. listeners to pull overseas broadcasters through the interference from the radio beacons in our hemisphere.

LW Stations. Some of the most common LW stations are radio-navigational aids, or radio beacons. You'll find them between about 190 and 405 kHz and also 510 through 525 kHz (anything above 300 kHz technically is MW, but we won't split hairs).

Some are aeronautical beacons, others are marine. Both employ slow amplitude modulated Morse code, making them easy to ID. Both are sources of DX, especially at night, although the majority are low powered with a daytime range of about 200 miles. While signals from radio beacons, which may run several hundred watts, have been received out to 1000 miles or so, DX contacts on 1750 meters of 150 miles are fairly un-

usual. But beacons are thinning out, as Global Positioning System (GPS) satellites and VHF/UHF airport equipment are used increasingly.

Around 100 kHz, you'll find LORAN-C, which is a radio-navigation system used by ships and planes to accurately determine their position. Special receivers pick up the signals from the network of 100-kHz transmitters at various points throughout the world, and analyze minute signal time-of-arrival differences from multiple sites to calculate position. However, this system slowly is going out of favor as GPS usage increases.

You'll also come across the Ground Wave Emergency Network (GWEN), which is a system of LW sites that form an emergency network to provide command and control communications in the event of nuclear attack. GWEN is designed to overcome nuclear-caused electromagnetic pulse (EMP), relaying teletype messages and linking strategic alerting sensors and warning radars. The 2- to 3-KW stations operate between 150 and 175 kHz. The signals are short bursts of encrypted digital information that many listeners describe as ear-shattering.

There are, of course, many other military, government, and commercial stations on LW that you'll likely hear. You will also come across several standard time and frequency stations, notably on 60 kHz, such as WWVB in Colorado. Besides 1750-meter stations, there are other fixed, mobile, aeronautical, marine, radiolocation, and radionavigation signals you may hear. Too, there are "strange long-wave bedfellows" using Morse, RTTY, and digital modes only the military could tell us about—if they wanted to do so.

Longwave Propagation. How do signals propagate at LW? Much depends on just how low the frequency is. At the high end of LW, propagation isn't much different from the familiar AM BCB. Daytime propagation there is limited mostly to groundwave, but nightfall can extend coverage by thousands of miles. Medium- and high-frequency signals are absorbed by the lower layers of the ionosphere and the earth, while LW signals are absorbed less.

The reflectivity of the ionosphere on LW tends to remain fairly constant, making long-distance LW communications much more stable than communications on SW. This is one reason

THE LONGWAVE CLUB OF AMERICA

Since 1974, LW enthusiasts have had a "just for us" style forum in the Longwave Club of America (LWCA). It was organized to promote LW DXing, experimentation on frequencies below 530 kHz, and activity on the 1750-meter band.

The LWCA publishes *The LOWDOWN*, a monthly newsletter that contains loggings, beacon-station information, LowFERS and MedFERS activities, and equipment designs for both reception and transmission. There are several columns and features that cover beacons, LW loggings, the 1750-meter band, and special interests such as earthquake and geophysical monitoring. *The LOWDOWN* is the best single source for LowFERS and MedFERS activities: it contains up-to-date listings of enthusiasts, their callsigns, frequency of operation, and other operational characteristics.

Membership in the LWCA and a one-year subscription to *The LOWDOWN* is \$18 in the U.S., \$19 in Canada, and \$26 overseas. Information is available from publisher Bill Oliver at LWCA.

why LW broadcasting is so popular in many parts of the world: stations operating on LW can be heard coming through day or night, every day. LW also is ready-made for time and frequency stations, where the stable propagation doesn't introduce many anomalies in received signals.

For a given power, groundwave range is much greater on LW than on MW or SW; at the lowest frequencies, range can be global. In fact, the lowest frequencies, ELF and VLF, can travel halfway around the world and penetrate a short distance beneath the surface.

During the day, LW propagation is mostly by groundwave. As frequency decreases, signals propagate in duct-like or waveguide fashion. The groundwave travels over extended distances because it hugs the earth and follows its curvature.

There is some skywave propagation on LW. As frequency approaches MW frequencies (300 kHz), skywaves become common, especially at night. During the day, the low frequencies tend to be slightly reflected from the D or lowest ionosphere layer. At night, the D and E layers mostly disappear and signal absorption decreases. Signals then can be reflected back to the earth from the highest ionospheric F layers as skywave (skip) signals.

The 1750-meter band enjoys fairly stable propagation characteristics but suffers from high noise. There are relatively few users, so there's little propagation forecasting in the amateur radio press for 1750-meter LowFERS. However, MW propagation is comparable to the 80- and 160-meter propagation forecasts in the ham magazines.

In all types of LW communications, however, atmospheric noise is a limiting factor. High noise levels plague LW, with the tropical regions being the worst. Here, thunderstorm static indeed can be terrible. Manmade noise from household and industrial appliances, light dimmers, and motors, also affects LW reception greatly.

Other than using a good noise limiter or blanker, about the only receiving-end fix you can apply to the noise problem (other than locating antennas away from power lines and buildings) is to boost the signal-to-noise

ratio at the receiver by using a directive, noise-canceling antenna such as a loop, or an "active gain antenna" with a preamp right at the antenna. More on them, and some other ways to help resolve the noise problem, later.

The 1750-Meter Band. The FCC allows for some types of RF devices that don't fall under its other rules in its Part 15 regulations, "Radio Frequency Devices." Part 15 covers both unintentional limited-radiation devices, such as radios and TV sets, computers, TV receivers, etc., all of which may generate radio signals as part of their op-

eration; and intentional radiators, such as garage-door openers, cordless telephones, wireless microphones, and highway and tunnel radio systems, etc., which deliberately radiate signals. (Part 15 also prohibits radiation at certain critical frequencies, such as 100 kHz, where LORAN-C is used, and 500 kHz, a ship emergency frequency.)

You'll find several interesting provisions tucked away in Part 15. One section permits the no-license-needed use of up to 1 watt RF power input and a 15-meter (50-ft.) long antenna, including the transmission line and ground lead, between 160 and 190

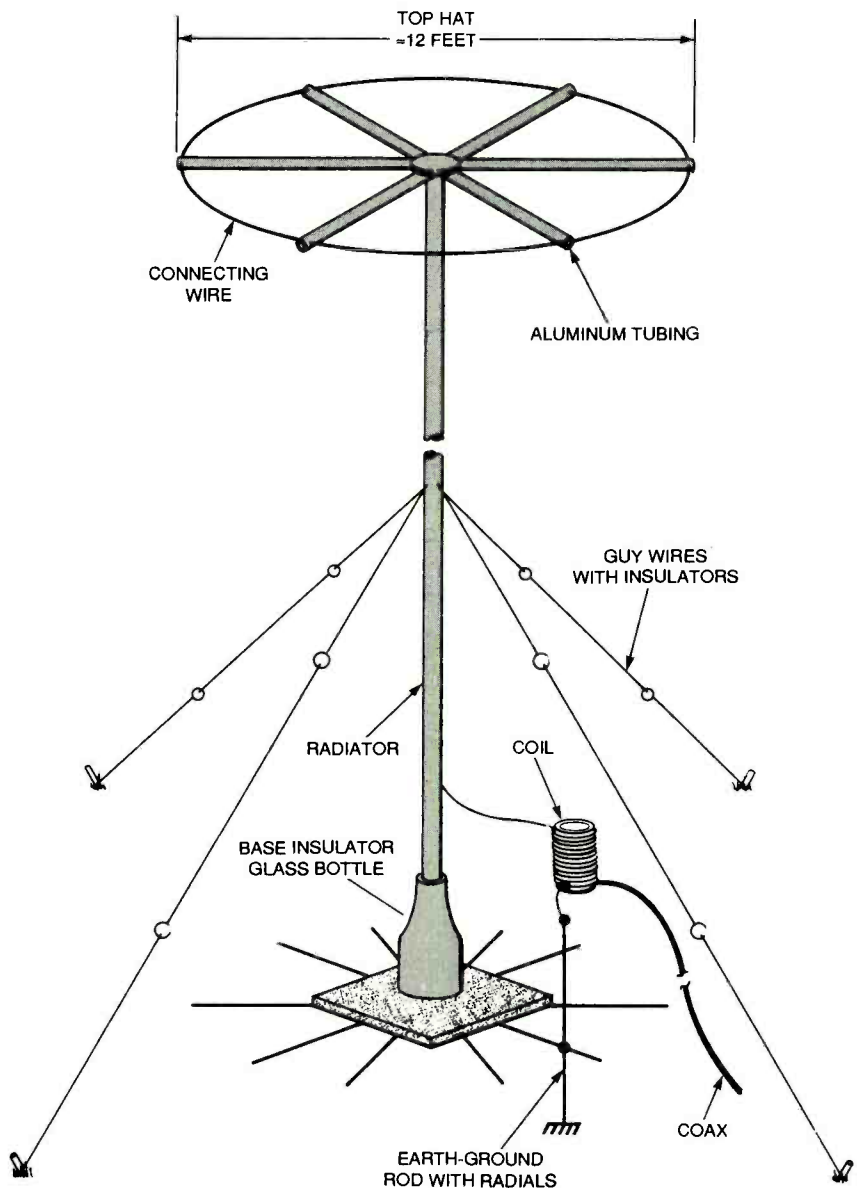


Fig. 1. Here's a typical 1750-meter LowFERS transmitting antenna. Note that the total length of the antenna, transmission line, and ground lead legally can't exceed 15 meters.

kHz. Another section permits similar MW operation from 510–1705 kHz with 100 milliwatts and a short, 3-meter (about 10 feet) antenna, again including the transmission line and ground lead. A third Part 15 section, which we won't be concerned with, governs other operation in the 535- to 1705-kHz range. This section is mainly for "carrier current" and "leaky coax" systems as used on college campuses, at entertainment parks, and along roadways.

Some hobbyist experimental stations operating under Part 15 call their stations LowFERS (or MedFERS, if on MW). For years, a small but enthusiastic group of experimenters has been communicating on the so-called "1750-meter band," running from 1874 to 1578 meters (160 to 190

THE ELECTROMAGNETIC SPECTRUM

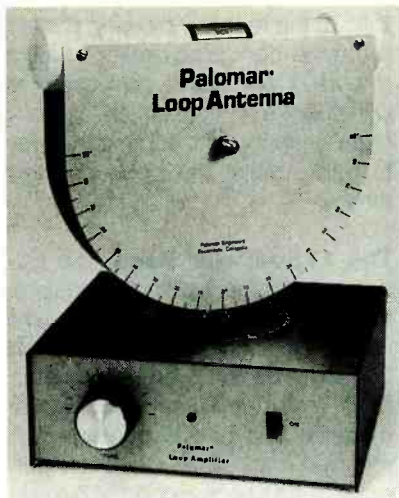
To see clearly where LW and MW fit into the electromagnetic spectrum, let's take a brief look at the spectrum as a whole, in terms of frequency.

The total usable spectrum generally is considered to extend from a few Hz to approximately 300 GHz. This truly immense range of frequencies is broken up into smaller groupings that are easier to understand and deal with conceptually.

In the lowest range are the frequencies known as the ultra low frequencies (ULF), from zero to 3 Hz. Just above ULF lie the extremely low frequencies (ELF); they cover 3 Hz to 3 kHz. Above that, from 3 to 30 kHz, are the very low frequencies (VLF). Next come the low frequencies (LF), from 30 to 300 kHz. This is the upper limit of LW, although some consider anything below the AM broadcast band (BCB) to be LW. The medium frequencies (MF), or MW, extend from 300 to 3000 kHz (3 MHz).

From 3 MHz to 30 MHz are the high frequencies (HF). Above them are the very high frequencies (VHF), from 30 to 300 MHz. The ultra high frequencies (UHF) extend from 300 to 3000 MHz, or 3 GHz. From 3 GHz to 30 GHz are the super high frequencies (SHF), and from 30 GHz to 300 GHz, the extremely high frequencies (EHF).

Of course, people aren't always consistent in labeling frequency or wavelength. Often, anything below about 500 kHz is referred to as LW, when 300 kHz actually is the dividing line between MW and LW. On the high end, too, there's blurring. MW ends and SW starts at 3000 kHz (3 MHz), but many consider MW as stopping just above the AM broadcast band, or around 1705 kHz. ■



The LA-1 Loop Amplifier made by Palomar Engineers can be used with any of six plug-in accessory loops to cover LW, 10–40 kHz (for OMEGA), 40–150 kHz (for WWVB), 150–550 kHz, AM BCB, 160 and 80 meters (including the MW "top end,") and HF to 16 MHz.

kHz). As we've seen, 1750 really isn't a ham band at all: no operator or station license is required. And, as we have also seen, the FCC rules governing operation there set forth some tough requirements, including one that says that all emissions below 160 kHz or above 190 kHz (in other words, outside the 1750-meter band) must be suppressed by at least 20 dB.

The FCC restrictions do make LowFERS operation challenging. Fortunately, there are no stipulations as to emission type: you can use SSB, AM, FM, RTTY, CW, and other modes. There are, of course, no restrictions on receiving antennas or equipment.

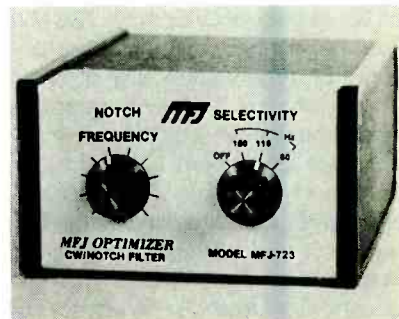
Even with the power and antenna limits, experimenters sometimes span 100, 300, and—very rarely—1000 miles or more, mostly with automatic, one-way beacon transmissions. From time to time, two-way LowFERS QSOs take place over moderate distances.

Then, there's GWEN. Its presence over most of the 1750-meter band has forced activity above 175 kHz; much 1750-meter action, especially beacons, has been centered near 189.5 kHz. Most work has been on CW, though advanced digital modes are being tried.

Since the FCC frowns on amateur call signs on non-amateur frequencies, many operators use either their initials, old-style telegraphers' "sines," or nicknames as IDs for their two-way

communications or beacon stations. The Longwave Club of America (LWCA's) monthly journal (see the "Longwave Club of America" box) lists these beacons.

Is an LW amateur band on the horizon? Well, with the increasing interest in the 1750-meter band, the American Radio Relay League (ARRL) in June 1992 approached the government regarding a shared amateur radio band in the LW region. The proposal has been favorably received, at least initially, by the FCC and other government agencies, such as the National Telecommunications and Information Administration (NTIA). A government study even concluded that amateurs could indeed use an additional 2180 kHz of spectrum space—including a 30 kHz-wide ham band at 160–190 kHz, but don't hold your breath waiting for it to materialize.



The LW bands are replete with annoying interference. This low-cost MFJ "Optimizer" filter helps you pull out signals of interest and notch out interference.

Most countries that use the LW broadcast band (about 150–285 kHz) aren't particularly interested in allowing amateur operation on 1750 meters. However, the German Department of Communications reportedly will create a ham band around 140–150 kHz in the near future. Many LowFERS believe this is actually a better choice for a new ham band than 160–190 kHz since it's below the overseas LW broadcasting band and thus offers more opportunities for DX, especially transatlantic amateur LW communications.

LW Receiving Equipment. To most radio listeners, LW indeed is terra incognita, unknown territory. One reason has been the lack of high-performance receivers covering LW.

By the time you tune down to 500 kHz, most receivers are far less sensitive than they are on SW. The assumption apparently is, at LW, you won't be able to hear anything but the strongest signals over the noise. However, today several suppliers sell receivers, receiving converters, filters, antenna tuners, loops, and active gain antennas that make good LW reception possible.

For communications equipment capable of tuning below the AM BCB, you can buy a military-surplus receiver, new or used commercial set, or a receiving converter. You can even build your own LW radio. Let's look at some of these possibilities:

You can find surplus receivers that tune down to 150 kHz, or so. Unfortunately, many such radios require restoration, and most need modification for 120-volt, 60-cycle AC. Actually, most tube-type surplus sets are pretty old and tired, halfway through the 1990s, so results may be disappointing if you use them for LW reception.

Possible surplus LW receivers include the BC-453, BC-1206-A, BC-348, BC-779, ARB, RAK-7, R-439, URM-41, RBA, RBL, and R-389 URR. The latter set, made for the government by Collins Radio in the 1950s, is a very good radio whose coverage extends to VLF.

The LW bands are covered by a few older commercial communications receivers that you might find at used equipment dealers or at hamfests, but in view of their age and older technology, it's best to avoid them. These radios include the Heathkit DF-2, Hammarlund RDF-10, National NC-66, Drake SPR-4, Kenwood R-300, and Realistic DX-300.

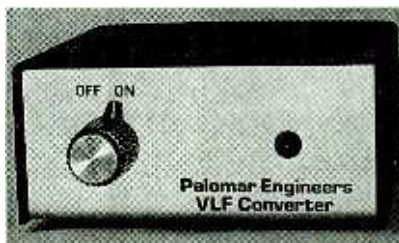
Moving upscale, the 1950s-vintage National HR0-60 still is a good general-coverage receiver. With its accessory G, H, and J plug-in coil sets, it tunes down to 50 kHz. The Hammarlund VLF Super Pro, known as the SP-600-VLF, also is a well-regarded set.

There are some excellent, newer, LW-capable communications receivers on the market, too, though most are expensive. These include the Watkins-Johnson HF1000 (about \$3800); Drake R-8A (\$1060); Japan Radio NRD-535D (\$1200); Kenwood R-5000 (\$1040); ICOM R-71A (\$1250); AOR3000A (\$1050); and Yaesu FRG-100B (\$590). Others include the Lowe HF-150 (\$600) and HF-225 (\$970). All of these radios tune the

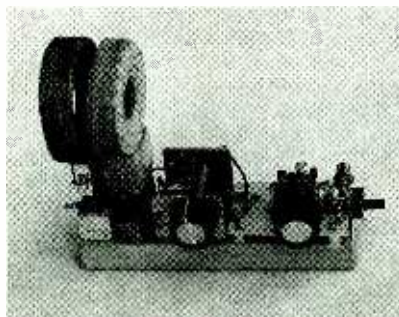
1750-meter and MW bands; most tune as low as 50 or 100 kHz and some go much lower.

Several good, lower-priced "world band" radios also tune LW. These include the Grundig YB-400 (\$200) and Satellit 700 (\$500); Sangean ATS-808 (\$170) and ATS-606 (\$160); Sony ICF-2010 (\$350), ICF-SW55 (\$350), and ICF-SW7600G (\$200); and Panasonic RFB-45 (\$170). However, not all world-band radios have a beat frequency oscillator (BFO), needed to receive CW signals.

Most of these radios are available



This Palomar Engineers VLF Converter lets you receive the low bands for about \$80; all you need is a communications receiver and an antenna.



Obtaining good receiver sensitivity on LW is often a problem, but you can use a preamplifier to boost reception. Shown here is a homebrew, regenerative RF preamp with LowFERS coils.

through dealers. These include Amateur Electronic Supply, Associated Radio, C. Crane Co., Electronic Distributors Co. (EDCO), Electronic Equipment Bank (EEB), Grove Enterprises, Ham Radio Outlet, Lentini Communications, Universal Radio, and several other firms.

One of the least expensive ways to listen to LW, though, is to buy a VLF/LF frequency converter and hook it up to your present communications receiver. Converters are available from several suppliers, including Palomar Engineers.

The Palomar Engineers VLF-A Converter is \$79.95. It uses a crystal-con-

trolled local oscillator and a mixer to translate the 10- to 500-kHz range to the 80-meter amateur band, from 3510 to 4000 kHz. A similar unit, the VLF-S, converts VLF to 4010-4500 kHz for general coverage (rather than ham-bands-only) receivers.

At least two firms, Curry Communications and LF Engineering Co., offer accessories for LW. These include equipment for LF and VLF reception, 1750-meter band operation, and VLF/ELF natural-radio-phenomena detection. Products include VLF/LF converters and preamplifiers, active-gain antenna systems, and wire and loop receiving antennas, as well as some esoteric accessories for both VLF and ELF.

As mentioned earlier, one of the LW reception problems you'll encounter is noise. Static levels increase greatly as you go down the dial, so LW reception is marred by natural and man-made noise. But some accessories can help in coping with static. Both automatic noise limiters (ANLs) and automatic noise blankers (ANBs) can be effective against certain types of noise.

The ANL is the older and simpler circuit, one that merely whacks off noise pulse peaks, reducing them to tolerable levels. The ANL usually degrades the receiver's audio. A noise blanker is more complex; it effectively silences the receiver during the noise pulse. The ANB often is adjustable whereas the noise limiter normally is an on-off device. The ANB doesn't degrade audio nearly as much as does the limiter.

A newer technology involves Digital Signal Processing (DSP) filters, which can make real improvements in 1750-meter communications. They simulate analog filters, varying their characteristics to react to changing conditions. They offer superior performance in reducing interference on voice, CW, and RTTY by converting the received audio, both signal and noise, to digital data and processing it. Several firms offer DSP-based filters. One is JPS Communications, which offers the NIR series noise and interference reduction units.

DSP also offers the ANC-4 Antenna Noise Canceller. Installed at the antenna connector, it cancels locally generated noise, such as power-line, computer, and TV noise. This is done

SUGGESTED READING

Are you interested in reading and learning more about LW, MW, LowFERS and MedFERS? Check out these books, guides, newsletters, and other specialized publications.

The Low and Medium Frequency Radio Scrapbook: The "dean" of radio hobbyists who focus on FCC "Part 15" bands is Ken Cornell, W2IMB, of Point Pleasant Beach, NJ. He has self-published the *Scrapbook* for over 20 years. The latest, 9th edition is a 93-page, how-to-do-it compendium that offers you LW information and equipment designs for receiving and transmitting. It has a general introduction to the 1750-meter band, details on operating LW and MW beacons, and an introduction to LW earthquake and geophysical monitoring. The book is \$17.50, postpaid book rate, or \$18.75 first-class mail. Checks should be payable to Ken Cornell.

The Active Antenna Scrapbook: A second, new scrapbook also is available from Ken Cornell. It's the Active Antenna Scrapbook, a 29-page booklet that has more than you ever wanted to know about active-gain antennas—short verticals that have a built-in preamplifier for increasing the signal-to-noise ratio. The booklet has circuits for several broadband and remotely tunable, LW and MW active-antenna designs. Included are designs for regenerative preamplifiers, which Ken claims are capable of excellent LW and MW performance. The scrapbook also includes reprints of articles from *The LOWDOWN* that deal with active antennas and ferrite loops. The booklet is \$10 postpaid in the U.S. via first class mail, or \$13.00 for foreign airmail.

The World Below 500 Kilohertz: If you want to learn more about this part of the spectrum, this is a good, one-stop tutorial on LW, by L. Peter Carron, Jr., W3DKV. The 64-page booklet, probably the only available beginner's book on LW, offers a nice overview of LW and introduces many of the "strange bedfellows" that reside there. It's available from Universal Radio for \$4.95, plus \$2 shipping and handling.

Shortwave Receivers Past and Present: Don't let the word "shortwave" in the title fool you. This 1993 blue book, by Fred J. Osterman, also includes some excellent LW and MW receivers. It's a 106-page directory of the vital statistics of more than 200 communications receivers, tube-type and solid-state, marketed over the past 20 years. It provides specifications and photos of most of the

receivers. Also included in the book is a chart showing the new and approximate used cost of each set. It's \$8.95 plus \$2 shipping and handling from Universal Radio.

BBS Radio: The National Directory of Radio Hobby Bulletin Board Services: This Tiare book by Mike Witkowski lists several hundred BBSes devoted to the radio-communications hobby. The BBS listings show the board's name, area code, and telephone number. A location also is shown for most listings. It's \$9.95.

The NRC AM Radio Logbook, 13th Edition: For North American MW AM stations, this is one tool you'll want. It includes day and night antenna and power information, format, hours of operation, address, network affiliations, etc. Price is \$19.95 for U.S. readers and \$20.95 for Canadians; it's \$3 less for National Radio Club (NRC) members. The Logbook is available from NRC Publications. (NRC membership is \$24.00 for U.S. listeners, \$25.00 for Canadians. For particulars and information on their DX News newsletter, contact the NRC Subscription Center.)

A DXer's Technical Guide: Now in its second edition, this 120-page International Radio Club of America (IRCA) book answers questions on MW receiver and antenna theory and performance improvement, receiver accessories, receiver modifications, and more. It's available from the IRCA Bookstore for \$6 to members, \$8 to others. An introductory brochure, *An Introduction to Broadcast Band DXing*, also is available for 35 cents. (IRCA membership is \$25.00 for U.S. listeners, \$27.00 for Canadians. For particulars and information on their DX Monitor newsletter, contact the IRCA.)

Transmitting Antennas And Ground Systems For 1750 Meters: For a comprehensive background on LowFERS antennas, order a copy of this book, edited by Michael Mideke. This is a 60-page, 1987 collection of articles from various LowFERS publications. It's \$5.00 postpaid from Max Carter, 46 14th St., Wheatland, WY 82201.

Radio Electronics Series of Articles: You'll find detailed discussion and construction details on VLF through HF active antennas, loops, and antenna tuners in a series of articles by R. W. Burhans. The series appeared in our sister publication, *Radio Electronics* (now *Electronics Now*), in the February through June 1983 issues. Check your local library for these issues.

LowFERS 1750-Meter Transmitters. There are few, if any, commercial LowFERS transmitters and transceivers on the market today. But it's not too difficult to build LW equipment—most designs use a simple, solid-state,

crystal-controlled exciter and power-type FET final amplifier. Over the years, various do-it-yourself LW construction projects have been described in the amateur press.

A bibliography of VLF/LF construction projects (1750-meter band transmitters and transceivers, receivers, converters, etc.) is available from the ARRL Technical Department; or you can download it from the ARRL BBS (filename VLFTXT) or the Long-wave BBS (see below). You'll also find that several RF circuits are in Ken Cornell, W2IMB's *The Low and Medium Frequency Radio Scrapbook* (see the "Suggested Reading" box). Other designs appear in the LWCA's journal, *The LOWDOWN*.

An important construction article is "Build Your Own Lowfer Transceiver," by David Curry, WD4PLI, of Curry Communications, in the April 1994 *QST*. He described a 1750-meter LowFERS CW transceiver, the CW-893. The receiver portion is similar to the military RBL LW receiver. The transmitter section generates 1 watt of power input, and it's VFO (variable frequency oscillator) controlled.

Curry Communications also offers a 1750-meter transverter kit, the SAM-1, which allows any radio amateur with 80-meter capability to operate on 1750. The unit includes both a receiver upconverter and a transmitter downconverter that takes an 80-meter signal from a conventional amateur transceiver and converts it to a 1750-meter signal; it also receives on 1750 and converts the signals to ham-band frequencies. The firm also expects to have a 1750-meter SSB transceiver, a LF synthesizer, and an audio-receiving processor available in the near future.

LW Receiving Antennas. There are many types of horizontal and dual-polarized wire antennas you can adapt for LW. LW receiving antennas are much like those for the 160-meter amateur band or for MW AM BCB DXing, only on a larger scale. The *ARRL Antenna Book* is a good place to start for antenna basics.

You'll find in antenna books all sorts of variations on singlewires, longwires, end-feds, Marconis, and combination vertical and horizontal L's for LW reception. As a rule, you should get as much wire as possible in the air and

before the noise gets into the set. Front-panel controls let you adjust the phase and magnitude of the local interference, leading to deep noise cancellation. The \$175 product works down to 100 kHz.

run it well clear of all surrounding objects and noise sources. Best reception results on LW usually are achieved with an antenna that's tuned or trapped to keep out strong local AM BCB stations.

One classic receiving antenna for LW and MW is the Beverage, with its gain and directional characteristics. It consists of a horizontal wire a wavelength or more long, sometimes 1000 feet or more, suspended 10 to 20 feet above the ground and supported at intervals. The Beverage normally is terminated at the far end with a resistor which is connected to a metal stake that is driven into the ground. It's pointed in the direction of the desired signals.

Any discussion of LW antennas wouldn't be complete without a discussion of receiving loops. Loops are enjoying renewed popularity on LW because they can be physically small yet work well, they can be resonated or tuned to a particular frequency, and they can be rotated to take advantage of their directionality. Most loops are built to have a figure-eight pattern.

You'll find loops are quieter than single-wire outdoor antennas, are less prone to swamping by strong local BCB stations, and can be used effectively to null out noise and interference. Some loops allow for greater noise reduction by enclosing the loop wires in a special, nonmagnetic shield. This technique can markedly improve the overall signal-to-noise ratio of the received signal. However, you may find poor results with indoor loops due to noise radiated from household wiring. Palomar Engineers and Kiwa Electronics are two really good sources for various loop antennas.

Another option is an active-gain antenna. Such an antenna popular on LW consists of three main parts: a physically short, vertical steel whip or wound coil element; an antenna-mounted preamplifier; and a receiver coupler. Some LW buffs assert that active-gain antennas they make the best overall LW receiving antennas, at least for modest-space, urban locations. Such antennas can improve receiver performance by reducing overall sensitivity to various local noise sources.

You can mount these antennas



Shown here is a crystal-controlled MedFERS transmitter, circa 1975. It uses an enameled wire tank coil and is ferrite-rod tuned. You can substitute a slug-tuned VFO coil for the crystal.

easily outdoors, away from noise and distracting objects; the amplified signal is routed to the LW receiver through a length of coaxial cable whose shielding minimizes noise pickup. Curry Communications, LW Engineering, MFJ Enterprises, and several others make this type of antenna system.

LW Transmitting Antennas.

Designing an efficient antenna for the 1750-meter band is a challenge because of the FCC's 15-meter length restriction. These antennas are very short, electrically speaking, and they also have very low radiation resistance.

The best LowFERS antennas probably have efficiencies below one percent, and most will be even less efficient than that. Despite these limitations, if you're resourceful in reducing loss in the antenna system and maximizing efficiency in the transmitter, your signals can be detected over much longer ranges, especially when using CW.

For transmitting on 1750 meters, almost any antenna will do for casual experimentation, out to a mile or two. However, for best results you should use a short, loading-coil resonated vertical antenna, topped with a large, horizontal "capacitance top hat," and secured with guy wires (see Fig. 1). A glass bottle insulates the base of the antenna, with the loading coil being connected between the radiator and the ground system. The center con-

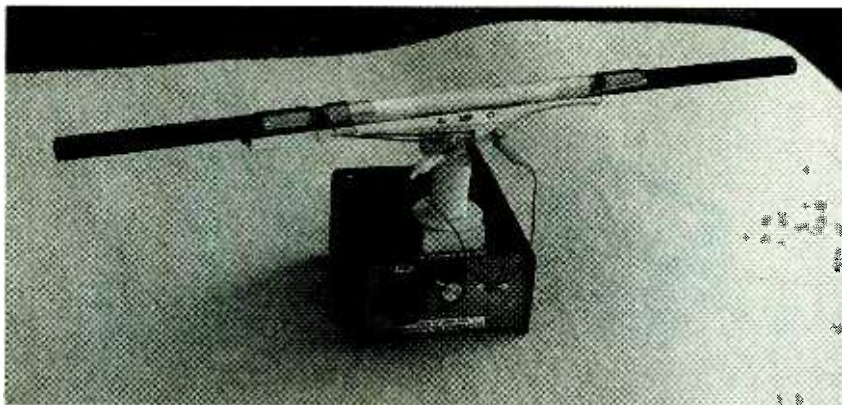
ductor of the coax feedline is connected to the coil tap. A ground rod and a 25- to 30-foot or greater radial system are used. The total length of the antenna, transmission line, and ground lead legally can't exceed 15 meters.

The essential components of a LowFERS antenna system are the ground system, a loading network, a vertical radiator, and a top hat. The vertical radiator is used in conjunction with a substantial ground rod and a 25- to 30-foot radial system. Typically, a separate vertical active-gain whip antenna is used for receiving.

The simplest loading network is a low-loss, high-Q (quality factor) coil in series with the antenna, preferably above the center of the antenna for optimum efficiency. It tunes out the capacitive reactance of the antenna and brings the feedpoint impedance down to a reasonable level. Although the radiating section can be sloping or bent, the height above ground is actually more important in securing good performance than is the total length.

A top hat improves the antenna's current distribution. When you add a top hat to a vertical, the top hat doesn't radiate, but it increases the effective height of the vertical portion.

A good, low-resistance ground is also very important for a LowFERS transmitting antenna. Some LowFERS get good results with lengths of chicken wire forming a ground screen 50



One of the most popular antennas for MW DX is the loop; loops are small and can sit on a desk or table where they can be turned for optimum peak or null. Shown is an experimental MedFERS dual-rod, ferrite-loop antenna with regeneration.

feet square or larger. Another approach is to put out a number of radials, each at least as long as the antenna height, with several of them terminated at their outer ends in an earth ground. When a sophisticated ground system isn't practical, you can run connecting wires from the base of the antenna to all available grounds—water pipes, metal buildings, or wire fences.

Mediumwaves and MedFERS. The easiest parts of the radio spectrum for you to explore include the MW AM BCB. DXing the BCB is an exciting way to enter the listening hobby, and it doesn't require a major investment in equipment or antennas. All that's required is time, patience, and knowledge. The immense popularity of the BCB helps to explain why many people like to transmit in or adjacent to the BCB.

The U.S. MW AM BCB currently extends from 535 to 1605 kHz (down to 525 kHz in Canada). To complicate things for MedFERS, the FCC has released a list of allotments for the expanded BCB, 1605–1705 kHz. Stations that are experiencing high levels of interference will begin appearing on 1605-1705 kHz soon. The FCC's objective in expanding the band was not to increase the number of AM stations on the BCB, but to decrease congestion.

This is good news for AM DXers, but how this expansion will affect MedFERS isn't clear. MedFERS have taken advantage of the relative quiet in this segment to accomplish amazing DX with 100-milliwatt transmitters and 10-foot antennas, under FCC Part 15.

There's no lack of signals below the BCB. Up to 405 kHz, there are aeronautical and marine beacons aplenty. Other signals include mobile stations, 410-kHz direction finding, the 500-kHz distress and calling frequency, the 512-kHz ship-calling frequency, and more beacons from 510-525 kHz. The main MW inhabitant, of course, is the 535- to 1605-kHz standard AM BCB and its extension to 1705 kHz in the U.S.

Travelers' Information Service (TIS)/ Highway Advisory Radio (HAR) stations and some licensed experimental stations presently are found in the 1605- to 1705-kHz "top end" area in the U.S., along with unlicensed MedFERS Part 15 stations. But they all may be squeezed by new BCB stations and will have to try to find frequencies with the least interference.

The DX stations, including MedFERS, that you're able to receive depend largely upon MW propagation conditions. Those vary depending upon the time of day, the season, and other factors. On MW, the single most important factor for good DX is time of day. MW signals almost always get absorbed by the D Layer during daytime. As a result, most MW signals received during daytime will arrive by ground-wave, making reception of signals over a few hundred miles away unusual.

At night, however, the ionosphere reflects MW signals, making it possible for signals to be heard at much greater distances, up to a few thousand miles, via skywave. DX reception also tends to be better in winter than in summer, due to the season's lower atmospheric noise and longer hours of darkness.

You also can work MW DX when your receiving station and/or the transmitter are in partial darkness; it's possible to hear distant stations using "grayline" or "terminator" propagation. Most MW DXers log the greatest number of stations in the hour or two around sunrise and sunset, especially in the fall and winter. Most anything can happen in these turbulent periods; such times can offer flea-powered MedFERS transmitters a chance to come through, at least momentarily.

You should keep in mind that MedFERS activities are constrained by the FCC even more than LowFERS activities. The FCC's rules in Section 15.218 permit MW operation from 510–1705 kHz with 100 milliwatts and a 3-meter (about 10 ft.) antenna. This contrasts with the 1-watt power and 15-meter antenna allowed LowFERS. These constraints make it difficult to be heard at distant locations. Consequently, there are relatively few MedFERS stations, probably only about 30–60 of them. Most of the active stations employ low-power (100-milliwatt) CW beacons from 1605–1705 kHz in the top-end area. Other beacons tend to cluster around 510–515 kHz. There's little MedFERS two-way work.

Of course, MW is popular with frustrated radio disk jockeys and others using home-type AM "wireless mikes" or "wireless broadcasters," but their signals usually don't get very far. Pirate radio stations pop up from time to time in and adjacent to the AM BCB, although this type of MW activity has decreased in recent years. Most of the pirates appear to have migrated to around 6950 or 7400 kHz, just below and above the 40-meter amateur band, where it's easier to radiate more of the power they generate. But we really shouldn't call these stations MedFERS in that pirates don't operate under Part 15 or any other FCC rules.

MW Receivers and Transmitters.

Almost any radio capable of AM BCB DXing can be used in a MedFERS set-up. However, many radios, even those designed for quality SW reception, aren't great BCB performers. Some features you should seek in a BCB/MedFERS receiver include provisions for an external antenna, high selectivity, digital frequency display, and a

BFO. Most communications receivers and world-band radios cover MW and meet most of these requirements.

MedFERS transmitters are homebrew—no commercial MedFERS transmitters are offered today. However, some well-constructed wireless broadcasters can be pressed into service as MedFERS transmitters, especially if they are modified for crystal control, and a few homebrew designs have been advanced by MedFERS enthusiasts like Ken Cornell.

At least one firm offers a Part 15-compatible AM transmitter that could be adapted for MedFERS work. Ramsey Electronics offers the AM-1, a \$34.95, 100-milliwatt kit that operates in and adjacent to the standard broadcast band; its range is up to ¼ mile, depending on antenna and conditions. (Ramsey also offers several low-power, quality FM, FM stereo, and TV transmitters.)

MedFERS Receiving Antennas.

MedFERS receiving antennas are basically what you'd use for AM BCB reception. Most MW receivers have a short internal ferrite rod, but suitable mainly for receiving high-power distant stations. For more advanced DX-ing, external antennas offer advantages.

The most common external antenna is a randomwire, 50 feet or more in length. A more advanced wire antenna is the Beverage, mentioned previously. One problem with your using a wire antenna for MW is the wire's inability to reject strong local signals. Most receivers lack the dynamic range to effectively deal with very strong signals from a local AM BCB broadcaster as picked up by a randomwire. Thus, some sort of tuned antenna is best for all but the most isolated, rural locations.

Much as on LW, one of the most popular antennas for MW DX is the loop antenna, and it can be either of two types: ferrite rod or air-core wound wire loop. These antennas are small (1 to 3 feet in diameter) and sit on a desk or table where they can be turned to peak or null received signals as needed.

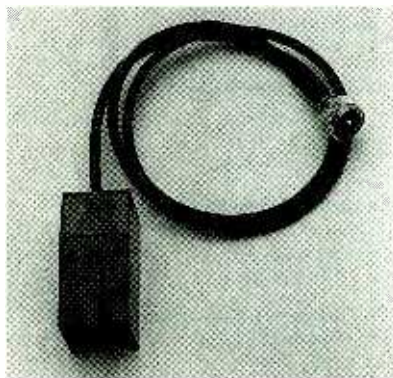
Plans for building MW loops are available through International Radio Club of America (IRCA) and National Radio Club (NRC) publications. Also, Palomar Engineers offers a handy

"Loop Coupler" that facilitates connecting an outboard loop to radios with built-in antennas that don't have an external antenna jack. Active-gain antennas also are popular at MW.

MedFERS Transmitting Antennas.

Since there are no restrictions on MedFERS receiving antennas, separate receiving and transmitting antennas generally are used. Unfortunately, the FCC's 10-foot antenna limit doesn't leave room for flexibility.

Designing a satisfactory transmitting antenna will take some headscratching and trial and error. One



Many BCB radios have built-in loop antennas, but no connector for an external antenna. This Palomar Engineers Loop Coupler will magnetically couple an antenna to a radio's built-in antenna.

simple option is to attach a 10-foot window-mounted wire to the MedFERS transmitter, located on a desk near the window. A few operators have reported success with transmitting loops, but these haven't caught on.

Roof-mounted vertical pipe antennas, usually with a top hat of stiff wire or metal tubing, and often with a loading coil, and with ground radials laid out over roof shingles, are popular. You can install the transmitter in an outdoor shed (preferably metal) and mount the antenna on its roof, feeding audio, power, and control cables to the transmitter for remote operation from your home. Often antennas are placed in the clearest part of the yard.

Low-Band Web Sites. Several features of the Internet are of interest to LW and MW radio hobbyists. Most interesting of these is the World-Wide Web. The Web has become an

organizing system that makes it easy to find information and move among various Internet resources. (See the monthly *Net Watch* column in this magazine.)

Here are a few Web pages featuring amateur-radio and listener topics. Though the focus of most sites is on amateur radio and SW listening, some of the sites we list have items of interest to LowFERS and MedFERS.

Radio Resources on the Internet is found at <http://www.wave-rider.co.uk/~paulj/radio.html>. This is a very good place to begin your search for Web-based radio information.

The Radio Netherlands Receiver Data Bank is at the URL <http://www.rnw.nl/rnw/en/pub/receiver.html>.

Gilfer Shortwave is at <http://www.pics.com/gilfer/>.

The Shortwave Radio Catalog is found at <http://itre.ncsu.edu/radio/>.

Kenwood Communications can be found at the URL <http://www.accessnv.com/kenwood/amateur.html>.

Kiwa Electronics is found at the Web URL <http://www.wolfe.net/kiwa/>.

The ARRL operates the ARRL Web page, which you can find at the URL <http://www.arrl.org/>.

Lowe Technical Services USA is yours for the browsing at <http://www.exchange.com/lowe/zts1.htm>. Their UK home page is found at <http://www.demon.co.uk/lowe/>.

USENET Newsgroups. There also are considerable radio hobbyist resources you'll find in USENET newsgroups. These are discussion groups that focus on specific subjects that are the Internet equivalent of online service and BBS forums.

To my knowledge, there's no specific forum dedicated exclusively to LW or MW. But you may find the discussions and information postings on several radio-related newsgroups to be useful. Some of the more promising USENET newsgroups are the following—their names are fairly descriptive of their contents:

- alt.radio.pirate
- rec.radio.amateur.antenna
- rec.radio.amateur.equipment
- rec.radio.amateur.homebrew
- rec.radio.broadcasting
- rec.radio.info
- rec.radio.shortwave
- rec.radio.swap

FOR MORE INFORMATION

American Radio Relay League

225 Main St.
Newington, CT 06111-1494
Tel. 203-594-0200
BBS: 203-594-0306

Associated Radio

8012 Conser
Box 4327
Overland Park, KS 66204
Tel. 913-381-5900

CQ Communications, Inc.

76 N. Broadway
Hicksville, NY 11801-2953
Tel. 800-853-9797

C. Crane Company

558-10th St.
Fortuna, CA 95540
Tel. 800-522-8863

Carter, Max

46 14th St.
Wheatland, WY 82201

Cornell, Ken

225 Baltimore Ave.
Point Pleasant Beach, NJ 08742
Tel. 908-899-1664

Curry Communications

737 North Fairview St.
Burbank, CA 91507
Tel. 818-846-0617

Davis, John H.

P.O. Box 367
Warm Springs, GA 31830
Tel. 706-672-0964
Longwave/Part 15 BBS: 706-672-0360

Electronic Distributors Co. (EDCO)

325 Mill Street, N.E.
Vienna, VA 22180
Tel. 703-938-8105

Electronic Equipment Bank (EEB)

323 Mill Street, N.E.
Vienna, VA 22180
Tel. 800-368-3270

Gilfer Shortwave

52 Park Avenue
Park Ridge, NJ 07656
Tel. 800-445-3371

Grove Enterprises

P.O. Box 98
300 South Highway 64 West
Brasstown, NC 28902-0098
Tel. 800-438-8155

Ham Radio Outlet

933 N. Euclid St.
Anaheim, CA 92801
Tel. 800-854-6046

International Radio Club of America (IRCA)

P.O. Box 1831
Perris, CA 92572-1831

IRCA Bookstore

Attn: Phil Bytheway
9705 Mary N.W.
Seattle, WA 98117-2334

JPS Communications, Inc.

P.O. Box 97757
Raleigh, NC 27624-7757
Tel. 800-533-3819

Kiwa Electronics

612 S. 14th Ave.
Yakima, WA 98902
Tel. 800-398-1146

LF Engineering Co., Inc.

17 Jeffry Road
East Haven, CT 06513
Tel. 203-248-8851

Lentini Communications, Inc.

21 Garfield St.
Newington, CT 06111
Tel. 800-666-0908

The Longwave Club of America (LWCA)

Bill Oliver, Publisher
45 Wildflower Rd.
Levittown, PA 19057
Tel. 215-945-0543

National Radio Club, Inc.

And NRC Publications
P.O. Box 164
Mannsville, NY 13661-0164

NRC Subscription Center

Box 118
Poquonock, CT 06064-0118

Palomar Engineers

P.O. Box 462222
Escondido, CA 92046
Tel. 619-747-3343

Ramsey Electronics, Inc.

793 Canning Parkway
Victor, NY 14564
Tel. 800-446-2295

Tiare Publications

P.O. Box 493
Lake Geneva, WI 53147
Tel. 800-420-0579

Universal Radio, Inc.

6830 Americana Parkway
Reynoldsburg, OH 43068-4113
Tel. 800-431-3939

Bulletin Board Systems. The Longwave/Part 15 BBS System is a hotbed of online activity. It's operated by LowFERS and MedFERS hobbyist and *LOWDOWN* columnist John H. Davis, KD4IDY. The BBS has a great deal of information on LW, MW, and FCC Part

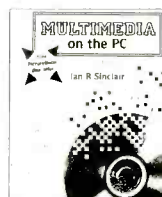
15 activity. It's free and can be reached at 706-672-0360; log-on parameters are 8-N-1. You may also wish to peruse the Tiare publication, *BBS Radio: The National Directory of Radio Hobby Bulletin Board Services*, by Mike Witkowski, or the *CQ Amateur Radio*

Almanac, for other radio-oriented BBSes.

Another great BBS is the ARRL Technical Information Service (TIS). You'll find that the ARRL has several downloadable text files that deal with LW issues. You can access them and other amateur-radio- and electronics-related information via BBS at 860-594-0306, or in the ARRL area in America Online's Ham Radio Club (Keyword HAM or HAM RADIO). If you have Internet FTP access, connect to the oak.oakland.edu FTP site; you'll find the ARRL files in the "/pub/hamradio/arrl" directories. ARRL files also can be reached at the ftp addresses: ftp.cs.buffalo.edu in the "/pub/ham-radio/qex" directories; and at mgate.arrl.org.

We think you'll find the low bands to be an interesting complement to the more conventional aspects of radio communications. The microwaves may be more exotic, but there's still a great deal to learn about LW. Twist your dial as low as it will go, and enjoy a challenging form of radio you may not even have known existed. Give LW and MW a listen: with a bit of care, there's no telling what you may pull out from underneath the static! ■

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Build a Remote-Control Interface for your Computer

BY STUART BALL

Sitting in front of a keyboard is not always the most practical way to control your computer. For example, if you tried to run a computer slideshow for a business presentation, more than a few of those present might have a hard time seeing over your head! Or perhaps you would like to play a simple game with a few friends, and would prefer not to have to crowd around the keyboard. In either case, being able to sit away from the computer while controlling it is desirable. If you build the *Remote-Control Interface* described in this article, you'll be able to do just that. The unit receives the infrared signal from your TV or VCR remote controller and transmits the data serially to your computer.

IR Remote-Control Basics. A wireless infrared remote uses an infrared LED to transmit information to a receiver. That receiver has a matching IR-detector diode and circuitry that extracts the digital information from the IR pattern.

The IR signal that is transmitted is a modulated carrier. That means that a base frequency is turned on and off to transmit the digital information. The standard carrier frequency for IR remotes is 40 kHz. While there is a single standard carrier frequency, the transmission bit timings and word lengths vary. All have the following characteristics in common, though:

For starters, the carrier is frequency modulated. That is, a one bit takes longer to transmit than a zero bit. Also, all carriers transmit a sync bit at the start of each word. All words are the same length, and each key that you

Operate your computer from across the room with any TV or VCR remote controller.

press on the remote will cause a unique pattern, with a known number of bits, to be transmitted.

The sync bit is longer than an ordinary bit; the transmitted carrier is on for an extended period, then off for an extended period. That is followed by the bits of the digital word. The Remote-Control Interface decodes two common formats: The first format uses 22 bits, each 1.6- to 3.3-microseconds long. The second format uses 32 bits, each 1.2- to 2.2-microseconds long. Another mode in the Interface analyzes the bit pattern transmitted by a remote (that will be described later).

Circuit Description. The schematic diagram of the circuit is shown in Fig. 1. IR-detector module MOD1 (available from Radio Shack as part no. 276-137) contains an IR detector, a 40-kHz filter, and waveshaping circuitry (all enclosed in a shielded box). The module has excellent sensitivity and the ability to reject unwanted signals. The module provides a TTL-compatible output that is fed to one of the inputs of an 8031 processor, U1, which has a multiplexed data bus.

Processor U1 decodes the IR data, which is then captured during the first half of the data transmission cycle of the 74LS373 octal latch, U2. During the second half of the cycle, the data is transmitted to the 27256-2 EPROM, U3, where it is affected by one of three operating modes (more on that later on when we discuss the Firmware

later on) and retransmitted to the Interface's output driver—a MAX232. That IC, U4, translates TTL signals to RS-232 levels for the computer. The connection between the Interface and the computer is made with SO1, a DB25S connector.

Power for the circuit is provided by a 9-volt AC adapter. That voltage is regulated to 5 volts by a 7805 regulator, U5. Because the voltage is insufficient to drive the RS-232 line; however, the MAX232 contains an internal DC-to-DC converter that generates the +12 volts needed to take care of that.

Construction. The author's prototype was built on a perforated board and was wired point-to-point. However, if you are interested in using a PC board, send an SASE to the address given in the Parts List. If there is sufficient interest, a printed-circuit board will be made available, and ordering information will be forwarded.

If you build the circuit using a perf-board you can either connect the DB25 connector (SO1) to the board using a 26-pin header, a matching IDC connector, and a 26-conductor ribbon cable (wire 26 would have to be clipped), or you can connect SO1 directly to the board. Either way, there are only four connections made to or on the DB25 connector: Pins 4 and 5 of SO1 should be connected to each other, pin 3 of SO1 should be connected to pin 14 of U4, and pin 7 of

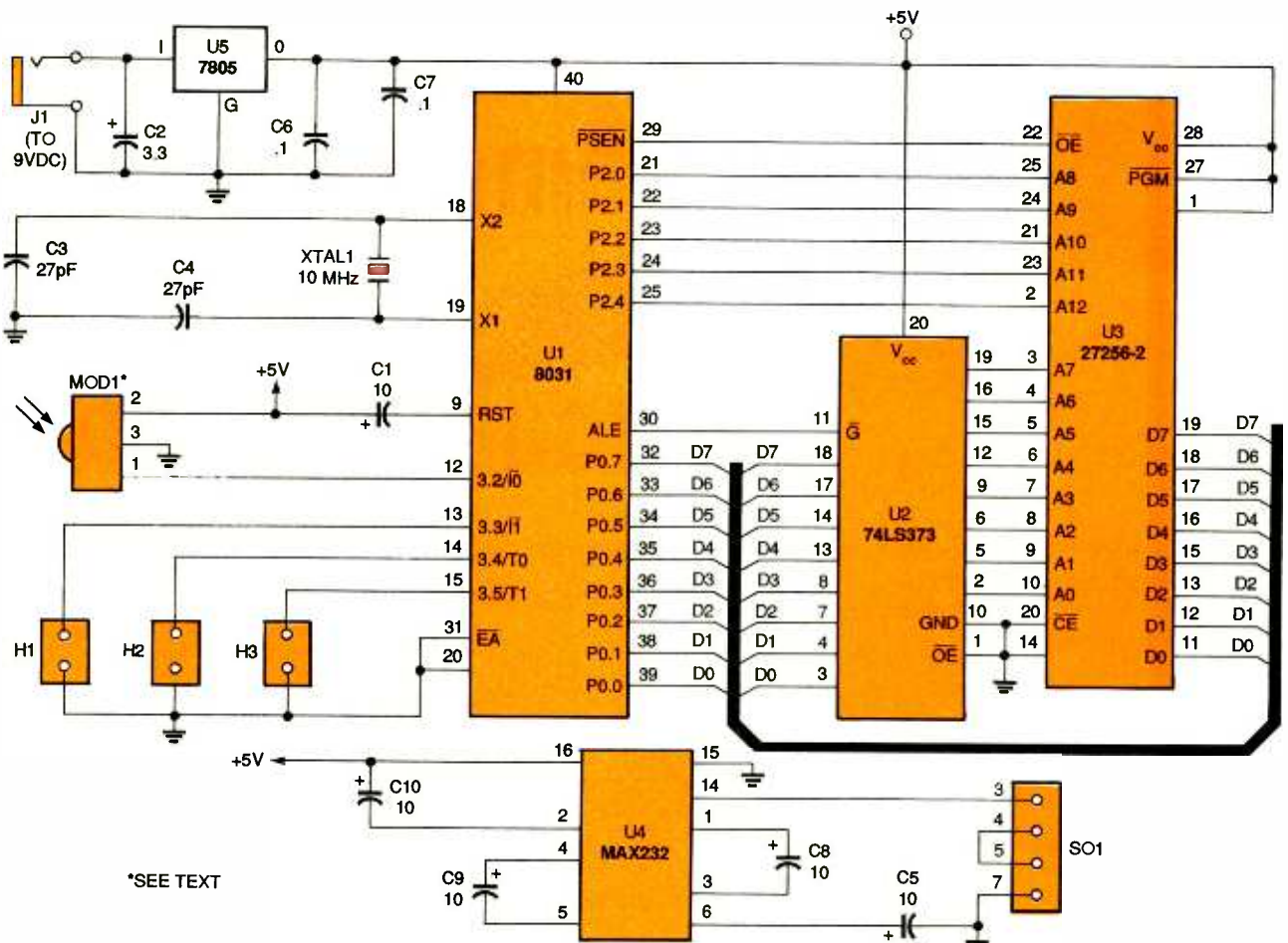


Fig. 1. As this schematic shows, the Remote-Control Interface has a relatively low parts count. That is made possible by the configuration of the 8031 processor (U1) and the EPROM (U3), which allows for efficient processing of IR signals that are received by the IR module, MOD1.

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REMOTE
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000011
11111111 11111111 11111111 11000001 11000001 10000011 10000011 00000111
00000110 00001111 11111100 00011100 00111111 11111000 01111111 11110000
11111111 11100001 11111111 10000011 11111111 00000111 11111110 00001110
00001111 11111100 00011000 00111111 11110000 01110000 11100000 11111111
11000001 11000011 10000011 10000111 11111111 00001110 00001111 11111100
00011111 11111000 00111000 01111111 11100000 11111111 11000001 11111111
10000011 11111111 11111111 11111111 11111111 11111111 11111111 11111111
11111111 11111111 11111111 11111111 11111111 11111111 11111111 11111111
11111111 11111111 11111111 11111111 11111111 11111111 11111111 11111111
11111111 11111111 11111111
LOCAL
Power key - Toshiba TV remote

Chat Mode - Press ESC to end

```

Fig. 2. Here's a typical analyzer-mode data block. It was captured on a PC, using PROCOMM in chat mode. Zeros represent the "ON" carrier condition and ones represent carrier "OFF," or no signal. Each character position represents 150 microseconds of time.

SO1 connects to ground.

The IR-detector module should be mounted at the edge of the board, so that it can be exposed to IR signals

through a hole in the project case. The Radio Shack detector module specified for MOD1 is readily available, but you could remove the re-

mote detector from a junked VCR or television and use it on the board instead. Of course, figuring out the wiring for that approach is up to you.

The 7805 regulator, U5, needs to be mounted on a small heat sink. Use IC sockets for the other four integrated circuits. Also, when laying out the placement of the components, make sure that the 10-MHz crystal, XTAL1, is located near U1 (in other words, the amount of wire connecting the two should be kept to a minimum).

Power-jack J1 should be mounted to the side of the project enclosure. Make sure that the jack you use for J1 matches the plug on your AC adapter. Any adapter that produces 9-volts DC at 500 mA will work fine.

When installing the three 2-pin headers, H1-H3, you might want to label them to make it easy to tell which is which. That is important because to use the different modes of the Remote-Control Interface, you will have to use certain jumper configurations

on each of the headers. Mistaking one header for another will result in the unit being set improperly.

Firmware Operation. The EPROM (U3) in the Remote-Control Interface uses firmware with three modes of operation for interpreting the data stream. The firmware was written in 8031 assembly language, using the CROSS-16 meta assembler from Universal Cross Assemblers, and can be obtained on disk from the source

PARTS LIST FOR THE REMOTE-CONTROL INTERFACE

SEMICONDUCTORS

- U1—8031 microprocessor, integrated circuit
- U2—74LS373 octal latch, integrated circuit
- U3—27256-2 EPROM, integrated circuit
- U4—MAX232 TTL to RS-232 converter, integrated circuit
- U5—7805, 5-volt regulator, integrated circuit

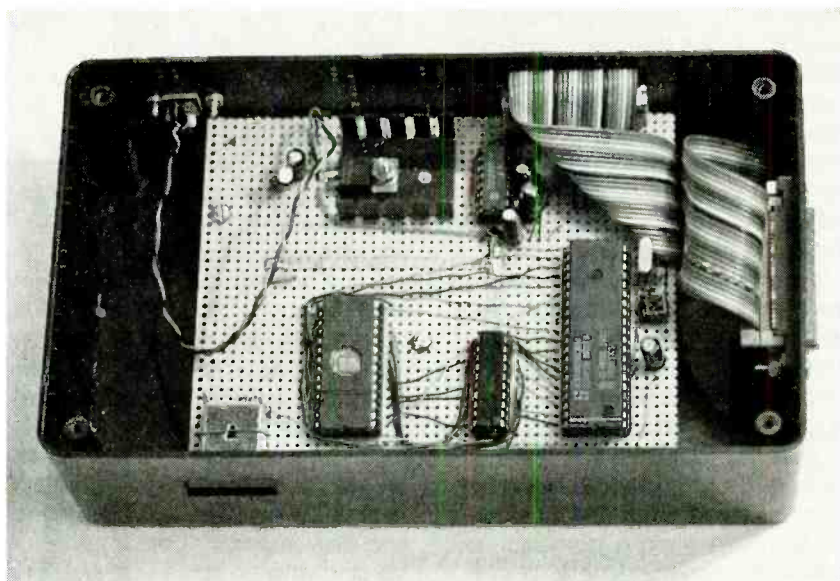
CAPACITORS

- C1—10- μ F, 16-WVDC, electrolytic
- C2—3.3- μ F, 25-WVDC, electrolytic
- C3, C4—27-pF, ceramic-disc
- C5, C8—C10—10- μ F, 35-WVDC, electrolytic
- C6, C7—0.1- μ F, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

- MOD1—Infrared-detector module (Radio Shack #276-137 or equivalent)
- XTAL1—10-MHz crystal
- H1—H3—2-pin header
- SO1—DB25S connector
- J1—Power jack (should match AC-adaptor plug)
- Perfboard materials, enclosure, 26-pin board-mount header with matching IDC connector (optional), 26-conductor ribbon cable (optional), AC adapter (9-volts DC, 500 mA), wire, solder, hardware, etc.

Note: The following are available from Stuart Ball (741 Okie Ridge, Yukon, OK 73099): a 5.25- or 3.5-inch disk (please specify which) containing the firmware source code and hex files for the Interface—\$11.50; U3, programmed with the code, is available for \$15.00. Oklahoma residents, please add appropriate sales tax.



The author's prototype was built on a perforated board, using point to point wiring. As you can see, the DB25S connector is attached to the board with a ribbon cable.

mentioned in the Parts List, or can be downloaded from the Gernsback BBS (516-293-2283). A pre-programmed EPROM is also available from the source in the Parts List.

The first mode of operation is called the "analyzer mode." In that mode, the firmware waits for a signal from the remote unit, then begins sampling the data stream every 150 microseconds. After 100 milliseconds of data has been sampled and stored, it is converted to ASCII for transmission to the PC. Spaces are inserted every eight characters, and a carriage return/linefeed sequence is sent after 72 characters. That mode is intended for use in decoding the format of an unknown remote.

Figure 2 shows a typical analyzer-mode data block. That data was captured on an IBM-compatible PC, using PROCOMM (a communications program) in chat mode, then printed with the "print screen" function. In Fig. 2, zeros represent the "on" carrier condition and ones represent carrier "off," or no signal. Each character position represents 150 microseconds. The sync signal is on for 9.3 microseconds (61 continuous on samples) then off for 4.5 microseconds (30 continuous off samples). That is followed by a 1-microsecond zero bit (five on samples, three off samples), then another zero, then a 2.2-microsecond one bit (five on samples, ten off samples). The complete data pattern for that example is as follows:

```
Sync 0000 0100 1111 1101 0100 1000
1011 0111
```

When interpreting data in analyzer mode, remember that the Interface samples at 150-microsecond intervals. Therefore, the data has a resolution of 150 microseconds. In the example shown, some of the zero bits have an off/on pattern of 5/3, others have a pattern of 5/2, 4/3, etc. The one bits have a similar ambiguity. To find the actual bit timing of an unknown remote, average the patterns over several bits.

The second mode, the "encode mode," receives IR data and parses it into a single data byte for the PC. The IR format has 22 bits, with 1.6- to 3.3-microsecond bit times. A single output byte is generated by exclusive-OR'ing the incoming data bytes. The data is not an even multiple of eight bits, so the trailing bits are padded with zeros for inclusion in the final sum.

The third mode, the "decode mode," receives IR data and parses it into four bytes to the PC. That data format is 32 bits, with a 1.2- to 2.2-microsecond bit time. That is the format illustrated (in the analyzer mode) in Fig. 2. In decode mode, the example shown in Fig. 2 would result in the sequence 02FD48B7 (h) being transmitted to the host computer.

In the first two modes, the Interface looks for a valid sync bit to begin the data stream. Each received bit generates an interrupt to the 8031 pro-

cessor, U1. The first bit, presumably the sync bit, causes the internal timers to start. If the time to the next interrupt is correct for a sync bit, then the time between the following interrupts is measured. The one/zero threshold is determined by the time between bit edges. Time is measured using one of the 8031's internal timers.

In all three modes, data is sent to the PC at 1200 baud. The baud rate is controlled by one of the internal 8031 timers, and can be adjusted by changing the firmware. In a typical application, software in the PC would receive the ASCII data from the Interface, and perform some operation (change screens in a VGA slide show, for example) when a particular key was pressed on the remote.

The Remote-Control Interface can be switched between operation modes by changing the jumper configuration on two of the two-pin headers, H1 and H2. Header H3 is unused in the present version of firmware. However, if you obtain the source code on disk, you could change the setup of EPROM U3 to have H3 accommodate another mode. The first two headers are encoded as follows:

When H1 is shorted with a jumper, the Interface is set in analyzer mode and H2 is ignored. If H1 is open, the unit is set into either the second (encode) or third (decode) mode, depending upon the jumper configuration of H2. If H2 is shorted, the unit will have a data format of 22 bits, with a 1.6- to 3.3-microsecond bit time (which is the second mode). If H2 is open, the Interface has a 32-bit data format, with a 1.2- to 2.2-microsecond bit time (the third mode).

Use and Setup. To use the Interface, first determine which data format is used by your remote controller, using the Interface's analyzer mode. Use a serial cable to connect the Interface to a serial port on your computer. The Interface will send either a single hex byte (two ASCII characters) or four hex bytes (eight ASCII characters) for each key that is pressed on the remote controller.

Note that the Interface only sends data to your serial port. To interpret that data and have it actually do something, you will need to either write or acquire software that will do so. With a little trial and error, you

should be able to figure out what key sends what codes to the PC. Once you have that figured out, assigning software functions to each key becomes easier. Because the Interface does no error-checking on the data it receives and sends, you must make sure that your software rejects any unknown codes it receives.

Once you have determined what key does what on your remote, you will have to label the remote so that you can remember the functions. Obviously, this project is meant for use with an off-the-shelf remote. Many remotes use a sheetmetal cover with the key descriptions. If that is carefully removed, the cover can be repainted and new legends applied with dry-transfer lettering. Or, if you are very careful about masking the keys, you might be able to paint and re-label the panel without removing it.

Applications. Remote control of a multimedia presentation or a software demo is probably the most practical use of the Interface. Normally, when a piece of software is demonstrated to a large group, everyone wants to crowd around the screen but the person demonstrating it must be near the PC and the keyboard. With an IR remote controller and the Interface, software demos, as well as multimedia presentations and slide shows, can be controlled.

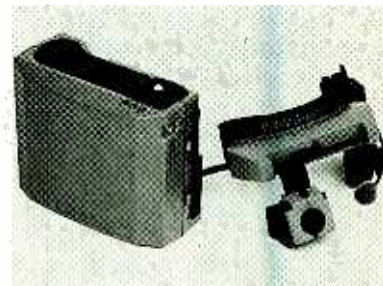
Here's a possible application of the Interface in education: If you have a remote controller with a 0-9 keypad, you could use the Interface and an on-screen calculator program to demonstrate math problems to a classroom of elementary students. Of course, the keys which perform mathematical functions will have to be marked as such; for example, the STOP button could be the one that performs addition (if no key on the remote creates the code for a "+" sign, then the calculator program would have to be altered to accept another character to cause it to perform addition). If the numbers displayed and the monitor are large enough, an entire class should be able to see.

You can use almost any piece of software with the Interface, as long as the software has a reasonable number of possible commands (the remote should have enough buttons to accommodate them). ■

MOBILE ASSISTANT

(Continued from page 31)

Mobile Assistant could replace labor-intensive procedures that now use handwritten entries on a clipboard, which must be then manually key-punched into a remote computer. Instead an inspector could speak information into a microphone that is connected directly to the belt-mounted computer.



The canteen-size, IBM-compatible, belt-worn computer weighs only 2¾ pounds. It currently packages a 486-50 MHz processor, and a 340-MB internal hard drive.

The Future. Computer Products and Service Inc. is already working on a second-generation Mobile Assistant that has increased computing power, weighs less, has improved battery life, and is less costly. Currently, the basic Mobile Assistant system costs \$10,000. With peripherals and options, it can have a bottom line of \$17,000 or more.

Due in late 1996, the new system is expected to feature a faster CPU running at from 75 to 120 MHz, plus built-in multimedia and communications capabilities. More PCMCIA slots and special communication antenna ports will be added. Increased storage on hard drives is planned, with up to 1.5 GB anticipated. Weight and size will decrease by 40 percent. A full-color VGA display is also being planned. ■

FOR MORE INFORMATION

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22-WATT AMPLIFIER

(Continued from page 29)

the source mentioned in the Parts List). Though it might get tedious trying to line up and insert the IC1 pins in the PC board with the heatsink attached, this is easier than trying to align the mounting holes in the heatsink for mounting to IC1 with the latter already soldered to the PC board. Pre-drill the mounting holes in the heatsink to match those on IC1.

Apply a thin layer of heatsink compound to the back of IC1; then use two #6 screws and nuts to attach the heatsink. Screws should be snug but not over-tightened as this can damage the IC. Clean away any excess heatsink compound; then install and solder the IC1 pins into the PC board. Note the placement of pins 1 and 17.

Visually inspect for and remove any solder bridges, cold-solder joints, etc. Tight places to watch for solder bridging are around pins 2-5 and 13-15 on the IC. Refer to Figs. 2 and 3 if in doubt as to whether foils and parts should be touching or not. After the circuit passes a strict visual inspection, you can proceed to put the circuit in an enclosure.

While either a metal or plastic enclosure can be used to house the Amplifier, you should be sure that it is well ventilated to allow the heatsink to do its job. Keep in mind that even though plastic boxes are usually cheaper, metal boxes offer better shielding and durability in harsh environments. An LED in series with a 1000-ohm resistor can be added into the circuit (tack soldered onto the V+ foil trace and ground) to serve as a pilot light indicating when the unit is powered up. There is no provision on-board for a fuse, but a 7½ to 5- to 10-ampere fuse in the power line to the Amplifier is highly recommended.

Connections. Attach the Amplifier to your car stereo as follows. First attach the line-level signal source from the stereo to the inputs on the board. Speaker-level signals from car radios will work if they are single-ended rather than bridged. The way to determine this is by checking the loudspeaker outputs at the back of the radio. If there is a common ground

and one lead per loudspeaker, it is a single-ended output. If there are two leads per loudspeaker coming out of the radio and neither lead is common to ground, it is a bridged output and should not be connected directly to the Amplifier. If you do, you will effectively short half the bridge out and probably damage the radio.

Next connect one pair of your car's speakers to the Amplifier. As we mentioned earlier, for two pairs of speakers, you should build two Amplifiers. Heavy-duty, 6- x 9-inch, three-way, four-ohm, oval loudspeakers are a good match for the amplifier. While it may be tempting to use existing, factory-installed loudspeakers, there are two things that require caution. First, many systems do not use the BTL output configuration and may therefore have only one lead going from the radio to the loudspeaker. The other loudspeaker lead may be grounded to the loudspeaker frame.

Another concern is the power-handling capability of the existing loudspeakers; they need to be rated for at least 20-watts RMS. In spite of the rating (in watts), small loudspeakers can only generate a limited amount of sound. Within reason, bigger is usually better, especially for bass response (bass response falls off sharply as loudspeaker size decreases, particularly at higher listening levels). This amplifier will drive a pair of bookshelf loudspeaker boxes (10-inch woofer, 4-inch mid-range, and a dome tweeter, for instance) just fine, but that type of loudspeaker box is usually impossible to mount in a car. The amplifier will drive eight-ohm loudspeakers, but will deliver more power into four-ohm loudspeakers. Most automotive loudspeakers are four-ohm, but check yours to be sure.

Finally, make the +12-volt power and ground connections between the Amplifier and your car's electrical system. Test the sound system to make sure it works, and then secure the Amplifier in place. The location of the unit is entirely up to you, but most people like to keep amplifiers in the trunk.

With good front and rear speakers, two of these Amplifiers will provide excellent sound and lots of power. Performance will be as good as commercial units in this power range and better than cheap units rated at "peak" power. ■

AUTOMATIC HEADLAMP

(Continued from page 38)

against engine heat, rain, snow, and road hazards.

Splice the wire connected to the cathode of D3 to the low-beam wire of either headlamp. Do that by removing a small amount of insulation from the low-beam wire and wrapping the other wire around it. Apply solder for a good connection and then insulate it thoroughly with plastic electrical tape. The lamp has three wires for either high beam, low beam, or ground. Be sure to properly identify the low-beam wire. If in doubt, use a voltmeter to check which wire is hot when the low beams are operated by the instrument panel switch.

The free connection of the fuse holder (the side not connected to the source of Q1) should be connected to the positive side of the car battery. Many vehicles have two wires at this location, one for the starter and the other for the electrical system. Choose the smaller of the two wires. Solder and insulate the connection with tape.

Locate the selected windshield wiper lead as described earlier, connect it to the Control module as shown in Fig. 8A or Fig. 8B, depending on which configuration applies (again, as described earlier). Then connect the remaining wire of the module, +12V wipers or circuit common, to either the windshield-wiper-motor +12-volt source (which is switched off with the ignition key) or the vehicle chassis (ground) as required.

Replace the ground connection on the vehicle's battery. Tighten the screws or nuts securely. This completes installation of the control module.

Final Checkout. Testing the circuit at this point is simple. Start the engine of your vehicle and turn on the windshield wipers. Check the headlamps to verify that they are illuminated, but not at full brightness. Verify that the headlamps stay lit for each of the speeds of the wipers.

Turn off the windshield wipers. The headlamps should be extinguished. This completes the final checkout. You and your vehicle are now ready to go! ■

DIGITAL CAMERA

(Continued from page 10)

many other "regular" cameras, and many of the same old familiar features are still there. An LCD panel on the back of the camera indicates the resolution setting, flash mode, auto-focus mode, battery level, zoom mode, number of pictures taken, number of pictures remaining, timer status, erase mode, data copy mode, and whether a memory card is installed or not. The number of pictures taken and remaining also reflects whether or not a memory card is installed.

The viewfinder of the 10-C looks much like any other modern camera. Looking through the viewfinder you'll see close-up compensation brackets for different types of pictures and the auto-focus target mark (the spot that the camera will normally focus on). When the shutter button is pressed halfway down, the camera will auto-focus; the picture is taken when it's pressed all the way down.

The 10-C has different auto-focus (AF) modes for different situations. A multi-AF mode is used when the subject is not in the center of the picture. In this mode the camera uses multiple infrared beams to focus the lens. A spot AF mode is used when the subject is smaller than its surroundings; in this mode the camera will focus on the "spot" at the center of the lens. A focus lock feature allows you to focus on something and have the camera hold that focus as you reposition it.

The camera's 3x zoom lens can be used manually to move in and out as you prefer, or it can be set to work automatically in the program zoom mode. In this mode the camera zooms in automatically depending on the size of the subject and the distance to it. A macro mode lets you position the camera about 19 inches from the subject for close-up work.

The flash also has three modes. In the auto-flash mode, the flash will come on when it's necessary. The fill-flash mode is best used when the camera needs additional lighting, like when the subject is darker than its surroundings. A no-flash mode can be used when you don't want the flash at all. One last neat feature is the camera's built-in timer. This lets you set up a

picture and have enough time to get in the picture yourself before the shutter clicks.

Software. The Dycam 10-C comes with all the software you need to import, view, manipulate, and save images. A supplied cable connects the camera to a serial port on the computer. The software first imports data from the camera and then shows you thumbnails of the pictures. You then select images you want to load. Images can be saved in many different formats, including BMP, TIFF, JPEG, and more.

The software also lets you adjust the images to correct for various problems. Images can be sharpened, resized, cropped, color adjusted, and more. Of course you can also manipulate the images to your heart's content with your favorite photo-retouching software. The Dycam software also lets you control the camera from the computer if you need to.

Accessories and Limitations. As mentioned before, the 10-C camera has a threaded collar around the lens that lets you add on other lenses and filters. However, the camera is a viewfinder type, and not an SLR (single-lens reflex). This means that you look through a different lens than the picture is taken through. Therefore, the effect of any add-on lens or filter can only be seen in the final picture. However, pictures taken with this camera are essentially free, so you can experiment all you want without spending any money on bad pictures.

We tested out two accessory lenses, a close-up set and a wide-angle lens. Both are available from Dycam for \$89 each. The wide-angle lens gives nearly a fish-eye view of the world, and allows you to get a large scene in view without being too far away. The fish-eye effect can be removed by cropping and manipulating the final image. The close-up set is a series of three lenses that can be stacked to create the desired effect.

Unfortunately, the Dycam 10-C is not ideally suited for close-up work. Detail level in the electronic image is not equal to a conventional photograph, and detail is usually what you want to see in a close up. For example, the pictures you see in this magazine of PC boards and ICs close up could

not be taken with the 10-C. Actually they could be taken, but they wouldn't be clear enough to be reproduced here. For the most part, any picture you could take with a non-professional 35-millimeter camera could also be taken with the 10-C.

If you already own a computer and happen to take a lot of photographs, then the Dycam 10-C will be a handy investment. Even if you are not interested in a digital camera now, you soon will be—you'll have no choice. At some point the quality and prices of electronic cameras will be close enough to conventional ones so that the savings on developing and film will be more than enough to make the purchase worthwhile. In the meantime, owning an electronic camera will allow you to do things that are impossible with a regular camera. ■

FOR MORE INFORMATION

Dycam, Inc.
9414 Eton Ave.
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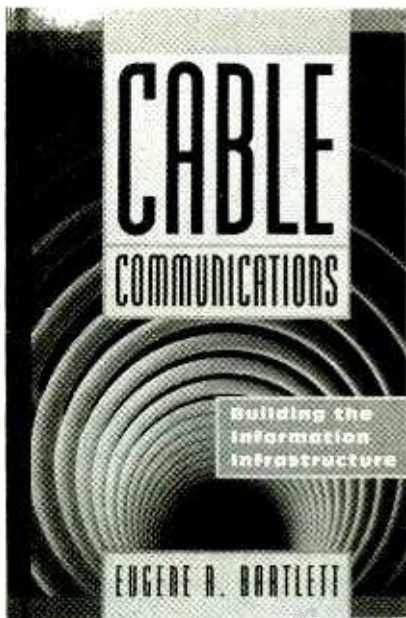
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CABLE COMMUNICATIONS: Building the Information Infrastructure

by Eugene R. Bartlett

This book explores the many technologies now merging into the "information superhighway," with a focus on the cable systems that will form the backbone of the highway. The book not only analyzes the systems that are currently in place, but also reports on those in development. It provides in-depth discussions of the work required to interconnect and bridge the many systems into a complete information network.



Written in easy-to-understand language with a minimum of technical jargon, the book covers both video and audio technology in detail. It examines a wide range of important considerations, describing the types of cables and wires being used, demonstrating cable-system transmission and control methods, investigating cable-system signals sources, and showing how to maintain and improve the information highway. The book also explores the role played by the information highway in global telecommunications.

The book features full coverage of everything from non-conductive cables to coaxial cable systems, from tele-

phone signals and message traffic to hard-wire controls, from fiber-optic computer data systems to commercial applications, and from personnel education and training to the present status of the information highway in the world marketplace. A number of helpful appendixes cover such aspects as wire-loop resistance, the velocity of propagation, broadband noise combining, frequency testing, satellite ground-station pointing, and SONET networks and testing techniques.

Cable Communications: Building the Information Infrastructure costs \$50 and is published by McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 800-2-MCGRAW. **CIRCLE 90 ON FREE INFORMATION CARD**

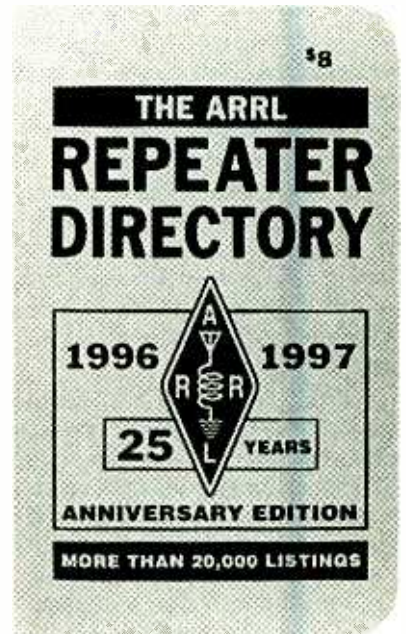
THE ARRL REPEATER DIRECTORY 1996-1997

from the American Radio
Relay League

Amateur-radio enthusiasts will be hard-pressed to find more information packed into a pocket-sized source than the over 20,000 listings contained in this book. The 25th Anniversary Edition of the Repeater Directory features many more coordinated repeaters than were found in previous editions and more FM listings as FM has become an increasingly popular mode of operation for the amateur-radio operator of the 90s.

The handy reference manual includes repeater locations, frequencies, and other pertinent data for the United States, Canada, and (where available) the Caribbean, Central and South America, Pacific Islands under U.S. jurisdiction, and parts of Europe. It provides readers with the information they need to contact Frequency Coordinators and regional members of the American Radio Relay League (ARRL) Spectrum Management Committee and Digital and Future Systems Committees. In addition, it features listings of packet radio systems and worldwide propagation beacons. A national listing of ARRL Special Service Clubs includes their meeting times, locations, and contact persons.

The ARRL Repeater Directory



1996-1997 costs \$8 and is published by The American Radio Relay League, 225 Main Street, Newington, CT 06111-1494; Tel. 860-594-0200; Fax: 860-594-0303; e-mail: pubsales@arrl.org; Web: <http://www.arrl.org/>.

CIRCLE 91 ON FREE INFORMATION CARD

BUILDING A 3D GAME ENGINE IN C++

by Brian Hook

Most game-programming books hand you a finished game engine—locking you into someone else's design from the beginning—and then tell you how to add on a few features. It's easier to present a finished product than to explain everything that developers need to understand about game programming.

This book takes the opposite approach. It gives you all the technical details and know-how, along with insider's shortcuts and tricks-of-the-trade. It shows you how to build your own custom engine from scratch, using AST3D, a powerful 3D graphics library that is included on the companion disk. The disk also includes source code for Borland and Watcom C++ compilers and an original 3D game engine that you can use to create your own games.

Together, the book and disk allow



you to build the game you want, without having to pay a licensing fee. You'll learn how to design and develop professional-quality games, including 3D graphics games; implement collision and boundary detection; and create "intelligent" entities using artificial-intelligence algorithms.

Building a 3D Game Engine in C++ costs \$34.95, including disk, and is published by John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012; Tel. 800-CALL-WILEY; Web: <http://www.wiley.com/cobooks/>.

CIRCLE 92 ON FREE INFORMATION CARD

INTERNET SECURITY FOR BUSINESS

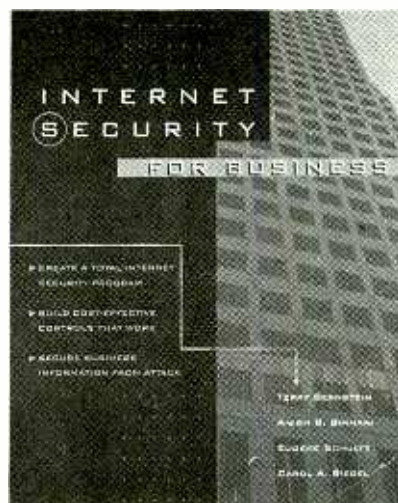
by Terry Bernstein, Anish B. Bhimani, Eugene Schultz, and Carol A. Seigel

Businesses set up Web sites specifically to encourage people from around the world to visit, browse, and retrieve product information. But by creating an Internet presence, they also open the door to some unwanted visitors—some with mischievous or malicious intentions. How can potential troublemakers be weeded out?

This book provides business and managerial perspectives on why, when, and how to implement Internet security controls. Written for the manager who needs to understand the dangers that lurk online, the book outlines a complete program for securing a full range of Internet and Intranet services, including firewalls, electronic commerce, encryption and digital signatures, e-mail, and Internet news service. It also contains easy-to-follow

guidelines on how to educate and train employees to identify and respond to almost any breach of security, both internal and external.

Internet Security for Business costs



\$34.95 and is published by John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012; Tel. 800-CALL-WILEY; Web: <http://www.wiley.com/compbooks/>.

CIRCLE 93 ON FREE INFORMATION CARD

GETTING STARTED IN PRACTICAL ELECTRONICS

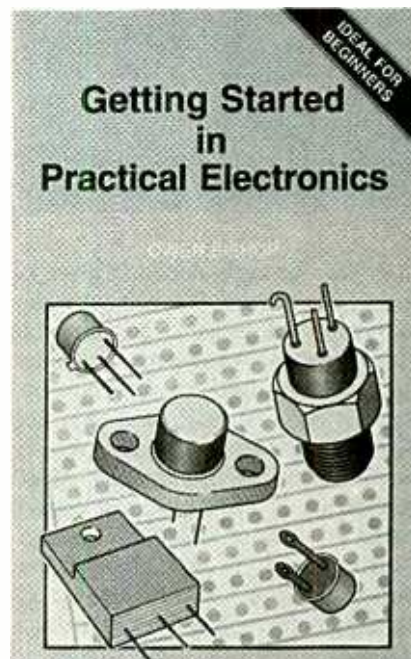
by Owen Bishop

Electronics can be a fascinating hobby and a good career choice—but its technical nature and jargon makes it intimidating for newcomers. This book strives to answer all of the questions that beset beginners, from defining the terminology to explaining how to use a soldering iron. Rather than discussing electronics theory and application in cut-and-dried text, the book uses hands-on projects and experiments to illustrate electronics concepts. Readers learn while doing.

The book is divided into two parts. The first part, aimed at absolute beginners, explains everything needed to build the 30 projects presented in the second part of the book. The opening section describes what electronic components look like, how to handle them, what to ask for when buying them, and what they do. It shows readers how to understand circuit diagrams, how some simple circuits work, and how to perform simple calculations needed to make circuits work as you want them to.

It also describes several different construction and troubleshooting techniques.

The 30 projects in the second section of the book are divided by degree of difficulty into three chapters. All of the projects are powered by battery, so the beginner is in no danger from electric shock. Printed-circuit designs are included.



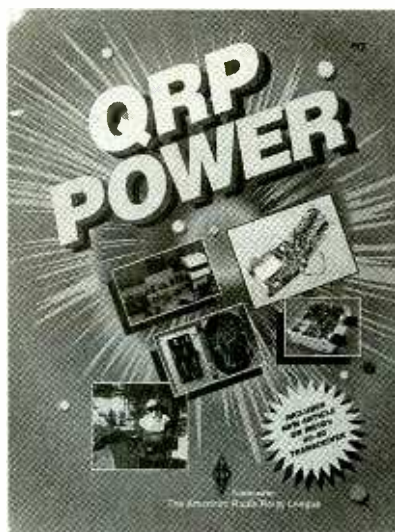
Getting Started in Practical Electronics (Order No. BP345) costs \$5.95 plus \$3 shipping and handling and is published by Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.

CIRCLE 94 ON FREE INFORMATION CARD

QRP POWER!

compiled by Joel Kleinman, N1BKE, and Zack Lau, KH6CP/1

A QRP station, by definition, is one that runs on 5 watts or less. Thousands of ham-radio enthusiasts know that it really isn't that hard to work the world on 5 watts—or 200 milliwatts, for that matter. Although it's a challenge to run on low power, QRPers gladly embrace the task. They enjoy the feeling of accomplishment attained when they make worldwide contacts using less power than it takes to light a tiny bulb. Operating savvy, antenna efficiency, and patience take the place of raw power.



Written for experienced QRPers as well as newcomers, this book provides everything you need to get the most out of low-power operating. It contains the best recent QRP articles from publications such as *QST*, *QEX*, and *The ARRL Handbook*, as well as a new, in-depth article on the popular 40-40 transceiver. The articles cover current trends in amateur low-power communications, and present projects that readers can build themselves, including a 40-meter regenerative receiver, a one-watt transmitter, and circuits to modify existing rigs.

QRP Power costs \$12 and is published by The American Radio Relay League, 225 Main Street, Newington, CT 06111-1494; Tel. 860-594-0200; Fax: 860-594-0303; e-mail: pub-sales@arrl.org; Web: <http://www.arrl.org/>.

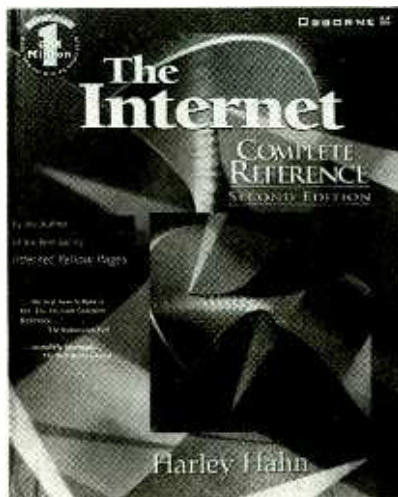
CIRCLE 95 ON FREE INFORMATION CARD

THE INTERNET COMPLETE REFERENCE: Second Edition
by Harley Hahn

This book is intended to serve as a guide and a companion on your every journey into the Internet. Written in a friendly, first-person style, the book reassures and entertains readers, without insulting their intelligence. By learning how the Internet and its visual component, the World-Wide Web, work together, readers learn how to navigate both with confidence.

The book is organized to make mastering the Internet and the Web a

logical, comfortable process. It explains what is needed to connect to the Internet, how to communicate with people around the world using e-mail, chat rooms, IRC, and MUDs; and how to use browsers to access a variety of Internet resources, such as gopher, FTP, Usenet, telnet, and e-mail. Extensive Web coverage describes what the WWW really is and how to use it; Web Pages and Home Pages; URLs; links, forms, and image maps; and Web directories and Search Engines. A 200-page directory to Internet resources is included. Throughout the book, icons alert readers to pertinent information that can be quickly referenced in catalog listings.



The Internet Complete Reference, Second Edition costs \$32.95 and is published by Osborne/McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710; Tel. 800-227-0900.

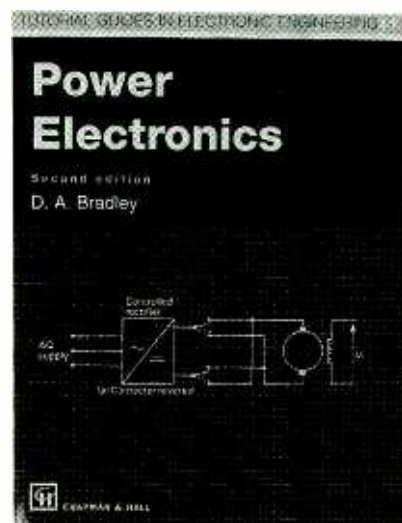
CIRCLE 96 ON FREE INFORMATION CARD

POWER ELECTRONICS: Second Edition
by D. A. Bradley

Although power electronics is a rapidly expanding field, it is often not given in-depth coverage in engineering classes. This tutorial guide to power electronics is designed to fill that gap for undergraduate students at the first- or second-year level.

The book provides complete coverage of the field of power electronics, beginning with a discussion of the operational characteristics of various devices and ending with a summary of

complete power-electronics systems. It reviews the design and operations of both AC converters and DC systems. Numerous worked examples, exercises, marginal notes, and references reinforce the main text.



The second edition contains an extensive update of the original book, along with a new chapter on power supplies. The worked examples have also been revised and updated. The book offers a timely analysis of micro-computer applications, coverage of control algorithms, and case studies obtained from a number of manufacturers.

Power Electronics costs \$25.95 and is published by Chapman & Hall, One Penn Plaza, 41st Floor, New York, NY 10119.

CIRCLE 97 ON FREE INFORMATION CARD

THE REVOLUTIONARY GUIDE TO VISUAL BASIC 4 PROFESSIONAL
by Larry Roof

Written for experienced programmers who are moving to Visual Basic 4.0 (VB4) Professional release (32- or 64-bit) from either 3.0 or another development tool, this book assumes a good knowledge of the fundamentals of Visual Basic and of programming in general. The book focuses on four key areas for developers using VB4: the Win32 API, Objects and OLE, Databases, and the VB development cycle. Each area receives in-depth

continued on page 63

DOS or Windows or Both?

BY JEFF HOLTZMAN

Windows 95 was supposed to solve the problem of running DOS applications and games under Windows. In my experience, it hasn't. So here's how you can have your cake and eat it too. Even though there is no DOS in Win95 (wink, wink), Win95 still responds to most of the commands used by DOS 6 to customize the way a given machine boots.

By using those commands, you can simultaneously: Set up your machine to run either "DOS" or Win95, and optimize usage either way. The benefits will be better system stability and more efficient operation. Another benefit is that you'll be able to run Win95 from the command line, and return to the command line to do something else if necessary.

What we'll do is set up your system so that it boots to a "DOS" prompt. Of course, if you issue the VER command at that prompt, you'll see something like the following:

```
C:\>ver  
Windows 95. [Version 4.00.950]
```

Actually, we won't necessarily boot to a DOS prompt. We'll use the CONFIG.SYS menu system supported in DOS6 and Win95 to create machine configurations optimized for different environments (for example, running DOS games or running Win95). And best of all, you can extend the techniques shown here to add other configurations.

OVERVIEW

What we're going to do is edit several of Win95's system-configuration files. There are numerous ways to make your system non-bootable if you're not careful, so carefully follow these steps before doing anything else.

Within Win95, create a boot diskette using Win95's My Computer, Control Panel, Add/Remove Programs, Start-Up Disk.

Still within Win95, start a DOS box. Copy the following files from C:\ to the boot diskette: CONFIG.SYS, AUTOEXEC.BAT, MSDOS.SYS. Note

that all three are text files. However, MSDOS.SYS may not show up in a normal directory listing, because it's normally a hidden file. Therefore, you can issue the command:

```
C:\>dir /a
```

to see all the files in a directory. Then you can use the ATTRIB command to make MSDOS.SYS accessible as follows:

```
C:\>attrib -r -h -s msdos.sys
```

Copy the file to the boot diskette; then add or edit the Options section of the file to include the following, making sure you don't delete anything, especially all those lines full of x's.

```
[Options]  
BootGUI=0  
Logo=0
```

Save the file. Now rename CONFIG.SYS and AUTOEXEC.BAT to anything you want. Close the DOS box, and shut down Win95, forcing it to restart the computer.

After the computer reboots, you'll see the usual "Starting Windows 95..." message, and then find yourself at a pure "DOS" prompt. Since you booted with no AUTOEXEC.BAT, you won't have much of a path, and obviously there will be no device drivers.

Now create a new CONFIG.SYS with contents as follows:

```
[menu]  
menulitem=DOS, DOS (games)  
menulitem=Windows, Windows 95  
menuDefault=DOS, 10
```

```
[Common]
```

```
[DOS]
```

```
[Windows]
```

Yes, the [DOS] and [Windows] sections are empty for now. We just need them there so the menu system will work

properly. Later on, we'll add real-mode device drivers to the DOS section, and anything else you might require to the Windows section. Items listed in the [Common] section will be executed by all defined configurations.

Now create a new AUTOEXEC.BAT as follows:

```
@ECHO OFF  
Echo Processed by both DOS and  
Windows!  
goto %config%  
  
:DOS  
Echo DOS!  
goto END  
  
:Windows  
echo Windows  
  
:END
```

Note the environment variable %config%. It contains a text string corresponding to the choice you made at boot time. Anything in AUTOEXEC.BAT before the GOTO %config% will be executed by both configurations. Note the GOTO in the DOS section. It is required to skip over the commands in the Windows section. Otherwise those commands would get executed too. Most people deplore the use of GOTO statements in any type of programming, but DOS's (oops—I mean Win95's) batch language is so wimpy that there's no choice.

Now reboot. If you've typed everything correctly, you should see a menu that allows you to select DOS or Windows. Then, by inserting the appropriate device drivers and utility programs in the corresponding sections of the new CONFIG.SYS and AUTOEXEC.BAT files, you'll have an optimized multi-boot setup.

For example, the files I use on my kids' machine appear in Listing 1 and Listing 2. In CONFIG.SYS, note that the DOS sections load real-mode (DOS only) drivers for a sound card and a CD-ROM. The Windows sections load

continued on page 79

HAM Radio

Winter Ham Activities

BY JOSEPH J. CARR, K4IPV

Now that it's the dead of winter, what do you do? Of course, if you live in southern California or around Tucson, Arizona you can snicker at the idea that summer and winter are substantially different. For most of the nation, however, winter brings a deep freeze.

Speaking of cold weather, our cars (or mobile rig transportation units) are often difficult to start. I had a ham uncle, now deceased, who lived in the Midwest in an area where temperatures of -30 degrees were not uncommon. Car batteries don't crank well at very cold temperatures. Add to that the problem of the thick, viscous oil in the engine requiring more current to overcome, and the result is a deeply disappointing attempt to get moving (*rah-rah-rah-splutzz* is not exactly the sound that I want to hear from my car's starter).

Uncle Julian taught me a little trick that seems to work well in cranking a cold automobile engine. Turn on the headlights on high beam, as well as the interior lamps and the radio, for about five minutes prior to starting the engine. Right before you crank, turn all that stuff off and then turn the key. The reason batteries don't work so well cold is that their internal resistance goes up at those temps. But turning on the lights and a few other things for a few minutes draws enough current to take the edge off the battery's deep freeze. While it may not be up to April efficiency, it's a lot better than cold cranking that darn battery. I've tried it a few times, and it seems to work quite well.

Of course, one way to keep warm and enjoy hamming in winter is to operate a bunch. You will find that the HF bands get real interesting this time of year. Go tune around 40-meters between 0000L and 0500L and see what's there (or hear what's there as the case may be). A lot of far eastern stuff rolls in during those hours. It is relatively easy for you to hear Japanese, Australian, and New Zealand stations during the wee hours.

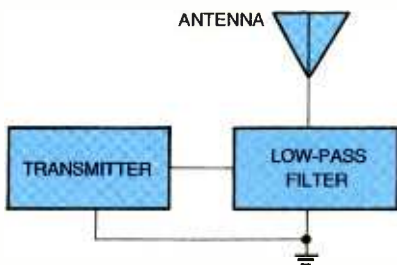


Fig. 1. Here's how to insert a low-pass filter to kill harmonics from your transmitter.

But winter storms bring down antennas, and the climate isn't well suited to putting them back up, so operating may be terminated. For those nights, you might want to try something else. One thing, of course, is reading back issues of **Popular Electronics**, or one of my books. Or how about studying for the next higher class of amateur-radio license. Even if your antenna is not up, a few feet of wire will allow the receiver to operate, and that means you can copy the W1AW ARRL code practice sessions. Write ARRL at 225 Main Street, Newington, CT, 06111 for a copy of their schedule. Or, if you have Internet access, try e-mailing them at hq@arrl.or.

Another thing to do is build something. Although some people are fond of saying that hams "don't build anything anymore," my own experience tells me this is not so. While fewer hams, or a lower percentage, might be building, I get a strong response from readers whenever I do anything on simple, low-cost construction projects. This time, let's look at a classic TVI filter that is a bit different from the normal sort of filter found in ham radio.

LOW-PASS FILTERS

Television interference (TVI) is nobody's friend. When it rears its ugly head, you get mad, your neighbor gets mad (or your spouse!), and no one wins. In really severe cases, when it is your fault, you might even get tossed off the air with "quiet hours" imposed. Not fun.

The solution to TVI for HF transmitters is to insert a low-pass filter between

the transmitter output and the antenna feedline. Figure 1 is a simple block diagram that shows how to do it. Even some antenna tuners don't help because they are designed as simple "line flatteners," some of which are actually high-pass filters (great!). Most of the time, the usual low-pass filter that you can obtain from ham supply stores works well.

However, there are times when the simple filters are not terribly effective. One of those times is when the affected stations are on TV Channel 2 (54-60 MHz). That channel has some special problems because it is harmonically related to several ham bands, and receives some of the lower-order harmonics (2nd, 3rd, 4th, etc.).

Another problem is that the effectiveness of simple pi-section and tee-section low-pass filters depends on the load and source impedances being constant and resistive. If a complex or varying impedance is presented, then all bets are off. Not only will the suppression of harmonics be reduced, but there are some malignant little situations where the reactance of the load impedance tunes the reactance of the filter, creating resonances that increases, not reduces, the harmonic. Wonderful! Talk about getting a false sense of security!

ABSORPTIVE FILTERS

Figure 2 shows the block diagram of a simple absorptive filter. Traditional low-pass filters are reflective. They reflect the unwanted harmonic energy

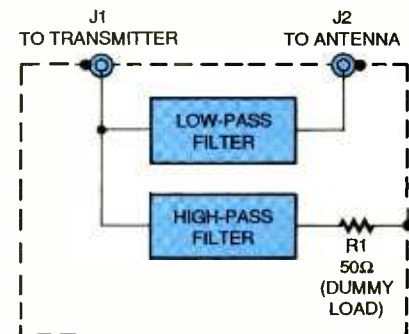


Fig. 2. Use this block diagram of an absorptive filter if you get interference complaints.

back toward your transmitter. The filter in Fig. 2 doesn't do that mean little trick. The low-pass filter section passes the desired HF signals to the antenna at J2, while the high-pass filter section, on the other hand, passes the harmonic energy through a high-pass filter to a dummy load, where it is absorbed. The energy of the harmonics is basically converted to harmless heat.

output capacitor of the low-pass filter, leading to the antenna, is series-resonant tuned by an additional inductor. This series trap is tuned to 52 MHz, so will provide an extra measure of TV channel 2 suppression. It will also add some more attenuation at odd integer multiples of 52 MHz, although not as much.

The dummy load must—repeat

The book covers the new object extensions to VB and shows how encapsulating code and data makes life easier, safer, and much more efficient.

The Win32 API is examined from the Visual Basic programmer's perspective, including a detailed look at Registry manipulation and Windows messages. A complete run-down of developing multimedia applications rounds off the first part of this useful guide.

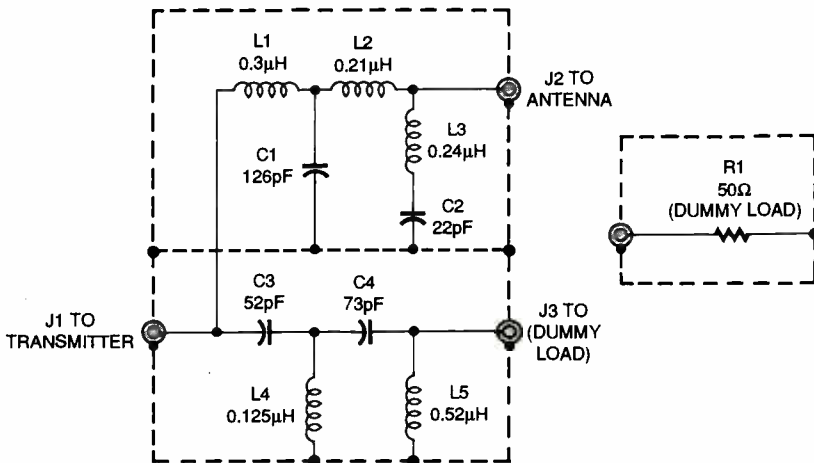


Fig. 3. Here's an absorptive-filter circuit that is effective and easy to build.

The absorptive filter in Fig. 3 is based on the classic design by Weinreich and Carroll from 1968. The high-pass and low-pass sections are shielded from each other (even though in the same shielded box) to prevent interaction.

If you want to try building this filter, wind the coils on high-powered toroids. The instructions that come with the toroids will tell you how many turns will equal what value (it varies with the type of material and size of the core). Alternatively, you could wind an air-core coil using the nomograms in *The ARRL Handbook for Radio Amateurs*.

I built one for QRP rigs (5-watt CW). It used the Amidon T-50-2 toroidal cores. For those cores, the coils are wound as follows:

- L1 = 8 turns
- L2 = 7 turns
- L3 = 7.5 turns
- L4 = 5 turns
- L5 = 11 turns

For the QRP rig, the coils could be wound using 22-gauge hook-up wire, although for any higher power that wire is unsuitable.

One feature of this circuit is that the

MUST—be noninductive, and have a value of 50 ohms. For high-power transmitters, at least a 250-watt dummy load should be used, although higher power ratings won't hurt anything. It is prudent for ham operators to keep a dummy load handy for off-the-air testing.

I have two: a 3000-watt unit and a 250-watt unit. If you want to use the regular station dummy load, rather than trying to find the correct resistor, then build it like the diagram: J3 leads to the dummy load through a very short length of coaxial cable, or via a double-male coaxial connector if that proves mechanically sound.

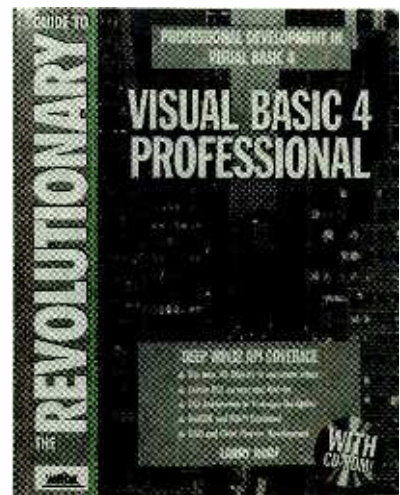
That's all for this issue. I can be reached by snail mail at P.O. Box 1099, Falls Church, VA, 22041, or by e-mail at carrij@aol.com.

ELECTRONICS LIBRARY

(continued from page 60)

coverage, and techniques are illustrated using complex example projects that bring out the real issues involved in all aspects of commercial Visual Basic development.

The included CD-ROM contains all the source code from the book. It also has a hypertext version of the book.



The book's next section is devoted to OLE—what it is and how to put it to work in useful applications, including a help-file creator that uses the Word OLE object. Readers are shown how to use OLE automation to create custom Internet applications using Netscape Navigator.

Database coverage starts with the data controls and goes on to present a detailed analysis of creating networked multi-user and client/server database systems. The final four chapters describe the process of creating a real-world Visual Basic application—a Workflow automation tool. Bringing together all the techniques from the book, it shows how to design, code, optimize, and distribute the application, including the creation of professional online help.

The Revolutionary Guide to Visual Basic 4 Professional costs \$44.95, including CD-ROM, and is published by WROX Press, 2710 West Touhy Avenue, Chicago, IL 60645-9911; Tel. 800-814-4527; Fax: 312-465-4063.

CIRCLE 101 ON FREE INFORMATION CARD

ANTIQUE Radio

A Spate of New Books

BY MARC ELLIS

Work on the project I had intended to continue talking about these last few months, *The Knight Kit Star Roamer*, is still at a virtual standstill! First, I was stopped by the arrival of summer, with its attendant yard work and home-maintenance chores. Then we moved into the radio-show season, when I spent one week each at RadioFest (Elgin, IL) and the Antique Wireless Association Rochester Conference (upstate New York). Following Rochester, I took another week off to vacation in Boston.

Luckily, although your faithful columnist hasn't been able to put in much workbench time, a number of interesting new books have appeared in his mailbox or been slipped to him at the conferences. And they are a ready-made subject for this month's column!

TUBE LORE by Ludwell A. Sibley

This is nothing less than a compilation of virtually every tube type manufactured in this country from 1920 to the present. Included are not only the receiving tubes that most of us antique-broadcast-set buffs are familiar with, but also special-purpose, transmitting, military, and unique types produced by individual manufacturers.

As the author points out in his Fore-

word, this is not a tube manual. You won't find basing diagrams or extended documentation of operating parameters. You also won't find many pretty pictures. What you will find is a short "bio" on each tube (ranging from a few lines to a few paragraphs) that provides information on the main application(s) and key operating characteristics.

With this book on your shelf, you'll never have to wonder whether the odd-ball tube you found in that flea-market grab bag is a rare and useful device to be kept and treasured—or something so peripheral that you'll want to fob it off on someone else at the next club event. And many other features of the book are worth the price of admission all by themselves.

One of them is the six-page "Tube User's Guide," which is crammed with street-smart information on using, testing, identifying, repairing, reactivating, and dating your vintage bottles. For example, did you ever realize that you could save time when testing a batch of tubes by setting up the filament pin connections and filament voltage first, and then letting the tube warm up while you make the other settings on the tester? Sibley points out that this is perfectly safe because no known tester applies plate voltage before the "test" button is pushed.

Another section I enjoyed browsing through is "Trends in Tube Design." Starting in the 1930s, when innovative designs began to replace "electric lamp" style tubes, this chapter takes the reader through the development of acorn, metal, Loktal, miniature, sub-miniature, lighthouse, button-stem octal, Nuvistor, Compactron, Novar, "9-T9," and high-reliability tubes. It's a truly invaluable perspective on the history of the vacuum tube.

Also of more than passing interest is the section on military tubes, which contains a very thorough "ID" list that includes U.S. and Canadian types. Many little-known tubes not found on most such lists have been researched and included by Sibley. Wondering if that tube with a "VT," "CG," or other

armed-forces prefix is something you can use to fix Grandma's cathedral? Look it up here and find out!

One feature I might argue with is the list of auction prices (mostly 1993–1995 vintage) at the conclusion of this book. For one thing, prices seem too ephemeral to be included in a volume of such permanent and lasting value. For another (to my mind), there is not a big enough collector base to stabilize the prices of radio items to the point where they should be valued in the manner of vintage artifacts such as cameras, glass ware, dolls, furniture, and the like.

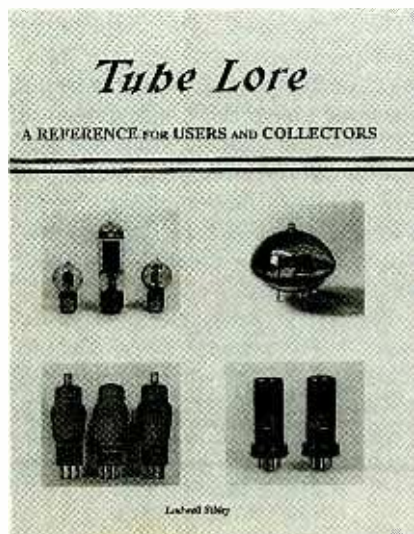
Having folks around who, rightly or wrongly, consider price lists to be gospel tends to take the serendipity (and fun) out of collecting. To quote from the author's Foreword: "As with all auction 'actuals,' these are snapshots of single transactions and should be used with caution."

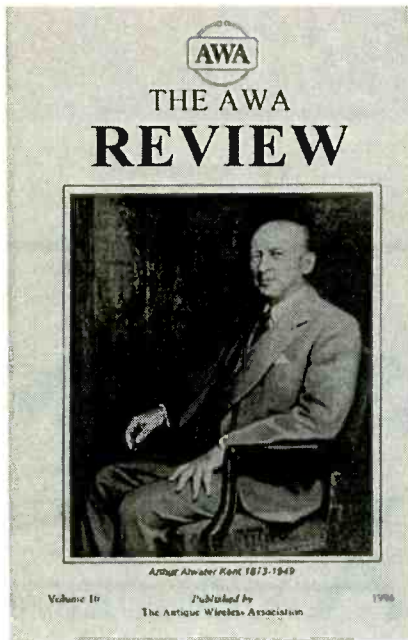
Tube Lore is a highly recommended addition to any radio collector's library. It is a 1996 self-published, 8-1/2" × 11-inch, softbound, 186-page book. You can get it for \$19.95 postpaid in North America, and for \$24.95 elsewhere. Contact Ludwell Sibley, 44 East Main Street, Flemington, NJ 08822.

THE AWA REVIEW: Volume 10, Edited by William B. Fizette, K3ZJW

Beginning with *Volume 1* in 1986, the Antique Wireless Association has sought and published authoritative papers on the history of wireless communications. Eleven years later, *Volume 10* continues this tradition by presenting six papers by experts in their respective subjects.

"Atwater Kent—Master of Marketing," by noted AK authority Ralph Williams, looks at Atwater Kent in his role as marketer and promoter of his products. "The Race for Radiotelephone: 1900–1920," by radio researcher/professor Mike Adams, discusses the five key individuals responsible for





the development of radiotelephone technology. Christopher Bacon's "Commemorating the 75th Anniversary of Radio Central" recounts the history of RCA's huge radio-transmission facility at Rocky Point, New York.

"Defiance in the West—The Heintz and Kaufman Story," by tube experts Hank Olson and Al Jones, tells the story of a well-known tube manufacturer's legal battle with David Sarnoff and The Radio Trust. "The Collins Radio Company—Ingredients of Success," by F. Parker Heinemann, describes the formation and early years of the Collins Radio Company and includes some superb photos of early Collins transmitters. Floyd Paul's "Gilfillan Bros. Inc., Early Records" covers the early years of The Gilfillan Radio Company and includes photos of some desirable collectibles.

Like all of its predecessors in this series, *Volume 10* is authoritatively written and tightly edited. It was published in 1996 by the Antique Wireless Association. The softbound book measures 6 × 9 inches, is 261-pages long, and contains approximately 190 illustrations. You can get it in the U.S. for \$20 postpaid (write for foreign pricing). Contact Dex Deeley, Antique Wireless Association, 8 Briar Circle, Rochester, NY 14618.

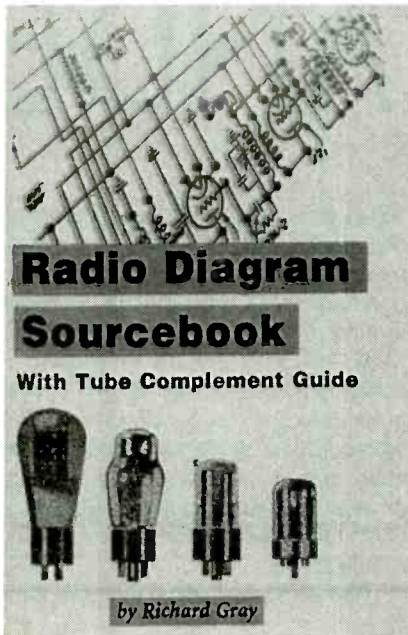
For those who would like to start a collection of *AWA Reviews*, back issues are available going back at least to *Volume 6*. For information write to

The American Wireless Association, 2 Walnut Place, Apalachin, NY 13732.

RADIO DIAGRAM SOURCEBOOK

by Richard Gray

This book grew out of author Gray's frustration in locating reliable sources of service information and in identifying unmarked sets. He spent many hours in libraries searching through old advertisements and service manuals to identify the major information sources and pinpoint the strengths and weaknesses of each one. The results of that research, originally published as a



series of articles in the *Gazette* of the Southern California Antique Radio Society, form the basis for Part 1 of this book.

Titled "Early Service Information," the 28-page section is a useful review of vintage-radio documentation, including the Rider, Gernsback, Beitman, and Sams collections, as well as original manufacturer's service literature. The section concludes with some very helpful suggestions on how to identify a radio chassis when the manufacturer and/or model number is not known.

Gray's best source for identifying "mystery radios" was the very rare *Sylvania Tube Complement Book* (1944). The fact that it was far too big to reprint in a club newsletter, even in sections, led Gray to publish his book. The *Sylvania* book appears, in its entirety, as Part 2 of the *Radio Diagram*

Sourcebook. This excellent reference covers 10,000 pre-WWII radios, giving the make, model, tube complement, dial-lamp number, and IF frequency for each. It also contains alignment, tube-testing, and tube-substitution information; a trade-name-to-manufacturer cross reference; and a dial-lamp characteristic chart.

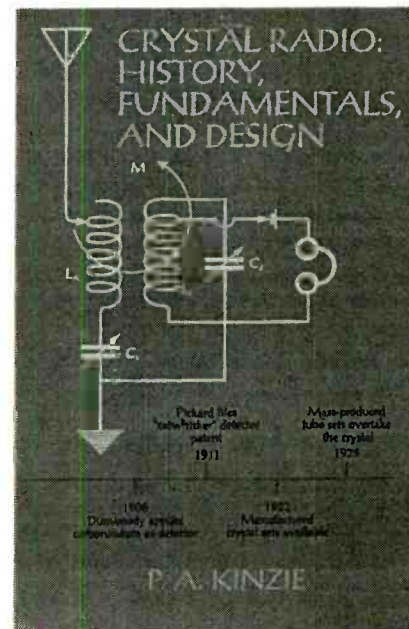
This "one-stop" source of identification and service information should be a welcome companion in your workshop! Published by Sonoran Publishing, LLC. in 1996, this softbound book measures 6 × 9 inches, and is 270-pages long. Its suggested retail price is \$18.95; it's available from most antique-radio sources.

CRYSTAL RADIO: History, Fundamentals and Design

By P.A. Kinzie

This latest addition to the books published by the Xtal Set Society neatly bridges a gap in the literature of the crystal set. Though in vogue for only a short time, the crystal set was, for many, the key that opened the door to a whole world of point-to-point and broadcast communications. *Crystal Radio* provides the reader with concise but comprehensive information about the development of crystal radios, and also provides what he or she needs to know to make them work.

In the book's three major sections,



continued on page 70 65

DX LISTENING

Farewell, ANDEX

BY DON JENSEN

For 22 years, Andes DXers International was the listeners' club sponsored by HCJB, the Voice of the Andes shortwave station in Quito, Ecuador. Some months ago, its several-thousand members, worldwide, learned that this era was ending.

ANDEX, as the club's name was usually abbreviated, was operated as the off-the-air counterpart to the long running "DX Partyline" broadcast aired by this popular and easy-to-tune South American religious SW station. Under a series of managing editors, from the now-retired Clayton Howard to Ken MacHarg, its publication, *Andex International*, went out regularly, gratis, to thousands of club members all around the world.

But, announced MacHarg, "Times change, and the interest in the publication has dropped through the years. Reading material has changed and is much more available than it was in the past. So we put ANDEX to rest."

Nonetheless, ANDEX and its SWL's newsletter had a good run! "Before I ever came to Ecuador to live and work, ANDEX was part of my window on South America," MacHarg wrote in the bulletin's final issue. "In fact, I have fond memories of reading ANDEX from issue number one.... And I'm proud to say that I have a complete collection of every issue ever published." It was in the ANDEX newsletter that many shortwave listeners learned about the people and culture of Ecuador, unique customs such as the "old men" (stuffed dummies set on fire on New Year's Eve to mark the arrival of the new year), and the Andean tradition of raising guinea pigs, not as pets, but for food!

The bulletin contained capsule profiles about shortwave stations in Ecuador and elsewhere in South America—other broadcasters that

CREDITS — Jerry Berg, MA. Peter Card, RI. Peter Costello, NJ. Don Dacus, AR. William Flynn, OR. Harold Levison, PA. Mark Mohrmann, NY. Bob Pierce, MA. Dan Ziolkowski, NY. North American SW Association, 45 Wildflower Road, Levittown, PA 19057. World DX Club, c/o Richard D'Angelo, 2216 Burkey Drive, Wyomissing, PA 19610.



Here's the longtime logo of HCJB's Andes DXers International newsletter.

SWLs could hear, or hope to log someday. There were technical tips on signal propagation, building antennas, and how to use receivers. ANDEX members around the world were profiled, as were, frequently, HCJB on-the-air personalities, giving faces and backgrounds to some of the station's familiar voices. Once, years ago, *Andex International* even published my photo and an interview recorded when I visited the Quito broadcast facilities during a Latin American trip.

This slim publication featured illustrations of members' favorite QSL cards from stations around the world. And there were "soft sell" inspirational messages tucked in the bulletin as well; for that, after all, is HCJB's mission in the world.

"Familiar names crop up," said MacHarg, nostalgically paging through more than two decades of back issues, "names of people on and off the air through the years...Clayton and Helen Howard, Ruth Stanley, Bob Beukema, Dee Baklenko, Brent Allred, John Beck and more...at the Voice of the Andes."

Its last managing editor saluted, too, the member-readers of *Andex International* who sent in to the station "loads of correspondence." ANDEX and its news bulletin now are part of the past, but HCJB, the popular Voice of the Andes, goes on. And its non-broadcasting outreach to regular listeners is not over.

"Even as the decision to close

ANDEX was made," said Rich McVicar, a former director of HCJB's listener club and now programmer and frequency manager for the station, "discussion began on how to bring the club back in the future on the Internet. That will depend on available personnel."

For now, though, shortwave listeners who also have access to e-mail can get the *Andean Herald*, which is sent out twice-weekly by computer from HCJB's English Language Service. It contains information on upcoming programs—data that's more detailed and timely than that in the station's regular program schedule. There's no charge for subscribing to this electronic newsletter. You can post your request to english@hcjb.org.ec.

SECRET RADIO VOICES

One of the more interesting aspects of shortwave listening has always been the clandestine broadcasters that populate the airwaves. Wherever and whenever there is some politically "hot" spot in the world, you will usually find one or more of these illicit radio stations. Whatever their locations—often secret—or languages broadcast, they usually represent the "outs" trying to counter the authorized programming of the "ins." Often they are the voices of exiled elements, fomenting trouble, or trying to, for the governments they oppose.

Mathias Kropf, a German listener and expert on listening to these clan-

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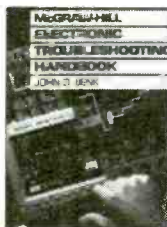
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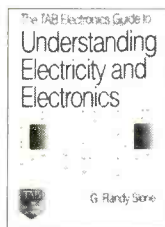
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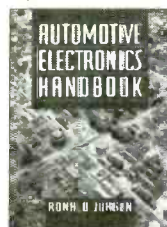
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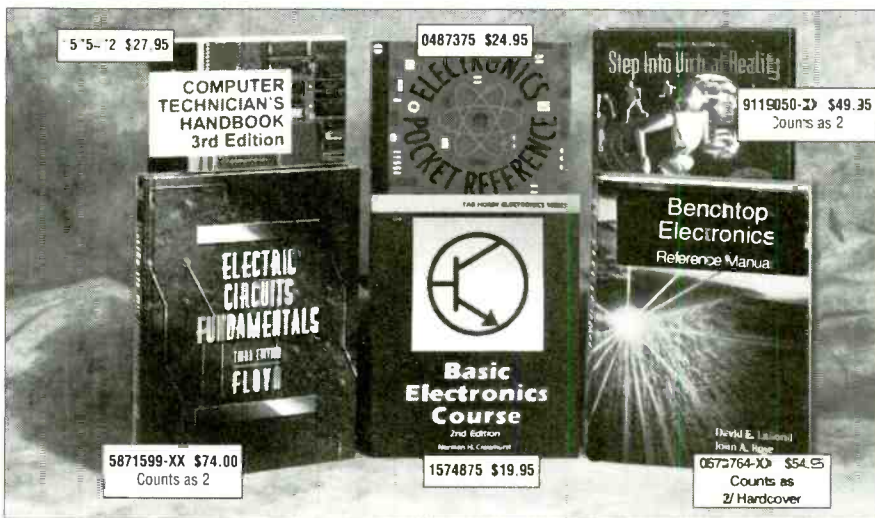
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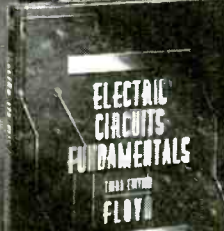


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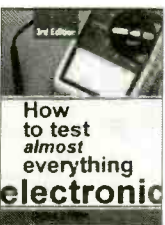
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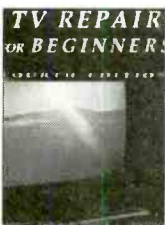
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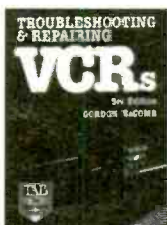
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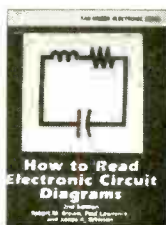
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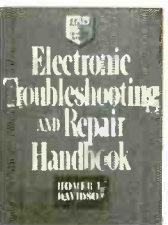
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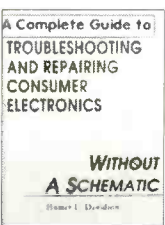
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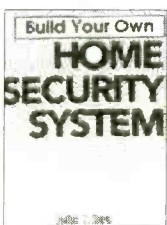
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destine SW stations, regularly writes about them in *Contact*, the monthly bulletin of the World DX Club in England. Clandestine stations come and go, as the winds of domestic and international politics shift around the world. But some stay on the air for surprisingly long periods of time; in some rare instances, for decades!

Currently, says Kropf, the average number of years of service by active clandestine stations is 8.4 years. For comparison, the figure was 8.1 years in 1995, and 5.9 years in 1991.

Let's now take a look at some of the oldest shortwave clandestine voices that are still found on the air today (their names are shown in English, but are actually translated from their native tongues):

Voice of National Salvation, a North Korean clandestine whose programs are aimed at South Korea, began life in 1970 as the Voice of the Revolutionary Party for Reunification. Look for it broadcasting in Korean around 4,120 kHz at about sunrise at your location.

Radio Echo of Hope is South Korea's answer to the above, directing its programming to listeners north of the 38th Parallel. It has been on the air since 1973, and currently is said to be operating on 3,985 kHz about 1100 UTC.

Voice of the Resistance of the Black Cockerel is a clandestine station that has aired anti-government broadcasts in Angola in southern Africa since 1979.

Voice of Iranian Kurdistan and Voice of Iraqi Kurdistan are the twin clandestine voices of the opposition to the established regimes of Iran and Iraq as the Kurdish minority struggles for its own political identity. They have been on shortwave since 1980. The former has been reported as operating on variable frequencies around 4,000 and 7,300 kHz at 1400 UTC; the latter on approximately 4,075 kHz at 0500 UTC.

BBC QSL'S

The British Broadcasting Corp., as many SWLs know, responds to listeners' reports of reception with acknowledgments that do not include as extensive details as many DX fans would wish. It is disappointing to QSL collectors that Auntie Beeb in London will not note on those acknowledgment cards the location of the particular relay station, wherever it is in the world, airing a particular transmission. For those

SWLs trying to log stations in as many different countries as possible, it is important to have the transmitter site, be it Antigua or Singapore, Seychelles or Lesotho, noted on the QSL.

You can come out ahead, notes Dan Smith, Daventry, England, in a recent issue of the World DX Club bulletin, by sending your BBC reception report directly to the overseas relay station. Here are some of them:

BBC East Mediterranean Relay Station (P.O. Box 219, Limassol, Cyprus) replies directly with a data specific QSL card.

BBC Far Eastern Relay Station (P.O. Box 434, Singapore) does the same.

BBC, via Caribbean Relay Co. Ltd., (P.O. Box 1203, St. John's, Antigua and Barbuda) often responds to reception reports by letter.

BBC Atlantic Relay Station (English Bay, Ascension Island) verifies by letter.

BBC Indian Ocean Relay Station (P.O. Box 448, Victoria, Seychelles) also responds by letter to reports.

BBC Lesotho Relay Station, Senior Engineer (c/o British High Commission, P.O. Box 521, Maseru, Lesotho) has replied to reports with a detailed letter.

DOWN THE DIAL

Looking for some new loggings? Try these.

ALGERIA—17,448 kHz. Radio TV Algerienne has French-language programs around 1800 UTC, but there is interference from WYFR.

BELGIUM—9,925 kHz. Radio Vlaanderen airs English news, a DXers program and press review, beginning at 2330 UTC.

CHILE—6,090 kHz. Radio Esperanza has been heard around 0745 UTC with a recorded religious program in English. Later, Spanish programming resumes, with station identification and religious music.

GUYANA—3,290 kHz. Guyana Broadcasting Corp. is noted around 0330 UTC playing pop music with English lyrics. And, during the early morning hours around 0830 UTC, the station again was heard with instrumentals and Hindi music.

HUNGARY—11,870 kHz. Radio Budapest is noted beginning at 0100 UTC with English news and identification.

KUWAIT—11,990 kHz. Radio Kuwait's English transmission at 1930 UTC apparently includes a relay of the station's local FM outlet, since it identifies

as "Super Station 99.7, Radio Kuwait." It switches to Arabic programming at 2100 UTC.

LESOTHO—3,255 kHz. BBC's Lesotho relay station is heard shortly before 0500 UTC with the program, "Network Africa," with identification on the hour. This transmission is paralleled on 9,600 kHz as aired by the BBC Atlantic relay on Ascension Island. ■

ANTIQUÉ RADIO

(continued from page 65)

Kinzie covers the historical development of the crystal detector, the fundamentals of receiver design, and of crystal-set design. A fourth section deals with the crystal material itself. Each section includes a bibliography of related current and historical books and articles for further reference. If you enjoy working with crystal sets, you'll find the collected reference material presented in this volume to be invaluable.

Published by the Xtal Set Society (P.O. Box 3026, St. Louis, MO 63130), this 5-1/4" × 8-1/4"-inch, softbound, 119-page book is available for \$10.95 plus \$2.50 shipping and handling.

Another recent publication of the Xtal Set Society is also worthy of note: *Crystal Sets: Volume V* (85 pages, 5-1/4" × 8-1/4" inches, softcover). The book includes the six issues of the society's newsletter ending November 1995. It costs \$9.95 plus \$2.50 shipping and handling if ordered alone. However, there is no additional shipping and handling charge if it is ordered along with *Crystal Radio: History, Fundamentals and Design*.

See you again next month, when, maybe, at long last we'll get back to that Star Roamer. Until then, I'd sure like to hear from you! Please feel free to send your comments and questions to *Antique Radio*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■



"How about making a switch to turn off the light so I can get some sleep?"

SCANNER SCENE

When Disaster Strikes

BY MARC SAXON

Here's a clever piece of hardware. It's called the *Xplorer Test Receiver*, and it is another one of those intriguing products from *Optoelectronics*. The *Xplorer* is a handheld near-field surveillance (and, if you will, test) receiver that automatically sweeps through the range of 30 to 2000 MHz (2 GHz) in less than one second.

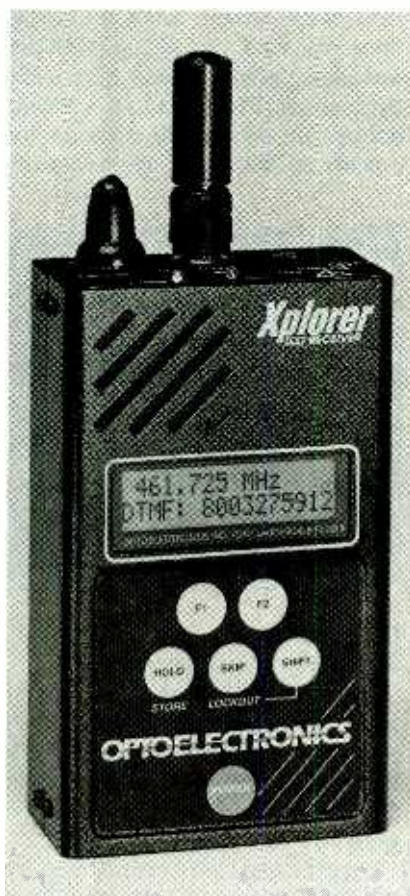
As it sweeps, the *Xplorer* will lock in on any active frequency being transmitted from its local area, reproducing the FM audio for monitoring on its internal speaker. There are more than a dozen operating modes.

A two-line backlit LCD readout displays the transmitted signal on the top line. The second line can be switched to show decoding of CTCSS, DCS, and DTMF tones, LTR trunking, relative trunking, FM deviation, and even latitude and longitude.

The receiver's operation permits manual skip, frequency lock-out, auto or manual hold, and the recording of 500 frequencies. The frequency-recorder memory register might include such information as frequency, time, date, latitude, and longitude.

The *Xplorer* has a serial data interface that provides for TTL and RS-232C formats, and an NMEA-0183 interface for providing Global Positioning System (GPS) information, including altitude. A headphone jack is provided, as well as an auxiliary jack that can be used to control a tape recorder. The receiver's internal rechargeable battery pack takes a full charge in less than an hour, using the included AC charger. An LED on the *Xplorer's* panel advises when it's time for a recharge.

Operation is really quite simple (the *Xplorer* has only five buttons on its panel.) For all that it can do, that's minimal. It has unlimited potential for a wide variety of hobby, law-enforcement, private-security, and test purposes. Its versatility allows the *Xplorer* to cross over into many different applications. Take it to any location where there are some communications, turn it on, and you can listen in while also getting a



Optoelectronics' Xplorer nearfield surveillance receiver has hobby, law-enforcement, security, and test applications.

listing of the actual frequencies that are being used. Think of the possibilities!

The *Xplorer* costs approximately \$900. For more information, contact Optoelectronics, 5821 N.E. 14th Avenue, Fort Lauderdale, FL 33334. You can call 954-771-2050, or send e-mail to opto@igc.net.

WHEN THINGS GO AWRY

The Federal Emergency Management Agency (FEMA) is the organization that participates in the aftermath of all large-scale disasters in the United States. That category includes those wrought by nature (earthquakes, floods, tornadoes, hurricanes), ecological threats (such as accidents at nuclear plants), and acts of terrorism or enemy attack.

Although FEMA has an extensive HF network, the agency also makes heavy use of frequencies that can be tuned in on scanners. While FEMA stations would, of course, be expected to be most active during actual disasters, they can often be monitored at other times, both during practice drills and with routine traffic.

That being the case, you'll want to know FEMA's reported national simplex and repeater output frequencies. The primary emergency repeater frequency is 138.225 MHz; the primary emergency simplex frequency is 141.725 MHz. The National Civil Radio System simplex channels are 164.8625 and 165.6625 MHz. FEMA portable repeaters operate on 142.975, 143.35, 143.375, 143.425, 143.975, 168.40, 168.075, 168.10, and 168.70 MHz. The National Warning System uses 167.925, 167.975, and 169.875 MHz. The Urban Search and Rescue Team Simplex frequencies are 408.5125, 409.4875, 410.4875, 410.5125, 413.2125, 416.0375, 416.8125, 416.9375, 417.5875, and 417.6625 MHz. The Federal Executive Board Emergency Net is on 170.20 MHz. Coordination with USAF (Wideband FM mode) is on 266.05, 273.8, 305.55, 322.75, 336.8, 382.35, 397.05, and 399.75 MHz. Other frequencies include 138.575, 139.10, 139.225, 139.45, 139.95, 140.025, 140.90, 141.95, 142.025, 142.40, 142.925, 142.95, 143.05, 143.25, 143.60, 143.625, 148.575, 163.10, 169.25, 409.125, 418.05, 418.075, and 418.575 MHz.

Depending on how many spare memory slots you have available, it might be worth programming all, or at least some, of those frequencies into your scanner. If you can't program any right now, at least keep this list handy. In the event that FEMA ever needs to swing into action in your area, these channels will be the ones to monitor.

ANOTHER NEW RADIO SERVICE

The Low Power Radio Service 71

(LPRS) was created by the FCC in the 216- to 217-MHz band. It is considered a Personal Radio Service for short-range use, authorized on a secondary non-interference basis for low-power users. The FCC suggested that it is also suited to law-enforcement tracking systems, auditory assistance devices for persons with hearing disabilities, health-care assistance for persons with illnesses, and point-to-point network control communications for Automated Maritime Telecommunications Systems (ATMs).

Transmitters will need to be FCC-type accepted before they can be marketed, and must meet the agency's technical standards. Under the LPRS technical standards, a transmitter must be produced in a manufacturer's choice of any one of three possible bandwidths (5, 25, or 50 kHz), and is limited to 100 milliwatts of effective radiated power (ERP).

Individuals will not be required to get licenses for LPRS operation. The FCC feels that using any agency-type accepted transmitter should be sufficient to meet the needs of the service and the agency.

Now you know where to monitor for the next generation of police bumper-beepers.

CLARIFICATION, PLEASE

Bill Intelisano, of Altamonte Springs, Florida, is new at scanning. He recently acquired a RadioShack PRO-34 but has become confused about terms used for modes such as *WFM*, *NFM*, *SSB*, *Digital*, *AM*, and *FM*.

In a nutshell, aircraft communications are in AM mode, the same as your local medium-wave broadcasters. Virtually all other two-way VHF/UHF scanner communications are FM (more specifically, NFM, which means narrow FM.) WFM means wide FM, which is the mode used by FM and TV broadcasters, plus some specialized UHF stations. SSB stands for Single Sideband, which is used primarily on HF (shortwave). Digital modes are voice or non-voice systems that cannot be monitored on present-era scanners.

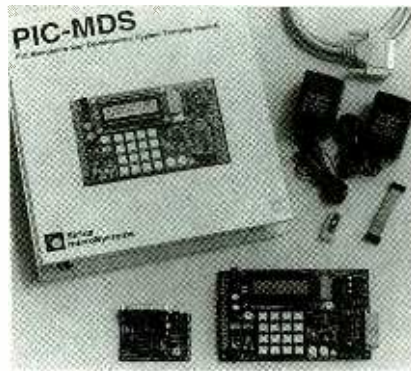
That's a wrap. We're looking forward to having you back with us next time. Please share with us your frequency lists, questions, and ideas. Write to *Scanner Scene*, **Popular Electronics**, 500 Bi-County Blvd., 72 Farmingdale, NY 11735. ■

NEW PRODUCTS

(continued from page 25)

data-logging, and interrupt routines.

The PIC-MDS development board includes both PIC16C71 and PIC16C84 microcontrollers, a 16-key matrix keypad, a 2-line by 16-character LCD, a ZIF socket, buffered LED port state indicators, an RS-232 serial port, two analog input potentiometers, a 256-byte serial EEPROM, an oscillator socket for crystals or ceramic resonators, on-board +5-volt and variable



DC power supply, and screw terminal and header connections to all pins.

Microcontroller applications are created and assembled on an IBM PC using the PM Macro Assembler. The training text fully explains each example and its operation. Users can then write their own applications.

Applications are programmed into the PIC16C71 or PIC16C84 using the included EPIC programmer, which is capable of programming all mid-range 18-pin PICs. Optional 28- and 40-pin socket adapters are available.

The PIC-MDS development system costs \$299. Hobbyist and student versions are also available. For more information, contact Sirius microSystems at 172 Harvard Road, Waterloo, Ontario N2J 3V3, Canada; Tel. 519-886-4462; Fax: 519-886-4253; Web: <http://www.siriusmicro.com>.

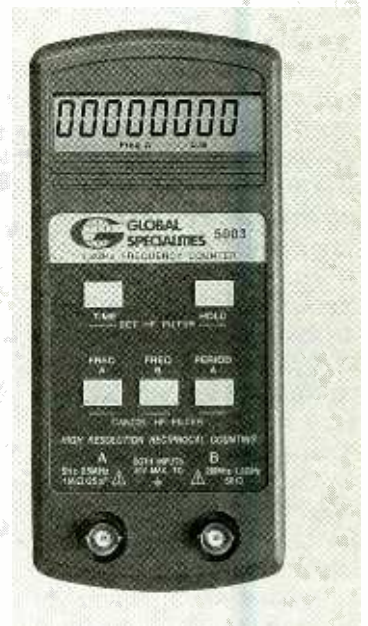
CIRCLE 86 ON FREE INFORMATION CARD

1.3-GHz HANDHELD FREQUENCY COUNTER

Global Specialties' Model 5003 is a compact, battery-powered 1.3-GHz frequency counter that offers handheld convenience combined with the features and performance normally found only with higher priced benchtop mod-

els. Its sensitivity is high across the whole frequency range, with no dead spots. A low-pass filter can be selected to reduce noise and ensure stable readings at lower frequencies.

The Model 5003 features a 0.45-inch high, 8-digit LCD readout with a full range of indicators to depict measurement function, time, overflow, trigger activity, hold, input A, input B, low battery, and all measurement units. Only five large buttons are needed to select all functions and ranges. A special hold function allows readings to be frozen on the display for measuring non-continuous signals or recording results later. A unique "push to measure" feature gives a virtually instantaneous reading followed by an automatic power-down after 15 seconds.



The Model 5003 hand-held frequency counter costs \$250. For further information, contact Global Specialties, 70 Fulton Terrace, New Haven, CT 06512; Tel. 203-466-6103; Fax: 203-468-0060.

CIRCLE 87 ON FREE INFORMATION CARD ■



"Sam, haven't you learned how to exit the Internet yet?"

Circuit Circus

More Electronic Sensors

BY CHARLES D. RAKES

Let's see now, last month we started on a sensor odyssey and looked at several light- and touch-activated sensor circuits. With sensors abound, we're going to continue on course and look over a few not-so-common sensor circuits.

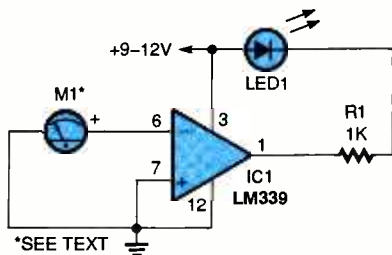


Fig. 1. This vibration detector uses an analog meter as its sensor.

PARTS LIST FOR THE VIBRATION DETECTOR (Fig. 1)

IC1—LM339 comparator, integrated circuit
LED1—Light-emitting diode, any color
R1—1000-ohm, 1/4-watt, 5% resistor
M1—Analog meter, 0-50 μ A, 0-1 mA (see text)
Power source, wire, solder, etc.

VIBRATION DETECTOR

Our first entry, see Fig. 1, uses a basic electrical instrument as a sensing device. The instrument, which has been around for ages, is the D'Arsonval analog meter. For all you digital circuiters, that's the meter with a needle instead of glowing digits. The meter used in my test circuit was a new-model Simpson 260 VOM.

It does look a little unusual having a meter connected to the input circuit of a comparator and not to its output. But we're not using the meter in this circuit to display an output. You see, the needle in an analog meter happens to be very sensitive to external movement and vibration. For this reason, we'll use the meter to generate an output.

An analog meter is built like a miniature generator. A multi-turn armature, which connects to the meter's needle, is positioned between the poles of a powerful permanent magnet. Any need-

le movement causes the armature to move in this strong magnetic field, which produces a minute voltage across the armature's winding.

In this circuit, any movement or vibration will cause the armature to produce a small electrical signal. An LM339 comparator (IC1) amplifies the armature's signal, causing LED1 to flicker on and off as the needle moves back and forth. (Note that in all the circuits that use it, the LM339's unused pins should be tied to ground.)

Maximum sensitivity occurs when the meter's needle is in the same plane as the external moving force. Also the sensitivity may be maximized by adjusting the meter's mechanical zero scale up and away from the end peg.

The choice of meter also plays an important part in the circuit's sensitivity. The Simpson's 0- to 50-microampere range is by far more sensitive to weak movements or vibrations than the 0- to 1-milliamperere range.

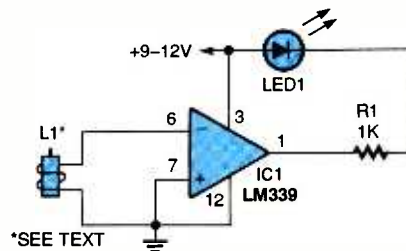


Fig. 2. A relay coil makes a great magnetic-field detector.

PARTS LIST FOR THE MAGNETIC-FIELD DETECTOR (Fig. 2)

IC1—LM339 comparator, integrated circuit
LED1—Light-emitting diode, any color
R1—1000-ohm, 1/4-watt, 5% resistor
L1—110-volt AC relay coil (see text)
Power source, wire, solder, etc.

MAGNETIC-FIELD DETECTOR

Our second sensor circuit, shown in Fig. 2, replaces the meter, as the sensing element, with a relay coil, L1. This arrangement is very sensitive to varying magnetic fields. Move a small per-

manent magnet past the relay coil and LED1 will respond.

The sensor's operation is similar to the previous circuit with the coil located in a fixed position and the magnet in motion. Just about any relay coil will work, but for maximum sensitivity select a coil with the most inductance that will also have the greatest resistance.

Placing a permanent magnet a few inches away from, but in line with, the coil's pole piece turns the circuit into a sensor that can detect a ferrous object passing between the magnet and coil. Any time the magnetic field changes, a small AC voltage is generated across the coil. The voltage causes LED1 to flicker on and off.

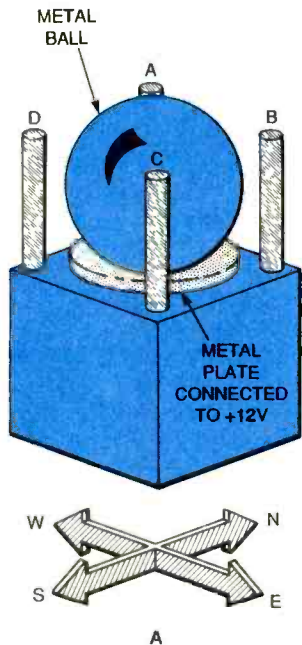
TILT SENSOR

Our next entry is an unusual tilt sensor with LED position indicators. Figure 3A shows the basic components used in the sensor. A metal ball sits on top of a metal plate that is mounted on an insulated stand. Four metal pins are located at each corner. The metal plate is connected to +12 volts, and the four insulated pins go to the sensor's input circuitry (we'll get to that in a moment).

When the ball is centered (in a non-tilt position), it does not come into contact with any of the pins. That means that no electrical connection is made between the ball and the pins. If the sensor tilts towards the north (as shown in the diagram) the ball will roll between pins A and B. That will complete an electrical circuit, placing +12 volts on both those pins. The table in Fig. 3B shows which pins will be contacted when the sensor tilts in each direction.

So what do you do with the information the sensor provides? It should be fed to the tilt-sensor decoder shown in Fig. 4. As you can see, pins A through D are connected to the inputs of several 4011 NAND gates (IC1-IC2). When both inputs of one of the NAND gates goes high, its output goes low lighting the LED connected to it.

In our previous example of a north tilt, both pins A and B will cause input



DIRECTION	BALL POSITION
N	A,B
S	C,D
E	B,C
W	A,D
NE	B
NW	A
SE	C
SW	D

Fig. 3. When the sensor in A tilts, a current is applied through the metal ball to one or two of the pins, indicating one of the directions shown in B.

PARTS AND MATERIALS LIST FOR THE TILT SENSOR (Fig. 3A)

- Metal ball (e.g. a ball bearing)
- Metal pins (4)
- Metal plate
- Insulated block
- Note:** Sizes of all components will depend on the overall size of the device.

pins 1 and 2 of IC1-a to go high. As a result, LED1, the "north" indicator, will light. All other gate inputs of IC1 and IC2 are pulled to ground with 47,000-ohm resistors. That leaves the remaining LEDs dark.

Note that each of the IC2 gates have both their input pins tied together and to one directional pin. That's to accommodate for tilting in directions between the four cardinal points. For example, if the sensor tilts to the northwest position, the ball only touches the A pin. That means that IC2-b's output

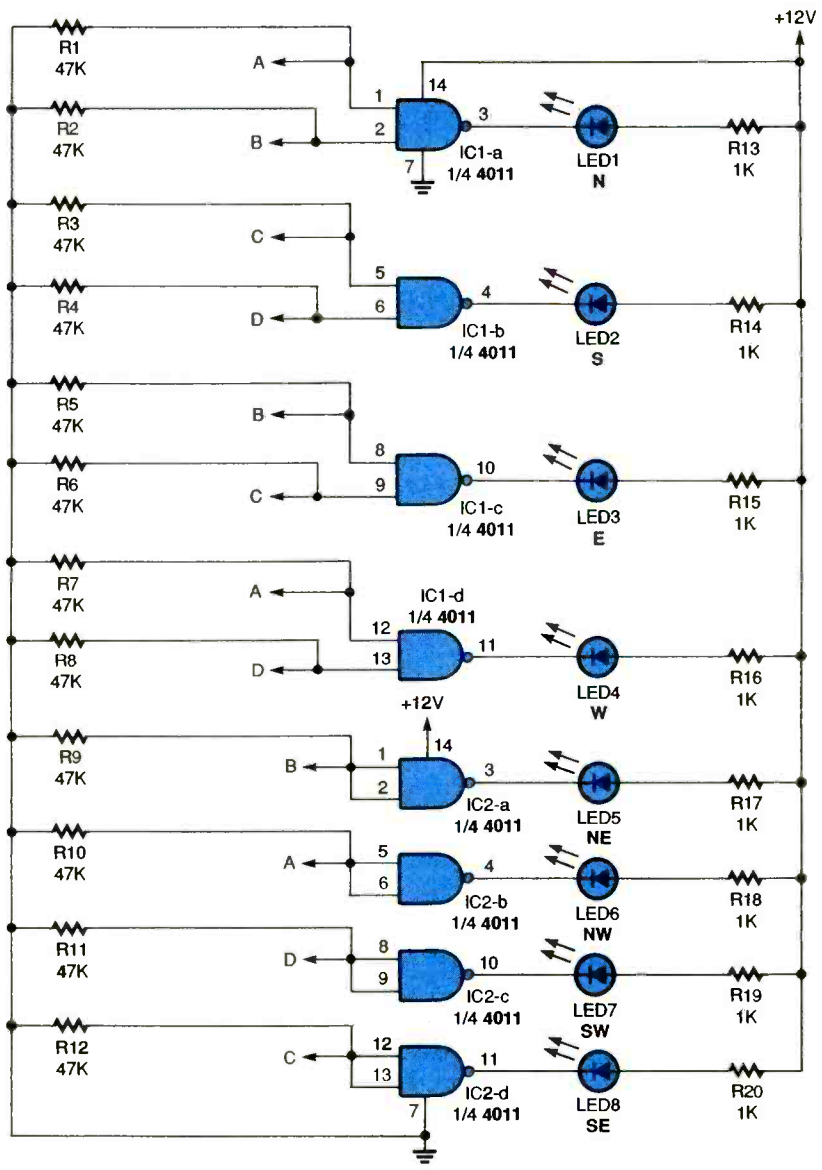


Fig. 4. This circuit decodes the information provided by the tilt sensor of Fig. 3, and provides a visual indication of direction with one of eight LEDs.

PARTS LIST FOR THE TILT-SENSOR DECODER (Fig. 4)

- IC1, IC2—4011 quad two-input NAND gate, integrated circuit
- LED1-LED8—Light-emitting diode, any color
- R1-R12—47,000-ohm, 1/4-watt, 5% resistor
- R13-R20—1000-ohm, 1/4-watt, 5% resistor
- Power source, IC sockets, wire, solder, etc.

will go low lighting LED6 (the "northwest" indicator). All other directions operate in a like manner.

WIND-DIRECTION SENSOR

Now let's take a look at another sensor-and-decoder-circuit combination (see Figs. 5 and 6). This one senses

wind direction and gives an output with last-position memory.

You'll need to build a wind vane like the one shown in Fig. 5. It should have a weighted front end and an air paddle in the rear. Attach a small, strong magnet to the front part of the wind-vane arm. Then, position eight reed magnetic switches in a circle around a piece of plastic pipe, and electrically connect them as shown.

Keep in mind that the drawing in Fig. 5 is not meant to serve as a blueprint for construction. Rather, it is offered as a general guide to use in building your own version. That's because the size or type of wind vane used is not critical. Only the placement of the sensors is important.

Note that the reed switches each

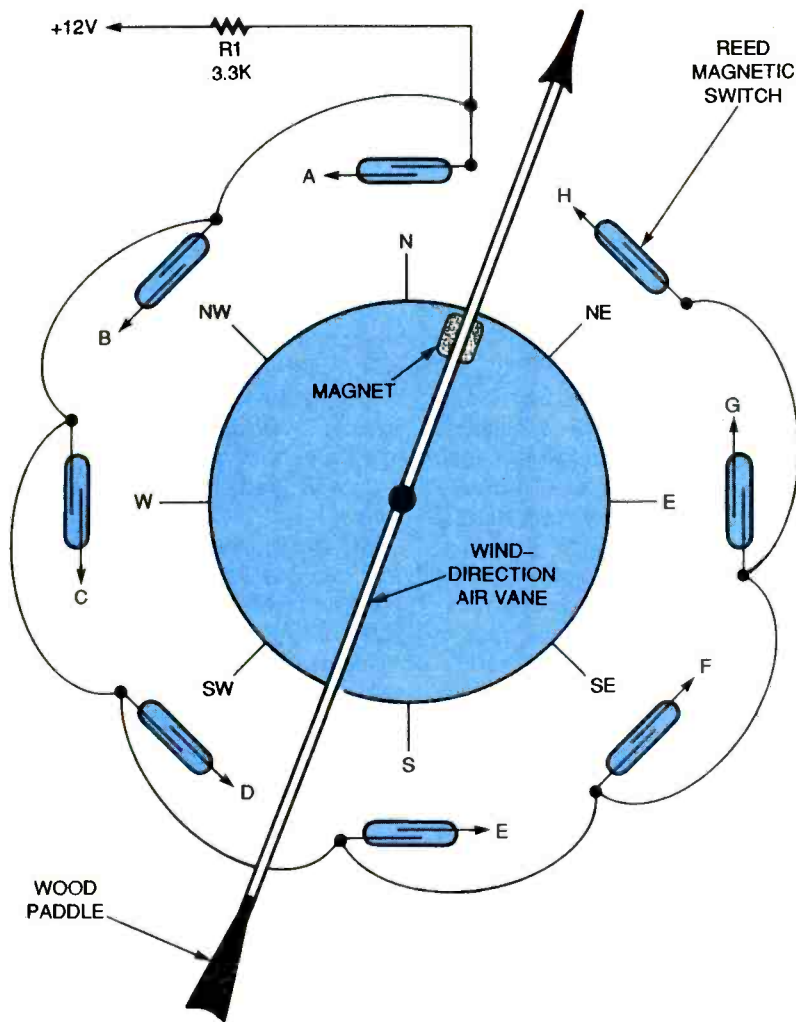


Fig. 5. The wind vane shown here will activate one of eight reed switches using a magnet on its arm.

PARTS AND MATERIALS LIST FOR THE WIND-DIRECTION SENSOR (Fig. 5)

- R1—1000-ohm, 1/4-watt, 5% resistor
- Reed magnetic switches (8)
- Magnet
- Plastic pipe
- Wood
- Power source, wire, solder, etc.

PARTS LIST FOR THE WIND-DIRECTION-SENSOR DECODER (Fig. 6)

- SCR1-SCR8—2N5061, ECG5401, or similar low-current silicon-controlled rectifier
- LED1-LED8—Light-emitting diode, any color
- R1-R8—1000-ohm, 1/4-watt, 5% resistor
- R9-R16—10,000-ohm, 1/4-watt, 5% resistor
- C1-C8—0.1- μ F, ceramic-disc capacitor
- S1—SPST switch
- Power source, wire, solder, etc.

electrically connect to points labeled A through H. Those points correspond to points A-H in the wind-direction decoder circuit shown in Fig. 6.

The decoder uses eight low-current 2N5061 SCRs and eight LEDs to latch and display the wind vane's position. If the wind vane is pointing due north, reed switch A is closed sending current into the gate of SCR1. That current turns the thyristor on, causing it to light LED1. If the wind shifts slightly to a position in between north and northwest or north and northeast, without activating any of the reed switches, LED1 will remain on indicating that the

last wind direction was north.

With SCR1 turned on, one end of capacitors C8 and C1 is pulled to ground. The other end of both capacitors is tied to the +12-volt buss through a resistor and LED; that means both capacitors are charged to near 12 volts. All other capacitors are not charged because both ends of each capacitor are returned to the +12-volt buss through a resistor and LED at each end. When the wind direction shifts to the northwest, the B reed switch turns

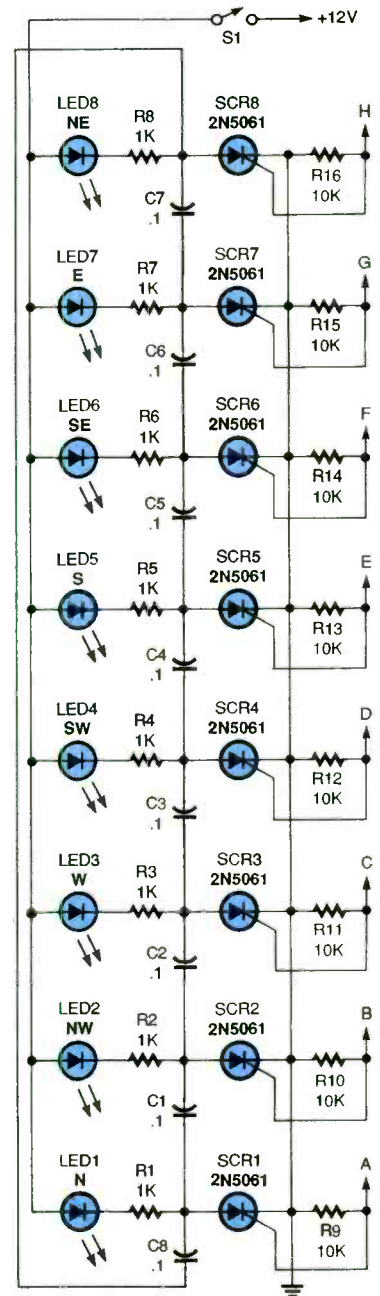


Fig. 6. This circuit decodes the wind vane from Fig. 5 and give a visual indication of which way the wind is blowing.

SCR2 on, thereby "taking" the positive end of C1, which is connected to its anode, to ground. This negative pulse turns SCR1 off as SCR2 turns on, lighting LED2 as a result.

REED-SWITCH REPLACEMENT

If you want to get fancy and do away with the eight reed switches used in Fig. 5, take a look at the reed-replacement circuit shown in Fig. 7. A Hall-effect integrated circuit (IC1) and a few components connected as shown replace

continued on page 78

Think Tank

Benchtop Stuffing

BY JOHN J. YACONO
TECHNICAL EDITOR
WINDOWS MAGAZINE

This month's circuits are all pieces of test equipment. As usual, the authors will be rewarded with a book from our library. If you'd like to participate, send in a schematic of a working circuit with a complete explanation of how it works to *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. If you send in enough quality circuits to fill a column, you'll receive a free kit and individually packaged MCL1010 chip from 1967 (see my first *Think Tank*, April 1991 for data).

To continue our discussion on semiconductors, I'll answer the questions I posed last month. To make a P-type semiconductor, you combine a tetravalent substrate material (with four outer or "valence" electrons) and a dopant with three valence electrons. The dopant is a "trivalent" material. When it combines with the substrate it provides one less electron than the substrate material needs to reach the magic number of eight shared electrons. That leaves a hole in the outer shells of all the pairs formed by doping. It's as though the dopant was a hole donor and the substrate was a hole acceptor. The absence of the appropriate number of electrons gives the P-material a characteristic positive charge, thus the name "P-type."

If you pass a current through a P-type material, electrons do move, but they don't completely fill the holes. The number of holes in the material remains fairly constant. When electrons flow into the material, they jump from hole to hole. This makes it appear as though the holes are jumping from place to place in the opposite direction. For that reason the holes are called the "majority charge carrier," and are considered responsible for current flow.

Now, what happens when you take an electron-glutted N-type material and put it in physical contact with an electron-poor P-type material? Where the materials touch forms what's called a "PN junction," and as you might guess, some electrons flow across the

junction from the N material into the P material, while holes flow from the P material to the N material. But after a short while the electrons and holes stop flowing.

The electrons that have flowed into the P material form a barrier of negative charge that dissuades further electrons from crossing the junction. The holes that flow into the N material also form a barrier that prevents further holes from migrating. This situation forms a region of potential near the junction that's positive in the N material and negative in the P material. The actual potential across the region is called the barrier potential.

The simple PN junction is the heart of the simplest semiconductor. Can you determine which one? Next time, we'll discuss how the barrier potential affects the component's behavior and how it works overall. Now, let's check out some letters.

SWITCHABLE REGULATOR

By connecting three Zener diodes in series with a switch and commonly available parts, you can make a three-voltage regulated supply (see Fig. 1). You should use 15-volts DC as the power source.

With switch S1 in the 6-volt position, the current from the supply through resistor R1 biases Q1 with a 6-volt input signal, which is reproduced

at the circuit output. With the switch set to the 9-volt position, a 3-volt Zener (D2) is added to the circuit boosting the output another 3 volts. Placing the switch in the 12-volt position will bias the transistor at 12-volts by adding another 3-volt Zener. Capacitor C1 filters the circuit's output.

—Joseph Anie, Tema Ghana, West Africa

Real nice. The circuit is extendible, too. You can boost the input voltage, number of diodes, transistor current rating, and number of switch positions to increase the range or granularity of the output voltage. Equipped with a cigarette-lighter plug, the circuit would make a great voltage adapter to power CD-players and other such devices in the car.

RS-232 PROBE

Up until now, I have held back from submitting any ideas because I didn't feel that any of my simplistic and very dedicated (single-use) circuits would be of general use. Recently, though, after having pegged my DMM, I needed to test the active inputs and output of an online RS-232 cable on my computer. I found these two circuits (see Figs. 2A and 2B) to be extremely useful for this and several other tests, so I thought I'd pass them along to **Think Tank** readers.

Basically, the testers are window comparators, with the windows being ± 3 volts wide. (Window comparators are very useful instruments, at least, in my workshop; so I have several.) The LM339 was chosen because of its open-collector output. In Fig. 2A resistors R1, R4, and R5 set the voltage-reference levels. When testing a wire, if it is driven by an RS-232 output, the test circuit's input will be driven high or low. In either case, one or the other of the comparators' outputs will go low, turning on the LED.

The circuit in Fig. 2A is very susceptible to changes in the supply. The circuit in Fig. 2B corrects that by incorporating the forward voltage drop of a 1N4001 diode to the threshold volt-

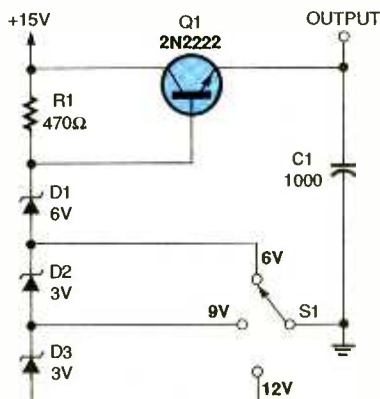


Fig. 1. This three-voltage regulated supply can be added to for more voltage ranges.

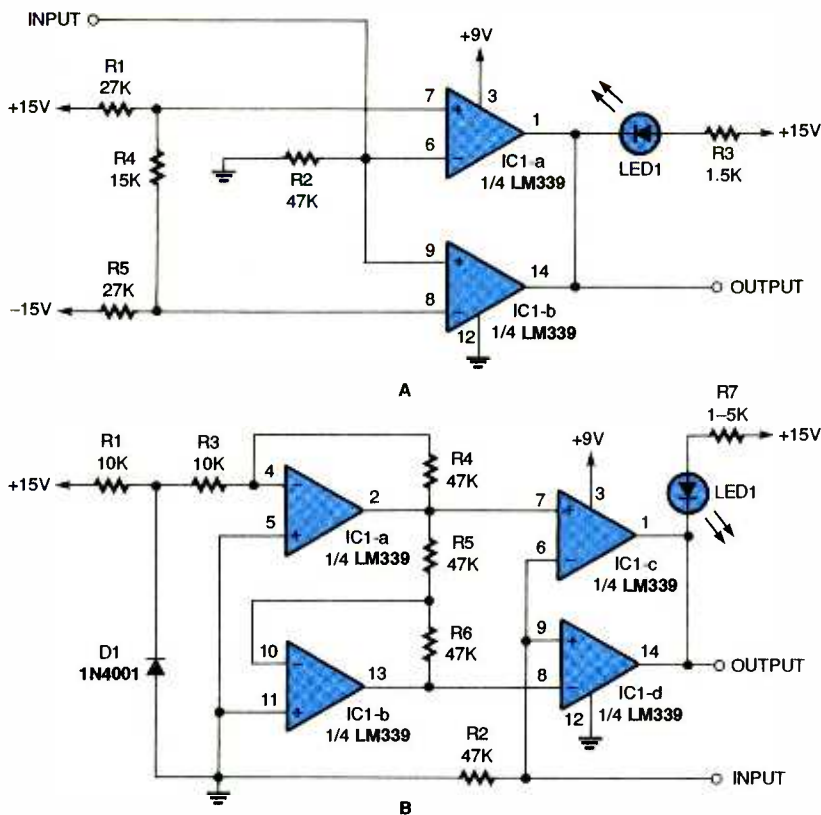


Fig. 2. These RS-232 probes work using a 3-volt window comparator.

ages at both of the op-amp's reference inputs.

The biggest advantage of this one over others I have is that it can be slipped into my shirt pocket for use on the road. I hope this is of some use to someone else.

—Michael E. Keller, Lancaster, PA

By adjusting the values of the threshold voltages, and connecting a buzzer to the output, you can use the circuit as an over-voltage alarm. Also, it's worth noting that a really simple RS232-tester can be made by placing a resistor and bi-directional LED in series. Add some probes and you will have a tester that can indicate the polarity of the signal, too.

LOGIC PROBE

The price of a logic probe knocked me out when I shopped around for one. So I put together some parts and pocketed the difference. The circuit (shown in Fig. 3) did just what other logic probes do. It uses a 4N35 optocoupler (IC1) and a C9013G transistor (Q1). A positive pulse at the base of Q1, turns on the transistor. The 10,000-ohm resistor (R2) limits the incoming pulse so as not to feed too much current to the base of Q1, pre-

venting the transistor from being damaged.

With the base of Q1 at a positive potential, electron current flows from the emitter to the collector junction. The incoming pulse also pulls pin 6 high, lighting up LED1 by allowing current to flow between pins 4 and 5. The 330-ohm resistor (R3) provides current-limiting for pin 6, while the R4 is the current limiter for pin 4.

When testing a digital circuit, if the LED lights up, that portion of the circuit is in a high state, and if the LED remains off, a low is present. The circuit

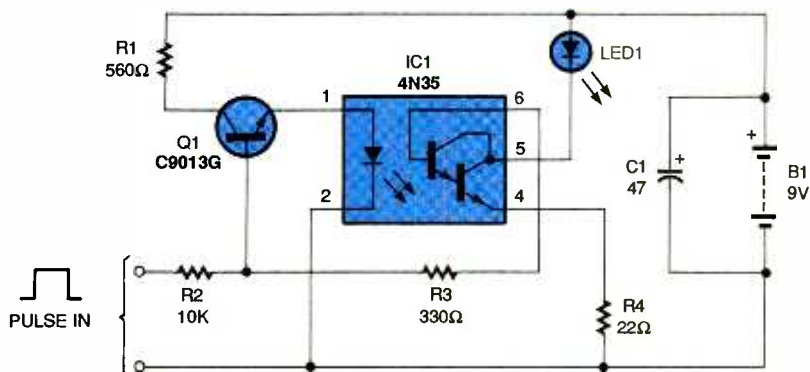


Fig. 3. Why buy a commercially available logic probe when you can build this simple one and save a lot of money?

can be placed inside a small enclosure if its connections are made as short as possible.

—Jose Ignatius A. Alea, Cebu, Philippines

A 555 monostable timer circuit would be a nice addition to stretch fast in-coming signals for detection. Switching the 555 circuit in and out of the signal path would permit the circuit to differentiate steady-state levels from pulses.

RF SIGNAL-STRENGTH CIRCUIT

I have enclosed information on a small project I completed last summer that I have found of much use in evaluating RF/IF filters for ham-radio projects. It is a detector based on the RSSI (received signal-strength indicator) output of a line of Motorola integrated circuits.

I used the MC3356 IC (See Fig. 4A for the schematic) but others that have the RSSI output can be used. My circuit uses only part of the IC's functions, namely the IF (logarithmic) amplifier and RSSI output circuit. A 9-volt battery is needed for operation. Components R2, C4, and C6 filter that supply. The other components surrounding the IC bias it, bypass high-frequency RF to ground, or couple the RF signals into the IC. A 40-dB attenuator is attached to the IC's input to handle large signals. (The RSSI voltage output will vary almost linearly with a 60-dB change in input power.) If vacuum-tube circuits are to be swept, then a 600-volt, 0.01- μ F capacitor should be used at the attenuator's input to isolate the higher DC potential they generate.

To use the circuit, an oscilloscope

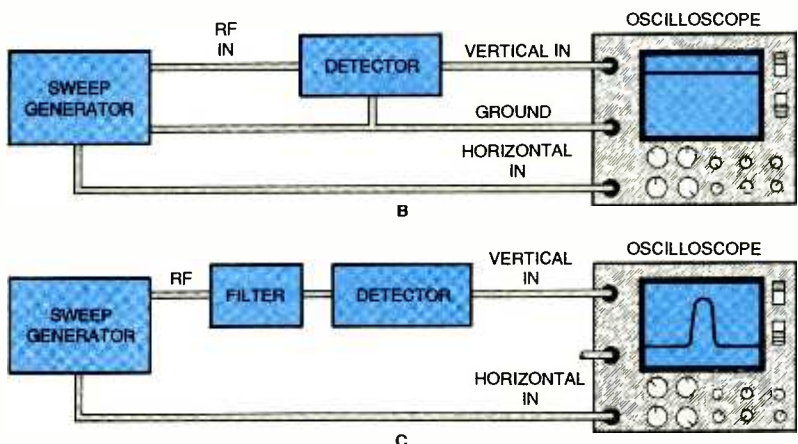
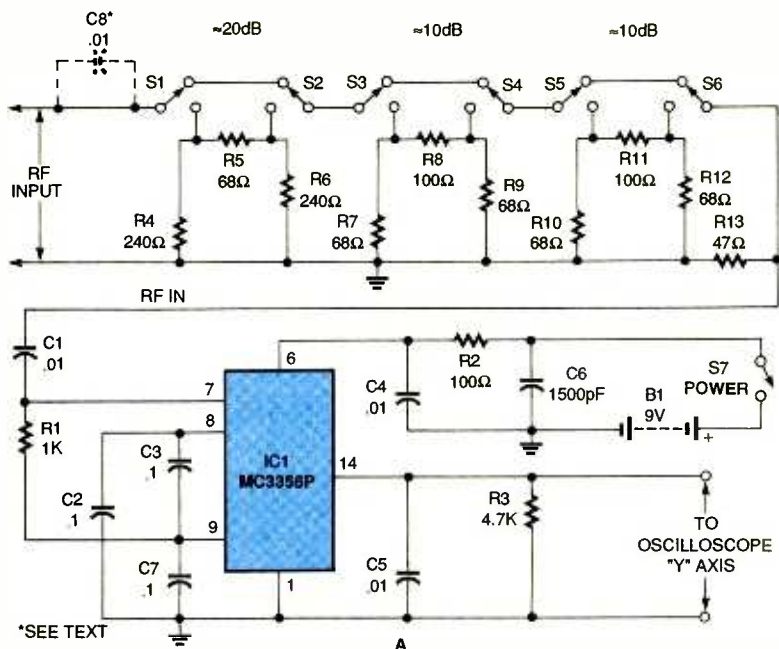


Fig. 4. Here's something not everyone has on their bench. It's an RF signal-strength circuit that works with an oscilloscope.

and a sweep generator are needed. The old sweep generators that were once used for radio/TV alignment will work if the sweep width needed isn't too small. Connect the circuit as shown in Fig. 4B, and adjust the signal level and attenuator until a flat line is seen across the top of the scope screen.

The next step is to insert the circuit to be adjusted or evaluated in between the sweeper output and the detector input (as shown in Fig. 4C). If the circuit has gain, you will have to switch on some attenuation using switches S1-S6. (Note that S1 and S2, S3 and S4, and S5 and S6 are paired up, and should be switched together. You can, of course, replace them with DPDT switches.) A pattern of frequency response for the circuit will be swept across the oscilloscope screen.

Changing any variable inductors or capacitors will allow you to adjust the frequency response as desired.

I have used this circuit to evaluate homemade crystal filters for insertion loss, and shape factor, as well as looking at the frequency response of RF pre-selector filters. As long as the filter to be swept is less than 1- to 2-MHz wide, and the center frequency is less than 20 MHz or so, the detector will work up to its full specification. Above 20 MHz, the frequency response starts to drop off, and the 60-dB range starts to shrink.

—Douglas Ripka, Rebersburg, PA
Very nice circuit indeed. I recommend using a shielded enclosure and coaxial cable for both the circuit's input and output. A switch for the optional capacitor would be a good idea, too.

CIRCUIT CIRCUS

(continued from page 75)

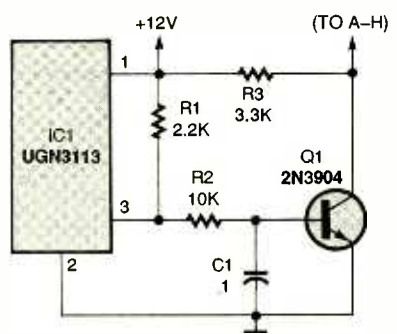


Fig. 7. This circuit can be used to replace one of the reed switches in Fig. 5.

PARTS LIST FOR THE REED-SWITCH REPLACEMENT (Fig. 7)

- IC1—UGN3113 Hall effect, integrated circuit
- Q1—2N3904 NPN transistor
- R1—2200-ohm, 1/4-watt, 5% resistor
- R2—10,000-ohm, 1/4-watt, 5% resistor
- R3—3300-ohm, 1/4-watt, 5% resistor
- C1—0.1-μF, ceramic-disc capacitor
- Power source, wire, solder, etc.

the reed switch. Of course you'll need eight circuits to replace all of the reed switches in the wind-direction sensor.

With no strong magnetic field near IC1, pin 3 is high, allowing base current to reach Q1. That current turns on the transistor and lowers its collector voltage to near zero. In this state, no gate current is sent out to the SCRs. When a magnet is positioned near the Hall effect IC, however, the output at pin 3 goes low, turning Q1 off and allowing gate current to flow to the decoder circuit, and thereby the connected SCR.

Here's hoping that one of these unusual sensor circuits will find a home in one of your future projects. Good circuitry until we meet here again next month.



"Remember when you made contact with the guys with the strange accent?"

COMPUTER BITS

(continued from page 69)

almost nothing, because Win95 does all that internally. In AUTOEXEC.BAT, the DOS section launches a separate batch file that allows the kids to select from a menu of games. Even my three-year-old knows how to get to his favorite piece of software. And the Windows section simply (you guessed it) launches Win95.

DEBUGGING AND CUSTOMIZING

If you have any problems, remember you can always boot from the floppy, restore all three of the files to the root of your C drive, and live happily ever after.

If you've got a multi-boot system that works at the boot-sector level, the new menu system described here will only come into play after you select Windows 95 from the boot-loader menu. In other words, you'll have to make two levels of choices: First, Win95 vs. your other multi-boot OS(es), followed by the appropriate choice from the new menu. This system works just fine on a dual-boot Win95/WinNT system, for example.

There are several other commands you can use in the CONFIG.SYS menus; see the MS-DOS 6 User's Guide (pp. 105-12) or online help for details. There are also several other settings you can add to MSDOS.SYS to customize its behavior. See the Windows 95 Resource Kit (p. 204-5) for details.

One particularly useful command allows you to specify a default menu choice and a time-out value. For example, add:

```
menuDefault=DOS, 10
```

to the Menu section of CONFIG.SYS. That will cause the DOS choice to be selected after a period of ten seconds, provided the user hasn't already made another selection.

To return to the command line from Win95, do a normal shutdown (Start menu, Shutdown..., Shutdown the computer). After you click OK, you'll be back in "DOS." This will not be the "DOS" with all the DOS-specific device drivers; it's just Win95's "DOS" mode. By the way, you won't have long file-

LISTING 1 CONFIG.SYS

```
[menu]
menuItem=DOS, DOS (games)
menuItem=Windows, Windows 95
menuDefault=DOS, 10

[Common]
numlock=off

[DOS]
DOS=HIGH,UMB
DeviceHigh=C:\WINDOWS\HIMEM.SYS
DeviceHigh=C:\WINDOWS\EMM386.EXE X=A000-CbFF frame=cc00 i=dc00-eff
2080 Verbose RAM
FILES=75
BUFFERS=32
LASTDRIVE=Z

REM SCSI CD drivers
DeviceHigh=C:\ADAPTEC\ASPI4DOS.SYS /D /P230
DeviceHigh=C:\ADAPTEC\ASPICD.SYS /D:ASPICD0

REM Sound card driver
DeviceHigh=C:\PROAUDIO\MV SOUND.SYS D:1 Q:7

[Windows]
REM Don't do anything special; Win95 does it all.
```

LISTING 2 AUTOEXEC.BAT

```
@ECHO OFF

:Common
prompt $P$G
path C:\BAT;C:\utl;C:\WINDOWS;C:\WINDOWS\COMMAND;C:\dos;
set TEMP=C:\WINDOWS\TEMP
set TMP=C:\WINDOWS\TEMP
set DIRCMD=/OE

goto %config%

:DOS
mscdex /D:ASPICD0 /L:Z
rem set audio card to max volume
\proaudio\pas set speaker to 100
set blaster=A220 i7 d1
lh mouse
mode con rate=30 delay=1
doskey
kids
goto END

:Windows
win

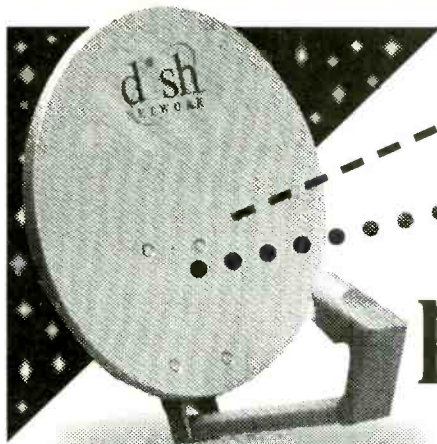
:END
```

name support in this mode, nor will networking work, nor will you have access to a CD-ROM drive or any other hardware controlled by a device driver.

My setup is actually a little more complicated, because some games need EMS memory, even though most won't function with a memory manager loaded. The point is that you can add

as many sections as you want to either or both files, and customize things to your heart's content. A common use is to load or not load network drivers. Another common use is to customize at-home and at-work settings. You could also create per-user environments, although you'd probably be better off using Win95's User Profiles for that task. But that's another story. ■

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Caller ID / RS-232

Connects between a telephone wall jack and an RS-232 serial port. Decodes the caller ID data sent over the phone line and sends it to your PC/Mac. In a pre-formatted ASCII character string. Create your own program to log the name, number, date, and time of all incoming calls. Block out unwanted callers to your BBS/modem. **\$34.50**

Telephone Call Restrictor

Connects to telephone wall jack. Disables all phones on the line if attempting to either: dial a number that has been stored in memory "Block" mode or, dial a number that has not been stored in memory "Allow" mode. Use touch-tone phone to enter telephone numbers into memory, and choose mode. Program from any phone on the line using your password. **\$35.00**

50 MHz Frequency Counter

Reads frequency from 1Hz to 50MHz and displays up to 7 digits on a 16x1 character LCD display. Auto-range feature provides floating decimal point and automatic placement of suffix (Hz, KHz, or MHz). Microcontroller based provides for very small parts count, only 2" x 3" big. **\$48.50**

Telephone Scrambler

Scrambles your voice before sending it over the telephone line. Prevent eavesdropping from an extension or tap. Connects between your telephone and wall jack. No modifications are required to your telephone. Full duplex operation. **\$43.00**

IR Remote Control Receiver

Learns and records the data patterns emitted by standard infrared remote controls used by TVs, VCRs, Stereos, etc. Lets you control all your electronic projects with your TV remote. Seven individual I/O pins can be assigned to any button on your remote, and can be configured for either "toggle" or "momentary" action. **\$32.00**

RS-232 Digital I/O

Give your home-brewed PC/Mac programs a link to the outside world! 12 I/O pins can be configured individually for input or output. Turn on/off relays, triacs, etc. Respond to button presses, switch changes, 4x4 matrix decoding with auto-debounce. Stack up to 16 units on the same serial port for a total of 192 I/O points. **\$32.00**

DTMF Decoder/Logger

Keep track of all numbers dialed or entered from any phone on your line. Connects to your telephone wall jack. Decodes all 16 touch-tones and displays them on an LCD display. Holds the last 240 digits in a non-volatile memory. Scroll through and view all telephone numbers dialed, credit card numbers entered, etc. **\$54.50**



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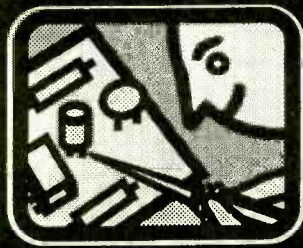
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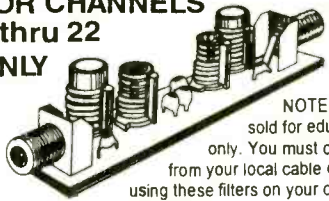
Ever lost frozen food because your freezer stopped? The TC-2 kit would have saved you money. An alarm activates when the temperature reaches a critical point. Turn ceiling fans on automatically when it gets too hot. This kit gives you 100mA of output. SIZE: 2" x 1.4" Power requirement 6 to 15V DC. If you want to switch more power see our Tnac (TP-1) or Relay (RP-1) Power kit. **KIT \$7.95**



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" **KIT \$14.95**

TV NOTCH FILTERS FOR CHANNELS 2 thru 22 ONLY



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. **KIT \$14.95**

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.



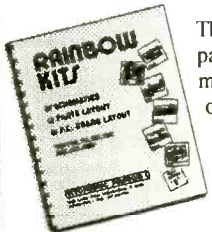
PHONE TRANSMITTER

Small but mighty, it fits anywhere. Phone line powered, never needs batteries. Transmits both sides of a phone conversation loud and clear, wireless, to any FM radio at great distances. Variable tunes from 70MHz to 130MHz FM. You can also use it as a speaker phone. SIZE: 1.25" x 6". **KIT \$12.95**

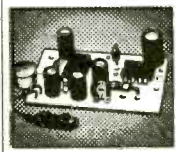


MICRO-MINIATURE PHONE TRANSMITTER

We haven't seen a smaller phone transmitter than the MMPT2 kit. Powered by the phone, it requires no battery. Transmits both sides of a phone conversation to an FM radio up to a 1/4 mile away. Tunable from 88 to 108MHz FM. Attach it to one phone or add it to the line to pick up all incoming calls. The MMPT2 is undetectable if properly installed. Unit has surface mounted parts, you install the leaded parts. Size .45" x 6" **KIT \$29.95**



This Manual contains schematics, parts lists & P.C. board layouts for many of the Rainbow Kits. Use your own parts to construct our kits. **KIT BOOK \$14.95 \$9.95 with the purchase of any kit.**



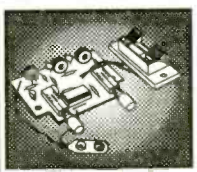
SUPER SNOOPER BIG EAR

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 to 12v DC. SIZE: 1.75" x 1" **KIT \$10.95**



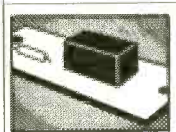
MICRO-MINIATURE WIRELESS MIKE

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" **KIT \$34.95**



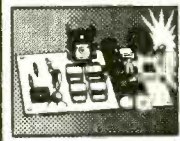
INDUCTANCE METER

This is the kit everyone has been asking for. Turn your digital volt ohm meter into an inductance meter. It will read inductors 3uH to 7MH. Power requirement 9v DC. SIZE: 1.75" x 2.5" **KIT \$14.95 \$8.95**



RELAY POWER KIT

Increase the output of any kit from 100mA to 3 Amps If you need to switch more power, up to 300 Watts, with the Light Genie, Temperature Genie, Timer or Vox kits, use the Relay Kit. We supply a two pole relay 1.5 Amps ea., tie both poles together and get 3 Amps. Size .75" x 2" **KIT \$9.95**



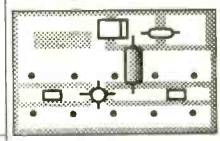
STROBE LIGHT

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" x 1.9" **KIT \$11.95**



DIGITAL THERMOMETER

The DT-3 kit will turn your digital volt ohm meter into an accurate digital thermometer with .1 degree resolution. Measure temperatures from -40° to 250F° The remote sensor is .25" sq. and can be mounted many feet from the meter. Power requirement 9V DC. SIZE: 2" x 1.35" **KIT \$8.95**



WIDE BAND PRE-AMP

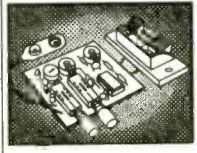
Uses PCB and surface mount technology for better performance. Use for scanners, HT's, Frequency counters, Satellite Receivers. It amplifies low-level (weak) signals. If the signal is extremely low, two amplifiers can be used in a series. **KIT \$19.95**

- 1MHz to 2.5 GHz 2.8dB NF
- 1dB compression=OdBm
- Gain: 1MHz- 20dB to 2.5GHz-6dB
- Power requirement: 12v @ 6Ma



FM STEREO TRANSMITTER

Own your own FM radio station. Any stereo signal you plug into the FMST-100 will be transmitted to any FM radio tuneable from 76 to 108MHz FM. Transmit a wireless link through an auditorium, from your car to your camper, listen to your CD's while mowing the lawn. Play music on one channel sing on the other. Clarity is excellent, approx. 40dB stereo separation. Length of antenna determines the distance of transmission. Complete with stereo input level controls & crystal for stereo separation. 9v battery operation. SIZE: 1.5" x 2.5" x 3" **KIT \$29.95**



CAPACITANCE METER

This kit will turn your digital volt meter into a capacitance meter. Turn that junk box of unmarked capacitors into a fortune of usable parts. Measure capacitors from 2.2pF to 2.2uF. Power requirement 9v DC. SIZE: 1.80" x 2" **KIT \$12.95**



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INTERNET: www.rainbowkits.com



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GENERATOR



20MHz

Manuf # OS-9020G

2-CH
DUAL TRACE



\$498.00

Order N° 50-820

1 MHZ FUNCTION
GENERATOR

Features

- Wider than specified frequency response
- High deflection factor of 1mV/div.
- Wide dynamic range up to 30MHz without waveform distortion
- Algebraic sum of CH1 and CH2
- Low drift with compensation circuit
- Superb trigger sensitivity
- Maximum sweep rate of video signals with internal TV sync. separator
- Jitterless trigger circuitry
- CH1 signal output terminal available
- Variable trigger hold-off
- High precision X-Y phase difference measurement up to 50kHz
- Built-in function generator with BNC output of 50Ω and TTL
- Three kinds of waveform are available with 50Ω output
- Flat output waveform frequency up to 1MHz

Specifications:

Vertical deflection: • Bandwidth :DC coupled (DC to 20MHz normal), AC coupled :(10Hz to 20MHz normal) • Deflection factor: 5mV/div to 5V/div in 10 calibrated steps of 1-2-5 sequence • Rise time: 17.5nS or less

Horizontal deflection: • Time Base A: 0.2μs to 0.2S/div in 19 calibrated steps. 1-2-5 sequence • Uncalibrated continuous control between steps of at least 1: 2.5.



CODE PE96

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WHEN ORDERING

Items are subject to availability.
Prices are subject to change without
any prior notice.

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Order N°	Brand	Min	Price
BU-208	TESLA	10	\$1.49
BU-208/O	TOSHIBA	1	4.50
2N-3055	TESLA	10	0.60
2N-3773	TESLA	5	1.20
2SD-1398	SANYO	10	1.49
2SD-1650	SANYO	5	1.69
STRD-1005	SANKEN	1	4.15
STR-30130	SANKEN	1	2.66
STRS-6301	SANKEN	1	8.50
TA-7777N	TOSHIBA	1	6.96
TDA-2005	SGS	5	1.49



TUN-O-WASH®
ORDER N° 30-0100

\$7.50

(CFC Free)

Fast drying electronics
grade cleaner for tuners,
controls and PC boards.

TUN-O-WASH is excellent cleaner and
degreaser for tuners, controllers and PC boards.

- Designed for cleaning and degreasing consumer electronics
- Cleans in one step, no rinsing required
- Contains no ozone depleting compounds
- CFC and HCFC free
- Not for use on energized equipment
- 12.5 Oz aerosol (12 cans per case)



DIGITAL MULTIMETERS
NEW! Digital

- Overload protect 1000VDC or peak AC on all other ranges
- Input impedance 10M Ohm on all ranges
- Base accuracy range ± 0.5 % to ± 1.0 %
- Resistance 200Ω, 2K, 20K, 200K, 2M, 20M
- Audible continuity response lower than 50Ω
- DC Voltage 200mV, 2V, 20V, 200V, 1000V
- AC Voltage 200mV, 2V, 20V, 200V, 700V

ORDER N° 50-815

DALCO



\$19.95

LOGIC Probe
ORDER N° 51-1015

- Length: 8 inches
- Range: 4.5 To 15 VDC
- Includes Test Leads
- Compatible With TTL, DTL, RTL, HTL, CMOS, NMOS Logic

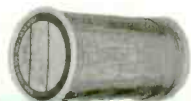
\$8.99

SOLDER ROLL

- 1 LB Spool
- 370 deg F melting point
- Fastest solder
- Alloy 60/40, tin lead, non corrosive flux, Diam. 1.2mm

ORDER N° 51-1005

\$3.95



COLOR CODED
LEADS HEAVY DUTY
ORDER N° 56-500

\$2.82

- 11" Long Wire Lead
- Insulated 1/16" Alligator Clips
- 20 Gauge Wire Size • 10 Leads
- BLACK, GREEN, RED, YELLOW, WHITE



SOLDER WICK

- Solder Remover
- Length 5 Feet

85¢

Min. 2 pcs.



VCR ALIGNMENT TOOL KIT

ORDER # 50-888

The most popular

\$24.99

- VCR Head puller
- Retaining ring remover
- Spring hook
- Micro screwdriver
- Hex key set • Fitted vinyl • Soft zippered case
- Dimensions: 9 1/2"(W) X 12 1/4"(L)
- 7 Assorted head & guide aligners
- 3 Reverseable screwdrivers (Small-Flat-Philips)



TEMPERATURE CONTROLLED
SOLDERING STATION

\$64.00

- Adjustable Temp.: 300°F - 790°F - 150°C - 480°C
- Grounded Tip for Soldering: Static Sensitive Devices, Heater Aid.
- Led Power Temperature Indicator
- Overheat Protection W/ Temperature Control
- Auxiliary Grounded Terminal
- Comes in digital LED display
- 48 Watts soldering iron

ORDER N° 51-1035



Universal Audio/video Remote
ORDER N° 82-1055

- Controls basic functions of TV, VCR, cable box, and CD or laser player
- Ergonomic design! Main buttons are in line with natural thumb motion
- Two-minute memory allows time to replace batteries without re-programming
- Programming reminder sticker inside battery compartment
- Sleep time for 60, 30, or 15 minutes (according to your TV)
- Set key recessed to prevent accidental deprogramming
- Spanish instruction included
- Requires four AAA Batteries (not included)



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Don't let the price fool you. This meter is a digital multimeter designed for engineers and hobbyists. Equipped with 5 functions and 19 ranges. Each test position is quickly and easily selected with a simple turn of the FUNCTION/RANGE selector rotary switch.

Rubber Boot Included

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

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.

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	\$19.00



Our Best Offer Ever on a

High Quality Full Sized DMM

\$19.00 any qty

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

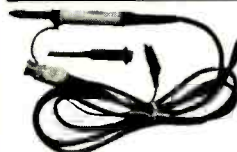
Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

hFE Test

Measures transistor hFE.

Switchable Scope Probe Sets

(Selectable X1/Rel/X10) These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP 9060) 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	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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<http://www.cir.com>

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.

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

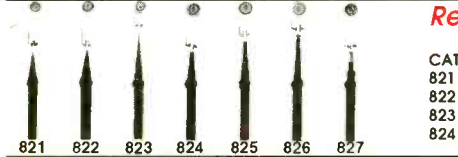


Electronic Soldering System with LED Display Deluxe temperature controlled system with LED display for maximum accuracy. Temperature is adjustable from 160°-480°C (320°-900°F). Iron heating power is 48 Watts. Runs on 24V from controller unit. Replacement irons and tips are available. Tip size is 5.3mm.

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



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

We now offer a variety of replacement tips for the SL10/SL30 soldering stations.

CAT NO	DESCRIPTION	PRICE EACH	
		1	5
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.

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 ₂ O)	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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We stock high quality 60/40(Sn%/Pb%), .031" and 63/37, .031" diameter. This is prime JIS certified solder that we maintain as a regular stock item (It is not "Left-overs, Rejects or Surplus") and you can buy it from us at a fraction of the price that you are used to.

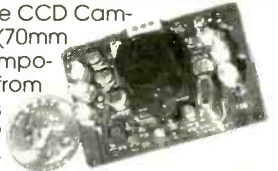


Tired of Paying Inflated Prices for Solder?

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 connecting three wires: red to 12V, black to ground (power & video) and brown to video signal output.



CAT NO	DESCRIPTION	1	5
CA-H34A	PCB Mounted IRCCD Camera	\$125.00	\$109.00

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CIRCUIT SPECIALISTS, INC. SINCE 1971

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602-464-2485
602-464-5824(FAX)**

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Plans • Ready-to-Use • Easy-to-Build Kits



Laser Ray Gun
Handheld, battery operated. Produces an intense burst of light capable of burning holes.
LAGUN2 Plans \$20.00
LAGUN2K Kit/Plans Price on Req



250KV Tesla Coil
10-14" of Explosive Bolts of Lightning!
• Transmit Wireless Energy
• Ion Motors
• Anti-Gravity
• Strange and bizarre pyrotechnical effects
• Many other experiments shown in detail
• Award winning science project!
BTC3 Plans \$15.00
BTC3K Kit/Plans with coil \$299.50
BTC30 Assbld Ready to Use \$399.50
BTC4 Plans, 500KV unit \$20.00

ATTENTION: Experimenters & Researchers!
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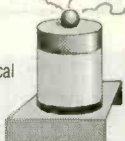
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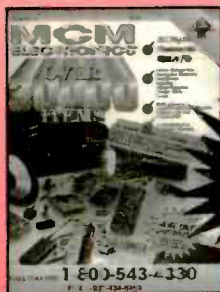
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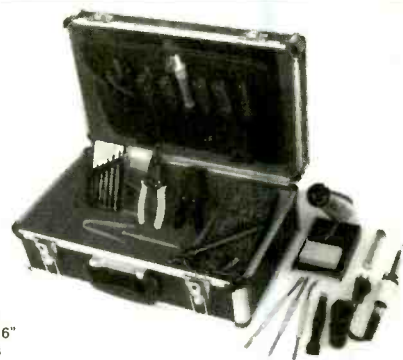
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- ND-3 - 3 pc. Nut Driver Set
- TL-8 - Precision Screw Drivers
- ST-5 - Screw Driver Slotted 3/16"
- ST-6 - Screw Driver #1 Phillips
- ET-10 - IC Puller
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- 4 Digit Display

\$225



MX-9300 Four Functions in One

• One instrument with four test and measuring systems:
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 (0-30V @ 3A, 15V @ 1A, 5V @ 2A)

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4 Fully Regulated DC Power Supplies in One Unit
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 Model EDM-163**

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7 Functions with data hold
 Compares to Fluke Model 77II

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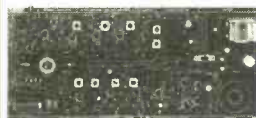
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• Dual time base
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• Sweeps to 5ns/division
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• Video sync separators
• 2-axis input
• Single Sweep
• V mode displays two signals unrelated in frequency.
• Component tester
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• 1mV/div sensitivity
• 23 calibrated ranges - main time base
• 19 calibrated ranges - delayed time base
• Signal delay time
• V-mode - displays 2 signals unrelated in frequency.
• Component tester
• 2-axis input
• Single sweep
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Special \$389.95**

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40MHz

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- 20MS/s Sampling Rate

- Analog with Delayed Sweep

- Analog / Digital Storage

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S-1340 \$475

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- Analog with Delayed Sweep

**2 Year
Warranty**

- 25MHz Analog
- Delayed Sweep

S-1325 \$325
• 25MHz Analog

OSCILLOSCOPE SELECTION CHART

ANALOG		Sensitivity (max)	No. of Channels	Sweep Rate Max ns/div	Delayed Sweep	Video Sync	Component Tester	Beam Find	Time Base
Model	Bandwidth MHz								
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		Analog Sen (max)	No. of Channels	Sampling Rate	Memory Channel	Internally Backed Up	Pretrigger %	Output	
Model	Bandwidth MHz								
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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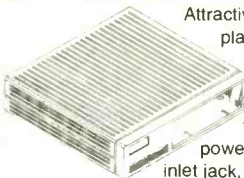
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power cord not included.

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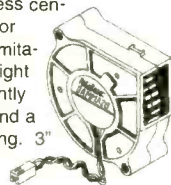
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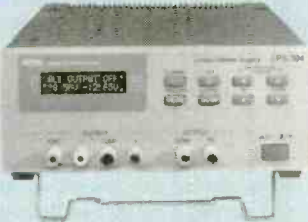
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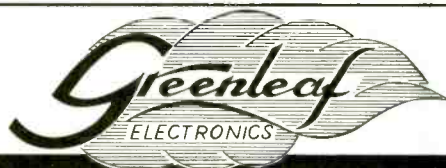
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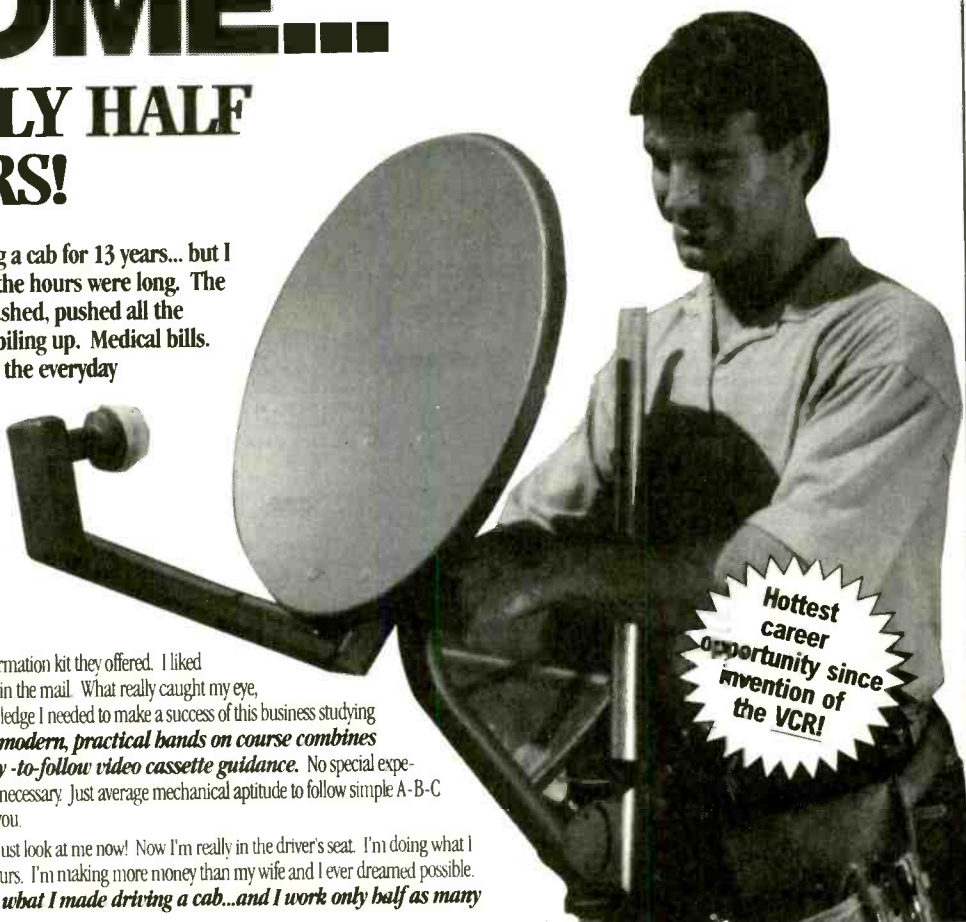
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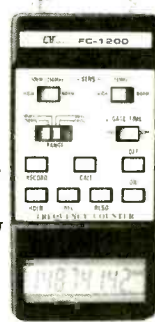
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Best Resolution LCR

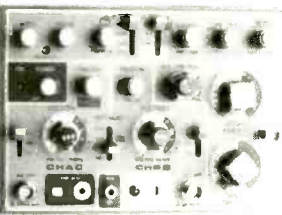
Inductance: 200μH-200H
Capacitance: 200pF-20,000μF
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Tachometer, Stroboscope, Humidity
& EMF adapter, Sound level meter,
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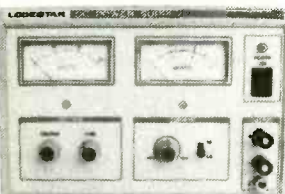


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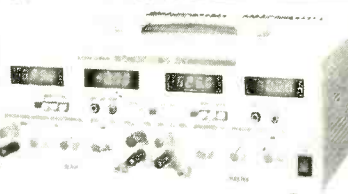
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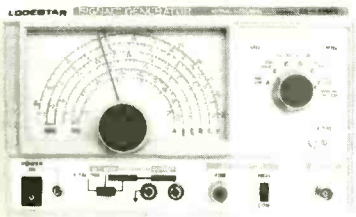
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Output distortion:
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Output impedance: 600 ohm

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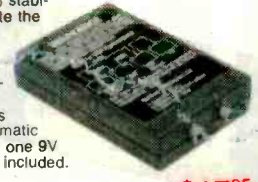
When used in conjunction with a cable TV converter or cable ready VCR, this handy device allows you to feed the cable TV stereo signal into your home sound system for superb audio reproduction of your favorite shows, movies, and sporting events.



#PO-189-110 **\$19⁹⁰**

Digital Video Stabilizer

The digital video stabilizer will eliminate the constant picture distortion caused by the copyright protection on movie videotapes. This unit is fully automatic and operates on one 9V battery which is included.

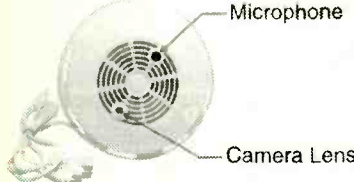


#PO-180-320 **\$17⁹⁵**

Decoy Cameras

These 1/3" CCD cameras offer a clever means of disguise. Both feature a 3.6mm wide angle lens, built-in electronic shutter, and a 12 VDC power supply. Minimum illumination: 0.3 lux. 400 line resolution. Smoke detector decoy camera includes an audio output.

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HIGH TECH
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Part #	Description	Price
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PO-335-540	Decoy clock camera	299.95



**"The Sound Bridge"
FM Stereo Wireless Transmitter**

The Sound Bridge is a mini FM wireless transmitter that can be used to broadcast stereo sound from any audio source like portable CD players, TVs, electronic games, CD-ROM, even computer soundcards, to your home stereo receiver! Adjustable from 89 to 95.5 MHz.



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**Portasol/Weller Butane
Soldering Tool**

**NO CORDS,
NO BATTERIES!**

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#PO-372-150 **\$25⁹⁵**

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Kit**

Deluxe probe kit features a modular design for longer life, switchable 10:1 probe with 150 MHz bandwidth, 2.8 ns rise time, and adjustable capacitance from 10-35 pF. 60" in length.

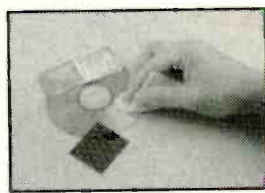


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5" heavy duty sealed back midrange with deluxe mesh grill. 1" aluminum voice coil. Popular midrange for auto sound installations. ♦Power handling: 35 watts RMS/50 watts max ♦Voice coil diameter: 1 inch ♦Impedance: 8 ohms ♦Frequency response: 800-10,000 Hz.



#PO-280-030 **\$7⁵⁰**

3 Channel Color Organ Kit

This sound to light unit features three separate outputs, which can be controlled independently. Each output reacts to three different bands of the musical spectrum: bass, midrange, and treble. Has built-in microphone, so no connection is required to music source, but a line input is provided.



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QUALITY
KIT!**

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TO 30KHz!** **Dayton Loudspeaker Co.®** **\$16⁵⁰**

#PO-275-050

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#PO-290-023 **\$19⁹⁵**



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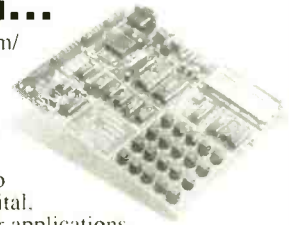
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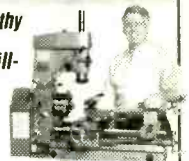
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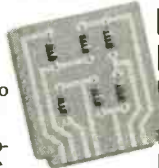
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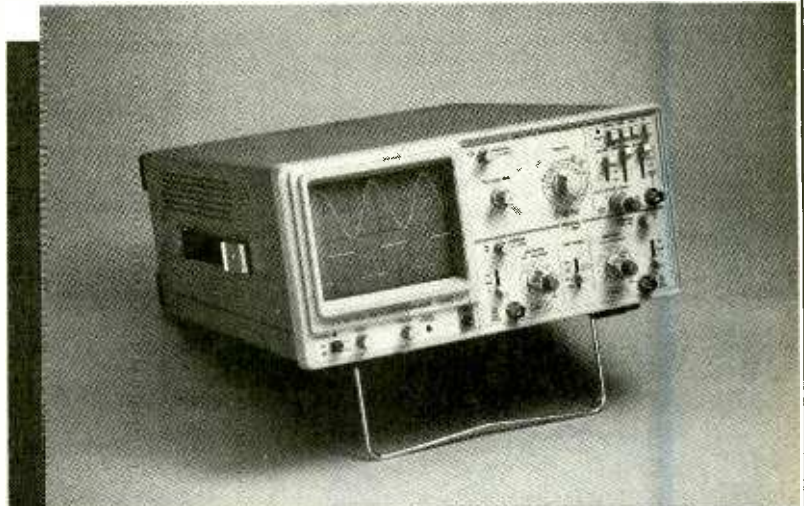
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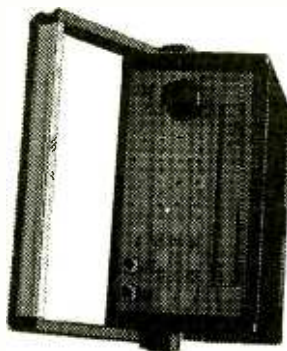
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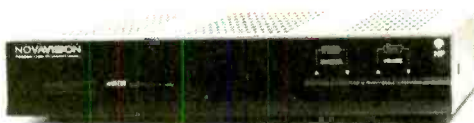
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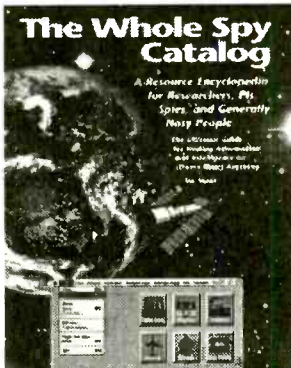
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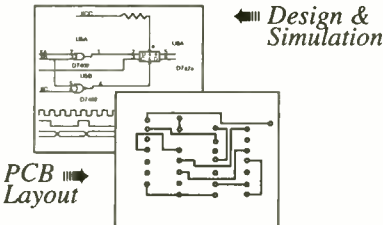
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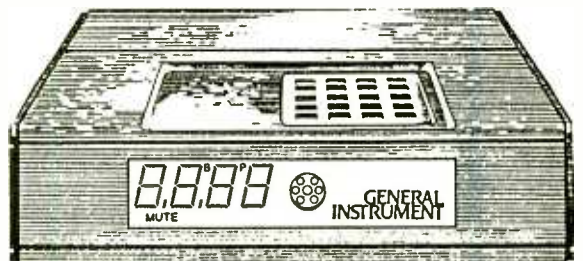
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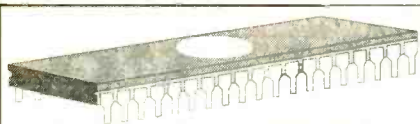
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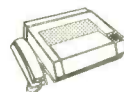
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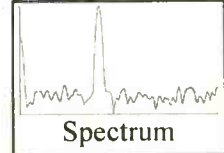
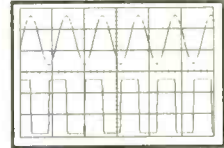
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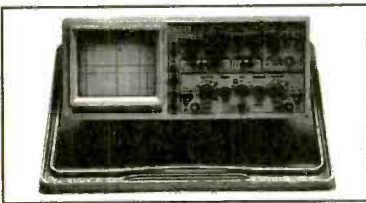
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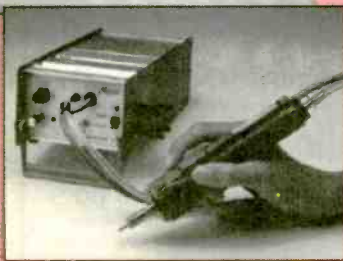
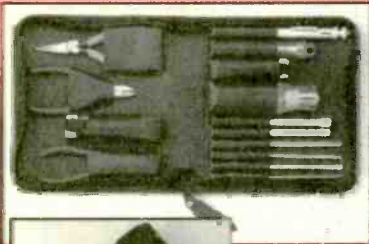


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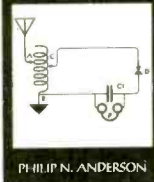
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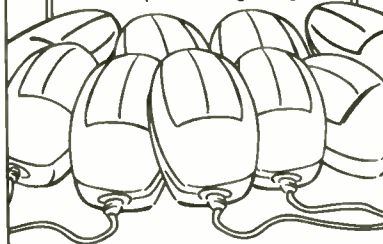
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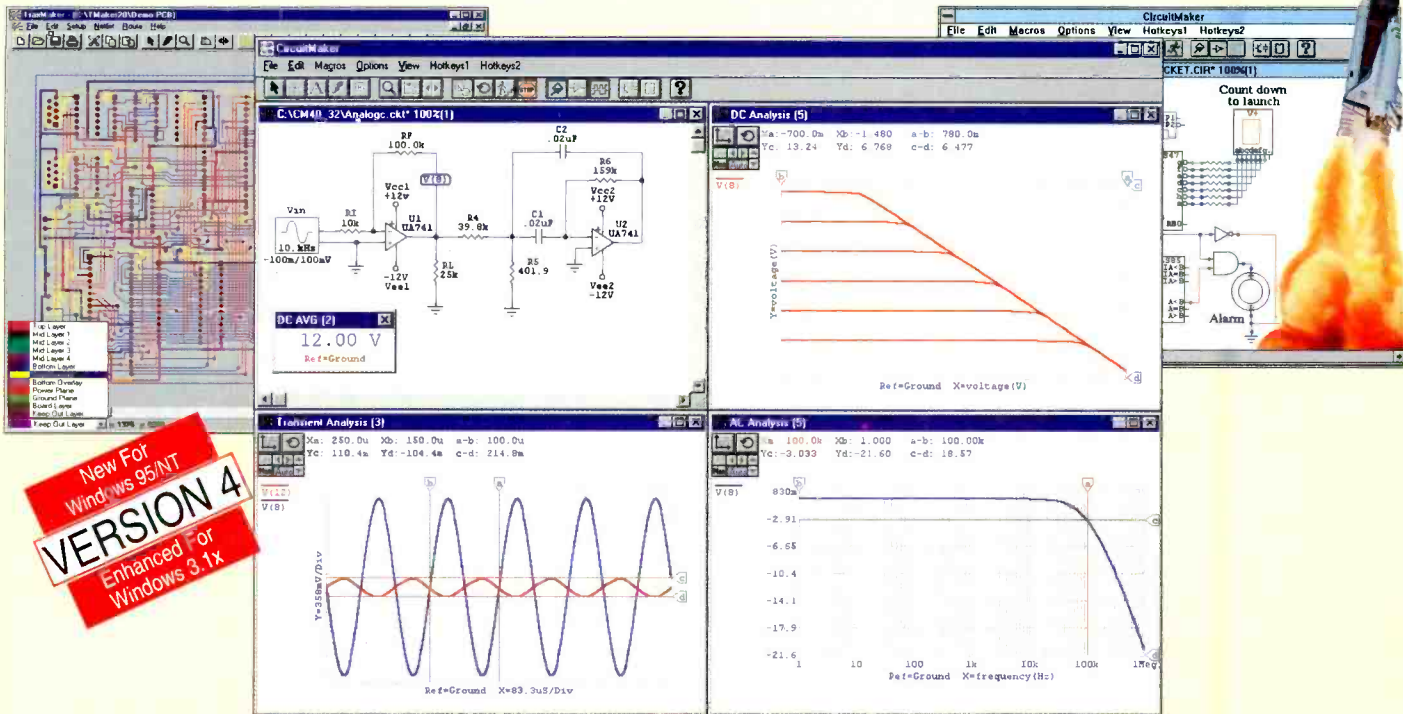
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