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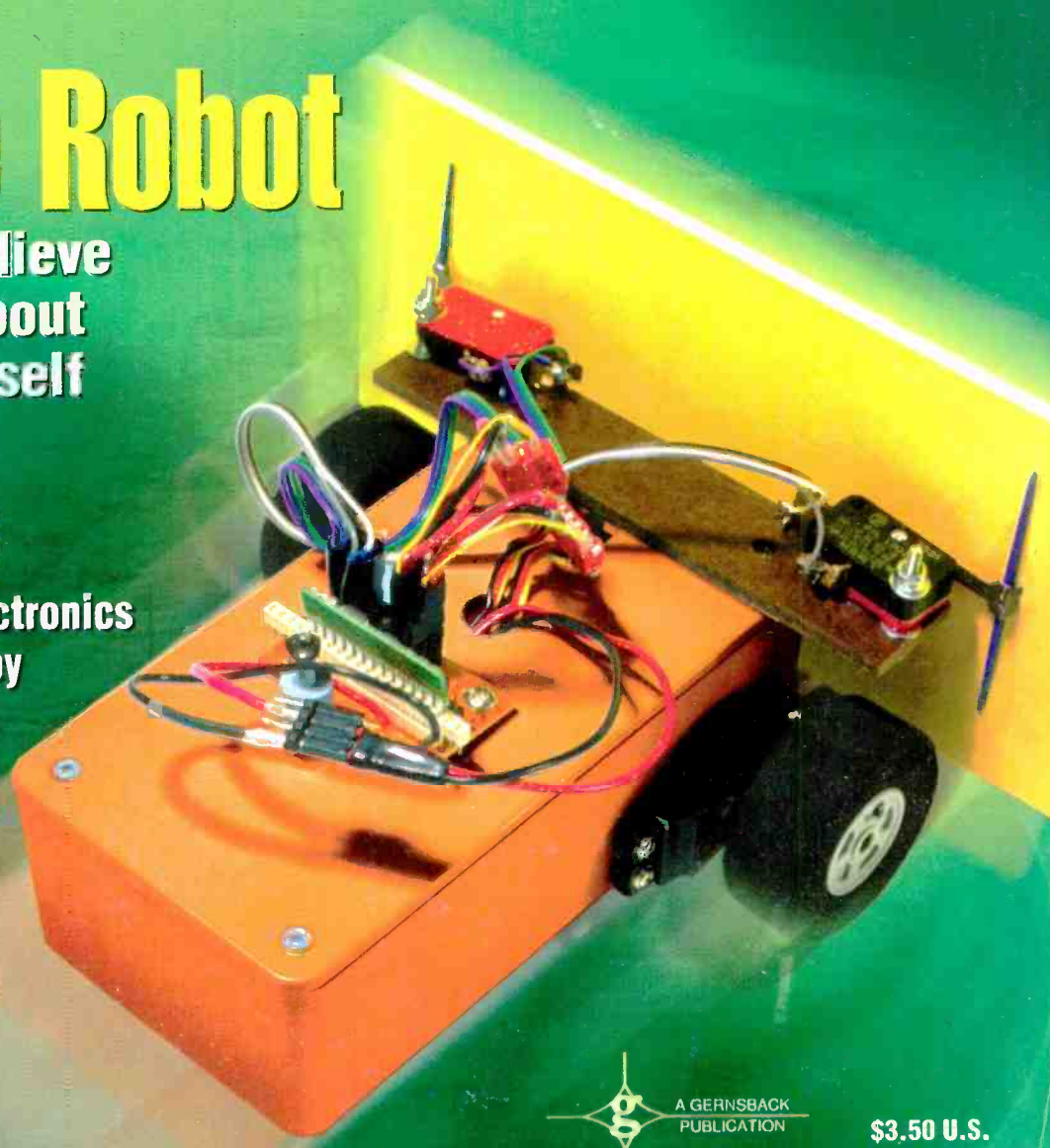

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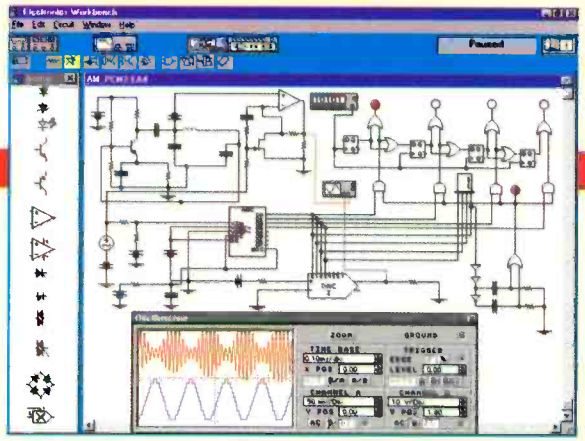

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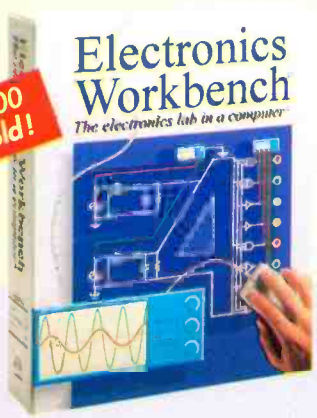

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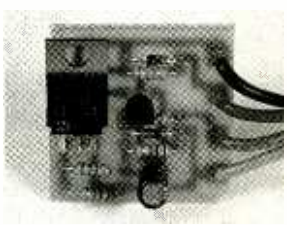
Page **29**



Page **39**

Page **45**

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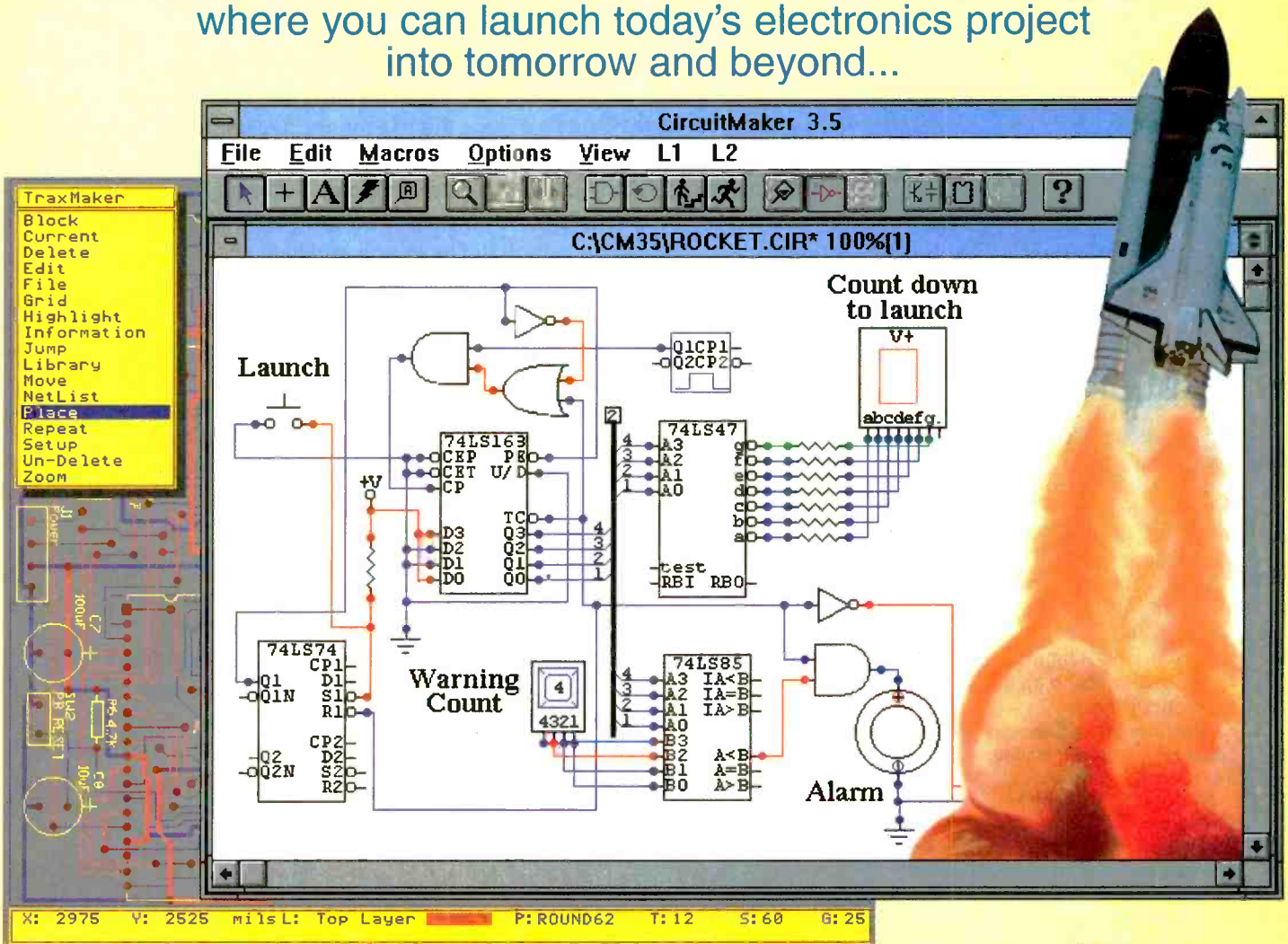

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Editorial

More Changes?

Ever since I started reading this magazine (in my teenage years) I have appreciated its straightforward, conversational text that immediately involves the reader. By avoiding the use of "engineeringese," **Popular Electronics** has provided educational articles that are entertaining and construction articles that are accessible to project builders of all skill levels. So, in keeping with that simple and effective style, I'd like to say:

Hi.

As you might have read in last month's editorial, Carl Laron, who was Editor of this magazine since the late 1980s, has now taken the helm of our sister publication, **Electronics Now**. But does that mean a change in what you've come to expect from **Popular Electronics**?

Absolutely not. I'd like to take this opportunity to assure you that I plan on keeping to the excellent quality standard that Carl has established for **Popular Electronics**. He's taught me a lot during the past few years that I've been his associate, and I feel honored to be stepping in to fill his position.

So what does the future hold? You won't be disappointed. We've got some great projects and features in the months to come that will be sure to awaken that sense of wonder that got us all into electronics in the first place. The amount of new technology out there is overwhelming, and we're committed to bringing the best of it to your doorstep each month.

This month, our cover story shows you how to build a robot that is fully programmable and easy to assemble, yet made of only a handful of parts. As you'll find out in the Mobile Robot article, the science-fiction-induced childhood dream of having a robot buddy is not too far away. The story begins on page 29.

Dan Karagiannis

Dan Karagiannis
Managing Editor

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TECHNOLOGY UPDATE

Breakthrough device creates a wall of silent noise that drives away annoying animal pests...

Now you can use ultrasonic power to repel annoying dogs, cats and many wild animals—without harming them.

by Charles Anton

Be honest. Even if you like animals, you don't want strange animals in your yard. You know what I'm talking about: dogs that dig holes and foul your lawn or cats that trample flowers and sleep on your car.

Common problem. If you live in a rural area, you've probably had trouble with raccoons, skunks or possums. If you live in the southwest, you may even have had problems with armadillos.

Until now, there weren't many options. You wouldn't want to harm a stray animal, and an animal control agency may take days to respond, if they do.

Modern solution. Fortunately, modern technology has provided an answer: the new Yard Gard. It uses high-frequency sound waves to force unwanted animals to leave the area. Yard Gard eliminates the need for repellents, trapping or physical attacks. Pests learn to avoid the areas Yard Gard watches over.

Ultrasonic power. Yard Gard's electronic ultrasonic generator broadcasts powerful "high frequency noises" that repels four-legged yard pests, yet is generally unobtrusive to people.* Tones are harmless, but animals find the sounds unpleasant, so they flee.

Why it works. Small animals depend on their acute hearing for survival. They can hear in the 18 to 25.5 kilohertz range which is beyond the range of most humans. When critical hearing frequencies are disrupted by strong pulses, animals feel threatened and leave the noisy area. Yard Gard takes advantage of this fact to protect your yard from pests.

Break their habits. Animals are creatures of habit. They establish a territory and generally follow the same travel routes. Yard Gard forces animals to change their patterns and establish new ones. They soon modify their habitual routes to avoid Yard Gard zones. Once that has happened, they'll no longer be a an irritating problem.

Just plug it in. Yard Gard plugs into any standard household outlet. Electricity consumption is very low and costs only about 25¢ a month to operate.

Yard Gard is designed for outdoor operation in all types of weather. You can use your Yard Gard all year round.

Three settings. Yard Gard has three frequency settings. At its lowest frequency setting, one Yard Gard covers an oval area of approximately 4,000 square feet—the size of an average city lot. Additional units can be added to accommodate especially large yards.

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

Keep the birds. Do you love to watch and feed birds in your yard? If you have problems with cats chasing birds away or killing them, Yard Gard is the answer. Birds are not affected by high frequency sound waves, but cats hate them.

Mount Yard Gard to a fence or porch railing, or place it on a post.

Try it risk-free. For a limited time, you can get the new Yard Gard at the introductory price of just $99. Call today to take advantage of this special factory-direct pricing. Yard Gard is backed by Comtrad's exclusive risk-free home trial. Try it and if you're not completely satisfied, return it within 90 days for a full "No Questions Asked" refund. Yard Gard is also backed by a two-year manufacturer's warranty. Most orders are processed within 72 hours and shipped UPS.

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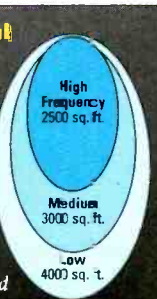

Humane. *Yard Gard causes no harm to animals. By creating a wall of high-frequency sound, it forces them to leave the area and create new habitual routes. While the sound is very annoying to animals, it is virtually unobtrusive to people.*

Non-toxic. *Chemicals used to eliminate pests can be dangerous to neighborhood pets or humans. Yard Gard poses no health risk when used properly.*

Nature-friendly. *Poisons and pesticides can pollute soil and water sources. Yard Gard deters pests with sound so it causes no damage to the environment.*

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LETTERS

Reader Requests

SWITCHING AMP REVISITED

I am writing about the "Switching Amplifier" article in the April 1996 **Popular Electronics**. In attempting to build this amplifier, I came across the following problem. On page 34, the parts-placement drawing shows C9 on the power-supply board; however, the Parts List does not mention it and the schematic diagram does not show it. Can you clarify the matter for me? I'd appreciate it.

Thank you for an excellent magazine.

S.D.
Don Mills,
Ontario, Canada

Actually, there are labeling problems with two of the capacitors on the power-supply board. Capacitor C9 should actually be labeled C3. The other problem is that two capacitors were labeled C5; the capacitor shown below D4 in the parts-placement should actually be labeled C1.

We apologize for any inconvenience this might have caused.—Editor

CHANGE OF ADDRESS

One of the companies listed in the "Multimedia Watch" column in the May issue of ***Popular Electronics*** *has moved. The new address for CD Titles is 411 Waverly Oak Road, Waltham, MA 12154-8414.—Editor*

HAVES & NEEDS

Here I am, young at heart (I'll be 70 in January), and trying to get into the little black boxes known as ICs. I took a course in radio repair from NRI back in 1943, but I haven't kept up with electronics.

I have a small problem I hope your readers can help solve. I purchased two different Heathkit breadboarding training modules at hamfests. I hope to use them, along with experiments in books and magazines, to increase my understanding of electronics. They work—at least, the power supplies work. Some of the other circuits might work. Of course, the modules did not come with a single piece of information.

One unit is the analog trainer, #3600. I can figure out most of it, except for what was supposed to plug into the back of the unit. On the back are two plugs, and threaded deals to attach something. One plug is a 3-connector, polarized 110-VAC power plug. I have no idea how the other plug, a 60-pin dual inline male connector, connects to the circuit board inside the unit. The connector is soldered directly to the circuit board. What is the pinout and what was the feature intended for?

The other unit is the Digital Design breadboard EI3200. I haven't figured out how to use the onboard clock or any of the features except the +5-VDC and the -12-VDC power. I need to know how to use the LEDs and the clock.

thank you for any help.

DONALD S. LAMBERT
1301 Kiblinger Place
Auburn, IN 46706-3010

I am looking for the user's manual and a schematic for an Electronic Measurements Corporation (New York) Model EMC215 tube and transistor tester, as well as the newest tube/transistor setting book for its twelve bank switches.

JAMES G. RYAN
1619 East 49th Street
Cleveland, OH 44103-2407

I am searching for the service manual and/or schematics for a Fisher video signal controller, Model TFM-190. I will gladly pay the costs for photocopying and shipping. Thank you for any help.

ROBERT H. PFEIL
935 Kintyre Way
Sunnyvale, CA 94087
Tel: 408-245-3490
e-mail: rpfeil@svpal.org

I'm trying to find a schematic and plans for constructing an LED speedometer readout to install on my new rear-wheel drive auto. I became spoiled with the display in my old car—a 1984 Camaro Berlinetta—which had numbers about an inch-and-a-quarter high and segments about an eighth-inch wide. I hope some other readers can help me out. Great magazine!

RAY CARLTON
880 Arlington Place, NE
Atlanta, GA 30306-3911
Tel. 404-872-8615

I'm interested in obtaining any information, including instruction booklets, service manuals, schematics, theory of operation, parts lists, and general information regarding two different items that I am trying to restore. The first is a 1959 "King of Diamonds" pinball machine, manufactured by D. Gottlieb & Co. The second is a Kellogg hand-crank wall telephone. I also need an ear-piece cord for the phone.

LOUIS M. IANNUZZELLI
1315 West 53rd Street
Davenport, IA 52806
Tel. 319-386-7897 (call collect)

I saved from the trash heap an AC/DC instrument calibration standard manufactured by Radio Frequency Laboratory Inc. of Boonton, New Jersey (P/O Model 829B, stock No. 6625-804-4993, contract No. AF 33(604)38770, 115V 10 50 to 400cy). Now I am trying to figure out what to do with it! I have no manuals. Can someone out there help me with information on this big, heavy piece of stuff?

MICHAEL PEARCE
811 East 7th
Superior, NE 68978

continued on page 16

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NET WATCH

Finding Electronics on the Web

BY DAN KARAGIANNIS

Anyone who has explored the World-Wide Web knows that finding an obscure item is not always easy. To help the lost and confused Internaut, at least a dozen notable search engines exist on the Web, as well as a few sites that let you use those engines simultaneously. However, none of those are exactly perfect (though at least some are getting better).

information: You guessed it, it's electronics. After all, if you're reading this magazine, chances are you are interested in acquiring electronics knowledge and discovering new applications for components. Also, in keeping with the idea that life shouldn't only be about serious pursuits (well, it's my idea anyway), we'll also take a look at the excellent new Twentieth Century Fox site.

If you'd like to find an electronics-related piece of information on the Internet, you'll love all the search options the Electronics Search FAQ contains.

A major problem that multiple-engine search sites face is that they have to accommodate "anyone's" request. In other words, whether you're looking for Greek recipes, pictures of galaxies, audio clips of a favorite band or artist, or electronics articles, you're using the same site. What does that mean? It means the sites do not cater to any one particular interest and are therefore not efficient at finding any particular type of information.

Well, this month we'll look at a site that makes it easy to find one type of

ELECTRONICS SEARCH FAQ

Let me start by saying that this great site has a somewhat misleading title. Frequently Asked Question (FAQs) are usually little more than a text list of questions and answers that are commonly sought after in a subject area. This site is much more than that, and, quite honestly, doesn't resemble any FAQ I've seen before. It looks more like a collection of useful resources to finding specific pieces of electronics- and electrical-engineering-related information, and has more than a moderate amount of links to explore.

For starters, the Electronics Search FAQ deals with what it calls "The Big Three," or FAQs, USENET newsgroups, and the World-Wide Web. Clicking on the FAQs and Technical Reports link presents you with options for locating those documents on the Net. Selecting the USENET link presents you with engines for searching through newsgroups for a particular piece of information, and, for those with browsers that support newsgroup access (like Netscape), there are direct links to a *lot* of electronics- and EE- related groups. Finally, the World-Wide Web link lets you use several search engines that the site's creators feel contain a good amount of relevant information.

Interestingly, the Electronics Search FAQ site contains links to a few useful overviews to searching the Net in general. Included are: All-in-One Search Page, Gower.Net, Internet Sleuth, Rice University, Use It, and Yahoo's List. Keep in mind that those are the types of general sites referred to in the beginning of this month's column. However, they can be educational, especially to newbies (new Internet users).

After you've explored The Big Three, you might want to check out a couple of "Oldies but Goodies." The first of those, FTP Sites, is a link to a few great FTP search engines, including my personal favorite, FTPsearch. There's also a recommended FTP site that contains source code and software useful to engineers. Then there's the Mailing Lists link, which I was disappointed in because it had no recommended lists at all, just places to conduct searches for ones that might appeal to you (that includes lists that have nothing to do with electronics).

Some who read that last criticism of mine might be able to argue that it applies, to some extent, to the other

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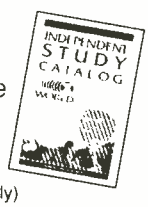

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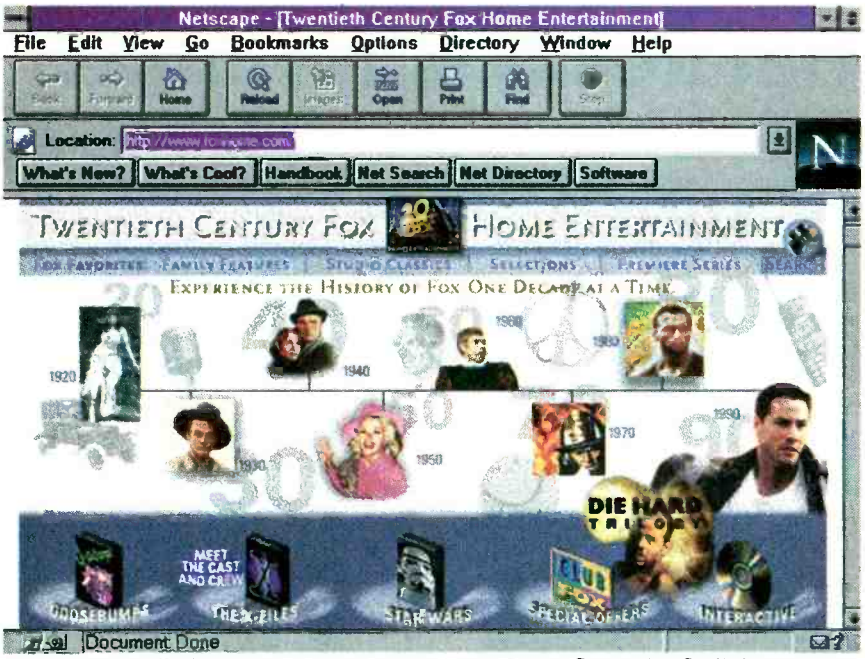

After eight decades of bringing magic to the big screen, Twentieth Century Fox finally brings its creations to the Internet.

features of the FAQ we've already covered. It's true that the FAQ site does mention a lot of external search engines that could be considered "generic" and not electronics-specific. The FAQ more than makes up for that shortcoming in its last section, however.

The Meritorious Search and EE Resources group of links is easily the most impressive feature of the site. There's a Books, Libraries, Bookstores, Databooks link that can get you going in the right direction when you're looking for some documentation, and an Internet Hot List that will help keep you up to date on topics like Ada and Realtime. Clicking on Internet Employment Resources can help you find a job working with some of the latest technologies, while selecting either the IC-Specific or Microcontroller/Microprocessor Index should make carrying out the design aspects of just about any high-tech job easier.

The most impressive feature of them all, though, is the EE Hunter, which is everything a category-specific meta-search engine should be. The EE Hunter unifies search engines at Web sites such as Analog Devices and Texas Instruments, as well as over 20 others. You can easily toggle between the sites, and thereby quickly find online datasheets, news articles, and Web resources. If you only try one feature of the Electronics Search FAQ, be sure to make the EE Hunter your choice.

20TH CENTURY FOX

Everyone likes to be entertained. If all we did was work, stress would surely claim us sooner or later. So what do you do to unwind? While each person has his or her own hobbies, one of the pastimes this country enjoys as a whole is watching movies, whether in a theater, home theater, or just in front of a regular TV.

Our next site this month is that of a company that has brought us eight decades of cinematic entertainment—Twentieth Century Fox. At this multisection Web presence, you can relive film history by going through a timeline of old favorites. Just click on the decade of interest to you and learn about the significant events and personalities that shaped the entertainment industry at that time. Those films that had the most impact include extensive information, including high-quality images of their legendary characters (keep in mind they make great Windows wallpaper).

In keeping with our search-engine discussion of earlier, it's interesting to note that the site has its own searchable database of information on any movie in the Twentieth Century Fox Home Entertainment (TCFHE) library. In less time than it takes to burn microwave popcorn, you can find your film favorites by typing in the title, name of a lead actor or actress, release year, name of director, or even which Oscar it won. When you find a title you're looking for, you can go to its page, if there is one (TCFHE plans on adding pages for three films from each decade, every four months), get some

One of the most popular features of the Twentieth Century Fox site is the Star Wars Trilogy page. You can download great-quality video files and many other types of goodies.

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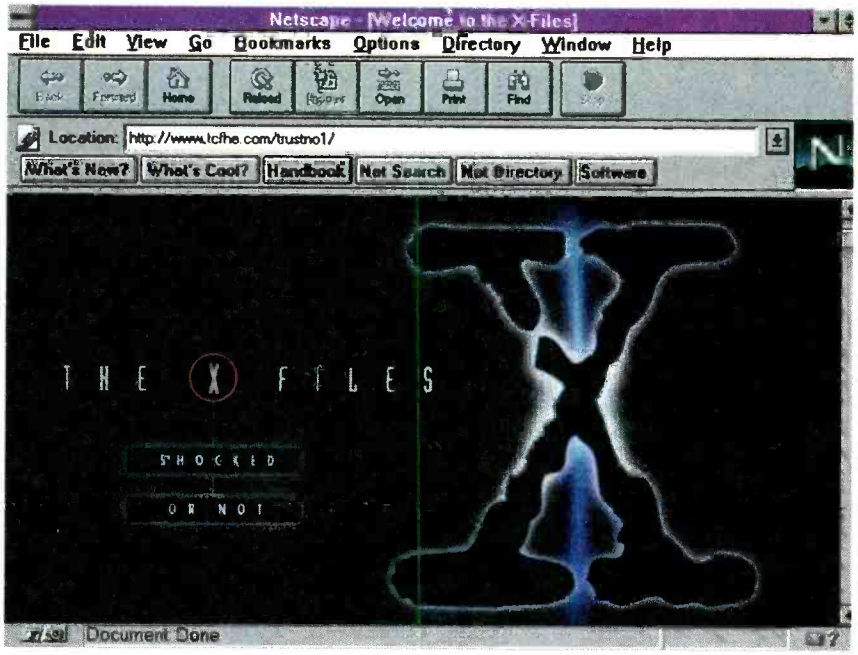

At the X-Files site, you'll find a game where you can take on the role of an investigator and search the Net for clues about a case you're assigned.

important information for research or trivia, or just help yourself decide what movie you want to rent from a local video store.

HOT SITES

Electronics Search FAQ
http://www.eg3.com/srcnet.htm

20th Century Fox Home Entertainment
http://www.foxhome.com

Star Wars Trilogy
http://www.foxhome.com/starwars/index.html

X-Files
http://www.foxhome.com/trustno1

This is truly one of those sites you have to see to appreciate. Movie memories can often bring back some pleasant nostalgia, and finding online goodies relating to a favorite film only adds to that feeling. For example, I particularly enjoyed the Star Wars Trilogy page within the site. I found some really incredible .avi files of scenes from the classic movies, and enough information to keep me busy for hours. Before you visit the site, though, be sure to have your VCR ready to roll one of the *Star Wars* movies. You might find yourself in the mood to do just that by the time you browse just a few of the areas there.

But it's not only nostalgia that keeps the TCFHE site interesting. There are also some excellent Web experiences based on current film magic. Try out the X-Files page to see what I mean. There's an extremely innovative role-playing game you can take part in where you are issued a casefile through e-mail and are then sent onto the Net to collect clues and solve mysteries. Just wait until you see some of the graphics at this site; you'll really get into the game.

That's all for this month. If you'd like to drop me a line, feel free to send e-mail to peeditor@aol.com, or snail mail to *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

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NEW PRODUCTS

PC/TV CARD

If you don't want to wait—and shell out big bucks—for the hot new television/computer combinations, you can get a similar effect today by adding a video/television card to your PC. The *DynaMax Hi-Rez Plus* card from Core Dynamics is an interactive, high-resolution card that provides you with "personal-theater enjoyment," and also features a video snapshot recorder for image capture, and on-board spatial stereo sound.

The Hi-Rez Plus lets you use your PC to watch TV, videos, or home movies; capture images for personal home page use or for video albums; receive financial updates; and play video games. It can also be used to create an inexpensive security or local video-conferencing system, or to add video snapshots to school assignments. Television functions include automatic channel surfing; five "hot channel" buttons; and NTC, PAL, or SECAM support. It displays 16.7 million colors at full frame and full motion (30 frames per second).

The video/television card is compatible with all VGA cards, without the need for internal cables. It supports up to 1280×1024 resolution. The 8-inch ISA bus card provides easy installation with true Plug-n-Play capabilities. It requires a Windows 3.1X- or Windows 95-compatible 386, 486, or Pentium PC with an ISA bus slot, a VGA monitor, and a VGA or SVGA graphics card.

The DynaMax Hi-Rez Plus card, complete with installation manual, VCR input cable, loopback cable, Windows 95 and Windows 3.1X software drivers, four CD-ROM titles (ESPN's *Baseball Tonight*, CNN's *Time Capsule*, *A Guided Tour of Multimedia, Second Edition*, and Corel's *PhotoPaint 5 Special Edition*), and a trial subscription to *Multimedia World*, costs $299. For more information, contact Core Dynamics, 8 Thomas Street, Suite 100, Irvine, CA 92718; Tel. 800-611-CORE; Web: http://www.core-dynamics.com.

CIRCLE 80 ON FREE INFORMATION CARD

CARBON-MONOXIDE DETECTOR DMM ACCESSORY

Fieldpiece Instruments' Model ACOK2 Carbon Monoxide Kit allows users to detect, in seconds, dangerous carbon-monoxide concentrations in ambient air, from registers, or even from more pinpointed sources. Designed specifically for use with a Fieldpiece "stick" digital multimeter, the kit includes the ACO1 carbon-monoxide snap-on head and the ACOP1 pump extension for pinpoint samples. The head and pump can be connected to most other digital multimeters using Fieldpiece leads.

The head slides onto the DMM to convert carbon-monoxide concentration in parts per million (ppm) to mV (millivolts) DC. Setting the meter on 200-mVDC or 2000-mVDC range displays carbon monoxide in ppm, with an accuracy of 5% ±3 ppm. The easy-to-use head is small and lightweight and has a long battery life. The catalytic sensor has been known to last for more than seven years and remain properly calibrated; life and accuracy may vary depending upon use, abuse, and exposure to harmful chemicals.

The pump extension requires no batteries and fits easily onto the head to measure carbon-monoxide levels at a specific point. Squeezing the pump's bulb samples air at the tip of the probe.

The ACOK2 Carbon Monoxide Kit costs $399. For more information, contact Fieldpiece Instruments, 231 East Imperial Highway, Suite 250, Fullerton, CA 92635; Tel. 714-992-1239; Fax: 714-992-6541.

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MULTI-FUNCTION AUTOMOTIVE TESTER

HC Protek's Model D-388 handheld automotive tester provides a variety of measurement functions for budget-conscious professionals and do-it-yourselfers. It is designed for the performance testing of sensors, batteries, cables, fuses, voltage, wiring, and connections; spark plugs, switches, and bulbs; carburetor feedback, breaker point, and solenoid dwell; engine rpm; and accessories, radios, and modules.

The 3-1/2 digit, 2000-count multimeter measures voltage, resistance, amps, rpm, duty cycle, and dwell, and performs diode tests. Its large LCD readout features a unique sub-display

continued on page 74

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Multimedia Watch

WinHEC '96 and Great Software for Kids

By Marc Spiwak
Technical Editor
Windows Magazine

I attended the Windows Hardware Engineering Conference for 1996 in the beginning of April. The purpose of this conference is for computer hardware engineers to get together and go over the general design goals for the PC of 1997. Bill Gates, who made the keynote speech on opening day, would like to turn the PC into an appliance. It should be able to do anything required of it, and set up and configuration should become non-issues. Inexperienced users should be able to immediately play a game, watch a movie, write letters and send e-mail, browse the Internet, hook up another device, or listen to voice messages.

I also sat in on lots of seminars and met with some vendors. The in-depth discussions at these seminars were, for the most part, over my head, but I did pick up a lot of general information on what we can expect to see in PCs down the road. For example, one seminar discussed what's necessary to turn the PC into a home entertainment center. Basically, PC audio needs tremendous improvement, display size must increase, and more sophisticated software is needed.

Audio will eventually be 8-channel 3D sound, and digital audio output is planned. The digital audio is great—it's more immune to noise and has higher S/N ratios. Also display size will increase as various techniques are used to produce a decent picture on an NTSC/PAL monitor. But basically, these displays are already here. Gateway 2000's new Destination system's big-screen monitor is actually a conventional TV tube with some enhancements and VGA electronics installed.

Another seminar talked about the new USB (Universal Serial Bus), which is intended for low-speed connections and IEEE 1394 for high-speed. USB has a peak bandwidth of 12 MB/s with a 4-wire connector. 1394 presently has a 400 MB/s bandwidth with a 6-wire connector, and bandwidth will increase to 2 GB/s in the future. Eventually a PC will become a sealed case with a 1394 interface being the only way to connect other devices. Devices will be hot-swappable with regulated power supplied by the interface. New devices will automatically configure themselves, much like a PCMCIA card. Consumer electronics (TVs, VCRs, cable boxes, camcorders, etc.) will eventually have the same interfaces.

Yet another seminar discussed advanced power management. Efforts are now under way to build PCs that will appear to be off at all times until you need to use them. Then they become instantly available like TV's. A "sleeping" PC will be able to unobtrusively wake itself up for routine maintenance (disk scanning, backups, etc.), and also be able to wake for modem rings and such.

Fig. 1. Let's Make a Word, featuring Guy Smiley as its host is a multimedia Sesame Street game show.

GREAT KID SOFTWARE

My son is growing fast. He's about a year and a half now, and soon he'll start taking an interest in my computer. Not that he isn't already interested in it—it's just that at this point in time he prefers to bang on the keyboard or pull it off the desk and let it dangle by the cord.

When my son is ready for the computer, he'll have a nice collection of children's software waiting for him. Having a child makes me interested in the children's software that comes my way, and this month I have some very nice software for kids. My son already loves *Sesame Street*, so I'm sure he will like the software I have waiting for him from the Creative Wonders division of Electronic Arts: *Get Set To Learn*, *Art Workshop*, *Letters, Numbers*, and *Let's Make a Word*. These are all intended for ages 3 to 6

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and have a suggested retail price of $34.95 each.

Get Set To Learn prepares kids for kindergarten by developing thinking and problem-solving skills through working with shapes, patterns, sets, sizes, colors, and more. Art Workshop lets kids create artwork by pasting "stickers" into scenes, putting costumes on characters, and working with coloring books; and none of it's at all messy! Letters and Numbers teaches alphanumeric skills with interactive games, songs, reading, shape identification, addition and subtraction, and so on. Let's Make a Word features Guy Smiley as the host of a Sesame Street game show that teaches words and fun at the same time.

Fig. 2. (CD Creator 2.0 makes it very easy to record your own CDs if you have a CD-R drive. The 32-bit software recognizes and works with many popular CD-R drives.

Recently I received two copies of *Gearheads* from Philips Media, a wacky strategy game where 3-D animated characters battle it out. I gave one copy to a friend who has a 5-year-old son. The graphics were cool but in my adult haste I couldn't figure out how to play it, much to the disappointment of the 5-year old. They went out for the day with their son anxious to get back and play the game. He ran upstairs when they got home, turned on the computer, and was busy playing Gearheads when my friend and his wife went upstairs 10 minutes later. This game sells for $39.99 and gets two thumbs up from a 5-year old.

Also from Philips Media is *Masterpiece Mansion*, a game that houses a 3-D-rendered mansion loaded with over 150 pieces of famous artwork. The player is trapped in the mansion and the only way to get out is to solve puzzles and games centered around the artwork. Background information on the art and the artists helps the player solve the game. This one sells for $39.99.

Speaking of 3-D-rendered worlds, *Connections*, from Discovery Channel Multimedia, is a game where you go from one environment to the next, looking for clues to help figure out how you got to this place and how you will get out. The game is based on James Burke's television show *Connections* on The Learning Channel. The game has a suggested retail price of $49.95.

OTHER NEW SOFTWARE

While on the topic of rendering things in 3-D, I should mention *myHouse 2.0* from DesignWare, Inc., which lets you design homes, interiors, and landscaping in 3-D. You can create 3-story plans, remodel rooms, and more. The software features automatic wall dimensioning, over 750 drag-and-drop symbols, adjustable gridpoints, a roof designer, and everything else you need to create the house of your dreams. You can even create movie walk throughs of your plans, all for $84.95.

Corel recently sent me its new *CD Creator 2.0* software designed for Windows 95. This 32-bit software makes it very easy to record your own CDs, but only if you have a CD-R drive. The 32-bit software recognizes and works with many popular CD-R drives, and makes short work of preparing data discs, audio discs, mixed-mode discs, and more. It can even help you design artwork for CD jewel boxes. Simple wizards allow you to make direct copies of other discs. The software is easy to use and does as much as possible to help you avoid errors when making CDs. CD Creator 2.0 has a suggested retail price of $495. Users of the previous version can upgrade for only $99.

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Graphix Zone sent me a copy of its new CD-ROM, *The Guided Tour of Multimedia/2nd Edition*. This update to the first edition is an interactive tutorial that teaches computer users what multimedia is, how to use it, and how to create it. Six interactive lessons teach Multimedia hardware, software, design, and production. This one costs $39.95.

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While I'm on the subject of tutorial-type software, I might as well mention some from Phoenix Publishing Systems. They are shipping a full line of *Discover* software designed to help users pick up the small points of different software titles. The Discover titles include *Windows 3.11, WordPerfect 6.1, Excel 5.0, Word 6.0, PowerPoint 4.0, Access 2.0*, and *Windows 95*. Each one is available in either a home or professional version, with the professional versions being more detailed and geared toward the average business user.

Frommer's Interactive Travel Guides are a series of multimedia guides based on the popular travel guides in print. The Multimedia travel guides from Macmillan Digital USA feature the full text of the printed guides plus supplemental listings for hotels, restaurants, ATMs, parking garages, hospitals, and more. With a laptop computer and one of these guides, you're ready to travel.

Last this month is a 6-CD value set from Dr. Schueler's Health Informatics that's designed to keep your family in good health. *Dr. Schueler's Medical Center 6* contains *Disease Prevention Made Easy, Virtual Autopsy, The Doctor Is In, Secrets To Burn Fat & Build Muscle Fast, Pharmacist On Call*, and *Adventures In Anatomy*. The 6-disc set will sell for the bargain price of around $35. ■

LETTERS

(continued from page 6)

I have a radio-detector-type S.E. 183A, serial number 2611, which was made for the Navy Department Bureau of S.E. by Wireless Specialty App. Co. of Boston, Massachusetts. It has three crystal contacts.

I hope that some of my fellow **Popular Electronics** readers can tell me about it, including the year it was used on ships. Any information would be appreciated. Thank you in advance for any help.

KENT MUELLER
30 Hamilton Avenue
Clifton, NJ 07011

A few years ago, Popular Electronics offered free fact Cards. I need a copy of the guitar preamplifier circuit.

I would appreciate it if someone could send me a copy.

GENE HENKEMEYER
409 24th Avenue North
St. Cloud, MN 56303
Tel. 612-363-4444

HOW MINE TURNED OUT

As a copier technician, finding squeaks and rattles is an everyday battle. So when I saw Charles Hansen's article, "Build the Auto Stethoscope," in the April 1995 issue of **Popular Electronics,** I knew there was hope.

Although I have an EET degree, I had never built an electronic project before. However, the Stethoscope plans looked so good, I was sure it would work. I decided to go to Gateway Electronics to get the components.

I found a PC-board-making process where the artwork is copied onto a transparency, ironed onto a piece of copper-clad PC-board material, and etched off. It took about one hour. Except it was a mirror of the art! Oops! Turning over the transparency solved the problem.

I drilled the board and stuffed the components. The soldering went quickly and there were no problems. I put it in a Radio Shack box and used a Radio Shack 4-pin connector to make the microphone connection nice and neat.

The plans called for a 3-wire microphone, but Radio Shack was out, so I had to use a 2-wire microphone. A 20-μF capacitor wired between signal and power for the microphone solved that problem.

When I powered it up, the Stethoscope gave a lot of feedback at high volume, So instead of using walkman headphones, I mounted a pair of 8-ohm B speakers wired in series into a set of shooting ear muffs. That actually solved the feedback problem quite nicely.

No design is ever really done. But I can't think of another way to improve this one. The proof of that is that my boss borrowed my Stethoscope and hasn't given it back yet. So I might have to build another one. By the way, it also makes a great shop amp.

I thank the author for a good design and a good project. I look forward to seeing more useful projects like the Auto Stethoscope in the future. Keep up the good work you've been doing.

D. M. W.
Lakewood, CO ■

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You've Come a Long Way, Baby

The Personal Computer: Yesterday, Today, and Tomorrow

Stroll through any of today's computer emporiums and you'll be dazzled by the seemingly infinite selection of powerful, reasonably priced personal computers, complete with all the (now standard) bells and whistles: color monitors and printers, multimedia capability, and extensive software packages. It's hard to believe that only 20 years ago, the computer market barely existed. In this month's **Gizmo**, we'll take a quick look at where the PC got its start, where it's at right now, and where it's likely headed in the near future. We'll also take a look at two PC packages that we consider representative of today's market.

A BLAST FROM THE PAST

The year was 1976, and the "home computer" market included the Altair B, S-100 machines, SOL, and SWTPC 6800s. It would be another five years before the IBM PC would burst upon the scene, and Apple Computer Company was a mere seedling.

Early in 1977, Apple began advertising "the First Low Cost Microcomputer System with a Video Terminal and 8K Bytes of RAM on a Single PC Card, for $666.66." You had to add your own case and monitor to the bare-board system. Later that year came the Apple II, fully built and ready to use—no soldering iron required. The system was affordable, and useful software was available for it. Apple soon gathered an enthusiastic following.

Apple wasn't the only player at the time. Cromemco, Sphere, and Ohio Scientific are names that only computer-history buffs would recognize today. But a couple of late-70s entries carved out lasting places in computer history: the Commodore PET ("Personal Electronic Transactior") and Tandy's TRS-80.

The PET, which made its official debut at the June 1977 Consumer Electronics Show, came with either 4K or 8K of RAM, a built-in monitor, a calculator-style keyboard, and a built-in cassette recorder for storing and loading programs—all for $795. The first TRS-80s went on sale in the summer of 1977. For just under $600, they came with 4K of RAM, but couldn't be connected to a printer. Radio Shack carried a line of preprogrammed software cassettes, all based on the TRSDOS operating system, which was not compatible with CP/M, the de facto standard operating system of the time.

The early 80s saw the introduction of the most popular home computer of its day—the Commodore 64, with a music-synthesizer chip, 16 colors, easy-to-use graphics, a plug-in floppy-disk drive, and a whopping 64K of RAM. The Commodore 64 could be purchased at K-Mart for a mere $400.

Atari's 400 and 800 and the TI 99/4A from Texas Instruments also had their dedicated followings. Yet those home computers, as well as the TRS-80 and the PET, appealed to a fringe group of buyers—primarily hobbyists and video-game enthusiasts. They never truly penetrated the home market; the closest the average consumer came to a "computer" was game-playing on an Atari 2600. Even in the business world, personal computers had yet to appear.

It took the power of a big name to give the computer a sense of legitimacy. And when that name appeared on the front of a microcomputer in 1981, the IBM PC flew off the dealers' shelves—even though the basic model featured only 64K of RAM and a cassette port for mass storage. IBM could barely meet the demand as volume orders poured in from large corporations.

As sales increased, so did the demand for software. Software developers, including, of course, Microsoft, rushed in to fill that need. As more applications became available, people began to see a reason—or, at least, feel a desire—to have a computer in the home as well as in the office.

IBM's first computer designed specifically for the home market, the PCjr, was introduced in late 1983 to mostly glowing

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reviews—and a distinct lack of interest from consumers. It ran PCjr software, which at the time of its introduction, consisted of five games. The PCjr was "compatible" with IBM PC software, but it didn't have the memory required to run it. As the corporate PC market boomed, the home computer market remained stagnant, at least from the standpoint of the average consumer.

For hobbyists, however the 1980s was an exciting time. Magazines such as *Radio Electronics*, **Popular Electronics**, and relative newcomer *Byte* had been publishing plans for building computers since the mid-1970s. By the early 80s they were joined by *Computer Shopper*, which gave would-be computer builders ready access to sources for the parts they needed.

By the mid-80s, IBM had added the XT and AT to its line of personal computers, and MS-DOS-based clones were popping up everywhere. It wasn't long before TRS-80 and CP/M machines went the way of the dinosaurs, with only Apple's Macintosh (and the Commodore Amiga) hanging in to challenge IBM/Microsoft's market dominance.

For years, the way to get the most bang for your computer bucks was to get your hands dirty and do it yourself. Even if you didn't start from scratch with plans from a magazine, you could save money buying a bare-bones machine and then upgrading parts ordered by mail or picked up at computer fests. As long as you knew your way around the inside of a computer case, you didn't have to worry that your computer would become obsolete—at least, not right away.

THE HERE AND NOW

All that has changed over the past few years. It isn't that improvements are slower in coming. In fact, the computer you buy today will be somewhat outdated by the time you bring it home. But as quickly as memory and CPU speed have increased, so have prices dropped. In today's personal computer market, you can get a top-of-the line, Pentium 166 computer with full multimedia and telecommunications capability for about what the IBM PC cost back in 1982. What to do with the 486 you bought a few years back? The kids can use it for school work—although you'll probably find them sneaking game time on your new multimedia PC.

PCs have truly become family purchases. More than 40% of U.S. households currently own at least one personal computer. And that percentage continues to increase steadily as more adults establish home offices, students require the power of a PC to stay competitive, and people of all ages seek Internet access.

Gateway's Destination might foreshadow what the future holds in store for PCs. It combines the functions of TV with a multimedia PC.

So what do you look for when buying a home PC? We hate to answer a question with a question, but: What will you use it for? You won't be able to make intelligent decisions about what type of computer will best suit your needs until you determine just what your needs are. Do you just want to play games? Will you handle your family finances electronically? Does your home business require graphics-intensive applications?

There are two reasons to figure out what types of software you'll be using before you decide on your hardware configuration. First, you want to be sure that the system you buy is fast and powerful enough to handle all your applications. Second, most of today's PCs are sold with bundled software packages thrown in. Look for the package that best meets your needs. You don't want to bring your new PC home only to find that you immediately have to go out and buy more software.

The next major factor to consider is your wallet. Unless you're as rich as Bill Gates, there's probably a limit on the amount of funds you can spend on a new PC. You might have to make some trade-offs to stay within your budget. Let's take a look at the various factors that go into a PC, and that affect its price.

At the heart of any PC is the central processing unit, or CPU. Forget about anything other than a Pentium. Computers become obsolete fast enough even if you don't buy the latest and greatest. Anything less than a Pentium 100 or compatible coprocessor won't do.

The next step up from a Pentium is the more powerful and sophisticated Pentium Pro, which is just beginning to trickle down to consumer/SOHO systems—at very high prices. And, at least for now, you're not likely to get extra performance for your extra dollars. That's because the Pentium Pro was designed for use with 32-bit operating systems, specifically, Windows NT. Windows 3.1 is a 16-bit system. Windows 95, which is a 32-bit system, uses quite a bit of 16-bit code so that it would be compatible with existing programs. Most home applications won't see any benefits from the Pentium Pro.

The CPU's speed is measured in megahertz. The higher the number, the faster the machine—and the higher the price. Pentium systems are available in 75-, 100-, 120-, 133-, 150-, and 166-MHz configurations. The 150- and 166-MHz are faster than most people really need right now, but they are likely to become obsolete more slowly.

The next number the computer shopper is confronted with is megabytes (MB) of RAM (random access memory). One byte equals the amount of data required to form a single alphanumeric character; one megabyte equals one million bytes. It isn't smart to skimp on RAM, the temporary storage space for the files and applications on which you are currently working. If you don't have enough RAM, your computer will be sluggish, and it might not be able to handle some powerful applications (particularly graphics-intensive ones) at all. Spring for 16 MB of RAM if you can afford to; 8 MB is the minimum you should consider.

Permanent storage is done on the computer's hard drive, and these days it's mea-

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sured in gigabytes. (A gigabyte is equal to one billion bytes.) Every program you install, and every file you create, uses up some of that permanent memory. One gigabyte is the absolute minimum you should consider today; a better bet is a system that includes a 1.2- or 1.8-GB hard drive.

Your computer can serve as your gateway to the entire world, as long as it is equipped with a modem. Modems use standard phone lines to exchange data with other computers—sending e-mail from your home office to someone at the main office, or surfing the Net. The speed of a modem—the amount of time it takes to transfer data—is measured in kilobytes per second, or kbps. If you plan to be online at all (and you probably will be eventually, even if you aren't planning on it now) look for at least 28.8 kbps. And it makes sense to look for a fax/modem, which most new PCs offer, so that you can send faxes from your computer and receive them as well.

Make sure your new PC has multimedia capabilities. Audio and video will enhance your computing experience, and many applications are now available only on CD-ROM. Even if you don't plan to immediately use any multimedia applications, you can use your CD-ROM drive to play audio CDs while you work. A quad-speed CD-ROM drive, state-of-the-art a year or so ago, is now the minimum to look for. A 6× drive is better, and 8× drives are now available. Videogame junkies, in particular, should splurge on the higher-speed CD-ROM drives.

Multimedia, by definition, includes video and audio. Guidelines published by the Multimedia PC Working Group for multimedia PCs specify MPEG video and a 16-bit, "wavetable" sound card, which produces CD-quality sound. Multimedia systems also include microphones for adding your own audio, and shielded stereo speakers, which can be mounted right next to your monitor without causing any interference.

The monitor is not always included in the price of a PC package. Monitors, like TVs, are measured diagonally. The most popular sizes are 14 and 15 inches, but 17-inchers are making inroads, particularly among users who spend a lot of time working on spreadsheets, computer-aided design work, and desktop publishing. Remember, though, a 17-inch monitor isn't as big as a 17-inch TV because PC manufacturers don't conform to the same FTC regulations when measuring screen sizes.

Besides size, you'll want a monitor that's SuperVGA-capable (SVGA) with a dot pitch of 0.28 or smaller and a resolution of at least 1024 × 768. Make sure the

(Continued on page 26)

Standing Apart from the Crowd

COMPAQ PRESARIO 9240. Manufactured by Compaq Computer Corporation, P.O. Box 692000, Houston, TX 77269-2000. Tel. 713-514-0484. Price: $2799.

Walk in to your local computer super store, and you'll be confronted by between one- and two-dozen different computer systems on the shelves. On the outside, they might look deceptively similar. You'll want to compare each one, however, to *Compaq's Presario 9240*.

The Presario 9240 is powered by an Intel Pentium running at 133 MHz, and is equipped with 16 megabytes of RAM in its standard configuration. Its mass storage is provided by a 1.2-gigabyte hard disk drive. Its 4× CD-ROM drive is one of the most interesting features—it's also a new PD-CD rewriteable drive, providing 650 megabytes of removable storage. A built-in fax/modem (28.8 kilobits per second data, 14.4 kbps fax) also provides voice telecommunication and even acts as a telephone-answering machine. Our system was also equipped with a new Compaq keyboard that does double duty as a text and graphics scanner.

By the time you read this, Compaq's fall lineup should be hitting the shelves of your neighborhood computer super store. However, the features of the 9240 are indicative of what you can expect from the new line.

The 9240 is designed with the home office in mind, but it doesn't neglect multimedia applications. The minitower case is one of the best we've ever seen. In Compaq tradition, large, finger-openable screws hold on removable side panels. On one side of the minitower case, the motherboard is mounted vertically. It plugs into a kind of backplane that runs along the bottom of the case. The backplane provides the expansion slots for plug-in accessories, and also the connectors for the floppy- and hard-disk drives.

Opening up the case for access to the expansion slots reveals a refreshingly empty box. The 9240 offers three AT slots, one PCI slot, and one additional slot that can be occupied by either an AT or PCI expansion card. As shipped, the 9240 has one PCI slot occupied—a SCSI card that controls the PD-CD drive.

These days, most people try to avoid ever going inside their computer cases. The 9240 is shipped with a full complement of accessories that should make add-ons unnecessary for quite a while. But, because the computer industry doesn't sit still, it will almost certainly become necessary to upgrade something or other.

Most of the things that would normally occupy expansion slots are contained on the motherboard—the PCI local-bus video, for example. Our computer was shipped with an added megabyte of video RAM plugged in on the motherboard. The IDE controller for floppy and hard drives is also motherboard-contained, but the connectors are brought over the expansion side of the case by the backplane board. Also on the motherboard are the sound "card" and parallel and serial ports. The modem is contained on a separate card, which plugs into the "feature slot" on the motherboard-side of the case.

Unlike some of the computers that have crossed our desks recently, the 9240 is refreshingly quiet. A single fan handles

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the cooling, yet the processor's heatsink wasn't excessively hot according to our "fingertip test."

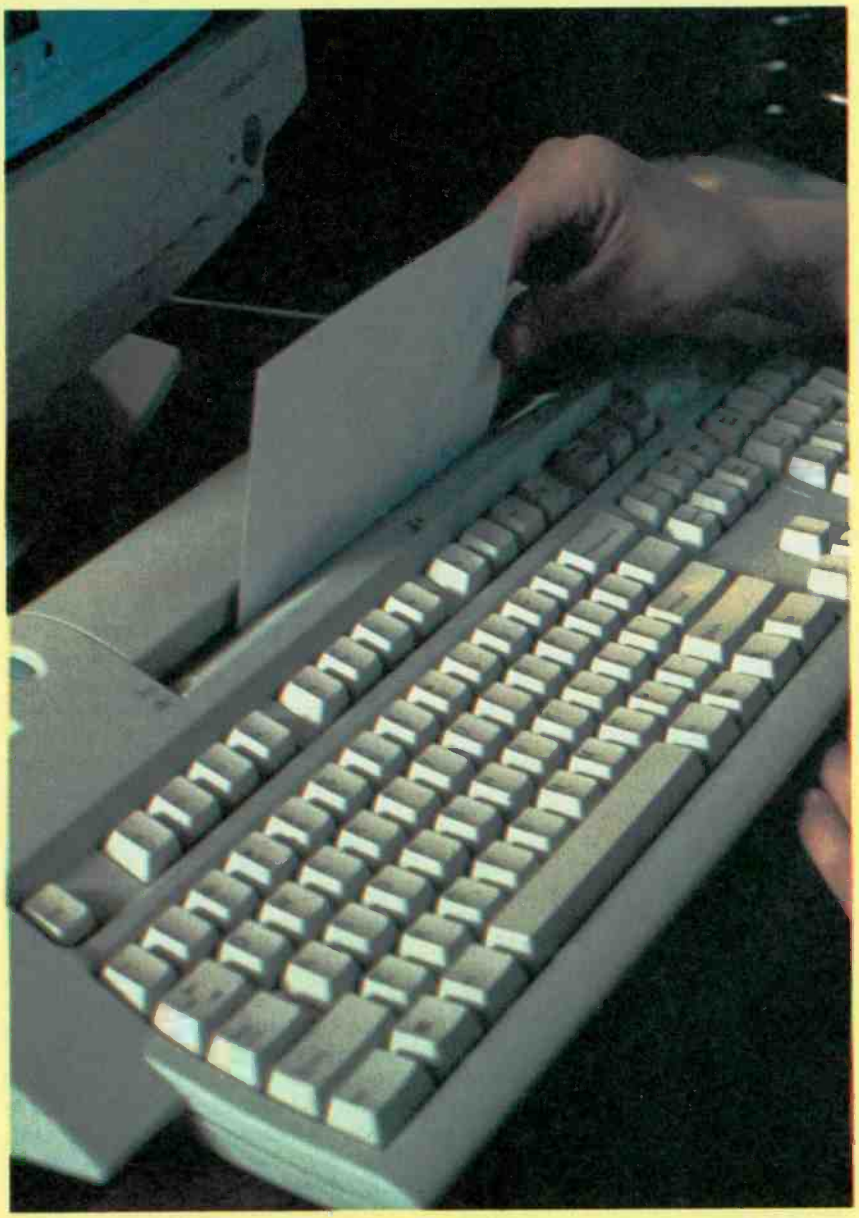
The 9240 is shipped with a wealth of software that tries to cover all the bases. First, of course, is Microsoft's Windows 95. What? You don't like it? Well, you might as well get used to it! Actually, Compaq provides two alternatives: The Compaq Activity Manager, and Launch Pad.

The Activity manager is a shell for Windows 95 that isn't all that bad. But we don't really see any intrinsic benefit over learning how to use Windows. A first-time user might find it easier to launch applications from the Activity Manager, but we would hate to see what would happen when he or she tried to install a new program.

Launch Pad is more sensible—it's an interface specifically for kids. We have no idea whether kids will actually like it, but that's not the point. Launch Pad serves as a way to keep kids out of *our* stuff if they don't have the right password. Launch Pad can be configured and customized for multiple little users.

The Presario 9240 also contains a bundle of productivity software. First is *Novell PerfectWorks*, which is a suite of applications that includes word processor, spreadsheet, database, drawing, and paint programs. We personally prefer *Microsoft Office*, but *PerfectWorks* is a more-than-capable contender.

Gold Disk's *Astound CSE* is provided to create multimedia presentations. Quicken's Special Edition is provided for money management.



The scanner keyboard is one of the unique features of the Presario 9240. It hasn't created a paperless office for us yet, though.

Compaq's *MediaPilot* software controls not only the CD and audio system, but also the telecommunications system, including an address book. The Presario 9240 has a full-featured, full-duplex speakerphone. Software includes *SpeechMail*, a voice-recognition package. It allows people to leave messages in any configured mailbox by simply speaking the name, or to listen to messages just by speaking the command—play next message, repeat, erase, etc.

Any computer that finds itself in a home is going to be used at least part-time as a game machine. Supplied on CD-ROM are *Descent Destination Saturn*, an action game; *Hardball 4*, a baseball game; and *Magic Carpet*, which is some kind of kid's game—but we're not really sure because we were never able to get it to run.

Reference CD-ROMs include *Compton's Interactive Encyclopedia 1996*, *The Family Doctor* (Creative Multimedia), *The Face of Life* (Magazine, that is), and *My First Incredible Amazing Dictionary* (DK Multimedia).

Interestingly, the CD-ROM applications aren't loaded on the hard disk; they must be installed manually before they're used. Fortunately, the documentation that describes the installation process is very well done, so users will end up learning typical installation procedures when they want to use the software.

Online software applications on the hard disk include America Online, Prodigy, CompuServe, Global Network Navigator, Reuters Money Network, the ImagiNation Network, Charles Schwab StreetSmart, and Dow Jones Personal Journal. All have trial subscriptions. Netscape Navigator V1.22 is also provided for browsing the Web.

Additional applications loaded on the hard disk include *Gift Maker* (Maxis), *Rand McNally TripMaker Special Edition*, *SimCity Classic*, and *Widget Workshop*.

Backup diskettes are not provided for any of the pre-loaded applications. When you turn the machine on, you are periodically prompted to make a set of backup diskettes. The thought of swapping through thirty diskettes was enough to make us put it off—until it was too late.

We loaded some older software (Compton's NewMedia's *Jazz: A Multimedia History*) that overwrote some of Window's multimedia drivers, and basically made our system unusable. We spent hours trying to get things back to normal. Fortunately, we had Windows 95 on a CD-ROM—otherwise, we would have been sunk. All in all, it is incomprehensible that Compaq does not include a backup CD-ROM that would allow you to restore the PC to its original state in the event of a catastrophe (or even a simple mistake). Yes, we could have avoided the problem by

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making the backup diskettes. But those 30 diskettes would cost us more than it would cost Compaq to press a CD-ROM, like most mainstream computer manufactures do. Worse yet, the press materials we received indicated that a QuickRestore backup CD was to be included. That means that Compaq didn't leave it out because of ignorance—they made a conscious decision to omit it.

Our system was equipped with a Presario 1510 SVGA monitor. It sports a "15-inch" screen with a viewable area of about 13.5 inches. The speakers supplied with the monitor clip easily on its side. They attach to speaker-output jacks (spring-loaded clips) on the rear of the monitor. The monitor, in turn, connects to the PC with two color-coded cables. (All connecting cables for the Presario are color-coded, making setup a breeze even for computer neophytes.) One cable goes to the audio-output jack on the rear of the PC, the other to the microphone-input jack. The 1510 monitor contains a built-in microphone for use with the full-duplex speakerphone and other applications.

The keyboard supplied with our system—normally a $349 option—is the *Scanner Keyboard* sold under the *Compatibles by Compaq* brand. Along the top of the keyboard is a slot for inserting images, drawings, photos, business cards, or anything else you want to scan. *PaperPort* software, from Visioneer Communications, Inc. is provided with the keyboard. We're not really any closer to having a paperless office, but the scanner keyboard is great. First, it really doesn't take up any additional space on the desktop, but it serves not only as a scanner, but a fax machine as well—even a copier if you're in a pinch.

The *PaperPort* software makes it easy to store scans in appropriate folders. For example, we were able to reduce our office clutter somewhat by scanning in articles from some of our favorite trade weeklies, and storing them by subject categories. *PaperPort* supports optical character recognition, so we could choose to save image files, or plain text files. Keep in mind that you don't have to buy a Compaq system to get the keyboard. It's available as a stand-alone add-on for any PC compatible.

As neat as the scanner keyboard is, the Presario has another, even more innovative feature: the PD-CD drive. PC-CD, (Phase-Change Dual, or simply Phase Change Disk) is a new rewritable optical disk format.

The disks, which store up to 650 megabytes of data, are housed in a special cartridge caddy. The PD-CD drive is actually two drives in one because it can read and write PD-CD disks as well as standard CD-ROMs. It automatically recognizes what kind of disk is inserted. For example, with a PD disk in place, the drive becomes logical drive D: and looks like a standard hard disk to the computer. With a CD in place, the drive becomes drive E:, a 4× speed CD-ROM drive.

PD-CD is a brand-new format, and market acceptance is far from certain. However, we'd bet that it will be a success. Although far slower than a hard-disk drive, the PD-CD leaves backup tapes in the dust. As hard drives get bigger and bigger, some manageable way to back up and store data is essential. PD-CD seems to serve that role remarkably well. New cartridges cost about $30. If they allow you to put off the purchase of an expensive new hard disk, they can actually end up saving you money.

All in all, the Compaq Presario 9240 is an excellent choice for the home, office, or home office. Its one glaring shortcoming is the absence of a backup system CD. Otherwise, it has the power to meet any of your computing needs. ■

Going Platinum

PLATINUM PRO MULTIMEDIA PC PACKAGE. Manufactured by Packard Bell, 1 Packard Bell Way, Sacramento, CA 95826; Tel. 916-388-0101. Street price: about $2700, including monitor.

Packard Bell's Platinum Pro line is representative of today's multimedia PC packages. We tested a Pentium 150-MHz, with 24 MB of RAM, a 2-GB hard drive, a 1.44-MB floppy drive, a 28.8-kbps fax/modem, a 6-X CD-ROM drive, and a 15-inch color monitor. "Extras" include a telephone answering system with full-duplex speakerphone, SRS 3D speakers, 1 MB of video memory (VRAM), MPEG1 full-motion video playback, and a remote control.

The Platinum Pro software bundle is extensive, with more than 40 titles. It features the Windows 95 operating system, as well as Packard Bell's own Navigator interface, intended to help new users overcome any computer phobia they may be experiencing. The Packard Bell Library disc contains systems manuals for on-screen help. Pre-loaded software includes *Quicken Special Edition, Microsoft Works 95, Microsoft Money 4.0*, and *Microsoft Design Pack*.

A large collection of CD-ROMs is also pre-loaded and ready to run when the discs are inserted. For kids, there's *My First Encyclopedia, Spider-Man Cartoon Maker, TuneLand*, and a couple of animated storybooks. Reference materials include *Microsoft Encarta*, a multimedia encyclopedia; *Mindscape Completer Reference Library*, a collection of ten reference books featuring photographs, soundtracks, animation, video, and text; The *Guiness Multimedia Disc of Records*, and the *Sports Illustrated Multimedia Almanac*. In terms of games, you won't find *Myst* or *Doom*, but tamer fare such as *Reader's Digest Multimedia Crosswords* and *The Journeyman Project Turbo*, a "photorealistic adventure game."

When you pull the Platinum Pro out of its box, you'll notice right away that the connections for all the peripherals are color coded. That makes initial setup a piece of cake. (Attaching the speakers, however, is trickier than necessary, requiring the use of a long, thin screwdriver.)

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Getting started is also easy, whether you're an experienced Windows user or complete newcomer to computing.

Children and novices might be more comfortable starting out using the Navigator interface, a "virtual home," with software arranged throughout its three rooms: the Living Room, Software Room, and Information Room. You can set up the Navigator so that the room containing the applications you're most likely to use is the room you'll always enter upon start up. You can also opt to bypass the Navigator altogether if you prefer to simply use the standard and more straightforward Windows 95 interface.

The Living Room features the consumer-electronic products you'd expect to see in a real home—a stereo with FM radio and CD player; a TV; a telephone, speakerphone, answering machine, and fax machine; and a clock—and some you probably don't have in your house—a WAVE player, a MIDI player, and a media controller. (Packard Bell does offer PCs that include TV and FM radio receivers, although our test model did not contain them.) By clicking on one of the realistic graphic representations, you can enter that application directly. Select the CD player, for instance, and you'll get an on-screen control panel from which to select play, pause, and track number. You can also send faxes, answer phone calls with the built-in speakerphone, and send and receive faxes using the icons found in the Living Room. Advanced telephony features allow you to set up multiple mail boxes, send faxes automatically, and even call your beeper when a call or fax is received.

If you click on the door at the right side of the Living Room, you'll move into the Software Room. Its bookshelves are filled with all of the Platinum Pro's pre-installed software titles, arranged in categories. Select a category to make the titles appear on the shelves, and then click on a title, and insert the disc if needed, to run that application. You can easily add your own software to the existing titles.

The Information Room is where you'll find the Library Bookcase, which contains all of Packard Bell's electronic manuals. The Tutorial Gallery provides access to multimedia lessons on such subjects as "Getting Started" and "Software Basics," taught by a video narrator using animation and colorful graphics. Another set of bookshelves holds icons for all of the available online services and electronic documentation. The Platinum Pro provides direct access to the Internet and to Prodigy, America Online, and CompuServe. You'll find demonstrations and explanations of the costs of each service in the Information Room. (Special discount offers are included.)

An added bonus with the Platinum Pro is a remote control, which can be used to operate the CD player and some PC functions.

The Navigator provides a host of features to make it easier to find your way around all the applications available to you. The InfoGuide, found in all three rooms, allows you to click on any icon to pull up a detailed help screen. By clicking on the Quick Tips icon, you can get helpful advice about the PC's features.

The Task Jumper icon is used to move directly to another application or function, even if you're not sure what it's called or where to find it. Clicking on the icon calls up a list of categories, such as Business or Home Electronics. You can play a CD without going back to the Living Room, or find your word processor even if you can't remember that it's part of Microsoft Works.

Also found in all three rooms is the Menu Key. Clicking on it activates the Fast Media feature, a shortcut to all of the system's multimedia functions. Selecting Fast Media changes the functions of the F1 to F8 keys. F1 will now provide online help; F2, direct entry to the speakerphone; F3 accesses voice mail messages; F4 is used to operate the CD player; where applicable, F5 and F6 provide access to the radio and TV; F7 mutes audio; and F8 brings up the active device's software interface, allowing access to advanced features. Fast Media also turns the arrow keys into volume and selection control keys. All of the Fast Media Functions can also be accessed using the remote control included with the Platinum Pro.

The Navigator's Tool Bar offers several more options for moving around your applications and using all the PC's features. The Media Controller is used to access digital recordings saved in .WAV format ("Wave" files); the musical instrument digital interface, or MIDI; AVI (audio video interleave); the CD player; and the Call Center, which instantly retrieves calls or voice mails. Other tool-bar features can be used to exit to Windows, lock and secure different areas, control volume, and see a list of all the programs currently running on the system.

Some of those same features can be accessed using special keys on the keyboard. There are two Windows 95 keys, located to the outside of each "Alt" key, that automatically call up the main Windows 95 menu when pressed (even when pressed accidentally, we might add). At the top right corner is a key labeled "Fn Menu," which activates the Fast Media option to change the function keys' purpose.

These days, when you buy a computer, you buy a connection to the rest of the world. The Platinum Pro is no exception. Equipped with a 28.8-kbps fax/modem, and connected to your phone line, the system allows you to place and receive phone calls, send and receive faxes, record voice messages, and forward calls to your pager number. The included software makes it easy to use online services and even learn to surf the Net. Packard Bell Internet access features the Spry Mosaic Web browser, e-mail, Usenet, and FTP, which allows users to download files from any Internet site. Seven free hours of access time helps new users get started.

The Platinum Pro also offers a voice-over-data package called VoiceView Talkshop, which allows you to talk and exchange data in a single phone call. When you use VoiceView Talkshop to go "teleshopping" at such online businesses as Blockbuster Music, 1-800-FLOWERS, and American Airlines, you can see their products on your screen and talk directly to sales people. VoiceView Talkshop can also be used for online technical support help, providing what Packard Bell calls a "personal home technician" to quickly diagnose hardware and software difficulties. The interactive support program allows a technician to capture screens; retrieve, set up, and configure files on your system; and correct them over the phone.

Coming from a 486 DX-50 running Windows 3.1, we found using the Platinum Pro was a dream. It took very little time for even the least computer-savvy family members to learn their way around the Navigator interface and Windows 95, discover new favorite programs among the bundled software, and load their old favorites—a speedy task on the 6× CD-ROM drive. We had a glitch or two; the fax machine was picking up our voice calls for the first day. But it was easy to iron things out, without having to resort to calling the tech support lines either the old-fashioned way, or via VoiceView Talkshop. In fact, we barely had to open a printed manual. ■

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All for Five, And Five for All

MFC-4500 MULTI-FUNCTION CENTER. From Brother International Corporation, 200 Cottontail Lane, Somerset, NJ 08875; Tel. 908-356-8880. Manufacturers suggested retail price: $995.95.

Home offices are popping up all over, thanks primarily to modern technology. Just plug in a computer, printer, fax machine, telephone, answering machine, modem, and copier; and you're connected to the rest of the world and ready for business.

Problems arise when you get home from Office Max and try to fit all that gear—not to mention your desk, computer stand, file cabinets, bookshelves, chairs, and wastebasket—into a corner of your bedroom, or the tiny spare room that must also house your NordicTrack.

Recognizing the space-crunch dilemma, manufacturers have created a new product category, called multifunction devices (MFD) or multifunction peripherals (MFP). Aimed directly at the SOHO (small office/home office) market, these all-in-one hybrids combine, at minimum, printing, plain-paper faxing, and copying functions. Many also offer scanning and fax/modem features. They not only require less space than all those separate units, but they generally cost less too because the same hardware performs multiple functions. Printing a fax, after all, isn't much different from printing any document.

MFDs make good use of the power and brains of your PC. They typically connect to the computer through its parallel printer port, and use Windows-based software interfaces. Faxes can be printed immediately, stored for later printing, or stored on disk. Speed-dial phone numbers and fax broadcasting numbers can be input using your computer's keyboard, instead of awkwardly shifting and selecting characters from the fax machine's front panel—some models even let you import names, numbers, and addresses from your existing address book in another software program.

Although by definition a multifunction device plays many roles, it often stars in only one. That's because manufacturers generally adapt an existing model of fax or printer by adding more functions. Its original role will surely be its strongest.

The Brother MFC-4500ML is a case in point. Based on the Brother HL-630 printer, it provides high-quality, 300-dots-per-inch (dpi) laser printing at a speedy 6-page-per-minute (ppm) rate. Text and graphics printouts are excellent, cleaner and crisper than that provided by the many ink-jet MFDs on the market in the $1000-and-under range. Although it doesn't slouch in performing its secondary functions of faxing, copying, scanning, and computer faxing via a fax/modem, the MFC-4500ML's forte is printing.

Like the HL-630, the MFC-4500ML uses Brother's proprietary "Straight Paper Path" technology. Rather than passing through a twisted route past a series of rollers inside the printer, the paper travels the shortest route between two points—a relatively straight line between the paper feeder and the output tray. That design has several benefits, including faster output, less paper curling and jamming, the ability to handle a wide range of sizes and even thick paper stock, and fewer parts to break down. (see Fig. 1).

Fewer parts also means smaller overall size—the MFC-4500ML has a tidy little footprint of just 14 square inches. With its front-panel numeric keypad and speed-dial buttons, it most resembles a fax machine. A closer look, however, reveals a horizontal row of function buttons, and two vertical rows of buttons for selecting printer and copier options. A small, two-line display shows the time and date, and provides status reports. Jutting out from the left side of the unit is a telephone handset—which, we suppose you could say, represents this MFD's sixth function.

Connecting the MFC-4500ML to a PC is a relatively straightforward affair. Even those who are technically inexperienced should have no trouble following the step-by-step directions on the included instructional video. It walks you right through the process, showing you how to attach all the paper trays, load the drum and toner cartridge, and make the connections to your phone lines and PC. A separate phone jack is provided for an external telephone or answering machine. Unlike most MFDs, which require only parallel-port connection, the MFC-4500ML must also be connected to the serial port for its Missing Link software interface—and PC faxing—to work.

Missing Link is a Windows-based, graphics interface used to control the fax/modem, printer, and scanner. It lets you program the MFC functions on your PC, instead of using the front-panel buttons. The Missing Link fax drivers can be used within any Windows application that supports printing.

You can use Missing Link to control printing, sending and receiving faxes, and scanning; and also to find, view, and "staple" (attach) documents. But first you'll use it for setting up the MFC-4500ML to meet your specific requirements, using MFC remote setup, "control panel" settings, one-touch/speed-dial setup, and the address book.

MFC remote setup provides a quick, easy way to program the MFC-4500ML, allowing you to download programs from the PC to the MFC, and upload programming from the MFC to the PC for easy editing. It also allows you to set your system for fax forwarding to another number or dialing your pager number. MFC remote setup requires you first to input your name, phone, and fax numbers, as well as the correct date and time. You can opt to have a transmission verification report printed after every fax sent and activity reports printed at certain intervals, to set a

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timer for delayed faxing, and provide the information you'll want printed on your fax cover page (including comments). You can also set the beeper volume, change the default time for the unit's energy-saving sleep mode, and change the incoming fax reduction mode from the factory-preset (automatically reduces incoming documents to fit on one page) to one of four fixed reduction ratios. Telephone options include pulse/tone, auto or manual re-dial (for faxing only), speaker and ring volume, and the number of rings before the MFC will answer.

The MFC database allows you to store 24 one-touch numbers and 100 speed-dial numbers for standard—not PC—faxing. You can also create up to six groups of numbers for fax broadcasting—sending the same fax to several people. You can download the database to the MFC-4500ML and, when you later want to make changes or additions, upload it to the PC for easy editing.

Using the MFC-4500ML's fax/modem mode to send faxes from your PC is a simple matter of filling in the information requested in the Fax Send dialog box, and selecting the start button. For fax broadcasting, or frequently used fax numbers, Missing Link provides an Address Book. You can set as many as ten separate Address Books, each with up to 500 entries. Unfortunately, it isn't possible to import names, addresses, phone and fax numbers from any other databases you might already have. But once you've taken the time to input the data, sending PC faxes from your Windows applications is an easy, virtually invisible, procedure.

The fax/modem offers delayed transmission and broadcast functions. The Fax OutBox helps you keep track of your outgoing faxes, showing the status of all unsent faxes and providing a complete activity log of all fax transmissions. That activity log is stored as a file that can be incorporated into other applications, such as a billing program.

When you receive faxes sent to your PC, your regular computer activity is not interrupted. The faxes are sent directly to your Missing Link InBox, which provides for electronic filing and indexing of faxes, maintains a log of incoming faxes, and prints out collated copies of multiple-page faxes. You can opt to view a fax on screen, store it, or print it.

Files you've scanned or faxes you've created using the Brother MFC-4500ML Missing Link—called Brother files—can be manipulated in various ways that will make the home-office worker's job a little easier. Brother files are compressed, multiple-page, black-and-white images, with a maximum image size of 8.5 inches wide by 14 inches long. Missing Link can easily scan, display, locate, print, and fax those files, which occupy a minimum of disk space and can be converted to other file formats.

Selecting the MFC Finder icon allows you to locate files in a few different ways. It's possible to browse through files and directories, perform keyword searches using a freeform description in plain English words or phrases, or search using the date the document was last changed and a portion of the document name. When you find the Brother file you were seeking, you can view, print, or fax it directly from the Finder.

To view, edit, print, and fax Brother document images, the Viewer is used. The Viewer allows you to immediately see all or part of your document on screen; scale and rotate your view of the document; move, delete, or add pages to a file; use the Windows Clipboard; and import and export images from and to other popular image formats, including Windows Paint.

The Missing Link interface also controls the MFC-4500ML's scanning functions. By selecting the ScanFile icon, you can directly input text and image documents into your PC, and add a written description (up to 127 characters) of the document. Multipage documents are saved as a single DOS file, making it easy to attach them to e-mail files and other Windows applications. Double-sided originals are automatically saved in the proper order. A batch of documents can be scanned at the same time, yet stored separately, by inserting blank separator sheets between each document. Or, if each document has the same number of pages, select "equal number of pages," and the machine will automatically separate them. You can adjust the contrast and resolution, and select Line Art for text, graphics, and black-and-white printed materials, or "Photographs" for photos and colored materials.

While you are scanning a batch of documents, you needn't stop your regular work—even if your work directly involves another MFC-4500ML function. The unit's dual-port design allows you to print documents through the parallel port while scanning, faxing, or copying another document via the serial port connection.

In its copier mode, the unit will print from one to 99 copies of each page. You can insert a stack of paper for copying multipage jobs, and the pages emerge in the right order—which is not the case for many of the unit's competitors—although it can't collate multicopy, multipage jobs. Four copy reduction sizes and three copy enlargement sizes are offered. Three resolutions include fine and superfine for text jobs, and photo for photographs and other graphics.

The MFC-4500MI truly stands out from the under-$1000 crowd. ■

YOU'VE COME A LONG WAY

(Continued from page 21)

monitor is non-interlaced, which means that every line on screen is refreshed and redrawn at every pass, reducing annoying flicker.

Printers are also sold separately in most cases. Laser printers provide the best quality and speed, at the highest prices. For many personal applications, an ink-jet printer may be sufficient.

Also not included—but certainly a worthwhile investment—is a backup system on which to store information for safekeeping in the event of a system crash.

Finally, you'll want to hedge your bets against obsolescence by ensuring that your PC can be upgraded as needed. It should have extra serial ports for devices such as modems, mice, and scanners, and parallel ports for printers. And there should be several extra slots inside for adding expansion cards.

That's it for the "basics"—what a difference a few years make! Today, the bells and whistles could include TV and/or FM radio cards, which let you watch your favorite shows and listen to the radio on your PC; a remote control to operate those consumer-type functions, as well as some PC functions; and video accelerator cards or extra VRAM (video RAM) to speed up the movement of video images.

What can you expect to pay for a PC package today? Prices vary widely by configuration and by dealer. We checked out the flyers tucked into this Sunday's paper, and found some of the following prices: A Pentium 166 from Digital, with 16 MB RAM, a 1.6-GB hard drive, 4× CD-ROM drive, 16-bit Sound Blaster-compatible sound, and 28.8 kbps fax/modem was advertised for $2099.95 at a local discounter, which was also offering an NEC 120-MHz Pentium with 16-MB RAM, 6× CD-ROM drive, 16-bit wavetable surround sound, and 28.8-kbps fax/modem for $1799.95. Each came with a "large software bundle" but no monitor. A home-office super center was selling the exact configuration of Packard Bell that we review below for $2599 including the monitor—and with a Hewlett-Packard inkjet printer thrown in for just $99 more. And a local consumer-electronics chain had an IBM Aptiva 150-MHz Pentium with monitor, 16-MB RAM, a 1.6-GB hard drive, 6-X CD-ROM drive, and 28.8-kbps fax/modem for $2749.96—$350 off the usual price of $3099.96.

LET'S SEE WHAT THE FUTURE BRINGS

If there's any industry that undergoes change faster than the computer industry, we're not aware of it. New, faster CPUs,

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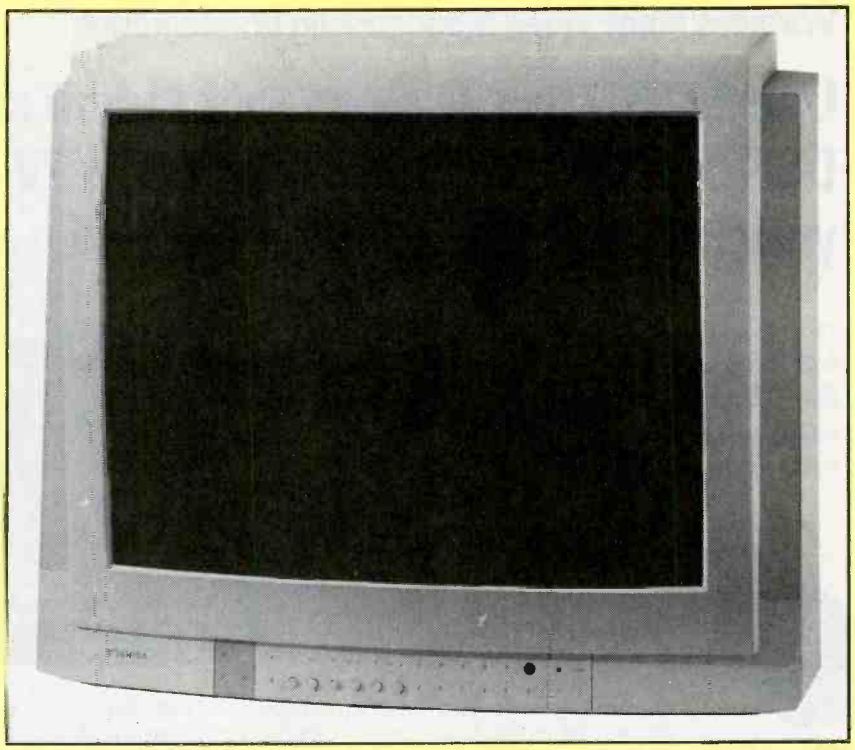
are announced every few months, followed by price drops for older ones. Even the PC itself might be changing fundamentally, as low-priced Internet access terminals are being proposed by several manufacturers. PCTVs, devices that combine both computer and television functions, are also beginning to hit the streets. High-speed modems that operate over cable-TV wires are sure to accelerate the process.

But that doesn't mean you should put off your PC purchase because of fears of obsolescence. There's never been a better time to buy a PC than today. ■

Monitor Your TV



TOSHIBA INTEGRATED MULTIMEDIA MONITOR, OR TIMM. Manufactured by Toshiba America Consumer Products, Inc., 1010 Johnson Drive, Buffalo Grove, IL 60089; Tel. 800-253-5429, ext. 397. Suggested retail price: $999.

There's no question that the line between the computer and consumer-electronics industries is blurring. In fact, next spring in Atlanta the two industries' largest trade shows—Comdex and the Consumer Electronics Show—are being held simultaneously in Atlanta. And many of the products that will be shown there are hybrids that could belong at either show.

There are television cards for your PC, and Internet access devices for your TV. Televisions and telephones are used for banking and shopping. Computers, equipped with sound cards, speakers, and CD-ROM drives, are used for entertainment and listening to CDs. Gateway's Destination PCs feature 31-inch screens and television tuners—definitely meant for the living room, not the desktop! RCA is test marketing a 35-inch TV that comes with a CD-ROM player and a modem, while Zenith's NetVision line of 27-inch and larger TVs will be Internet-ready.

Toshiba was ahead of the game when it introduced TIMM—the Toshiba Integrated Multimedia Monitor—early last year. With its 20-inch screen, TIMM serves as both a computer monitor and a television set.

Of course, not everyone needs a TV in the home office. Most of us can get the work day started without the help of Regis and Kathy Lee, and can make it through the afternoon without a dose of the soaps.

TIMM, however, is not being marketed as a home-office tool. Instead, it is intended for use in information kiosks, trade show booths, and interactive point-of-purchase displays—and maybe the occasional dorm room. It can also replace the old-fashioned overhead projectors in modern conference rooms, paving the way to visually exciting computer presentations and video programs.

There just might be a home market for TIMM—not for work, but for play. Videogamers will delight in the ability to back off a bit from the screen as they play their favorite games in large-screen style. It's a bit pricey, but not much more than today's 17-inch monitors. And when they're not playing games, they can still use TIMM for watching TV, video, or laserdiscs.

For TV viewing, TIMM features a 181-channel, cable-ready receiver with closed captioning. The VGA-compatible monitor hooks up directly to DOS-based PCs, although an adapter is needed for connection to Mac II computers. Composite and S-video jacks make it easy to connect a VCR, or laserdisc player.

TIMM's picture is bright enough for television viewing, yet clear enough for computer work. An Invar shadow mask allows operation at the higher voltages needed for brighter picture quality without loss of color purity or sharpness, even in the corners.

TIMM offers VGA-quality resolution of 640 × 480 pixels—not up to par with SVGA monitors. But for its intended applications of conference presentations, kiosks, and video gaming, TIMM won't be used as close up as would a desktop computer monitor. Toshiba claims that at that added distance, VGA is sufficient.

As for television watching, TIMM's performance is top-notch. It offers 500 lines of horizontal resolution; laserdiscs produce a resolution of 425 lines, and that's more than you'll get from videotapes or even CD-ROMs. The distance between pixels, or dot pitch is 0.58 mm, which Toshiba claims is a 36% finer pattern than is found in most 20-inch television sets—but that, too, is not up to par with SVGA monitors.

Sound is an important aspect of games and business presentations, and TIMM is up to the task with its built-in 10-watt audio system. The high-performance speakers in the unit, which are suspended in a tuned horn structure, improve signal separation and enhance full-frequency performance. The monitor also features a bass-boosting Sub Bass System circuit, as well as an MTS stereo decoder with SAP and dbx noise reduction.

TIMM is also the first multimedia monitor to come with a remote control. The remote can be used to operate all TV functions, and also to control several computer-related features. For instance, if you do need to use TIMM for close-up work—word processing or creating spreadsheets, for instance—the large screen size can be somewhat overpowering. The remote can be used to expand or contract the image either vertically or horizontally for comfortable viewing.

Although it is a well-made, well-though-out product, TIMM has been having some trouble finding its niche, particularly in the home market. It won't be "the next VCR"—but TIMM just might be the forerunner of a new, exciting, consumer technology, the PCTV. ■

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Wireless home video broadcasting breakthrough!

Use 2.4 GHz technology to transmit cable, DSS and VCR signals to any other TV in your home...*up to 300 feet away!*

WAVECOM Jr., from RF-Link, uses 2.4 GHz technology, circularly polarized transmission, four channels and FM to broadcast stereo audio and video signals with clarity never before available.

You can use WAVECOM Jr. with your:

- ✔ Cable TV
- ✔ Camcorder
- ✔ Computer
- ✔ Digital video disk
- ✔ Laser disc player
- ✔ Network TV
- ✔ Powered speakers
- ✔ Satellite (DSS)
- ✔ Security camera
- ✔ VCR movies
- ✔ Wireless cable

If you are like most people, you probably own more than one television and subscribe to cable or satellite programming. But in order to extend that special programming to your other TVs, you have to run miles of wire and/or pay for the additional connection. Isn't there a better way?

Watch TV on more than one set. New wireless home video broadcasting technology found in WAVECOM Jr. from RF-Link can transmit signals from cable, digital satellite system (DSS), even a VCR, from a video source (your main TV) to other TVs in your home, office or school without sacrificing picture or sound quality. You can even use it to transmit between your TV and computer, without wires or connection fees!

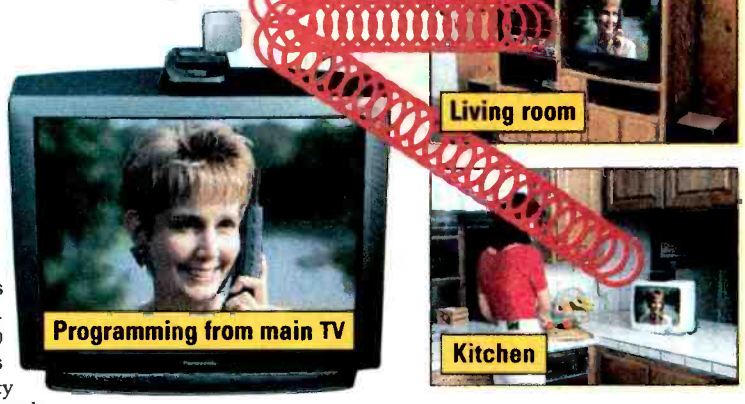
Introducing WAVECOM Jr. WAVECOM Jr. heralds in the latest in wireless transmission with 2.4 GHz technology. This new frequency is superior to 900 MHz in several ways: the most important benefit of the 2.4 GHz range is that it is totally uncluttered. WAVECOM Jr. is one of the very first products to utilize this frequency, enabling it to deliver consistently sharp stereo audio and video signals, through walls and ceilings, up to 300 feet away.

2.4 GHz circular-polarization technology. For years, the most advanced wireless products have boasted the use of the 900 MHz frequency using linear transmissions. But linear waves can be blocked by studs or other hidden barriers within your walls.

However, WAVECOM Jr.'s. 2.4 GHz technology uses a circular polarization signal to give you crystal-clear, powerful re-transmission of audio and video signals throughout your home, unobstructed by walls, ceilings or floors. Even if there is a wall stud in the path of the signal, virtually all of the wave is still free to pass to your television.

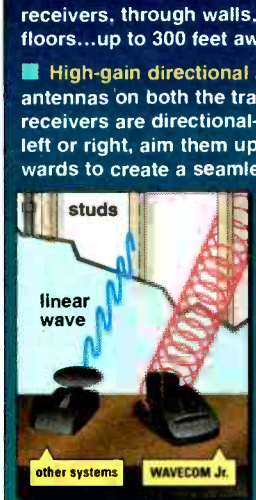
In addition, as signals get higher in frequency (from 49 MHz to 900 MHz to 2.4 GHz), the wavelengths get smaller. So where 900 MHz waves have difficulty passing through certain surfaces (like chicken wire), waves in the 2.4 GHz frequency range can do so easily. In fact, the combination of small wavelength size and circular polarization transmission means that there is virtually no obstacle that WAVECOM Jr. cannot overcome.

It's FM, not AM. WAVECOM Jr. uses FM to transmit signals, not AM, for the same reasons that FM stations are superior to AM stations. High-gain directional transmitting and receiving antennas are used, instead of omni antennas, to minimize interference from unwanted signals and inherent problems of *multipath* (a phenomenon where transmitted signals bounce around and create "ghosting").



THE WAVECOM ADVANTAGE

- **2.4 GHz transmission.** This brand-new, uncluttered frequency provides more clarity than ever thought possible in wireless home broadcasting systems.
- **300-foot range.** The WAVECOM Jr. transmitter can broadcast clearly to multiple receivers, through walls, ceiling and floors...up to 300 feet away!
- **High-gain directional antennas.** The antennas on both the transmitter and receivers are directional—turn them to the left or right, aim them upwards or downwards to create a seamless link.



- **Circular polarization.** WAVECOM Jr. utilizes circular polarized waves. Unlike linear waves, circular waves can pass through walls—*and the hidden obstacles within the walls*—unlike any other system.

Not even hidden studs can stop WAVECOM Jr.!

Exclusive features. One of WAVECOM's key features is the use of four channels for interference-free channel selection, which makes it arguably the most superior home video broadcasting system available. In many uses, up to *four channels* can operate simultaneously. This feature can be very useful for private and civil surveillance systems. It also facilitates using your existing camcorder to monitor babies, children and the elderly within your home or yard.

Last but not least, WAVECOM Jr. provides *stereo sound* with independent left and right audio channels. This enables you to hook up wireless powered speakers to your CD or cassette player. All total, WAVECOM Jr. from RF-Link is the solution to the dilemma posed by modern TV programming options. You can finally reap the benefits of your premium services throughout your entire home...simply, wirelessly and affordably!

Try it risk-free. WAVECOM Jr. is backed by Comtrad's exclusive risk-free trial. Try it in your home! If you're not completely satisfied, simply return it within 90 days for a full refund, "No Questions Asked." WAVECOM Jr. is also covered by a 90-day manufacturer's warranty.

WAVECOM Jr. System . . . . . **$199** $16 S&H
System includes one transmitter and one receiver.

Additional receivers . . . . . **$129** $12 S&H

Please mention promotional code **1761-PL-6666.**

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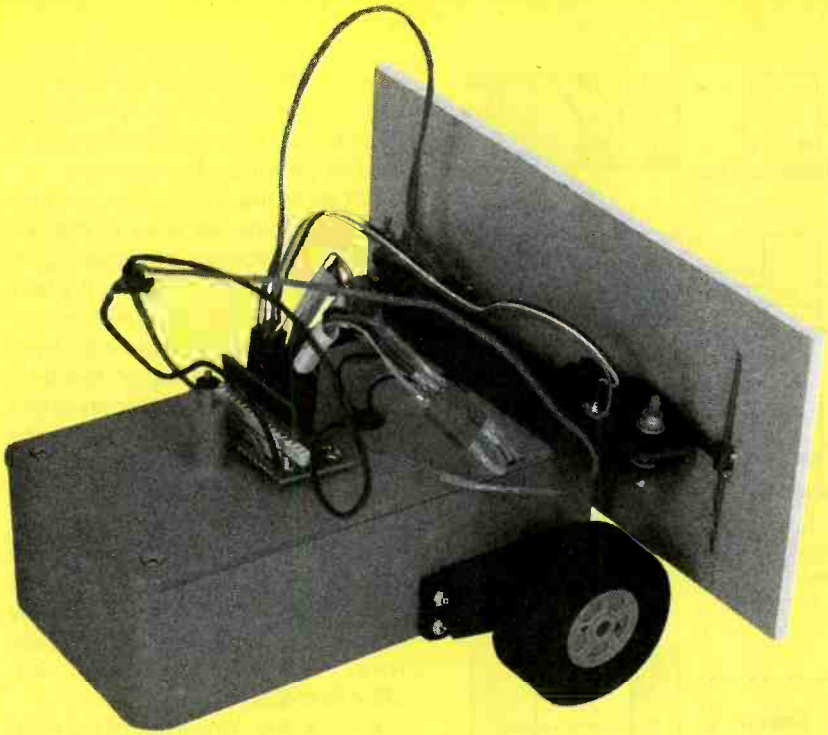

BUILD A MOBILE ROBOT

This fully programmable robot never gets stuck in a corner, and could be modified to do a whole lot more.

BY MIKE O'CONNOR

Building a mobile robot used to be a major undertaking. Early robotics hobbyists had to build everything from scratch, assembling logic gates, timers, and other discrete components into dedicated controllers. Then came the advent of custom microcontroller-based systems, which presented their own problems; mainly, hobbyists had to program in assembly language while struggling with primitive development tools.

But the struggles faced by those robot builders were not the only drawbacks to the hobby. The resulting creations were usually quite bulky, and not to mention expensive. It took a good-sized robot to haul around an early controller board—electric wheelchair motors and motorcycle batteries were common components. And while the early pioneers put a lot of effort and expense into their robots, if one of their robots malfunctioned it could knock holes in your house!

Now it's much easier and less expensive to build a robot. The advent of small, affordable microcontroller boards and the constant price reductions in servos brings robotics within the reach of more people. While even simple, programmable robots used to approach a thousand dollars in cost, you can build the *Mobile Robot* described in this article for about $100.

The programmable Mobile Robot uses two converted servo motors to get around. Each servo drives a wheel to provide differential steering; in other words, the Robot steers like a tank. Two bumper switches and a short program give the Robot simple reflexes to turn away from obstacles. Once you get your unit running, you can experiment with more sophisticated software and add new sensors.

The BASIC Stamp. Part of what makes the Mobile Robot such an affordable project is its "brain": Parallax's BASIC Stamp. That component opens embedded systems development to new groups of people. It's no longer necessary to learn assembly language, as the Stamp runs a simplified version of BASIC with many features that make it suited to robotics. Called PBASIC, the language supports logical operations, integer math, branching statements, and subroutines. With special-purpose statements, the Stamp can debounce buttons, send and receive timed pulses, and perform serial communication.

As we'll deal with later, writing programs for the Stamp is made simple using Parallax's editor/downloader software. That eliminates the need for a special programmer, emulator, or UV eraser. Programming is as simple as entering a program (either one you write or one of the ones listed later) into your PC, connecting the Stamp to the computer with a special cable, and downloading the commands to the Stamp.

The BASIC Stamp uses a Microchip PIC microcontroller running at 4 MHz. It has eight pins that can be used for input or output, and a 256-byte EEPROM that can hold up to 100 program statements. Fourteen bytes of RAM are available for variables, while additional data can be stored and retrieved from unused portions of the EEPROM.

Servo Basics. Tiny microcontrollers like the BASIC Stamp are only part of the reason why robots have gotten smaller—radio-control servo motors are the other part. Those compact, durable, and inexpensive motors are perfect for small robots, as their control and power electronics are already built-in. One output line from a microcontroller can drive a servo in either direction. What's more, a servo's low speed and high torque makes it better suited to robots than the high speed and low torque of most toy motors.

The Hitec servos specified for use in the Mobile Robot are controlled by pulse-width modulation. A control pulse is sent to a servo about 50 times a second; that pulse varies between 0.00075 and 0.00225 seconds. (For other brands of servos, Airtronics for example, the pulse varies from 0.00100 to 0.00200 seconds.) The position of the servo's output shaft corre-

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sponds to the duration of the pulse. For example, a 0.00075-second pulse will cause the shaft to rotate to the limit in one direction while a 0.00225-second pulse will cause rotation to the limit in the other direction. A 0.0015-second pulse will cause the servo to move to the center (see Fig. 1).

The shaft on a regular servo motor has a limited range of rotation and can't rotate through a full circle. Therefore, a robot couldn't travel very far with stock servos. The servo must be converted into a gear motor; such a conversion allows the shaft to rotate freely. But more on that later.

Circuit Description. The schematic for the Mobile Robot is shown in Fig. 2. As you can see, the parts count is extremely low. Power for the circuit is supplied by a 4.8-volt source (B1) that is made up of four 1.2-volt NiCd batteries in series; S1 is the power switch.

The bulk of the circuit's functions are carried out by the BASIC Stamp module, MOD1. That module can interface with a PC through the PCI, PCO, and GND pins, which are connected to header H1. The pin numbers shown next to H1 correspond with the pin numbers of a PC serial port.

Four of MOD1's eight signal pins are shown. Through those pins, the Stamp module can interface with the servo motors and bumper switches of the Robot. Pin P0 connects to servo-motor MOT1, and pin P1 goes to servo-motor MOT2. Bumper-switches S2 and S3 are connected to pins P6 and P7, respectively.

Now, how do those components work together? That depends on how the Stamp is programmed. Later we'll take a look at two different programs that can be used with the circuit. But before you can instruct the Robot, you have to build it. Let's examine how to do that next.

Construction. The author's prototype for the Mobile Robot was built using a modular design. In other words, the components of the unit were connected to each other with headers and connectors for easy removal and modification. If you plan on maybe adding more sensors to your Robot, or modifying it in some way, you should consider making connections in the same manner. Also, that approach lets you save money by using the same Stamp and servos in different robots.

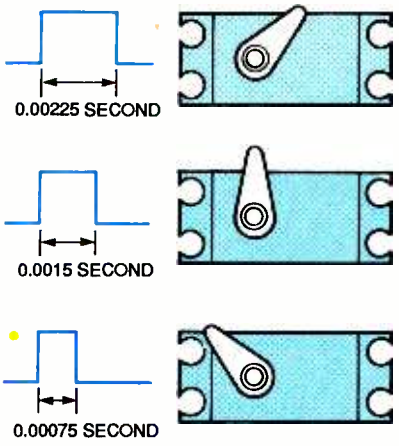

Fig. 1. Using pulse-width modulation, it is possible to control the movement of a servo.

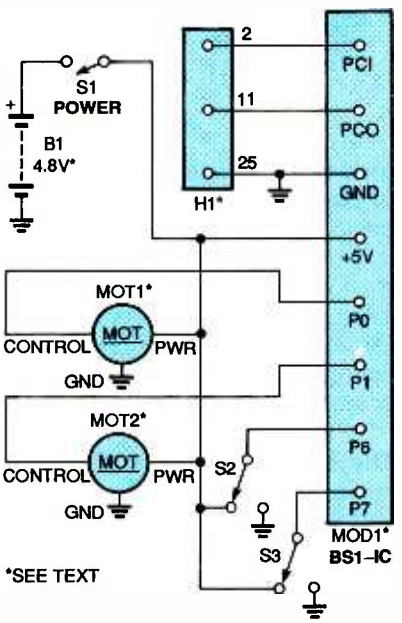

Fig. 2. Here's the schematic for the Mobile Robot. Thanks to the BASIC Stamp Module, MOD1, parts count is kept extremely low. Header H1 makes it possible to interface with a PC for programming purposes.

Now, we'll examine how to build each of the modular components of the Mobile Robot. Because MOD1 connects to all the components, that aspect of the electrical assembly will be dealt with last.

Servo Conversion. As mentioned earlier, before a servo can be used in the Robot it must be converted to a computer-controlled gear motor. That requires two steps: First, it is necessary to mechanically disconnect the potentiometer from the bull gear (the gear on the other side of the shaft). Then, the stop that limits the rotation of the bull gear must be removed.

Not all of the servos used in radio-control systems are easy to convert into microprocessor-controlled gear motors. For a servo to qualify, the front and back of its bull gear must be supported by the case or bearings. A servo with its bull gear supported by a potentiometer is not easily converted. The Hitec HS-425BB specified in the Parts List (see Fig. 3) is an easy-to-convert servo (the standard Hitec HS-300 is difficult to convert), and it is recommended for this project. If you can't find the HS-425BB servo locally, you could order it from America's Hobby Center (146 West 22nd Street, New York, NY 10011-2466; Tel. 216-675-8922).

To begin the conversion of the Hitec servo, remove the four screws that hold the servo together (but keep the bell crank or disk on the servo). Carefully remove the top cover, which will pull the bull gear off the potentiometer shaft. Then, gently remove the plastic clip from the potentiometer shaft. Align the shaft so the raised portion points lengthwise on the servo (see Fig. 4). In other words, the long sides of the shaft should be parallel to the long sides of the servo.

Remove the disk or bell crank from the bull gear and take the bull gear out of the cover. Use a hobby knife to chip the stop tab from the bull gear. Figure 5 shows two bull gears; the one on the left (with the bearing) has had its tab removed. Next, brush away any plastic crumbs from the gear train and reassemble the servo as shown in Fig. 6.

PARTS LIST FOR THE MOBILE ROBOT

MOD1—BS1-IC BASIC Stamp
MOT1, MOT2—Modified servo motor, Hitec HS-425BB or equivalent (see text)
S1—SPST switch
S2, S3—SPDT microswitch
B1—4.8-volt battery (four 1.2-volt NiCd batteries in series)
H1—3-pin header
Perforated board, enclosure, wheels, slide or caster (see text), bumper material (see text), electrical connectors (optional), 14-pin SIP socket, wire, solder, hardware, etc.

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When the potentiometer is disconnected from the bull gear, the output shaft is free to rotate continuously. The speed and direction will depend on the duration of the control pulse. A stream of 0.00075-second pulses causes the shaft to rotate at full speed in one direction, while a series of 0.00225-second pulses produces full-speed rotation in the other direction (see Fig. 7).

There are two conditions that will stop the shaft. Those are either when the microcontroller stops sending pulses or sends stop pulses. A stop pulse corresponds to the pulse that would produce the current potentiometer position if the potentiometer was still connected to the bull gear. Because the position of the disconnected potentiometer shaft will be different for each servo, you need to determine the duration experimentally. If the potentiometer shaft is centered (as explained earlier), the pulse width should be around 0.0015 seconds. As the pulses approach that duration, the rotational speed of the shaft will decrease. The Robot can therefore achieve a crude form of speed control by adjusting the pulse durations fed to the servo motors.

When you have finished converting a servo, repeat the procedure with another one so that you create two gear motors. Then, if you wish, attach the three leads of each to some type of three-pin connector to facilitate easy connection of the motors to the rest of the Robot circuit. Again, using connectors and modular assembly is not necessary. You could simply solder the leads to the circuit later on.

Fig. 3. Here's one of the Hitec HS-425BB servos used in the author's prototype.

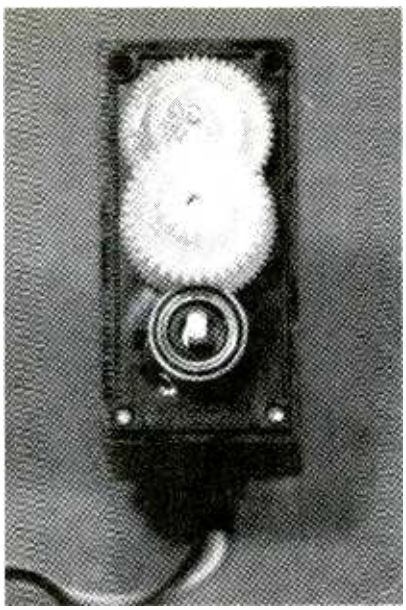

Fig. 4. The servo geartrain is shown here, with the bullgear removed. Note that the clip is off the potentiometer shaft and the shaft is aligned lengthwise.

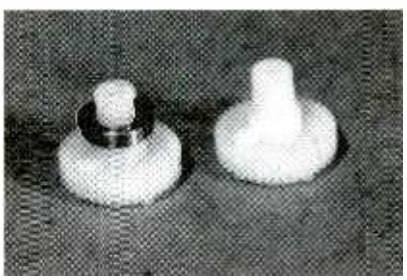

Fig. 5. The bullgear on the left (with the bearing) has had its tab removed, while the bullgear on the right is unmodified.

Mobile Assembly. The gear motors you just prepared need two more things to make them useful for locomotion: wheels and, of course, something to move (the Robot's body). Because the types of wheels used depend on the type of enclosure the Robot is built into, we shall consider the latter first. The author's prototype was assembled using a plastic project box for a frame. Project boxes make great robot enclosures because they are inexpensive and available from most electronics suppliers.

Whatever body you choose for your Mobile Robot, prepare it as follows: Cut openings in the sides for the gear motors (they should be placed towards one end of the enclosure, as shown in the photo of the Robot located elsewhere in this article). Then pass the motors through, marking the positions of their mounting holes on the enclosure. Remove the motors next, and drill mounting holes for the servos. Install the motors at this point.

The next step is to select two matching wheels. Make sure they provide sufficient traction to move the Robot and operate its bumper switches. The latter condition is important because if the switches do not press hard enough against obstacles, the Robot will not know they are present, and will spin its wheels oblivious of the fact that it's not going anywhere (more on the bumper switches later).

Also, the diameter of the tires must be large enough to provide adequate ground clearance. The wheels can come from a variety of sources including toys, RC cars and planes, and even lawn and garden equipment. Just keep in mind that larger wheels will make the Robot roll faster because it will travel farther for each revolution of the wheel.

Whatever type of wheel you choose, it's a good idea to drill a hole in the center that's large enough for the disk-mounting screw to fit through. That makes it easier to remove the wheels. You could attach the wheels to the servo disks with screws and aircraft lock nuts, or you can permanently attach them with epoxy or super glue. You might find that the standard disks that come with the servos are too large for some wheels; if that's the case, you can usually buy smaller disks from the source that supplied you with the servos.

When the wheel-and-motor assemblies are ready, mount them to the openings you made earlier. Then, cut an opening in the top of the enclosure so that you can pass the wires from the servos out to the top.

While we're on the subject of mounting wheels to the enclosure, it is relevant to mention the following important fact: To maximize traction, you should keep most of the weight in the Robot over the wheels. An easy way to accomplish that is to mount the four-AA-battery holder over the servos. That provides adequate traction and prevents the Robot from being easily flipped over. However, if you use large-diameter wheels you might want to mount the batteries under the servos, as you don't want the Robot to become top-heavy.

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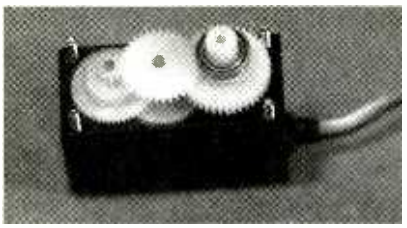

Fig. 6. When the geartrain is reassembled, the bullgear is placed on the potentiometer shaft and the middle gear is once again in the correct position, as shown here.

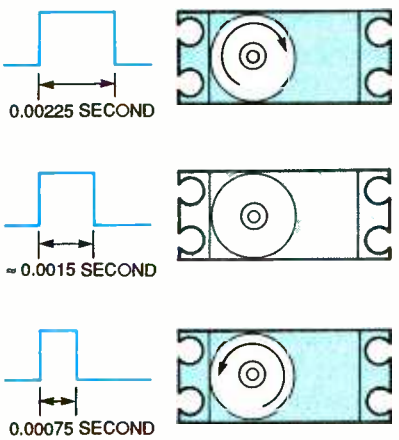

Fig. 7. On a modified servo, pulse-width modulation controls complete circular motion.

If you decide to use the battery pack for traction, mount it at this time. Wire power-switch S1 in series with the positive lead, cut an opening for the switch, and drill mounting holes for it. Then, either attach a connector of some type to its leads, or solder the leads to the rest of the circuit later. Pull those leads through the hole you cut in the top of the enclosure.

Even though most of the weight is carried by the driven wheels, something must support the other end of the mobile assembly. If it's only going to run on smooth, hard surfaces like wood or vinyl floors, the simplest solution is to use a drawer pull or half a ping-pong ball as a slide. For carpets, a small, free-rolling, free-spinning caster is ideal (you might have to search through a few hardware stores to find a suitable one). Keep in mind that such casters occupy a lot of the Robot's volume (Fig. 8 shows the caster that is mounted in the author's prototype). But whatever you use for the third support, be sure it won't cause the Robot to damage the floor or carpet.

Bumper Switches. With the Robot's mobile assembly completed you can now turn your attention to its sensors—the bumper switches. All the information the Mobile Robot receives from the environment comes from those switches. Even if you add more sophisticated sensors at a later time, the bumper switches will always remain the sensor of last resort. Any obstacle missed by sonar or IR range finders, for example, must be detected by the switches.

The most important requirements for the bumper switches used in the Robot is that they have a light activation force, yet still be able to withstand the impact of hitting an immovable object. Ordinary microswitches are more than adequate for a small, relatively slow robot like this one.

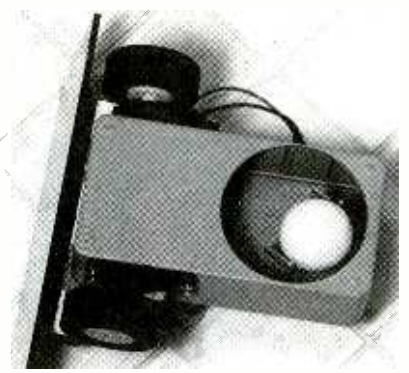

Fig. 8. The caster used in the author's prototype occupies about half the volume of the enclosure.

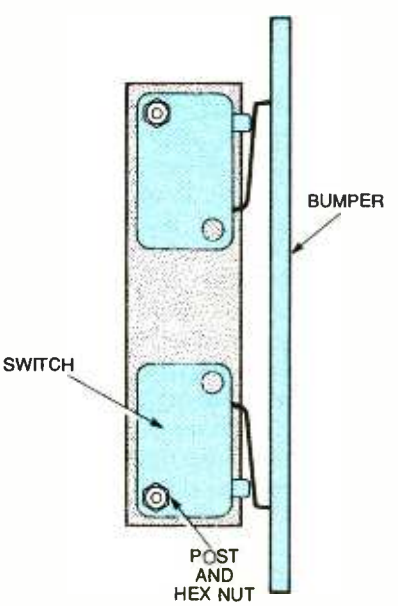

Fig. 9. Here's an overhead diagram of the bumper-switch assembly. The switches pivot on their mounting bolts when the bumper is hit.

Figure 9 shows an overhead view of the bumper switches. Use a single post and hex nut to mount each switch either to the enclosure itself, or to a separate piece of plastic that you can then mount to the enclosure. Position the switches approximately three inches apart.

Next, you must create a bumper from a sheet of plastic, wood, masonite, or foam-core art board. It should be the widest part of the unit to ensure that it hits any obstacle before the Robot's body does. Match the size of the bumper to the obstacles the Robot will encounter. A simple beam or bar can detect walls and the sides of large objects. However, you'll need a bigger bumper if your Mobile Robot will face a combination of small and over-hanging objects.

Once you've selected a bumper, hot-glue it to the switches. Make sure the switches pivot on the posts when the bumper is hit. A light force anywhere on the bumper should close a switch, and when the bumper is released the closed switch or switches must open.

Circuit Assembly. As mentioned earlier, you might want to consider building the Mobile Robot using modular-assembly techniques. If you wish to do so, Digi-Key (701 Brooks Ave. South, Thief River Falls, MN 56701-0677; Tel. 800-344-4539) and other suppliers have numerous connectors that you will find useful. The following assembly instructions will not be specific to the type of connection scheme you use, however.

One connector that you should definitely use is a 14-pin SIP socket to hold the BASIC Stamp module. Make sure the socket you use has 0.1-inch pin spacing, and is rigid, not flexible. The socket should keep the pins of the module from becoming damaged. Insert the module into the socket at this time.

Mount the socketed Stamp module to a piece of perforated board. Using the schematic shown in Fig. 2 as a guide, connect the leads from the servo motors to the circuit. Be careful to connect the correct wires to the correct points. On the Hitec servo specified in the Parts List, the control-signal

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LISTING 1

```
'mobile.bas 12 April 1995
'Mike O'Connor


'Simple reactive mobile robot program
'Program reads bumper switches and drives servos.
'Robot travels straight until robot hits an obstacle.
'Robot turns away from the side of bumper switch hit.

'       VARIABLES
symbol status = b2              'state of sensors
symbol rs = b3                  'right servo pulse
symbol ls = b4                  'left servo pulse

'       CONSTANTS
symbol delay = 20               'delay in milliseconds
symbol left = 0                 'left servo on pin 0
symbol right = 1                'right servo on pin 1

'       SERVO COMMANDS
'control pulses to servos measured in 10 microsecond
'units
symbol rf = 200                 'right forward
symbol rr = 100                 'right reverse
symbol rh = 160                 'right halt
symbol lf = 100                 'left forward
symbol lr = 200                 'left reverse
symbol lh = 164                 'left halt
'the duration of right halt rh and left halt lh depend on the
'converted servo.  You'll need to determine the correct
'value experimentally.

'                       GENERAL
'left servo is on pin 0
'right servo is on pin 1
'left bumper is on pin 7
'right bumper is on pin 6
'
'       STATUS
'condition                      status
'no hit                         0
'right hit                      1
'left hit                       2
'both hit                       3

'make pins 0 and 1 output and all others input
'note pins and dirs are numbered 76543210.
dirs = %00000011
'all pins low
pins = %00000000

main:                   'start of program loop
  status = pins         'read bumper switches
  status = status/64    'divide by 64 to ignore other pins
'determine the appropriate pulses to send to the servos
'based on the status of the bumper switches
  lookup status,(lf,lr,lh,lr),ls
  lookup status,(rf,rh,rr,rr),rs
  pulsout left,ls       'drive left servo
  pulsout right,rs      'drive right servo
  pause delay           'maintain timing of pulses to
'servos
goto main               'return to the start of the loop
```

wire is yellow, the power wire is red, and the ground wire is black. If you're using a servo you're not familiar with, ask someone knowledgeable at a local hobby shop or call the manufacturer.

Attach the leads from the bumper switches to the circuit next. Also, connect the loose wires from the battery pack and power switch. To complete on-board assembly, connect a three-pin header, H1, to the Stamp module and circuit ground. If you're using connectors, be sure to insulate all the soldered joints between wires and connectors with heat-shrink tubing.

Once the connections are all made to the board, mount it to the enclosure using screws and spacers. That completes the assembly of the Mobile Robot, which means it's time to give it some brains. In other words, it's time to program it.

Software. The two programs dealt with below will get your Mobile Robot rolling. Both are in the form of PBASIC that the Stamp can use. If you don't feel like typing them in, and you have a modem, you can download them off the Gernsback BBS (516-293-2283).

Let's start with a simple reflex program that only lets the Robot react to its immediate surroundings. In other words, it provides the Robot with no memory of the past or any knowledge of what it is doing. That program, shown in Listing 1, is a single continuous loop. During each cycle, the Stamp reads the bumper switches and sends out pulses to drive the servos.

The Robot's direction depends on the bumper switches. If neither switch detects a collision, both servos run forward. When a single switch closes, the servo on that side stops while the servo on the opposite side reverses. This causes the Robot to turn away from the obstacle. If both switches are closed, the Robot backs up. The switches are sampled about 40 times a second, so it's rare for both switches to be depressed simultaneously.

A robot running this program will roll across the floor until it hits an obstacle. Then, the Robot will turn away from the obstacle until its path is clear. With this programming, the Robot will tend to follow a wall around a room, and should rarely get stuck in corners.

You might get a real thrill watching your Robot circumnavigate the room for the first time. But after a while, the thrill wears off. That's when you should consider reprogramming the Robot. The next program, see Listing 2, is more complex. Using the program, the Robot examines its past to decide what action it should take. This program improves the Robot's ability to escape from difficult situations.

Programming Tips. It probably won't be too long before the two programs provided for the Mobile Robot will seem a little too limiting. Here are some tips that should make it easier for you to program the Robot on your own.

Keep in mind that this section is not a detailed description of PBASIC. Rather, it simply contains a few programming hints. In order to better understand the syntax of PBASIC, read Parallax's excellent documentation for the Stamp. It is clearly written and filled with helpful examples. A copy of the documentation comes with the BASIC Stamp Programming package.

Programming mobile robots is a trial-and-error process. You'll find that you're writing lots of programs in order

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LISTING 2

```
'newmoroa.bas 23 November 1995

'Mike O'Connor


'Program checks bumper switches for hits then drives the
'servos. The program also examines its recent history.  It
'keeps track of the time since its last collision and the last
'bumper switch hit. The robot travels in a straight line until
'it strikes an object. The robot turns away from the side
'that strikes an obsticle. If bumper switch continues to
'detect contact, the robot backs up and turns away from
'the last side to hit an object.

'          VARIABLES
symbol status = b2          'state of sensors
symbol rs = b3              'right servo pulse in 10
'microseconds
symbol ls = b4              'left servo pulse in 10
'microseconds
symbol no_hit = b5          'number of cycles since
'collision
symbol last_hit = b6        'last bumper switch hit
symbol count = b7           'counter for backup cycle
symbol turn_count = b8      'number of cycles of turning

'          CONSTANTS
symbol delay = 20           'pause in milliseconds to time
'pulses
symbol left_servo = 0       'left servo on pin 0
symbol right_servo = 1      'right servo on pin 1
symbol left_hit = 0         'flag for last bumper hit
symbol right_hit = 1        'flag for last bumper hit

'          SERVO COMMANDS
'pulse duration is in 10's of micro seconds
symbol rf = 200             'right forward
symbol rr = 100             'right reverse
symbol rh = 160             'right halt
symbol lf = 100             'left forward
symbol lr = 200             'left reverse
symbol lh = 164             'left halt

'          GENERAL
'looking at vehicle from the top with front pointing away
'left servo is on pin 0
'right servo is on pin 1
'left bumper is on pin 7
'right bumper is on pin 6

'          STATUS
'condition                  status
'no hit                     0
'right hit                  1
'left hit                   2
'both hit                   3

'          PROGRAM
'initialize i/o pins
'make pins 0 and 1 output and all others input
dirs = %00000011
'all pins low
pins = %00000000

read_bumpers:
  status = pins
  status = status/64        'ignore everything except pins 6
'and 7
  branch status,(straight,left,right,backup)
straight:
  turn_count = 0
  ls = lf
  rs = rf
  if no_hit > 250 then skip  'avoid over running the variable
    no_hit = no_hit + 1
  skip:
    gosub drive_servos
goto read_bumpers

left:
  turn_count = turn_count + 1
  last_hit = right_hit
  if turn_count > 20 then backup
  if no_hit > 5 and no_hit < 10 then backup
  no_hit = 0
  ls = lr
  rs = rh
  gosub drive_servos
goto read_bumpers

right:
  turn_count = turn_count + 1
  last_hit = left_hit
  if turn_count > 20 then backup
  if no_hit > 5 and no_hit < 10 then backup
  no_hit = 0
  ls = lh
  rs = rr
  gosub drive_servos
goto read_bumpers

backup:
  no_hit = 0
  for count = 0 to 20
    ls = lr
    rs = rr
    gosub drive_servos
  next
  if last_hit = left_hit then skip_to_right
    ls = lr
    rs = rh
    goto do_servos
  skip_to_right:
    ls = lh
    rs = rr
  do_servos:
  for count = 0 to 20
    gosub drive_servos
  next
goto read_bumpers

drive_servos:
  pulsout  left_servo,ls
  pulsout right_servo,rs
  pause delay
return
```

to create a few good ones. It's important to keep track of your work. Start organized and stay organized. Consider creating a subdirectory for your programs to keep them separate from other ones.

The Stamp's editor can save programs to and load programs from the disk but it can't show you a list of your

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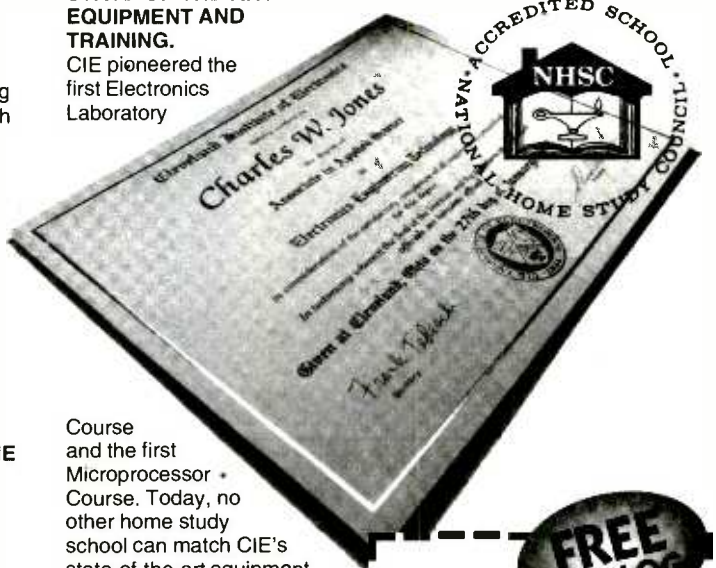

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programs. For that reason you might want to use the editor to create a file that keeps track of all your BASIC Stamp programs. Use the .BAS extension for the file so that the editor can read and write to it. Then, whenever you write a new program, update your program list. Be sure to include a brief description of each program and helpful comments about its operation; that way you'll know which ones to use and what to use each of them for.

There's another important reason to keep a current program list. When you save a program, the editor does not check to see if a program with that name already exists. If you're not careful, you could overwrite good programs.

The Stamp has a few quirks that you could program around, but which you need to know about. For starters, it evaluates mathematical equations differently than you would. The Stamp only performs integer math; that is, when it performs division, it ignores everything to the right of the decimal point. Also, mathematical and logical expressions are evaluated left to right; e.g., 7 + (2 × 5) = 45, not 17. Finally, the Stamp cannot recognize negative numbers.

Variable names in PBASIC can be of any length. Stamp variables can be bits, bytes, or words. However, bit variables can only be stored in the first two bytes of memory (b0 and b1). Variables stored in the last two bytes of memory (b12 and b13) might interfere with GOSUB instructions. Before you use a variable, it needs to be defined by the SYMBOL instruction.

A great feature of the Stamp's instructions is that many of them match the needs of the robotics hobby. The PULSIN and PULSOUT instructions can receive or emit a pulse accurate to ten microseconds. PULSOUT is perfect for driving servos. The PAUSE instruction creates a delay that's used to control the refresh frequency of the servos. Variations in the refresh rate, caused by changing pulse lengths or the different execution times of various instructions, usually don't cause any problems. Just remember that the PULSE and PAUSE instructions use different units of time. PULSIN and PULSOUT use ten-microsecond units while PAUSE measures time in thousandths of a second.

SUGGESTED READING

Books

The *BASIC Stamp Manual 1.2*, published in 1995 by Parallax Inc. (3805 Atherton Road, #102, Rocklin, CA 95765), is the documentation that comes with the BASIC Stamp. It contains clear, detailed descriptions of the Stamp and all PBASIC instructions. Twenty example applications with complete program listings and schematics are also found in this 172-page book.

H.R. Everett's *Sensors for Mobile Robots: Theory and Application*, published in 1995 by A.K. Peters (289 Linden Street, Wellesley, MA 02181), explains the theory behind a wide variety of sensors. The book describes a number of experimental and commercial sensors, though most of the systems covered are a bit expensive for hobbyists.

Mobile Robots: From Inspiration to Implementation by Joseph L. Jones and Anita M. Flynn is another excellent A.K. Peters book. The breakthrough text guides the reader through sensors, motors, and software. You'll also find the list of part suppliers helpful. A.K. Peters sells kits of the Rug Warrior robot featured in the book.

Fred Martin, Pankaj Oberoi, and Randy Sargent have written the *The 6.270 Robot Builder's Guide*. This collection of class notes from the MIT Lego Robot Design Competition is now in its second edition, published by The Epistemology and Learning Group (Massachusetts Institute of Technology, 20 Ames Street, Room E15-309, Cambridge, MA 02139). The chapter on sensors is particularly useful.

Gordon McComb's *The Robot Builder's Bonanza: 99 Inexpensive Robotics Projects* is a good introduction to most of the topics hobbyists building robots need to know about. The book was published by Tab Books (Blue Ridge Summit, PA 17924-0850) back in 1987, so some parts are outdated.

Robotics Age: In the Beginning is a compilation of articles from *Robotics Age* magazine that was compiled by Carl Helmers. Published by Hayden (Rochelle Park, NJ) in 1983, the book's been out of print for over a decade. However, it contains a number of articles that are still useful; the piece on stepper motors is excellent.

Periodicals

The Robotics Practitioner, published by Footfalls, Ltd. (483 S. Kirkwood Road, Suite 130, Kirkwood, MO 63122), is a new quarterly magazine. If you build robots, or even if you're merely interested in robotics, you should consider subscribing.

The monthly newsletter *Robots!*, published by the Robotics Society of America (P.O. Box 1205, Danville, CA 94526-8205), contains meeting summaries, book reviews, feature articles, and contest announcements.

The Stamp's BUTTON instruction reads and debounces a switch, then performs a GOTO when conditions are met. BUTTON is great for user-operated interfaces, but for reading bumper switches it is better to read the pins directly. Switches S2 and S3 are connected to the highest-numbered pins in the Robot (P6 and P7). Program the Stamp to read their values with the PINS instruction. Once the Stamp knows the status of a robot's bumper switches, the program running should contain IF...THEN or BRANCH instructions to send the execution of the program to the appropriate address.

The PINS instruction doesn't debounce the switches. However, because the Stamp reads the switches and drives the servos about 40 times a second, that isn't much of a problem. A small, slow robot like this one isn't going to get into much trouble in a fortieth of a second.

The Stamp accepts other forms of input as well. The POT instruction allows the Stamp to read a variable resistance by measuring the amount of time needed for a capacitor to discharge through the unknown resistance. That allows a mobile robot with CdS photoresistors to track a light source. Unfortunately, the POT instruction executes slowly because it must wait for a capacitor to charge and discharge. The time needed to execute POT will slow the refresh rate of the servos. Using the POT command while a robot is moving will slow that robot to a jerky crawl.

There are other ways to interface analog devices. For sensors that produce varying voltages, you can use analog-to-digitial (A/D) or voltage-to-frequency converters. The BASIC Stamp Manual explains how to interface the National Semiconductor ADC0831 A/D converter using three of the Stamp's pins. A voltage-to-frequency converter only requires a single pin and the PULSIN instruction.

As you can tell, the Robot is not limited to the bumper-switch sensors. Because the Robot only uses four of the Stamp's eight I/O lines, new sensors can be added to the unused lines. Additional bumper switches could provide 360-degree contact detection. Also, sonar or IR proximity detectors could enable the Robot to avoid obstructions instead of running into them.

Keep the Mobile Robot's versatility in mind. Using the Robot as a base for future experiments could be a lot of fun. ■

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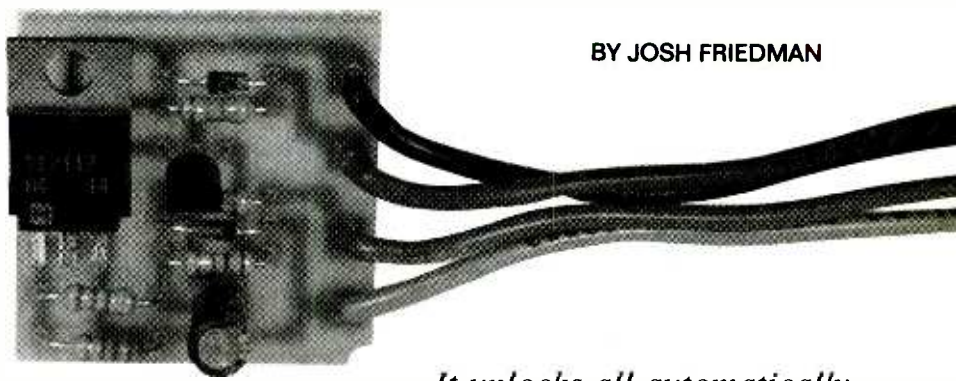
BUILD THE UNLOCK-TOO

BY JOSH FRIEDMAN



It unlocks all automatically locking vehicle doors when you turn off the ignition.

Certain new vehicles are equipped with power door locks that automatically lock when the transmission is shifted into gear. Unfortunately, you have to manually unlock the doors before exiting, which some might find inconvenient. If you have a vehicle with that feature, and would like to correct what many consider to be a design flaw, consider building the *Unlock-Too* described in this article. It automatically unlocks all vehicle doors when the ignition switch is turned off.

Unlock-Too will work on any self-locking, power door-lock system that uses a positive-voltage pulse-controlled relay. Several General Motors products built between 1992 and 1994 used such a system. Those included the Chevrolet Cavalier and Lumina, Pontiac Grand-Am and Grand-Prix, Oldsmobile Achieva, Cutlass Supreme and Ciera, and Buick Skylark and Century models.

Automatic-Lock Basics. Inside each door of a vehicle with power locks is an actuator whose main component is a reversible motor. When a door-lock switch is pressed, to either the lock or unlock position, battery power is applied to a corresponding relay (there's one for each position, although in many vehicles both the lock and unlock relays are in the same enclosure). The relay then applies the correct polarity voltage to the actuators, which perform the desired lock or unlock function.

In a car with automatic locks, turning on the ignition has the effect of activating the lock relay and actuators. The Unlock-Too does the opposite when installed in parallel to a vehicle's unlock relay. When the ignition switch of a vehicle equipped with the Unlock-Too is turned off, the unit closes the vehicle unlock-relay contacts for about half a second. That, of course, results in the doors becoming unlocked.

Circuit Description. The schematic for the Unlock-Too is shown in Fig. 1. For the following discussion, assume the circuit is installed in a vehicle.

When the ignition switch is on, the "+12V" and "IGN" lines connected to the circuit are within half a volt or so of each other. Resistor R3 reverse biases Darlington Q2 and keeps it cut off. Transistor Q1 is in parallel with Q2's emitter and collector; Q1 is "on" due to the large voltage drop across Q2's emitter and collector, but that has no effect on the circuit at this time.

When the ignition switch is turned off, voltage is removed from the "IGN" line, effectively placing R5 at ground level. That change occurs because the vehicle components also connected to the ignition power source act like a very low-value resistor in series with R5 to ground. Capacitor C1 provides a path for current to flow through R3–R5 and the vehicle components to ground. That flow will forward bias Q2, driving it into saturation and lowering its emitter/collector voltage to less than 0.5 volt. As a result, almost full battery voltage is applied to the vehicle unlock relay; transistor Q1 is cut off at the same time. The voltage divider of R3 and R4 prevents false triggering during voltage sags on the "IGN" line.

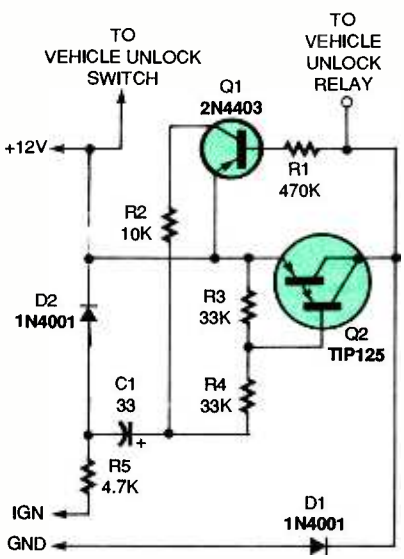


Fig. 1. When the Unlock-Too is connected to a vehicle, shutting the ignition switch off results in a forward biasing of Q2, which applies almost full car-battery voltage to the door unlock relay.

As current flows through C1 the capacitor begins to charge through R3–R5. Over time, less current will be available to forward bias Q2 and maintain saturation. When Q2's emitter/collector voltage drop reaches about 0.6 volts, Q1 will begin to conduct, forming a feedback loop with R1 and R2 that adds extra charge current to C1. That has an avalanche effect. The faster C1 charges, the faster Q2's emitter/collector voltage-drop increases. Then, the more current that Q1 conducts, the faster C1 charges and the faster Q2 is turned off.

As connected in the circuit, Q2 has a fast turn-off time. That turn-off action quickly opens the vehicle unlock-relay contacts and prevents them from chattering. After Unlock-Too turns off, a slight current flows through Q1, R1, and the vehicle unlock-relay coil to ground. Because the current is less

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than 30 microamperes, there is no danger of discharging the vehicle's battery over time. Diode D1 suppresses voltage spikes when the unlock relay is turned off.

Construction. The author's prototype for the Unlock-Too was built on a small printed-circuit board, although any project-building method can be used. If you wish to build the unit on a PC board, you can either use the foil pattern shown in Fig. 2 to etch your own, or buy a board from the source mentioned in the Parts List.

If you're using a PC board, follow the parts-placement diagram shown in Fig. 3. Begin by installing the resistors. Then add C1, D1, and D2, noting their polarity. Mount Q2 as shown in Fig. 3 (the tab is to the left). If you wish, gently bend the leads with needlenose pliers so that Q2 lies flat against the board. Do not install Q1 yet.

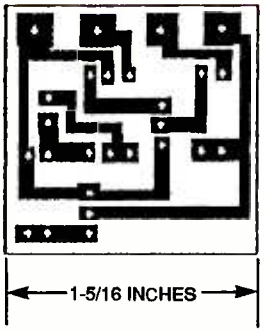

Fig. 2. If you'd like to etch your own PC board for the Unlock-Too, use this full-size template.

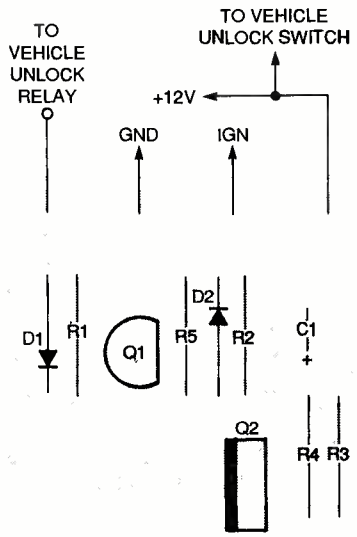

Fig. 3. When building the Unlock-Too on a PC board, use this parts-placement diagram as a guide.

Next, solder four 12-inch-long, 18-gauge stranded wires to the board for the vehicle connections. Those wires should be of different colors to avoid confusion later. In the author's prototype (and on any assembled units ordered through the source mentioned in the Parts List) the wires are as follows (from left to right in Fig. 3): the "to vehicle unlock relay" wire is black, "GND" is green, "IGN" is red, and "+12V" is orange.

Before completing the Unlock-Too board you should test it and conduct a simple experiment. Temporarily assemble the circuit shown in Fig. 4. The open-circle connections for "+12V" and "IGN" and the arrow connection for the "vehicle unlock relay" correspond to the matching leads on the PC board. Tack solder the components shown in Fig. 4 to the ends of the leads. The "GND" wire will not be used at this time.

Connect the test circuit to a 12-volt DC source and touch JU1 to the leads, as shown, for about 5 seconds. That simulates turning on the ignition. Then, remove JU1, simulating that the ignition is turned off. As mentioned earlier, Q1's feedback gives Q2 a fast turn-off time; without it, the LED should quickly come on but gradually turn off. If that had been a relay, its contacts would chatter when they tried to open, which would eventually damage the contacts and possibly the connected load.

Remove power from the circuit and install Q1, observing the orientation in Fig. 3. Then, perform the test again. This time, when JU1 is connected and removed, LED1 will turn on and after a half-second delay turn abruptly off. If any time during this test the Unlock-Too does not operate as mentioned, double-check the solder connections and wiring.

You can put the circuit board in any small, suitable enclosure. The author sealed the finished prototype board in Plastidip. That sealer is usually used to coat handles of small hand tools and is readily available in most hardware stores as a dip or spray. If you would like to do the same, trim the component leads as close as possible before applying the sealer to the finished circuit board. (Note that having different-color wires is mandatory if you plan on sealing the board.)

Installation. Before you begin installing the Unlock-Too, roll down a window to prevent locking yourself out of your vehicle. Also, keep in mind that all vehicles are different and we can't include make- and model-specific installation details. However, a generic connection diagram is shown in Fig. 5. If you don't feel comfortable with your vehicle's electrical system, you might want to ask an automotive technician for help.

Here's some useful information for those who drive the GM models listed earlier: They use a single relay package for lock and unlock functions. The relay can be identified by an in-line six-wire connector. Those six wires are arranged as follows: black (to the unlock switch), tan (to the actuators), black (ground), orange/black (+12

(Continued on page 56)

PARTS LIST FOR THE UNLOCK-TOO

SEMICONDUCTORS
Q1—2N4403 PNP transistor
Q2—TIP125 or TIP117 PNP power Darlington transistor
D1, D2—1N4001 silicon rectifier diode

RESISTORS
(All resistors are ¼-watt, 5% units.)
R1—470,000-ohm
R2—10,000-ohm
R3, R4—33,000-ohm
R5—4700-ohm

ADDITIONAL PARTS AND MATERIALS
C1—33-µF, 25-WVDC, electrolytic
Printed-circuit materials, project enclosure or Plastidip, 3M Blue Scotch Lock connector splices (optional), 18-gauge wire, solder, hardware, etc.

Note: The following are available from Josh Friedman (2665 Balfour Street, Eugene, Oregon, 97408): etched and drilled PC board—$6.00; assembled Unlock-Too unit, sealed, with four 12-inch colored wires soldered in place—$16.00. Shipping and handling for the continental U.S. is included in all prices (write for international shipping information). Checks and money orders accepted (drawn on U.S. banks only). Shipping will be delayed until personal checks clear. Oregon residents please add appropriate sales tax.

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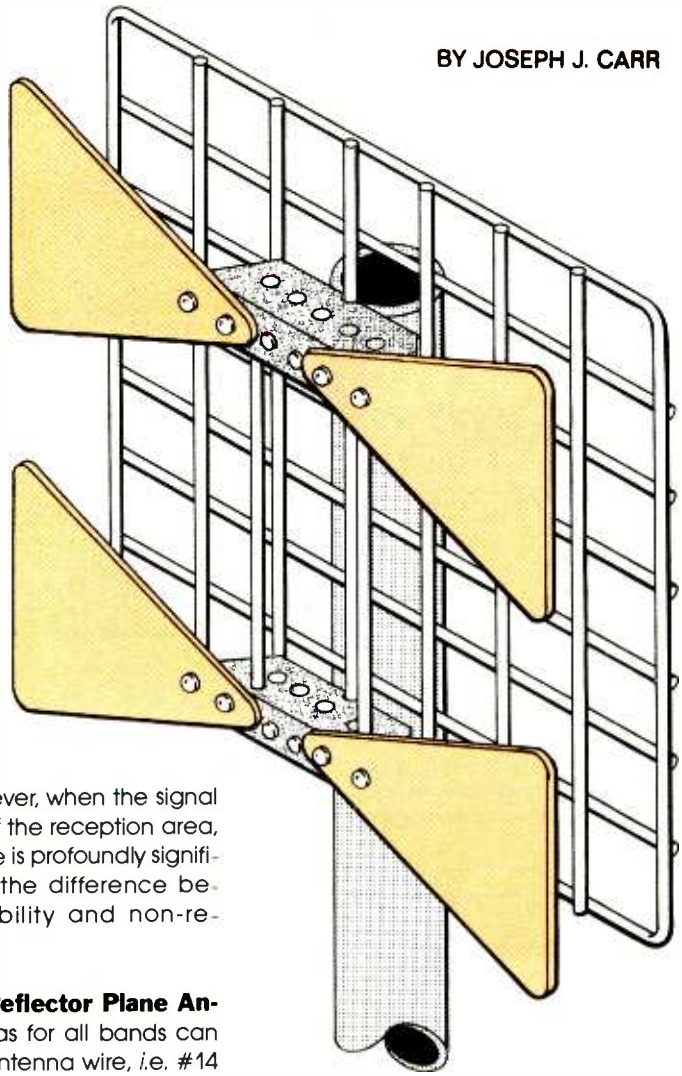
All About Reflector Antennas

BY JOSEPH J. CARR

Try these low-cost, easy-to-build antenna designs and get better performance from your VHF/UHF radio gear.



At one time, enthusiasts who monitored the VHF/UHF bands faced a dearth of good equipment. What was available a couple of decades ago was either single channel (or a few crystal-controlled channels), unstable, insensitive, or all three. Today, there is a huge number of VHF/UHF scanner receivers on the market, and the number of scanner-monitoring enthusiasts grows every year.

The growing number of scanner enthusiasts have many things in common with their brethren who work the lower frequencies; one of them is the need for a good antenna to get the most out of their gear. In this article, we will take a look at reflector antennas for use in VHF/UHF receiving applications.

What Are Reflector Plane Antennas? Reflector antennas are dipoles, or multiple dipoles, backed by a reflector plane located a quarter wavelength behind the dipoles (see Fig. 1). That arrangement converts a bidirectional dipole antenna into a unidirectional antenna. Because of the change in reflectivity, the gain of the reflector plane antenna is 3 dB higher than the dipole alone.

So what does 3 dB mean? In terms of power, the reflector antenna delivers twice as much received signal power to the antenna terminals of the receiver than the dipole. If the receiver has an S-meter, a 3-dB increase would represent about a half of an S-unit. In practical terms, when signals are strong, a 3-dB increase, while perceptible, won't make that much of a difference. However, when the signal is at the fringe of the reception area, the 3-dB increase is profoundly significant; it means the difference between receivability and non-receivability.

Materials for Reflector Plane Antennas. Antennas for all bands can be made with antenna wire, *i.e.* #14 stranded, copper-clad steel wire. But at VHF/UHF, several other options present themselves. The reason is that the wavelengths are much shorter, and most antennas are either quarter-, half-, or one-wavelength long. At 100 MHz (in the middle of the FM broadcast band), a half wavelength is 59 inches; at 400 MHz, it is 14.75 inches; and at 650 MHz, it is 9 inches.

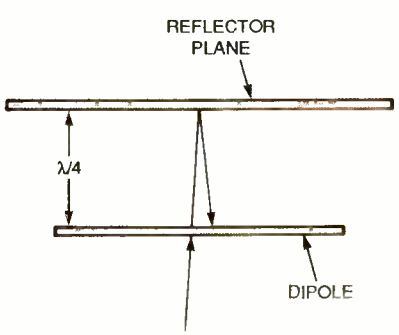


Fig. 1. The concept of a reflector antenna is quite simple—a dipole backed by a reflector plane spaced a quarter-wavelength away.

One option is the use of 300- or 450-ohm twin-lead transmission line in a folded dipole or another configuration. Another option is to make antenna elements out of #10, #12, or #14 solid wire, such as the wire used to carry electrical current in your house (make sure it's copper, not aluminum, or else it won't solder).

Brass and copper tubing is easily available at hardware and hobby stores. Copper-plumbing tubing comes in ¼-inch, ⅜-inch, ½-inch, ¾-inch, and 1-inch sizes. Hard drawn pipes are available in straight lengths of 4, 6, 8, and 12 feet (I'm told that 16-foot lengths are also available, but the lengths listed were actually found in a do-it-yourself hardware store when I surveyed it for this article). Soft drawn copper is more flexible, and comes in coils. The same diameters are available in coiled copper, but it's best to limit the use to the smaller sizes.

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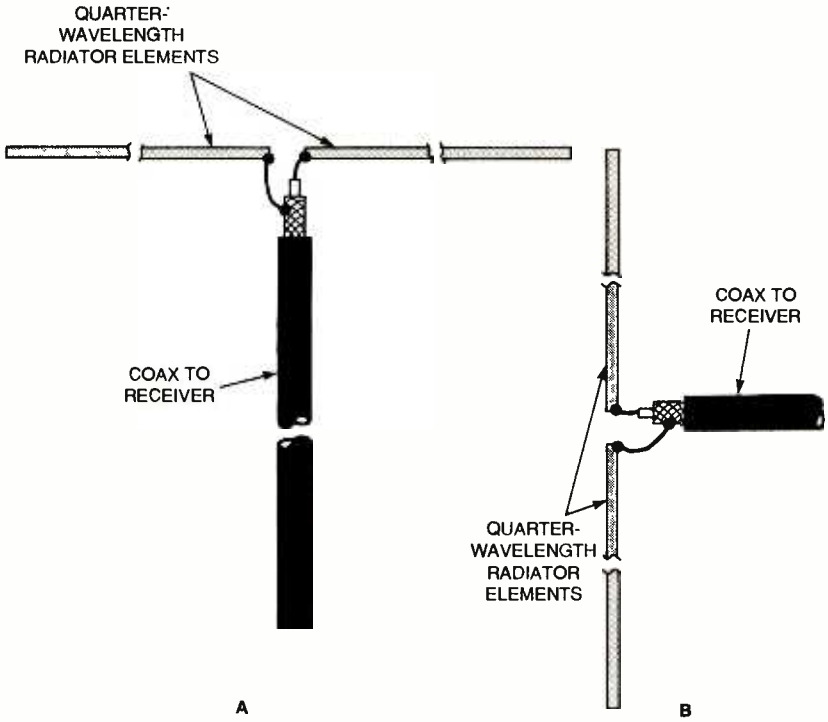

Fig. 2. A standard dipole is built using heavy wire or tubing and could be horizontally polarized (A) or vertically polarized (B).

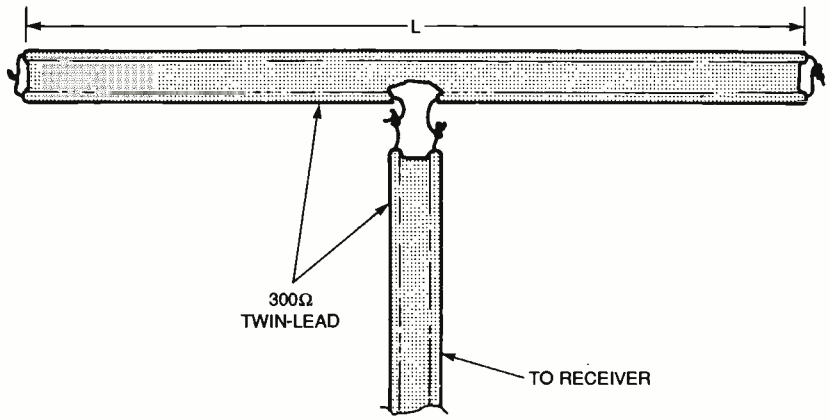

Fig. 3. TV-type 300-ohm twin-lead is ideal for making a folded dipole. Be sure to short the conductors together at both ends as shown.

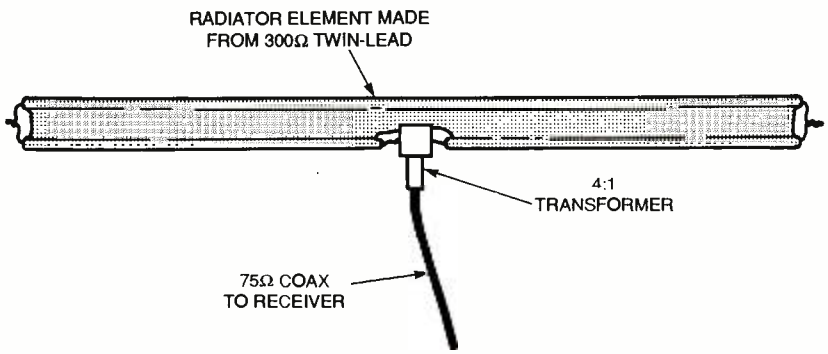

Fig. 4. If you want to use 75-ohm coaxial cable to feed your folded dipole, a 4:1 BALUN transformer should be used at the feedpoint.

Hobby shops are a good source of brass tubing and rods. They come in diameters from about 3/32 to 3/4 inch, and in lengths of 12, 18, and 24 inches. Again, there might be other lengths and diameters available, but on the morning I surveyed two local hobby/model shops, these were the sizes in stock.

It's possible to use copper foil and copper plate for either certain types of radiator element, or for the reflector screen. I've used roofing copper, but that's not optimal. The reason is that it's heavy gauge, so it must be worked with sheet-metal shears (and even then it's a pain). It's also terribly expensive stuff. One thing that drives the cost up is that roofing copper is not easily obtained in do-it-yourself hardware stores, but rather has to be obtained from commercial metal distributors. The one I dealt with had a $50 minimum order, so I bought a roll of 7-inch-wide, 1-pound/square-foot roofing copper (and because I don't use a lot at one time, that roll has lasted a long, long, time!).

Lighter gauge copper foil is available from hobby shops. I've seen 32-, 36- and 40-gauge copper foil. The latter is easily worked with dull scissors, but one has to be careful lest it crinkle. I found both sheets and rolls of all three gauges at arts and crafts shops. The largest supply was found at a specialty hobby shop that deals with dollhouse builders (who use it for copper roofs).

Radiator Elements: The Dipole. The actual antenna element, the radiator, in these designs is the dipole (of which, several varieties are used). The dipole is a half-wavelength radiator element that is fed in the center with 75-ohm coaxial cable. The antenna in Fig. 2A is for horizontally polarized signals, while the one in Fig. 2B is for vertically polarized signals. It is more important to get the polarity correct when working with VHF/UHF signals than it is for HF shortwave. The reason is that long-distance ionospheric propagation of HF signals makes the polarity of the received signal a jumbled random mess. But at VHF/UHF frequencies, it's likely to be the same at the receiver as it was at the transmitter.

At VHF/UHF frequencies, the dipole radiator element can be made of #12 or #10 solid wire, or copper/brass tubing of 1/4-inch to 1/2-inch size (I found in building a couple of these antennas that the 3/8-inch tubing

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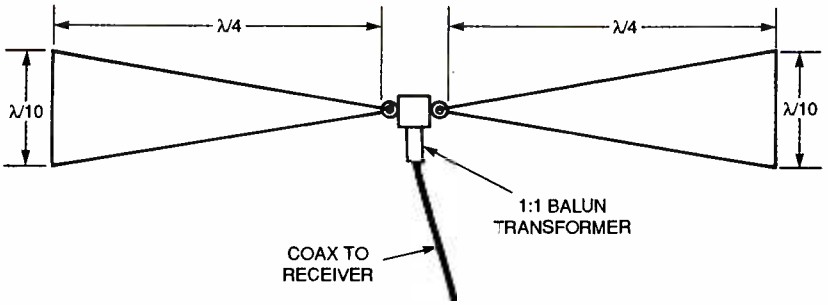

Fig. 5. The "Fan" dipole (also known as the "Bow Tie" dipole) is a variation of the folded-dipole theme.

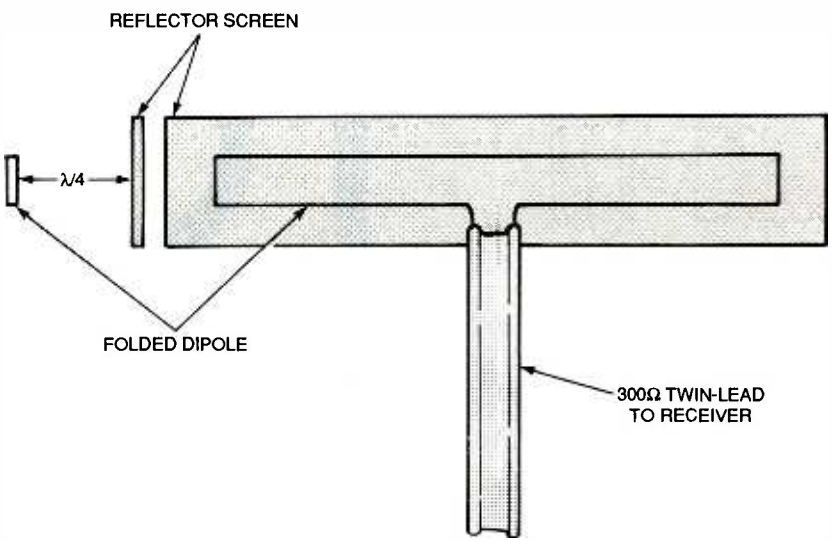

Fig. 6. The folded dipole reflector antenna consists of a folded dipole placed a quarter wavelength in front of a reflector plane; the plane should be flat, and about 15- to 20-percent larger that the dipole's length.

seemed to be the best compromise).

The overall length of the dipole is given by the following equation, and each element is one-half this length:

$$L = 5904/f_{MHz}$$

Where L is the length of the radiator element in inches, and f_{MHz} is the frequency in megahertz. Work that equation on a calculator, and you will discover where I got the lengths used in the examples given earlier in this article.

In Fig. 3, we see a folded dipole. That antenna is made from 300-ohm twin-lead transmission line. The length is as calculated from the previous equation. The ends of the two conductors of the twin-lead are scrapped clean of insulation (remove about 0.75 inches from each conductor). The two conductors (at both ends) are then twisted together and soldered. One of the conductors is split at the exact center. The insulation is stripped off for about 0.5 inch, and the wire cut. The two ends become the point at which the 300-ohm transmission line to the receiver is connected.

In some cases, you might wish to use a 4:1 BALUN transformer (see Fig. 4) at the center feed point in order to allow 75-ohm coaxial cable to be used between the antenna and receiver (instead of the 300-ohm twin-lead).

A variation on the theme is the fan dipole in Fig. 5. The elements of the fan dipole are made of two conductors that are spread apart enough to be about one-tenth wavelength (λ/10) at the ends. The bandwidth of the fan dipole is a bit greater than regular dipoles, even though it is a little harder to build. Like other dipoles, the elements are each a quarter wavelength (λ/4), for an overall length of a half wavelength (λ/2). The fan dipole can be fed directly with 75-ohm coaxial cable, or through a 1:1 BALUN transformer if one is available for the frequency that you select.

Folded Dipole Reflector Antenna. The folded dipole in Fig. 6 is mounted a quarter wavelength in front of a reflector plane. The reflector plane can be made of copper foil glued to a wooden or foam-core poster-board backing (Fig. 7A). Alternatively, it can be fashioned as a grid of #10 or #12 solid wire, or the brass rods mentioned above (Fig. 7B). If the grid method is used, solder the wires or rods together at the points where they cross each other. Be careful not to distort this assembly; it is important to keep the plane of the reflector flat. The size of the reflector is about 15% to 20%

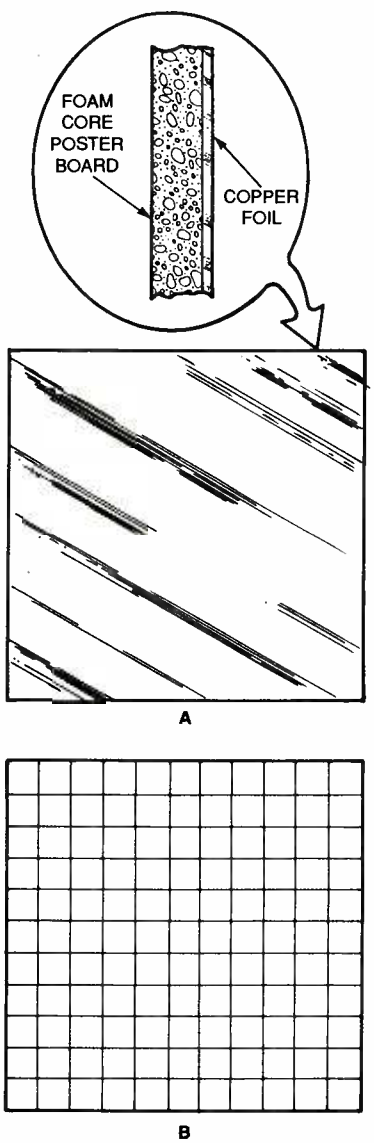

Fig. 7. The reflector plane can be made from a variety of materials. For example, copper foil over a wood, plastic, or foam-core poster board (A) or a wire grid made of #12 solid wires, or metal rods (B).

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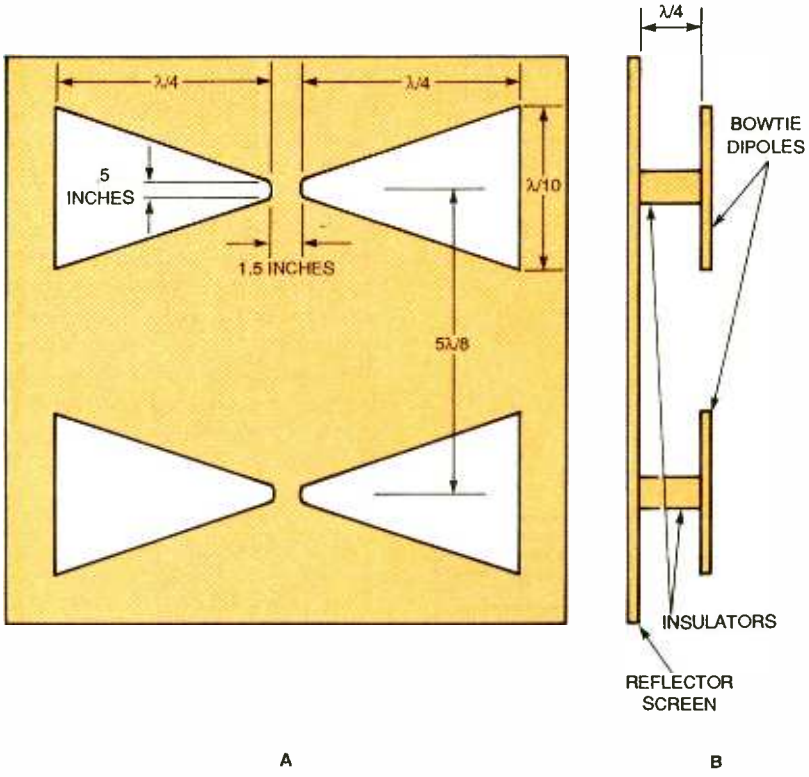

Fig. 8. The "Bow-Tie" reflector antenna, so popular for use in receiving UHF TV signals, can also be used to receive UHF radio signals. A front view of the antenna is shown in A, and a side view in B.

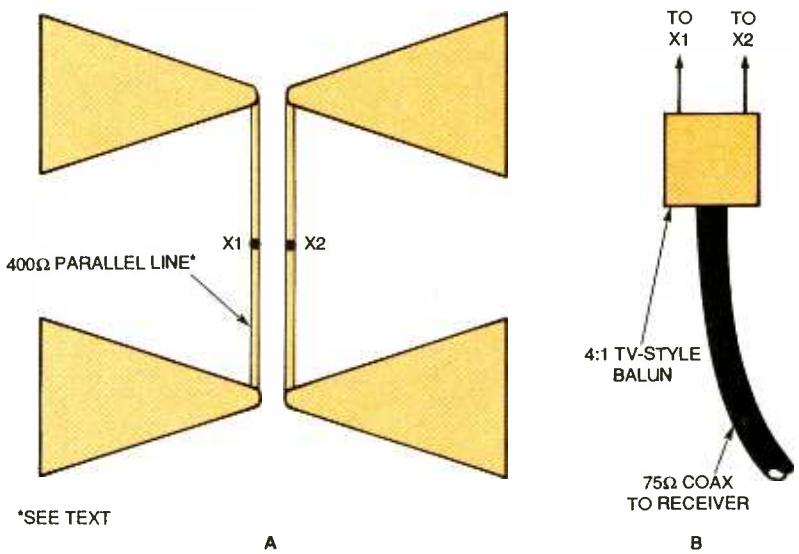

Fig. 9. The two bow-tie dipoles are connected together by a 400-ohm transmission-line harness (A). To use coax to connect to your rig, again use a 4:1 BALUN transformer.

(0.125λ to 0.2λ) larger than the folded dipole length.

Bow-Tie Reflector Antenna. A bow-tie reflector antenna is seen in Fig. 8A (frontal view) and Fig. 8B (side view); it is capable of about 6 dB gain. That type of antenna is very popular as a UHF TV antenna, and can be pressed into service for those scanner frequencies that lie close to the UHF-TV band as well. The dipole elements are made of sheet metal (preferably copper or brass). Each element is triangle shaped, fanning from ⅛-inch at the feedpoint to 1/10 wavelength at the ends, and is a quarter wavelength long. These lengths are calculated

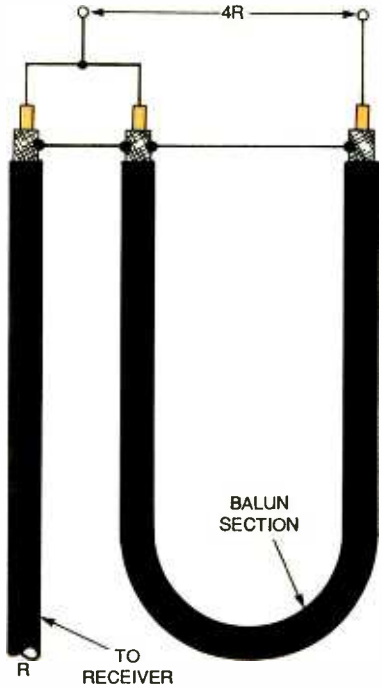

Fig. 10. If you do not want to buy a BALUN, one can be made from sections of 75-ohm coax cable.

from:

$$\lambda/4 = 2952/f_{MHz}$$

and,

$$\lambda/10 = 1180/f_{MHz}$$

The dipole elements are spaced 1.5- to 4-inches apart, to form a complete half-wavelength dipole. The dipoles themselves are mounted in the same plane, but 5/8-wavelength (5λ/8) apart. That distance is calculated from:

$$5\lambda/8 = 7380/f_{MHz}$$

The reflector screen should be about 20% longer than the dipole elements, and can be made exactly as above for the reflector folded dipole antenna.

The two dipoles are connected together by a transmission-line harness (Fig. 9A), which is a 400-ohm transmission line fashioned from either #12 solid copper wires (or the equivalent brass rod), spaced 4-inches apart, or from ¼-inch tubing spaced 3.5-inches apart. Alternatively, it wouldn't be too bad if 450-ohm twin-lead were used to connect the two dipoles.

The feedpoint is on the transmission-line harness, mid-way between the dipoles (points X1 and X2 in Fig.

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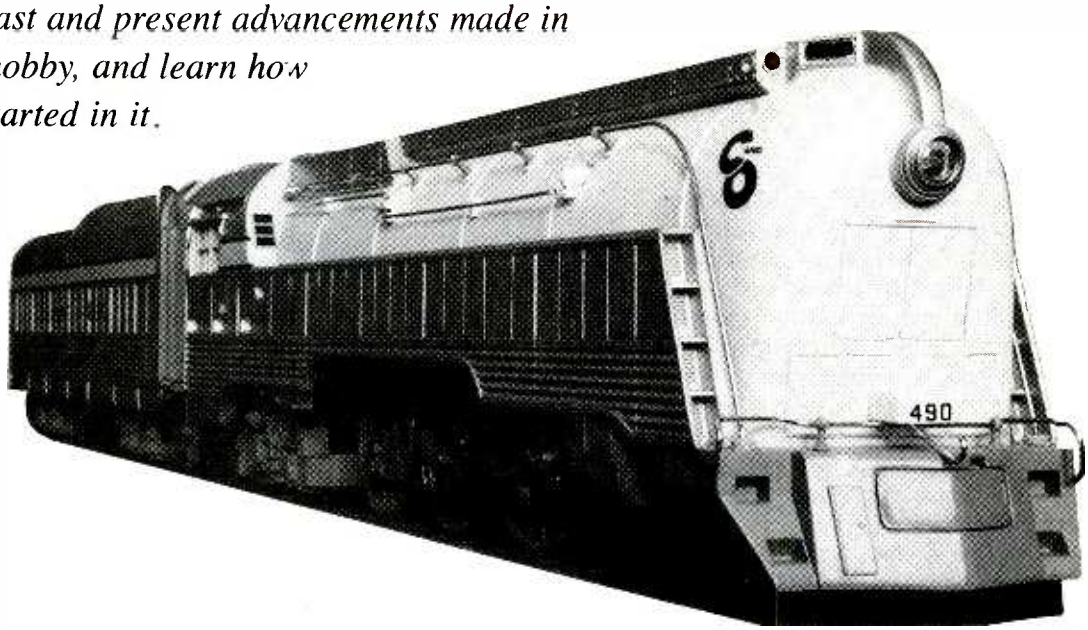
Explore the past and present advancements made in this popular hobby, and learn how you can get started in it.



TOY TRAINS

BY DENNIS EICHENBERG

The toy-train market is exploding because of electronics. That's because electronics technology has provided the "new" toy trains with a functionality and reliability never dreamed of in the past. And it's just getting started.

The toy-train hobby is a wonderful way to combine the nostalgia of yesterday with the high technology of today. It's something that grandparents, parents, and children can all participate in. The hobby provides a creative release, an application for electronic circuits, and perhaps even an introduction to electronics. It's not surprising to most that the hobby has its benefits; however, few know just how long the pastime has been around.

The Beginnings. Electric toy trains became commercially available in the United States in 1896 when Carlisle and Finch of Cincinnati offered a battery-powered trolley and track. That was a significant achievement at the time considering that electricity itself was just beginning to be used and understood. In 1897 Marklin of Germany introduced a complete electric train with a locomotive and cars.

Later, in 1901, Joshua Lionel Cowen of Lionel fame developed an electric railroad car called the "Electric Express" as a store-window exhibit. The window exhibit itself became a sensation and sold briskly. Several other firms such as American Flyer, Marx, and Ives soon began producing electric trains. And the hobby was born.

Gauges. There were no standard track widths or gauges when toy trains were first developed. That would change over the years as a number of different standards were developed. It all started in 1907, when Lionel introduced a track with a center rail that had one conductor and two outer rails connected together electrically as the other conductor. The width between the outer rails was 2.125 inches. That was referred to as the three-rail Standard Gauge and quickly became the American standard of the time.

Ives then made available, in 1910, O Gauge electric trains in which the width between the outer rails was 1.25 inches. Lionel also offered O Gauge trains in 1915, along with their Standard Gauge trains. O Gauge trains are still very popular, with many manufacturers constantly introducing new products for the line.

Next, OO Gauge trains, with a rail spacing of 0.75 inches, were made available in the 1930s. Also introduced in the 1930s were HO Gauge trains, with a rail spacing of 16.5 mm; HO Gauge is the most popular gauge in use today.

Things were then quiet until after World War II, when American Flyer developed two-rail S Gauge trains, which have a rail-spacing of 0.875 inches. The availability of S Gauge trains is a bit limited, but they do have a dedicated following and are still being manufactured.

The 1960s brought the introduction of N Gauge trains, which have a rail spacing of 9 mm; that is presently the second most popular gauge. Large Scale or G Gauge trains also became available in the 1960s. Although LGB was the first in 1968 to come out with them, several other manufacturers soon offered G gauge trains. The G Gauge track is 45 mm between the rails; also, the trains are very rugged and well suited for outdoor or indoor use.

Finally, Z Gauge trains were offered by Marklin in 1972. The rail spacing in those units is 6.5 mm. Although that is presently the smallest type of train commercially available, it is remarkably detailed and sophisticated despite its tiny size.

Electronic Evolution. You might be wondering by now just how electronics have improved the toy-train

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hobby over the years. Let's take a look at a few of those ways here:

For starters, in the early days of the hobby batteries powered most trains. That could make the hobby quite expensive after a while. All that began to change in 1906 when Lionel offered a train transformer to reduce household voltage to a safe operating voltage. The transformer eliminated the need for batteries and permitted the speed of the trains to be easily adjusted.

Many early trains used universal AC/DC motors in which the field winding was in series with the armature winding. A manual switch was then provided on some of the locomotives to permit the reversing of the motor by switching the phase between the field and armature windings. In 1924 Ives introduced remote-controlled reversing, which allowed a train to go forward, then pause, then reverse, then pause, and then go forward simply by interrupting the train power. The schematic for the reversing unit is shown in Fig. 1. It has become the standard reversing scheme, and many toy trains still use it today.

Of course, changing a motor's direction is not the only control a hobbyist would like to have over a train. That's why a remote-controlled switch track was introduced by Lionel in 1927. The switch track was activated by a miniature solenoid installed in the switch—a method that's still commonly used.

Lionel also introduced a remote-controlled train whistle in 1935. It consisted of a motorized fan that sent air through resonating chambers that were tuned like an organ. The whistle was controlled by a small DC current from the transformer, which activated a relay that was pulled in by DC only. Because the train was operated from AC, it was not affected by the whistle. The schematic for the whistle is shown in Fig. 2.

A further advancement was made by Lionel in 1936, when it introduced the remote-controlled coupler. The coupler included a miniature solenoid that was energized by a pickup from a special track section. Later the special track section included an electromagnet that activated the coupler mechanically. That latter method proved to be very reliable, and is still commonly used.

Smoking steam locomotives were

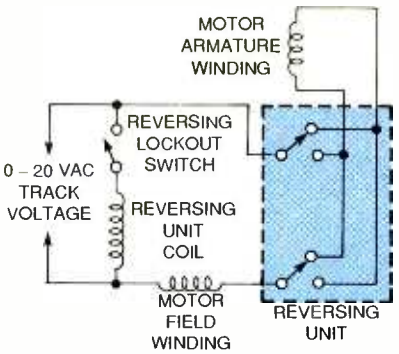

Fig. 1. This Ives circuit permits the reversing of the train motor by switching the phase between the field and armature windings.

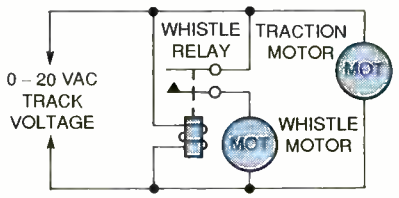

Fig. 2. This whistle circuit is controlled by a small DC current, which activates a DC relay and whistle motor. The train, which runs on AC, is not affected by the whistle.

introduced by Lionel in 1946. Such a train had a special lamp that would heat a pellet inserted into its smokestack. The following year the lamp was replaced by a nichrome wire and bellows synchronized with the wheels, which provided puffs of smoke as the train moved. That advanced system is still in use.

A different kind of electronic train set was offered by Lionel in 1947. The set had a vacuum-tube radio transmitter with two rows of colored buttons. The locomotive and tender, and the cars, each had a colored dot that matched the transmitter buttons, along with a receiver tuned to the particular frequency of the transmitter. That system permitted the train to be controlled anywhere on the track at any time without any special track sections or extra wiring.

As you can tell so far, some accessories are necessary for making a train set work better, while some are just for show. Of course, electronic accessories that enhance the appearance of a kit are part of what makes the hobby so enjoyable, and for that reason they have always been popular with toy-train owners. Simple add-ons like lamps and signals were available from the beginning. Then, in 1935, Lionel introduced an operating watchman that jumped out of a shed when the train passed. The watchman was activated by a solenoid installed in the shed. This was the first of many animated accessories, and is still produced today.

Control Systems. One challenge of train control is enabling several individuals to operate trains independently on a layout. The classic approach is to divide a track into several electrically isolated sections or blocks. On a large layout, though, the wiring becomes quite complex. For that reason, computers have been used on many layouts to ease the burden.

Computers permit trains to be programmed for any motion profile desired. Locomotive specifications, loads, and even weather conditions can be programmed to provide realistic train operation.

A further development is a standard protocol for toy trains developed by the National Model Railroad Association (NMRA). Called digital command control (DCC), the protocol is compatible with two- and three-rail systems. It is essentially a local area network (LAN), which uses the track rails to carry the signals. All data pertaining to the train, such as acceleration rate, deceleration rate, and load can be downloaded from a central controller to the integrated circuit installed in the locomotive. Therefore, DCC permits several locomotives to run simultaneously on the layout, all on the same track, without blocks, and individually controlled by one or more operators.

As shown in Fig. 3, DCC is a pulse-width modulated system. Controllers

This 1906 Lionel transformer eliminated the need for batteries and permitted the speed of toy trains to be easily adjusted.

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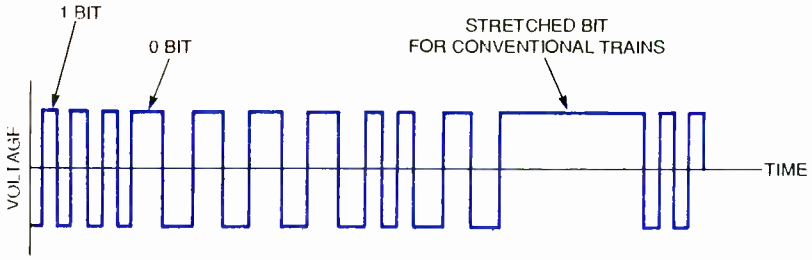

Fig. 3. As shown here, DCC is a pulse-width modulated system. Controllers transmit power and data in the same signal, and a decoder aboard the locomotive then extracts the information.

transmit power and data in the same signal, and a decoder aboard the locomotive then extracts the information. Each DCC signal has an address byte, an instruction byte, and an error byte. A typical system can have up to 99 addressable locations, which are upgradable to 32,000. Address locations are established in software during a two-way cycle that the train acknowledges by providing a momentary low impedance across the track. All other communications are one-way from the controller to the train.

Transmitted instruction bytes contain speed and direction commands. The baseline packet permits 14 speeds, which are upgradable to 128.

CLUBS

LGB Model Railroad Club
P.O. Box 15835
Pittsburgh, PA 15244-5835

Lionel Collectors Club of America
P.O. Box 479
La Salle, IL 61301

Lionel Operating Train Society
P.O. Box 62240
Cincinnati, OH 45262-0240

Lionel Railroader Club
P.O. Box 748
New Baltimore, MI 48047-0748

Marklin Club
P.O. Box 51559
New Berlin, WI 53151-0559

Marklin Digital Club
P.O. Box 51559
New Berlin, WI 53151-0559

National Model Railroad Association
4121 Cromwell Rd.
Chattanooga, TN 37421

Toy Train Operating Society
25 W. Walnut St., Suite 308
Pasadena, CA 91163

Train Collectors Association
P.O. Box 248
Strasburg, PA 17579

There are also software packages available to calibrate the trains. Such software runs a train through its paces to establish a speed/voltage table; the table is then downloaded to the trains so that a speed command from the central controller goes to the look-up table of the train to provide the correct operating voltage.

Conventional trains can also be operated with a DCC system. In this case the zero bit is stretched to impose an average positive voltage on the track to provide operating power.

The NMRA DCC Standards and Recommended Practices address a total of nine output functions. That permits a train's front and rear headlights to be turned on and off, while also being able to dim the headlight, and operate the Mars light, strobe lights, ditch lights (both constant on and alternating), classification lights, number boards, and sound module.

Also available are DCC switch decoders that permit switch tracks to be operated remotely from the controller. An operator can customize the timing settings of each switch track after it is installed in the layout.

In 1994 Lionel introduced the TrainMaster system, which is a transformer and remote-control system. It provides wireless walk-around control, multi-train operation, and realistic train-speed control. The TrainMaster system can either control the track voltage for operating conventional trains, or function as a Command Control that provides a constant track voltage and controls a digital receiver in each train.

In the TrainMaster control mode, up to ten trains can be operated on separate blocks. There is one wireless remote-control unit, one receiver for each block, and one transformer. The remote-control unit has a range of 150 feet. Any Lionel or Lionel-compatible sound system can be operated by the TrainMaster.

The TrainMaster system provides realistic acceleration and deceleration of the trains. Also, a "Big Red" pushbutton can be connected to permit control of the system by young children or the physically challenged.

OPERATING LAYOUTS

America's Railroads on Parade
1915 Pocahontas Trail, Suite A-4
Williamsburg, VA 23185

Choo-Choo Barn
Rt. 741 E.
P.O. Box 130
Strasburg, PA 17579

The Detroit Historical Museum
5401 Woodward Ave.
Detroit, MI 48202-4097

Lionel Trains Visitor's Center
Lionel Trains, Inc.
Chesterfield, MI 48051-2493

Nassau Lionel Operating Engineers, Inc.
Medical Arts Bldg.
Walcott Rd.
Levittown, NY 11756

The New York Botanical Garden
200th St. & Southern Blvd
Bronx, NY 10458

Oglebay Miniature Railroad & Village
Oglebay Resort & Conference Center
Wheeling, WV 26003

Railway City USA
Rt. 236
Kitter, ME 03904

Train-O-Rama
6832 E. Harbor Rd.
Marblehead, OH 43440

Trainland USA
3135 Highway 117 N.
Colfax, IA 50054

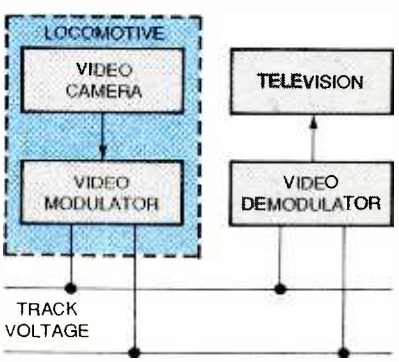

Fig. 4. In the Lionel Rail Scope system, a miniature electronic video camera is mounted inside a toy train. The video signal is transmitted from the locomotive over the rails to a receiver that is also connected to the rails.

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In the TrainMaster Command Control mode, a receiver connected to the track translates the command from the wireless remote control unit into a digital code transmitted over the track. Each locomotive has a receiver that translates the digital code to control multiple Command Control-equipped trains on the same track simultaneously and independently. It also controls the train's sound system, lighting, and couplers. In addition, the system permits operation of switch tracks and accessories.

Sound. Lionel introduced the Mighty Sound of Steam in 1972. This was an electronic sound system with a miniature speaker in the locomotive to provide a synthesized locomotive sound; it proved to be quite effective. Lionel took that sound technology a quantum step forward when it introduced their Railsounds in 1989. It provides a digital recording of the actual prototype. Thus a realistic whistle, horn, bell, chug, or roar emanates from the train upon command.

There are many other sound systems available. One of particular interest is the ALPS-3000 produced by Witco Computers and Electronics. It is controlled by a wireless remote controller that directs a library of digitally recorded sounds through any of eight amplified surround channels and strategically placed speakers, making it possible for the appropriate sounds to originate anywhere on the layout.

When the train is ready to depart the station, a press of a button will cause the conductor to shout "Board" from inside the station. Then, it's possible to ring the locomotive's bell, vent steam, chuff, and head for the main line. You can press other buttons to hear running water from a stream bed, ring a church bell, make the cows moo, or listen to the saws and hammers of a work crew. The speed-synchronized sound of the locomotive is channeled along the line, fading from speaker to speaker in surround sound so that the sound appears to be from the locomotive itself. Because no audio electronics or speaker need to be on the train itself, the sound system can be used with all train gauges, including the tiny Z Gauge.

The system is highly expandable permitting hundreds of sounds to be added. Also, a live microphone input is provided to permit customized messages to be produced.

Other Recent Developments. Lionel introduced the Rail Scope system in 1989. In it, a miniature electronic video camera is mounted inside a specially outfitted locomotive (available in every gauge), allowing the operator to see the layout on a television as the engineer would. A block diagram of the system is shown in Fig. 4. The video signal is transmitted from the locomotive over the rails to a receiver that is also connected to the rails. The signal from the receiver is then taken by wire to the television.

High technology is also being applied to track cleanliness. For reliable train operation it is essential that the track is kept clean to maintain electrical conduction. That can be an exhaustive physical task on a large layout. To facilitate track cleaning, Miniatronics manufactures an electronic track cleaner. Called Electrak Clean, it superimposes a high-frequency signal on the normal track voltage to ionize the gap due to contamination, and restore electrical conduction.

Software has also become important in the toy-train industry. One company, Sandia Software, produces a layout design program called Cadrail. It includes libraries for many different gauges so that a virtual layout can be developed prior to purchasing any hardware.

Future Developments. There are several areas of toy-train technology currently being developed that will become commercially available in the future. One is from Motorola, which manufactures a family of integrated circuits used in automation systems called neurons. Neurons use an ethernet type of system to provide inexpensive two-way communication when installed in trains. Thus the trains

TRAIN SOURCES

Aristo-Craft
346 Bergen Ave.
Jersey City, NJ 07304

Atlas Tool Co. Inc.
378 Florence Ave.
Hillside, NJ 07205

Bachmann Industries, Inc.
1400 East Erie Ave.
Philadelphia, PA 19124

Chicago Model International
855 Skokie Valley Rd.
Suite L
Lake Bluff, IL 60044

Dallee Electronics
P.O. Box 1921
Reading, PA 19603

Digitrax
P.O. Box 1424
Norcross, GA 30091

K-Line Electric Trains
P.O. Box 2831
Chapel Hill, NC 27515

LGB of America
6444 Nancy Ridge Dr.
San Diego, CA 92121

Life-Like Products, Inc.
1600 Union Ave.
Baltimore, MD 21211

Lionel Trains, Inc.
50625 Richard W. Blvd.
Chesterfield, MI 48051-2493

Marklin, Inc.
P.O. Box 51319
New Berlin, WI 53151-0319

Marx Trains, Inc.
209 E. Butterfield Rd. #228
Elmhurst, IL 60126

Miniatronics
561-K Acorn St.
Deer Park, NY 11729

Model Rectifier Corp.
2500 Woodbridge Ave.
Edison, NJ 08817

MTH Electric Trains
9693 Gerwig Ln.
Columbia, MD 21046

OTT Machine Services, Inc.
P.O. Box 1701
Lombard, IL 60148-8701

Right-Of-Way Industries, Inc.
1145 Highbrook St.
Akron, OH 44301

Sandia Software
9428 Tasco NE
Albuquerque, NM 87111

Tyco Industries, Inc.
540 Glen Ave.
Moorestown, NJ 08057

Wangrow Electronics, Inc.
P.O. Box 98
Park Ridge, IL 60068-0098

Weaver Models
P.O. Box 231
Northumberland, PA 17857

Witco Computers & Electronics
3563 Sueldo St., Bldg. B
San Luis Obispo, CA 93401

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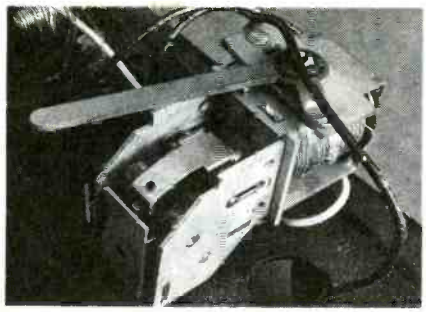


Reversing units for AC-powered trains, like the one shown here, are basically solenoid-operated drum switches.

will be able to "talk" to each other as well as to the controller.

Also, even though Z Gauge trains are now the smallest commercially available units on the market, further miniaturization is being considered. Extremely tiny motors have already been developed that will permit even smaller trains if a market exists for them. Of course, part of the fun of the toy-train hobby is still having a large, visually pleasing setup.

Getting Started. Now is the ideal time to enter or reenter the world of toy trains. Trains from the past can be used to get started, and you can then supplement them with the high-tech marvels of today as time and money permit. The compatibility of modern equipment prevents the obsolescence of older train equipment. Before jumping in to the hobby, though, you might want to try familiarizing yourself with it in one of the following ways:

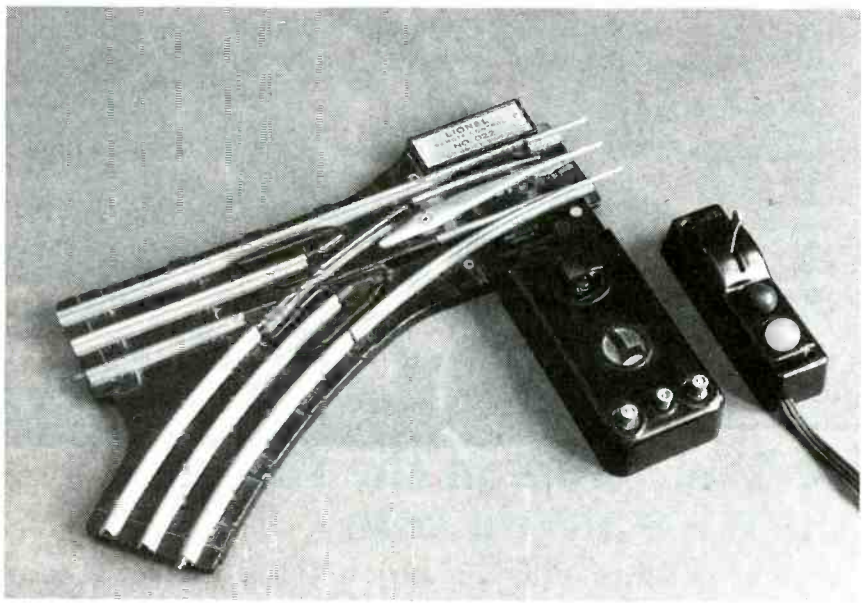
First, try attending a train show. Several shows are scheduled in every city each year; watch your local papers for scheduled times and places. The shows provide an opportunity to talk to several different suppliers about their equipment. Also, operating layouts are usually displayed at the shows.

Another way to get familiar with the hobby is to contact a toy-train club. Many of them have local organizations with regular meets that permit members to discuss their particular concerns and interests. A lot of the clubs have operating layouts in which the members take an active role. That is a perfect solution for apartment dwellers who desire to work on a toy railroad. A list of some of the clubs is included in the "Clubs" box.

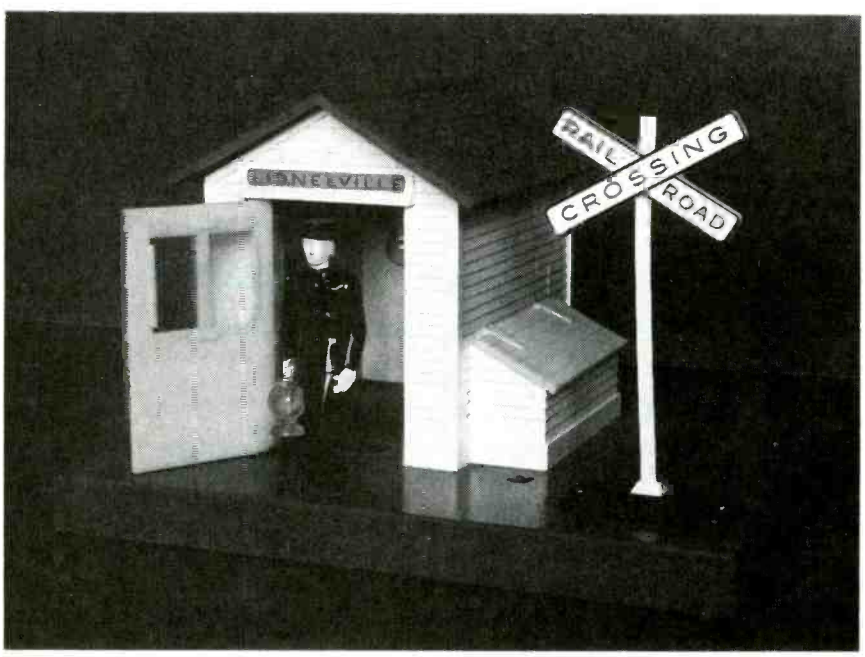
Want still another great way to get introduced to toy trains? Why not visit one of the many operating layouts throughout the country that are open to the public. Such displays provide an excellent way to see what kind of trains and layouts hold the greatest appeal to you. A list of some of those layouts is included in the "Operating Layouts" box.

Finally, you'll probably want to find out about the actual trains and accessories you'd have to buy. A list of some toy-train sources is included in the "Train Sources" box. Contact them for additional information on their products. Most manufacturers' literature provide a wealth of knowledge on what is available in the hobby and where the hobby is directed. Of course, the literature will also give you an idea of how much you can expect to spend on your new hobby.

The possibilities in the world of toy trains are endless, especially for the electronics hobbyist. It is an excellent forum in which to apply electronic circuits to enhance the trains' functionality, reliability, and appearance. ■



This remote-controlled switch track is activated by a miniature solenoid. Many train sets still use this same method.



This operating watchman jumps out of his shed whenever a toy train passes. It was the first animated accessory ever produced for a toy train.

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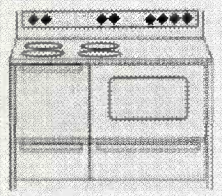
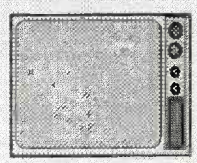
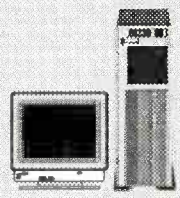
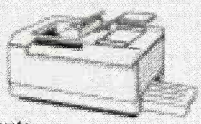
Where Do I Go When It Doesn't Work?



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- Electronic Musical Instruments
- Fax Machines
- Home Automation
- Home Theatre
- Microphones
- Microwave Ovens
- Printers
- Radar Detectors
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- Televisions Sets
- Vehicular Electronics
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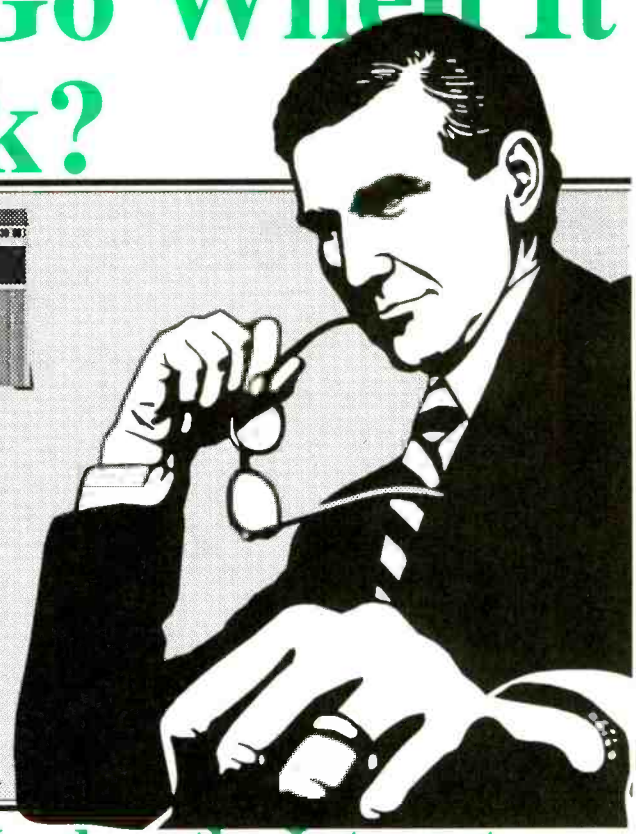

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Build A Solid-State Stroboscope

Use this precision handheld unit to make remote RPM measurements and view moving devices in stop-action.

BY SKIP CAMPISI

Have you ever wanted to have a good look at a rotating or reciprocating mechanical device while it's in high-speed motion? Or perhaps you want to measure the revolutions or strokes per minute of such a device? Well, the easiest way to accomplish that is with a stroboscope; however, commercially available units have their problems. Because they tend to use xenon or neon flash tubes, most stroboscopes require high voltages for triggering. Also, the tubes in them run rather hot and are expensive.

The *Solid-State Stroboscope* described in this article solves those problems by using LED technology. Forget about tubes that need to be replaced, the circuit will drive a super-bright LED, which has an extremely long life. Also, a high-voltage supply is not needed—the circuit uses a 9-volt battery as a power source. Best of all, the Stroboscope can be built for a fraction of what the tube versions cost.

The Stroboscope has two range settings, × 1 and × 10, that cover the 0- to 10,000-FPM (flashes-per-minute) rate. At the × 1 setting, the unit has an accuracy of 1% over the 100- to 1000-FPM range; at the × 10 setting, there is a 1% accuracy over the 1000- to 10,000-FPM range. That enables you to adjust the duration of the flash to fit a particular application. For example, if more brightness is required, use a longer flash; for clearer stop-action, try a shorter flash.

Circuit Description. The schematic diagram for the Stroboscope is shown in Fig. 1. When switch S2 is closed, a 9-volt battery, B1, is connected to IC3, a 78L05 voltage regulator, which provides a 5-volt source to the circuit. Capacitors C8 and C9 filter the supply.

A CD4046 phase-locked loop, IC1, provides a low-frequency square-wave to the circuit. Potentiometer R4—a 5000-ohm, 10-turn, precision potentiometer with a built-in turns counter—provides a way to adjust and get a direct readout of the FPM rate from 0 to 1000. Switch S1 lets you select the multiplier affecting that rate. Setting S1 to × 1 therefore gives you a 0- to 1000-FPM range, while setting S1 to × 10 results in a 0- to 10,000-FPM range. The values of the multiplier settings are determined by capacitors C1 and C2.

A 555 timer, IC2, configured in a monostable mode, provides a pulse with a width that is adjustable via R8. That audio-taper potentiometer allows the duration or pulse width to be varied from 10 microseconds at the minimum setting to 1000 microseconds at the maximum setting.

An MPSA14 Darlington transistor, Q1, is configured as a capacitive discharge-type current sink, which provides an approximately 90-milliampere pulse (for the pulse duration set by R8) through LED1, the flash output. The super-bright LED specified for LED1 has a maximum rating of 100 milliamperes.

Construction. The author's prototype was assembled using perforated board and point-to-point wiring. You can do the same, or feel free to use any other standard project-building method.

Start by mounting sockets for IC1 and IC2, but don't insert the ICs yet. Then, working away from the sockets, wire the resistors and capacitors, making sure that the polarized units are properly oriented. For best accuracy, choose a precise 1.0-μF capacitor for C1 and a precise 0.1-μF capacitor for C2; C1 has to be as close to ten times the value of C2 as possible. For the best linearity, R3 and R5 should both be close to 680 ohms.

Mount trimmer-potentiometer R2. Go on to install D1, D2, and LED2 to the circuit, followed by Q1. Make sure all those components are oriented properly. Leave short, insulated wire leads on the board for LED1, potentiometers R4 and R8, switches S1 and S2, and the negative battery connection. To complete the on-board assembly, install IC3 and then insert IC1 and IC2 into their sockets.

Mount R4, R8, S1, and S2 onto a suitable project enclosure. Then drill a couple of clearance holes for the leads of LED1 on the end of the enclosure. Install the LED to the enclosure using a dab of silicone sealant.

Next, install the board into the enclosure using spacers. Connect all the off-board components to their appropriate leads, and attach the battery snap to the negative battery lead and switch S2.

Calibration and Use. Connect a battery to the snap in the

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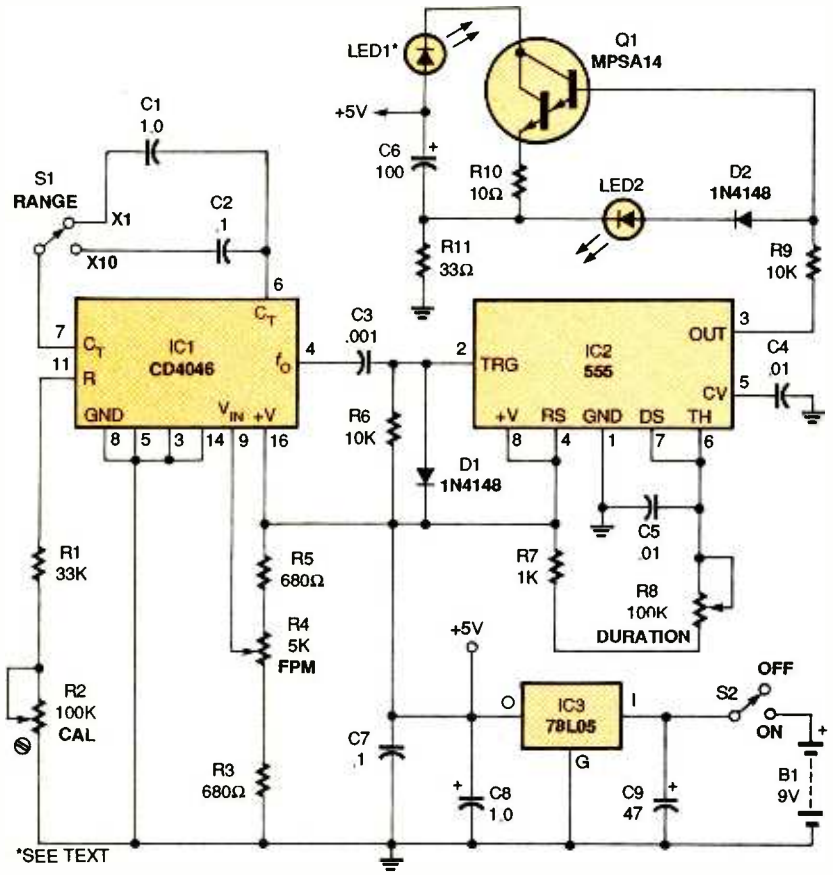

Fig. 1. Here's the schematic for the Solid-State Stroboscope. A super-bright LED, LED1, provides the unit's output.

Stroboscope. Set the duration-adjust potentiometer, R8, which ranges from 10 to 1000 microseconds, to mid position, or 100 microseconds. Then turn the flashes-per-minute potentiometer, R4, to indicate 900 on its counter. Set the range-select switch, S1, to × 10. With those settings, the unit should output approximately 9000 flashes per minute, although you still need to calibrate the circuit. Turn on the Stroboscope using S2; LED1 should come on. If you rotate R8 back and forth, the brightness of LED1 should vary.

To perform the next part of the calibration you will need a frequency counter. Attach the input leads from the counter between pin 4 of IC1 and ground, and adjust trimmer-potentiometer R2 for a reading of exactly 150 Hz at the 9000-FPM setting. You can test the linearity of the circuit by resetting R4 and checking the frequency again: At 6000 FPM, the reading should be 100 Hz; at 3000 FPM, 50 Hz; and at 1200 FPM, 20 Hz.

Using the Stroboscope is easy once you have a basic understanding of the images you will see at different flash rates. The following example is a description of how to make an actual RPM measurement on a rotating motor. The motor used to test the author's prototype was an 1800-RPM synchronous type running on 115-volts AC; try to use a similar motor for your own test.

Stick a "dot" of masking tape on the face of a small pulley. Then, attach the pulley firmly to the motor shaft and turn on the motor so the pulley (and the dot) spins. Starting with R8 at a duration setting of 1000 microseconds and S1 set to the × 1 range, advance the turns counter from 0 FPM up the scale while observing the image of the "dot" target. You'll see multiple images of the target at many settings; however, look for the settings that only give one single target image. Those occur at whole number divisions of the actual RPM; in the author's case, those were at 1800 divided by 4 (450 FPM), 1800 divided by 3 (600 FPM), and so on until the actual RPM at 1800 FPM was reached.

If you continue increasing the FPM setting, you will no longer see a single target image. Rather, at double the RPM rate (3600 FPM) you will see two images at 180-degrees apart; at triple the RPM (5400 FPM) you will see three images 120-degrees apart; and so on up the FPM scale. Noting those readings as you go will help you yield the

PARTS LIST FOR THE SOLID-STATE STROBOSCOPE

SEMICONDUCTORS

IC1—CD4046 phase-locked loop, integrated circuit
IC2—555 timer, integrated circuit
IC3—78L05 5-volt regulator, integrated circuit
Q1—MPSA14, 2N6427, or equivalent NPN Darlington transistor
D1, D2—1N4148 silicon switching diode
LED1—Super-bright light-emitting diode, orange, 12,000-mcd, 620-nm (Radio Shack part no. 276-206 or equivalent)
LED2—Light-emitting diode, yellow

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—33,000-ohm
R2—100,000-ohm miniature trimmer potentiometer, single-turn
R3, R5—680-ohm
R4—5000-ohm precision potentiometer, 10-turn, with built-in turns counter (Bourns #3610S or equivalent)
R6, R9—10,000-ohm
R7—1000-ohm
R8—100,000-ohm audio-taper potentiometer, single-turn
R10—10-ohm
R11—33-ohm

CAPACITORS

C1—1.0-μF, polyester or non-polarized electrolytic
C2—0.1-μF, polyester
C3—0.001-μF, ceramic-disc
C4—0.01-μF, ceramic-disc
C5—0.01-μF, polyester
C6—100-μF, 16-WVDC, electrolytic
C7—0.1-μF, ceramic-disc
C8—1.0-μF, tantalum
C9—47-μF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

B1—9-volt alkaline battery
S1, S2—SPDT miniature toggle switch
Circuit-board materials, suitable enclosure, battery snap, spacers, IC sockets, control knob, hardware, wire, solder, etc.

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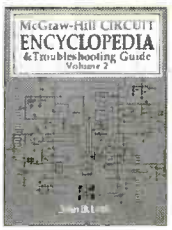

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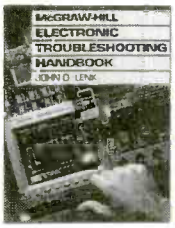

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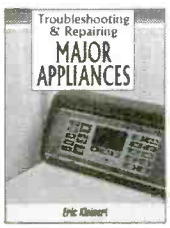

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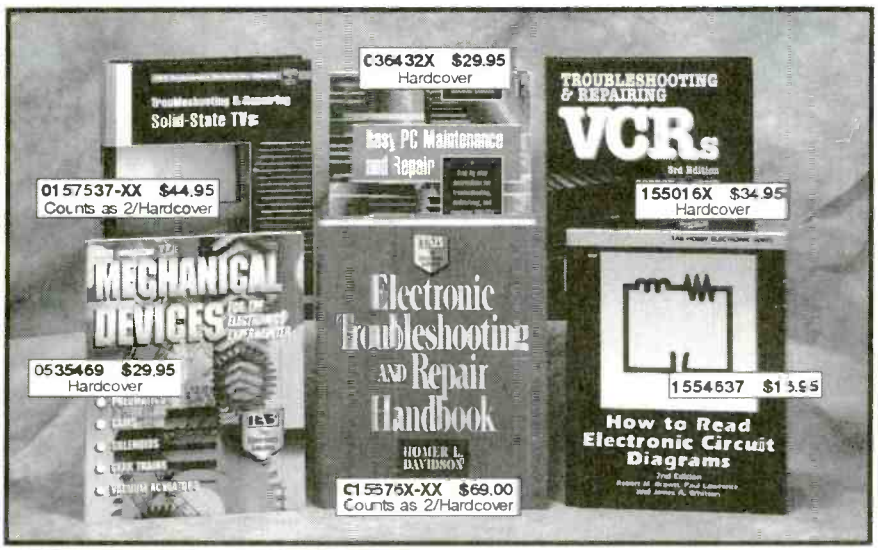

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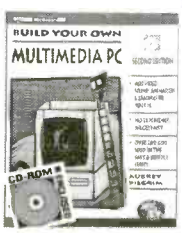

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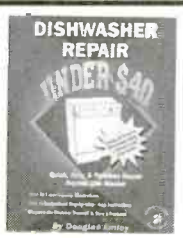

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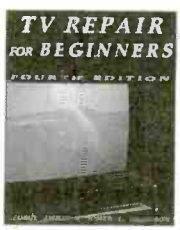

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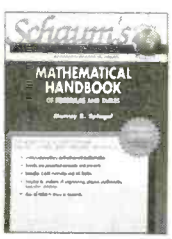

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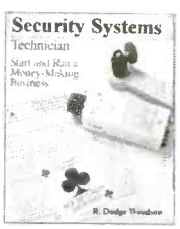

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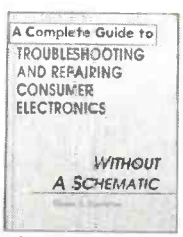

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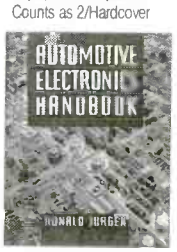

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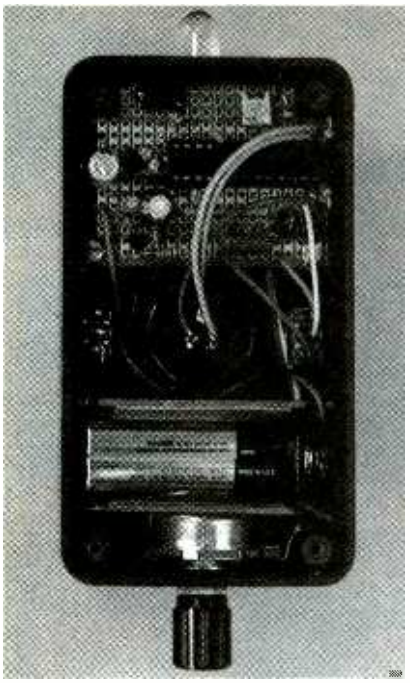

As you can see, the author's prototype was built on perforated board, although any assembly method can be used.

correct RPM rate. Watch for the change from the last single image to the double image. The former FPM rate should match the RPM rate of the motor, while the second FPM value should be exactly twice the actual RPM of the motor.

As with all strobes, the best results are obtained in a darkened room, with the unit just far enough away to cover the target area with the flash. That is of particular importance when using short flash durations (less intensity), which is what you should normally do for most stop-action photography.

The maximum-duration or brightest setting gives excellent results when doing RPM measurements, even in a normally lit area, as a slightly blurred image is of no consequence. Due to the natural divergence of the light beam from the LED, you can vary the area of light coverage just by altering the distance between the Stroboscope and target. ■

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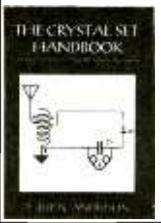

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UNLOCK-TOO

(Continued from page 40)

volts), gray (also to actuators) and blue (to the lock switch). Due to occasional production changes always verify pertinent wire functions with a test light or similar means.

The location of the relay in the vehicle varies from model to model. To identify the platform of your vehicle check the fourth digit of the vehicle identification number as seen through the left lower corner of the windshield. For vehicles with the letter N the relay is near the parking-brake control assembly. Remove the left-side lower hush panel for access. Vehicles with the letter W have the relay in the right-side electrical-center area behind the passenger-side, lower hush panel. Those vehicles with the letters J and A have the relay behind the glove box, to the right, and fastened to the inner body behind moisture-barrier tape.

Here are some tips on Chrysler vehicles: Most use two separate relays in a relay center located near the fuse block. Also, certain later models have computer-controlled lock systems. In vehicles like that, you'd have to add a small SPST relay to the Unlock-Too. Use the manufacturer's service publications for your model for exact details on where you can place the contacts. But no matter what vehicle you own, check with service publications for your model if there is any question on operation or parts placement.

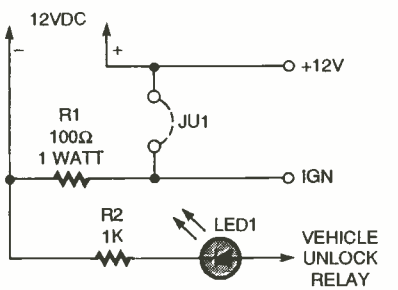

Fig. 4. This simple test circuit will help you determine if your Unlock-Too circuit is working, before you install it.

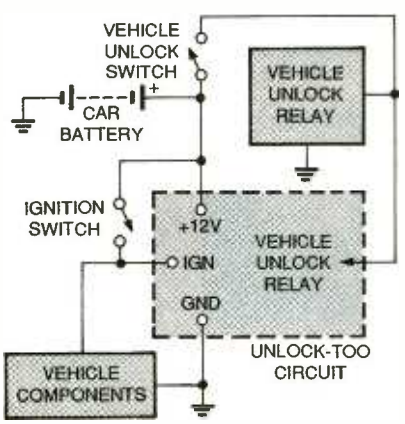

Fig. 5. Although all vehicle electrical systems differ, this connection diagram should help you figure out how to install the Unlock-Too. If you are uncertain about a connection, refer to your vehicle's service publications.

To make the connections shown in Fig. 5, you will need to make splices. That is, instead of cutting the wires in the vehicle's electrical system, simply peel back some of the insulation, attach the appropriate Unlock-Too lead, solder the connection, and insulate it with electrical tape. Another way to make the connections is to use 3M Blue Scotch Lock connector splices. When making the splices, keep in mind that open-circle and arrow connection points shown inside the dashed box in Fig. 5 correspond to the matching points on the circuit board.

Once you've made all the connections as shown, test the installation by turning on the ignition. Manually cycle the door locks with the vehicle switches making sure the last operation locks the doors. Next, turn off the ignition. The doors should automatically unlock. If any operation is incorrect, check that wire splices are secure and properly placed. After you are sure that the Unlock-Too is operating correctly, tape the unit in place to a harness. ■

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Timing is Everything

CHARLES D. RAKES

Time. That's what we're about this visit.

A young ham friend came by the other day and wanted a simple delay timer circuit for one of his top-secret projects. Knowing Jack (not his real name) from his past fiascoes, and not wanting to be directly involved in his ongoing project, I offered him the following timer circuits to choose from. The same offer holds for you, fellow circuiteers. I hope one or more of these circuits might be useful to you too.

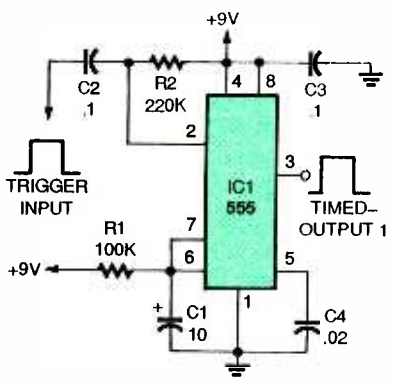

Fig. 1. This simple timer is based on a 555, which is the most well-known IC suitable for this application.

PARTS LIST FOR THE SIMPLE 555 TIMER (Fig. 1)

CAPACITORS
C1—10-µF, 35-WVDC, electrolytic
C2, C3—0.1-µF, ceramic-disc
C4—0.02-µF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS
IC1—555 timer, integrated circuit
R1—100,000-ohm, 1/4-watt, 5% resistor
R2—220,000-ohm, 1/4-watt, 5% resistor
Power source, wire, solder, etc.

SIMPLE 555 TIMER

Because Jack had not been exposed to many timer circuits, I wanted to start him out with the all-time wonder chip, the 555, and let him chew on it first. Mainly because there's so much available information on this IC, I figured it could keep him out of trouble and busy for days just looking for the perfect circuit arrangement.

This simple 555 timer, shown in Fig. 1, is a negative-triggered, timed-on circuit. The values of R1 and C1 determine the on-time period, which can vary from a few microseconds to over an hour. The output of the 555 (pin 3 of IC1) during the on-time period is high and will source up to 200 mA.

To lengthen the on-time period, either or both C1 and R1 can be increased in value. For long time periods when large capacitor values are used, the timing capacitor must be of high quality with minimum internal leakage.

Two or more timer circuits may be cascaded in series for extended time on operation. Just connect the output of the first timer (pin 3) to the trigger input of the second timer circuit, and repeat for each additional stage.

DUAL TIMER

If one 555 is so useful, then why not two in the same package? That same question must have come to IC manufacturers, as they came out with the 556, which is a dual 555 in one 14-pin package.

The dual timer shown in Fig. 2 uses the 556 (IC1) in a cascade timer circuit. The first timing period is set by the values of R1 and C5, and the second timing period by R4 and C6.

The first timer is set for a short timing period of about 1 second, and the second timer for a period of about 10 seconds. When the first section times out, the output at pin 5 goes low, triggering the second section on for its preset on-time. Varying the timing of each section is as simple as replacing R1 and R4 with 1-megohm potentiometers.

The timer's output may be used to drive relays and lamps with operating currents up to 200 mA. Both 555 and 556 timers can be used to sink current up to 200 mA when a timer circuit is at rest or in the timed-out mode.

CMOS CASCADE TIMER

Our next timer, see Fig. 3, uses a CMOS dual retriggerable monostable IC, the 4528, in a cascade timer circuit. Timing-components R3 and C1 set the on-time period of the first timer section (IC1-a), and R4 and C2 perform the same function in the second timer section (IC1-b).

Here's how the circuit operates: Momentarily pressing S1 triggers the

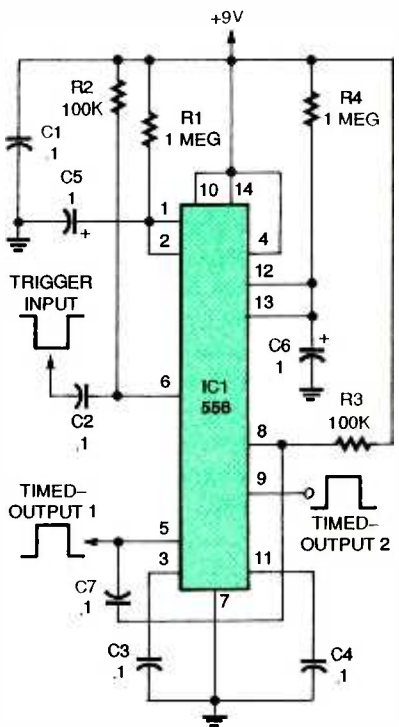

Fig. 2. Two are sometimes better than one. This dual timer contains a 556 IC, which contains two 555 timers in one package.

PARTS LIST FOR THE DUAL TIMER (Fig. 2)

IC1—556 dual timer, integrated circuit
R1, R4—1-megohm, 1/4-watt, 5% resistor
R2, R3—100,000-ohm, 1/4-watt, 5% resistor
C1-C4, C7—0.1-µF, ceramic-disc capacitor
C5, C6—1.0-µF, 35-WVDC, electrolytic capacitor
Power source, wire, solder, etc.

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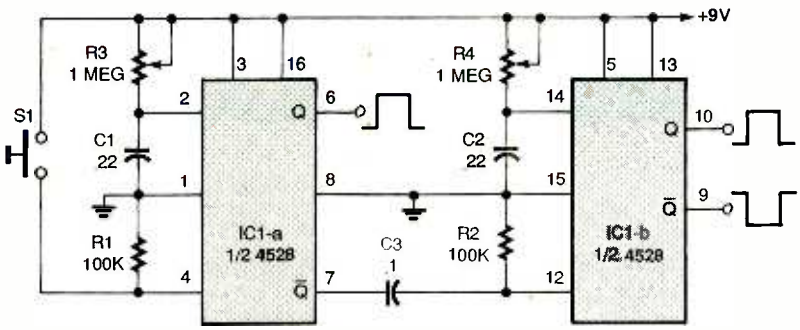

Fig. 3. The CMOS timer shown here can easily be cascaded with other similar 4528 circuits.

PARTS LIST FOR THE CMOS CASCADE TIMER (Fig. 3)

IC1—4528 dual retriggerable monostable, integrated circuit
R1, R2—100,000-ohm, 1/4-watt, 5% resistor
R3, R4—1-megohm, 1/4-watt, 5% resistor
C1, C2—0.22-μF, Mylar or similar capacitor
C3—0.1-μF, ceramic-disc capacitor
S1—Normally open pushbutton switch
Power source, wire, solder, etc.

first section, causing the output at pin 6 to go high and the output at pin 7 to go low for the preset time period. When the timer cycles out, the output at pin 7 goes back high, positive-triggering the second timer section at pin 12. During the second timing period, the output at pin 10 goes high and the output at pin 9 goes low, completing the dual timing cycle.

Additional 4528s may be cascaded in series to lengthen the overall timing cycle. Pins 6 and 7 may be tied together through 1N914 diodes to add the two output times. Connect the anode of one diode to pin 6 and the anode of the other diode to pin 7, and connect the diodes' cathodes together for the total time output.

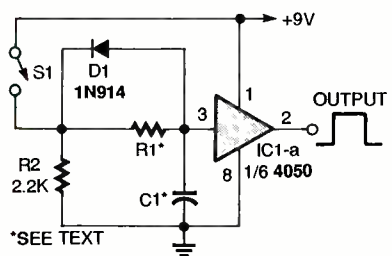

Fig. 4. Want a simple timer at practically no cost? Depending on what parts you have on hand, you can build this circuit for less than a dollar.

PARTS LIST FOR THE CHEAPIE TIMER (Fig. 4)

IC1—4050 hex buffer, integrated circuit
D1—1N914 silicon diode
R1—1/4-watt, 5% resistor, see text
R2—2200-ohm, 1/4-watt, 5% resistor
C1—See text
S1—SPST switch

CHEAPIE TIMER

Now that we got the conventional timing circuits out of the way, let's take a look at something a little different in timer-circuit design. The basic timer circuit shown in Fig. 4 consists of one section of a low-cost 4050 hex noninverting buffer IC, two resistors, a capacitor, and one diode. Depending on what parts you have on hand, you should be able to build it for less than a dollar.

The circuit operates like this: When S1 is closed, C1 begins to charge through R1 toward the 9-volt supply. When the voltage at the input of the buffer, pin 3, reaches about 70% of the supply voltage, the output switches high for an on-time delay function. As long as S1 remains closed, the circuit will maintain the high output at pin 2. Opening S1 resets the timer by allowing C1 to discharge through D1 and R2.

The timing-component values of R1 and C1 may be selected for almost any time-delay requirement. Because an RC time constant of 63.2% is very close to the 70% switching voltage of the 4050 buffer, we can use the standard RC time constant in determining the values of R1 and C1.

Multiply resistance in megohms and capacitance in μF for the RC timing value. A 1-megohm resistor and a 1-μF capacitor gives an RC timing value of 1 second. If a 10-megohm resistor and a 0.1-μF capacitor are used, the RC timing would also be 1 second. If the capacitor is increased to 10 μF and the resistor to 10 megohms, the timing period would be 100 seconds. For variable timing, replace R1 with a potentiometer and select the value of C1 for the timing range.

EXPANDED TIMER

Now, on to the expanded timing circuit shown in Fig. 5. There, three buffer stages are cascaded in series to increase the total on delay-timing period. Two additional timing circuits, like the one shown in Fig. 4, are connected in series, with the output of the first connecting to the input of the second and the third in a like manner. Each stage may have its own on delay-timing period, and can furnish a positive switched output to an external circuit. In this case an LED is connected to each of the timer's outputs as a status indicator.

The expanded timer only uses three of the six buffers in the 4050. If

continued on page 60

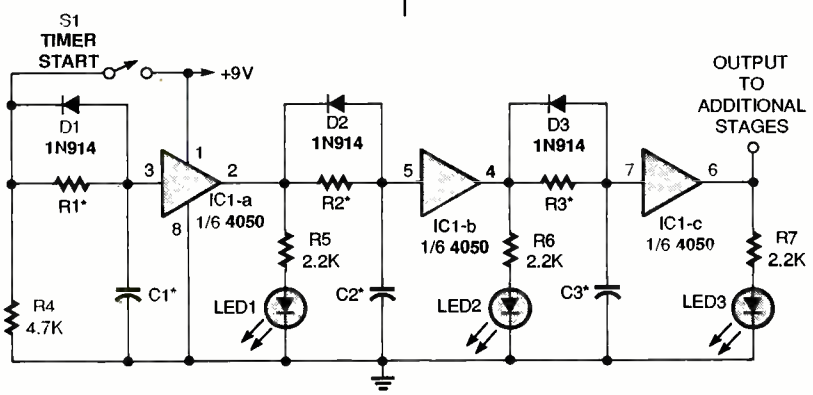

Fig. 5. This circuit is essentially three buffer stages, each similar to the one shown in Fig. 4, that are cascaded in series.

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SCANNER SCENE

Monitoring Mickey Mouse

BY MARC SAXON

Pity the scanner owner who, in search of the best, buys an expensive, advanced-technology scanner—even though his monitoring style doesn't require its overkill of fancy operating features. RadioShack to the rescue! Their PRO-2039 is a really good desktop scanner for the action-band adventurer who wants performance, but without paying for sophisticated features that probably will never be put to use.

The rig offers 200 memory channels arranged in ten banks of 20 each. There are another ten "scratch-pad" monitor memories for temporary storage of new frequencies discovered during searching excursions.

Frequency coverage is 30 to 54 MHz, 137 to 174 MHz, 380 to 512 MHz, and 806 to 960 MHz, plus the 108 to 137-MHz VHF aeronautics band. The two cellular bands are locked out at the factory and cannot be user-restored. The PRO-2039 can be switched to scan at either of two speeds: 8 or 24 channels per second. Similarly, it can search at either 8 steps per second or 50 steps per second.

Standard amenities include a priority channel, two-second delay, lockouts, an LCD readout, and a full hour of memory backup under power-loss conditions.

The IF frequencies are 10.7 MHz and 455 kHz. Selectivity at ±10 kHz is –6 dB, and at ±20 kHz, it's –50 dB. Sensitivity is 0.5 μV below 50 MHz, 1.0 μV between 137 and 512 MHz, and 2.0 μV on the VHF aeronautics and 800-MHz bands.

You can ogle the smart-looking PRO-2039 at any of RadioShack's 7000 retail outlets.

TAKE ME ALONG!

It's great to visit those spectacular Central Florida tourist attractions. Readers tell us that they are bringing along handheld scanners so they can enjoy the behind-the-scenes action while they spend their money—or while waiting on those long lines. That sounds reasonable enough, although it is possible that the use of handheld scanners is not permitted everywhere. Those attractions are private property, and they do have the right to ask you not to bring in a scanner. If they don't allow scanners, you can always chance it anyway, or just listen from your motel room.

For the many readers who asked about frequencies at Universal Studios, try these: 451.75, 461.125, 461.2875, 461.7125, 461.8875, 462.0125, 462.1125, 463.3875, 463.5875, 463.6125, 463.6375, and 463.6625 MHz.

Some of the better frequencies at and around Walt Disney World are believed to be: 464.125 and 464.40 MHz for security; 461.30 MHz for parades; 461.60 for Fort Wilderness; 462.625 MHz for the Magic Kingdom; 462.55 for the Monorail; 464.20 MHz for the resort; 462.65 for EPCOT; and 151.895 for 20,000 Leagues. The Hilton at Disney World is on 461.6875, 461.7125, 463.8125, 464.525, and 469.9375 MHz. The Walt Disney World Dolphin Hotel uses 464.525, 464.675, and 464.825 MHz.

Nickelodeon Studios uses 462.10, 464.0625, and 468.4625 MHz.

Sea World has communications on many channels, including 151.775, 151.805, 461.10, 461.675, 461.775, 461.85, 462.00, 463.325, 463.5625, 463.675, 463.825, 463.9125, 463.95, 464.0375, 464.0875, 464.10, 464.2125, 464.2875, 464.3375, 464.3875, and 464.4375 MHz.

At Cypress Gardens, monitor 464.375 and 464.875 MHz.

Busch Gardens uses 154.54, 154.57, 461.7125, 461.775, 462.0875, and 464.30 MHz.

Placing a scanner into search mode will surely root out many additional channels at each of those facilities, and should also produce frequencies used at attractions not listed here.

That should be enough frequencies to keep any dedicated scanner owner sufficiently dazzled to the point where the rides, parades, attractions, shops, crowds, and everything else blur into one large, annoying distraction.

RadioShack's PRO-2039 is a good choice for those who don't need cost-adding, advanced-operating features.

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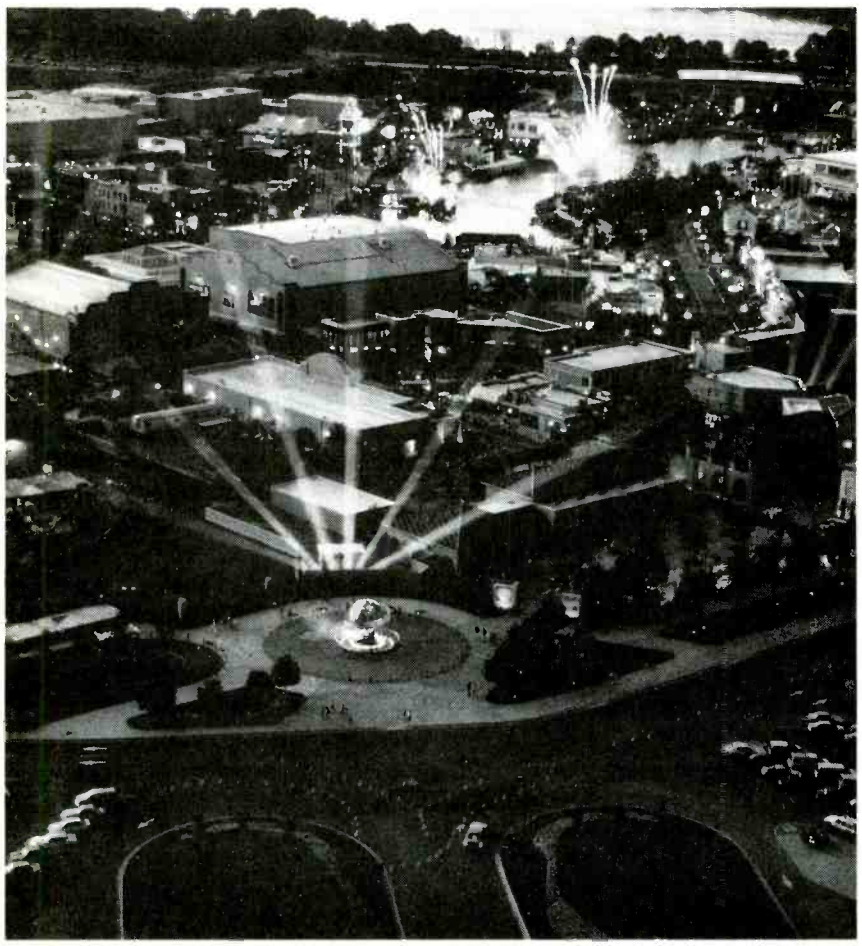
READERS WRITE

We received a postcard from Vince in Atlanta, Georgia, mentioning that as hurricanes threaten, there are National Weather Service-related communications noted on 165.995 MHz. That would be a worthwhile frequency to check out in other areas of the nation as well, insofar as it relates to that agency's communications during extreme weather conditions. Let us know if you pick up any activity.



Universal Studios Florida is a beehive of UHF communications.

Jess, in Broome County, New York, reports that when he got a speeding ticket, he also got a summons for having a mobile scanner. The cop told him that the mobile scanner was against the law. He wonders what that's all about, as he has had a mobile scanner for years and never before had a problem.

In New York, and in a number of other states, it is a violation of the vehicle and traffic laws to equip vehicles with receivers that can tune police frequencies. Licensed amateur-radio operators, reporters, and off-duty police officers are possible exceptions to such restrictions in specific states. It might be possible for others to secure special permits from the police to allow scanner installations.

Those laws seem to have originally been efforts to stop tow trucks, lawyers, and private ambulances from showing up at accident scenes. Certainly, hobbyists with mobile scanners would qualify for a summons where there is a law on the books banning them. A police friend advises (confidentially) that the extent to which that type of traffic law is enforced depends on the individual situation and the officer involved more than any other factor.

If there's a handheld in the car does that mean that the vehicle is "equipped" with a receiver? Is a scanner in violation of mobile laws even if it isn't programmed with police channels, or if all programmed police channels are locked out? For those who choose to have scanners in vehicles where such laws exist, opinions about these gray-area questions can be supplied only by the police officer who questions your use of a scanner.

Before using any type of scanner in a vehicle, it would be wise to find out if there are any laws regulating or restricting such use. Then, be guided accordingly.

KEEP IN TOUCH

That's all for this month. Please feel free to pass along news of frequencies to share with other hobbyists, or ask any scanner-related questions. We would like to hear your suggestions and opinions, too. Your continuing participation is appreciated and keeps us tops! Write to *Scanner Scene*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

CIRCUIT CIRCUS

(continued from page 58)

you wish, the three remaining buffers can be used for additional timing stages and cascaded with the three shown. Yes, you can add as many 4050 chips and as many cascaded stages that room allows. If you do not modify the circuit, and only use the three sections of the 4050 as shown, tie all of the other inputs to circuit ground.

Well, the clock on the wall says we're out of time for this visit. See you here next month. ■

PARTS LIST FOR THE EXPANDED TIMER (Fig. 5)

SEMICONDUCTORS
IC1—4050 hex buffer, integrated circuit
D1-D3—1N914 silicon diode
LED1-LED3—Light-emitting diode, any color

RESISTORS
(All fixed resistors are 1/4-watt, 5% units.)
R1, R2, R3—See text
R4—4700-ohm
R5-R7—2200-ohm

ADDITIONAL PARTS AND MATERIALS
C1-C3—See text
S1—SPST switch
Power source, wire, solder, etc.

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DX LISTENING

Exploring the Information Highway

BY DON JENSEN

More and more SWLs are exploring the Information Highway. If you haven't yet found the on-ramp, maybe now is the time. For shortwave listeners, there's a world of information on-line.

You can find the latest station schedules. There are reviews and equipment news, as well as individual and dealer advertisements for new and used receivers and accessories. Send your reception reports directly to the stations' e-mail addresses. Or just share your views and listening tips with other world-band radio enthusiasts.

You can, of course, use your usual search engines to lead you to shortwave related newsgroups and web sites. Or you can, as I often do, take a shortcut directly to *Pete Costello's Radio Catalog* (http://itre.ncsu.edu/radio/) which has user friendly links to just about any SW source you could want or need.

Says Costello: "These pages are an expanding set of World Wide Web links to documents, web servers, ftp and gopher sites, telnet services, audio files, pictures, graphics, schedules, software and interactive on-line programs.

"The catalog of hypermedia links is split into a set of web pages covering Radio Services; Shortwave Radio Topics, including Medium Wave and FM broadcasting; and Satellite Radio."

Veteran DXer Jerry Berg, Lexington, MA, who first introduced me to what he calls The Mother of all Radio Sites, says, "It is well organized, but it would take you a very long time to actually follow all the links in this thing!"

A little poking around revealed that to be no exaggeration. There's no practical way to introduce you to more than a fraction of what is there. Here are a few links through the Radio Catalog:

What time zone is it in... You can get local date and time for any time zone, UTC/GMT, or the time of day in many other world locations.

What's on shortwave right now... Paul Dwerryhouse of Melbourne, Australia, has linked his shortwave broadcast database to generate a listing of what is on shortwave from his vantage point. An excellent reference.

You can control and listen to a top-of-the-line Drake R8 receiver live over the Internet. From Reston, VA, Jeff Chilton provides a unique service to the SWL community. You can enter the frequency, mode and other SW radio settings, then listen to what his receiver is picking up.

Need help in identifying what lingo you're hearing on SW? Then try *Simon Colling's Foreign Language Recognition* page.

For 36 years, *Radio Nederland* has been offering free pamphlets and data sheets to help listeners get started in the hobby. Now many of these free publications are available on-line. You can link to it through the Radio Catalog, or go directly to Radio Nederland's web site (http://www.rnw.nl/).

Here are some other international broadcaster web sites:

British Broadcasting Corp. World Service
(http://www.bbcnc.org.uk/worldservice/)

Voice of America
(gopher://gopher.voa.gov/)

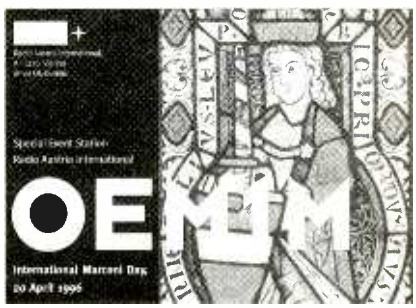
Radio Sweden
(http://www.sr.se/rs/)

Radio Australia
(http://www.abc.net.au/ra/)

Radio Japan
(http://www.nhk.or.jp/rjnet/)

Want a complete listing of U.S. and Canadian medium wave stations? You can download Werner Funkenhauser's AM Station Databases, all in .ZIP format.

You can link up with shortwave listening clubs worldwide; among them the North American SW Association, Danish Shortwave Clubs International, Benelux DX Hotline, Finnish DX Association and the Canadian French language Club d'Ondes Courtes du Quebec.



Radio Austria International issued this special QSL card to those SWLs who tuned its Marconi Day broadcast last April.

Available too through Costello's Radio Catalog are Chase Cotton's monthly shortwave program schedules for a number of the major international broadcasters, and Dwerryhouse's time-sorted list of English language programs. Manuel Rodriguez Lanza offers information on tuning the Latin American stations on the tropical shortwave bands.

MORE NET NOTES

Ralph Brandi, who maintains the North American SW Association's own web site(http://www.mcs.com/~ralph/html/naswa/) suggested more sources for the shortwave listener in a recent issue of that club's print Journal and at an SWL Fest gathering at Kulpsville, PA:

Along with Costello's Radio Catalog, says Brandi, Thorsten Koch's Internet Guide to Broadcasters (http://www.informatik.unioldenberg.de/~thkoch/)
is one of the first places to look.

Newsgroups? Try rec.radio.short-

CREDITS — Jerry Berg, MA; Ralph Brandi, NJ; Jim Clar, NY; Bob Fraser, MA; Marv Kaminsky, NJ; Richard Lemke, ALTA, Canada; Mark Mohrmann, NJ; Ed Newbury, NE; Denis Pasquale, PA; North American SW Association, 45 Wildflower Road, Levittown PA 19057.

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wave and rec.radio.info.

Mailing Lists? To get on board SWL-L, send the message "HELP" to listserv@cuvmb.cc.cuny.edu.

To subscribe to Hard-Core DX, send the message *(subscribe hard-core-dx)* in the body of an e-mail letter to majordomo@lists.kotanet.fi.

An excellent site for information from the Danish Shortwave Clubs International and the Swedish Shortwave Bulletin, plus other SW articles of interest is the Nordic Shortwave Center (http://sunweb.sds.se/org/swl/).

Medium wave enthusiasts should check out the National Radio Club page (http://alpha.wcoil.com/~gnbc/) and the Medium Wave Circle (http://www.cs.vu.nl/~gerben/mwc/).

HONORING MARCONI

In 1931, Guglielmo Marconi, the pioneer of wireless telegraphy, put the Vatican's first station on shortwave. To provide better reception throughout Europe, an experimental SW transmitter in Vienna, Austria, rebroadcast the Vatican's initial program.

That was the first shortwave relay broadcast in the history of radio. Today, such relay transmissions are commonplace.

Each year, both shortwave broadcast and amateur radio stations commemorate International Marconi Day. On April 20 this year, Radio Austria International and OEM1M, the special event ham radio station it sponsored, joined forces to honor the inventor.

Ham stations around the world were invited to register in advance for contacts with OEM1M. From this registration list, Radio Austria International's weekend DX program, "Shortwave Panorama" selected several ham stations and invited them to check in with OEM1M on a certain frequency. These QSO conversations were relayed by RAI to its shortwave audience worldwide.

The hams and SWLs tuned in to "Shortwave Panorama" that day were eligible to receive a special RAII/OEM1M QSL. That verification card is illustrated in this month's column.

If you want to tune in RAI's weekly DX program, at this writing it is aired to North America on Saturdays on 13,730 kHz at 1205 UTC, and on 9,655 kHz at 0005 UTC Sundays. (Remember that because Coordinated Universal Time or UTC is five hours ahead of Eastern Standard Time, the latter transmission is actually heard on Saturday evening in the U.S. and Canada.)

To keep current on RAI's broadcast hours and frequencies, you can write for a current schedule. The address is Radio Austria International, A-1136 Wien (Vienna), Austria. Or check its web site (http://www.ping.at /rai/).

DOWN THE DIAL

Here are some shortwave stations to tune for:

ALGERIA — 15,205 kHz, Radio Algiers International has English programs from 1800 UTC. It is heard with a newscast followed by U.S., European and African music.

ANGOLA — 9,535 kHz, Radio Nacional in Luanda is heard at 2000 UTC with a combination of English and Portuguese programming and music.

BRAZIL — 15,265 kHz, RadioBras has English programming at 1800 UTC. Listen for program host Alan Bennet with a mix of Brazilian songs and classical music.

HAWAII — 13,625 kHz, World Harvest Radio's SW outlet at Naaishu, Hawaii, KWHR is noted with religious programs and music from 1900 UTC.

ICELAND — 11,402 kHz, Iceland's NBS, broadcasting from the capital, Reykjavik, was heard from 1451 to 1455 UTC signoff. Programming was in the Icelandic language but mention of "Reykjavik" was noted.

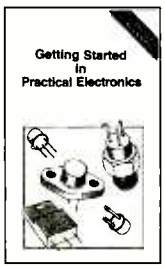
NEW ZEALAND — 11,900 kHz, Radio New Zealand International can be found here about 1400 UTC with a program of musical oldies, station identification and news.

NORWAY — 11,840 kHz, Radio Denmark is relayed on shortwave by Norwegian transmitters. This was heard at 1440 UTC with an English program called "Copenhagen: European City of Culture."

UKRAINE — 6,010 kHz, Radio Ukraine International operates on this frequency, in parallel with 6,130 kHz, at 2200 UTC. It was heard in English with an interview with the chief of the Ukrainian Writers' Union. ■

You can Build Gadgets!

Here are 3 reasons why!



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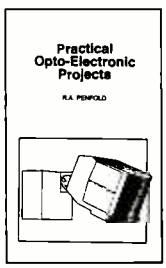
If you are looking into launching an exciting hobby activity, this text provides minimum essentials for the builder and 30 easy-to-build fun projects every experimenter should toy with. Printed-circuit board designs are included to give your project a professional appearance.



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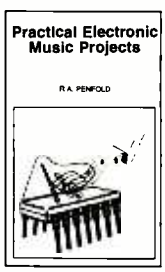
If you shun opto-electronic projects for lack of knowledge, this is the book for you. A bit of introductory theory comes first and then a number of practical projects which utilize a range of opto devices, from a filament bulb to modern infrared sensors and emitters—all are easy to build.



☐ **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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Antenna Topics

BY JOSEPH J. CARR, K4IPV

Antennas are always a popular topic because they are so important to successful radio operations. After all, even the best and highest-priced transmitter will not perform well without a good antenna. This month we'll look at a variety of antenna topics and move on to one exotic antenna—the Sterba curtain—that is great for the upper HF (say, above 10 MHz) or lower VHF regions, and easy to build. Above about 2-meters, other factors begin to become important and this kind of antenna loses its effectiveness.

ANTENNA GAIN

Antennas have a magical property called "gain." The gain of an antenna increases the apparent power level of the signal, during both reception and transmission. An antenna doesn't actually manufacture more RF power (which would violate the laws of physics), but instead refocuses the available power in a particular direction. The total amount of power remains constant, but the power density in any one direction is increased by the refocusing. That is also related to directivity, which is a measure of the refocusing.

There are two methods for specifying gain of an antenna. The first (and the one used most often by professional antenna engineers) is the isotropic gain. The second is the gain relative to a half-wavelength dipole.

Isotropic gain is a theoretical construction that treats the antenna as a radiating perfect sphere, and at some distance from the center of this infinitesimal sphere measures the power density. The total available RF power is distributed over the entire surface of the sphere, while the power density is measured in a small area (*i.e.* watts per centimeter squared).

Both types of gain are measured in decibels (dB), and are referred to as *dBi* for isotropic gain and *dBd* for gain over a dipole. Whenever the gain specification is not delineated dBi or dBd (*i.e.* when it is listed simply as dB), assume that dBi is meant. The difference is that dBd gain is 2.14 dB higher than dBi gain. For example, a beam antenna listed as having a gain of 6.94 dBi also has a gain of 4.8 dBd.

Antenna gain and directivity must also take other factors into account. Most people seem to think in terms of the polar or *azimuthal* pattern. That is the directional pattern as seen from above. But antennas radiate in three-dimensional space, so there is also an elevation aspect to the pattern.

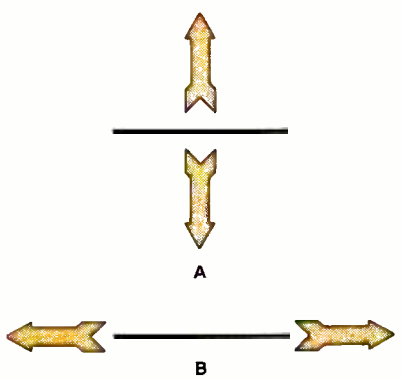

Fig. 1. A broadside array (A) sends its signal out on a line perpendicular to either the antenna element or the line of centers between the elements. An end-fire array sends its signal off the ends of the antenna element or array of elements (B).

It is common to take two slices, one elevation (vertical) and one azimuthal (horizontal), and use them to represent the entire antenna. The figure-eight dipole pattern is an example of an azimuthal pattern. The angle of radiation of the antenna is the angle of the main lobe in the elevation aspect of the radiation pattern (for long DX a low angle of radiation is desirable).

As long as those slices are truly representative, all is well. But professional antenna engineers usually take a number of envelope slices all around the compass and several azimuthal slices to totally characterize the antenna. For most of our purposes, however, a single pair of slices, one each from the vertical and horizontal aspects, is enough.

COAXIAL CHOKE

As with most antennas, the radiation pattern can be improved by reducing radiation and re-radiation from the feedline. To do that, make a 3- to 5-turn, 6- to 10-inch coil out of the coaxial cable, right at the connection to the balun transformer. This neat little coil can be taped or otherwise fastened to the balun or the center insulator, and should be used on most center-fed antennas.

END-FIRE VS. BROADSIDE ANTENNAS

Most gain antennas can be classified as either end-fire or broadside arrays. The difference is shown in Fig. 1. A broadside array (Fig. 1A) sends its signal out on a line perpendicular to either the antenna element (as in a half-wavelength horizontal dipole) or the line of centers between the elements (as in a pair of in-phase verticals, a half-wavelength apart).

An end-fire array, such as the W8JK antenna, sends its signal off the ends of the antenna element or array of elements (Fig. 1B). Some odd antennas are both end-fire and broadside, depending on the band they operate on (*i.e.* a single antenna operating on harmonically related bands).

VSWR AND IMPEDANCE MATCHING

One error that seems to be constant is that finding the lowest voltage standing-wave ratio (VSWR) means that the antenna is matched. The resonant point is indicated by the minimum point on the VSWR curve. But there is another issue. Before the antenna can be impedance matched to the coaxial cable (or other transmis-

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sion line) it must first have a feedpoint resistance that is equal to the transmission-line impedance. For example, our standard half-wavelength dipole has a feedpoint impedance of 73 ohms, so we feed it with 75-ohm coax and expect a VSWR of 75/73, or 1.03:1.

In reality, the feedpoint resistance of the dipole can be anything from a few ohms to 120 ohms, depending on its height above ground. If the actual impedance is 25 ohms, then the VSWR will be 75/25, or 3:1. However, a 3:1 VSWR will trip the automatic load control (ALC) of your transmitter so hard that a 100-watt transmitter will put out a mere 1 milliwatt!

If impedance matching and minimal VSWR is your goal, then the only—repeat only—suitable place for the antenna-tuning unit is between the far end of the transmission line and the feedpoint of the antenna. Impedance matching at the transmitter end of the transmission line does wonders for making the transmitter ALC think it's seeing a matched antenna, but the antenna is performing just as badly. ATUs used in that manner are called "line flatteners" and only fool the system into thinking it's working properly.

Another old saw that needs to be addressed is the matter of transmission-line length and VSWR. Many people attempt to reduce VSWR by changing line length. It doesn't work! I don't care what your meter makes you think is happening. In fact, professional radio technicians tell whether they are measuring true VSWR or merely getting a measurement artifact by adding about 1/8- to 1/4-wavelength (actual length not important) of transmission line to the existing line. If the VSWR reading changes, you are not measuring the real VSWR. If the VSWR does not change (or changes only a little to account for line losses), you are measuring the real VSWR.

The trick to making the antenna as perfect as any practical antenna can be is to match the impedance at the antenna end of the feedline. Length is irrelevant.

Well, the length is irrelevant unless you want to accurately measure the feedpoint impedance without climbing up on the antenna and teetering precariously on a ladder (and adversely affecting the measurement!). The impedance on the end of a transmission line (e.g. the antenna feedpoint impedance) repeats every half wavelength. So if the antenna-line length is an integer multiple of the half-wavelength, then the measurement can be made at the transmitter end.

The correct physical length to make an electrical half-wavelength is the half-wavelength multiplied by the velocity factor of the line, or

$$L = 492V/f\text{MHz}$$

where L is the length in feet, V is 0.66 for polyethylene dielectric coax and 0.80 for polyfoam coax, and *f*MHz is the frequency in megahertz.

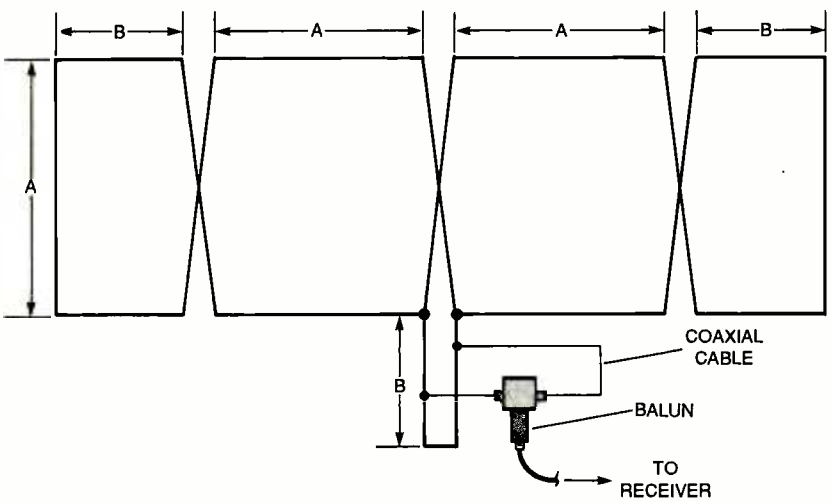

Fig. 2. A Sterba curtain array, shown here, uses only three loops, and is fed in the center by a balun and coaxial cable. Note the matching A and B lengths in the assembly.

SHORT STERBA CURTAIN

The Sterba curtain array is a well-known antenna in the shortwave-broadcasting world. It consists of a number of half-wave dipoles in an array that transmits broadside to the plane of the dipoles. Although shortwave broadcasters use huge Sterba curtain arrays, amateur-radio hams can make relatively simple Sterbas using only a few elements (as shown in Fig. 2).

The Sterba curtain array, which is one of three antennas usually called *Six-Shooters*, uses only three loops, and is fed in the center by a balun and coaxial cable. It provides about 4.8 dBi of gain and is bi-directional (the polar pattern is a figure-eight like a dipole, but more compressed). Other Sterba curtain arrays are end fed at either a corner of the squares or in the middle of the side of an end-square. Those arrangements are often fed with 600-ohm parallel open feeders. If the feeders are tuned, rather than matched, then the antenna will work on harmonically related bands, especially those of higher frequency than the band it is cut for.

KEEP IN TOUCH

That's all for this month. I can be reached three ways. Write to me care of the editors, or direct at P.O. Box 1099, Falls Church, VA 22041. Or, send me an e-mail at carrjj@aol.com. I tend to answer the e-mail when I get them, but it may take a few weeks to answer snail mail. ■

"Why don't you just blow one more fuse and come to bed?"

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Think Tank

Looking Back

BY JOHN YACONO
TECHNICAL EDITOR
WINDOWS MAGAZINE

This month, we've got some letters that provide or request help on circuits from past issues. We'll get to them after I present some more facts on our current topic: electromagnetism.

As I pointed out last month, current flowing through a wire generates a magnetic field. To help visualize a field, we normally draw lines with arrow heads around the object that generates it. For example, to indicate the electric field generated by a charged particle or object, we draw arrows coming out of the object if it's positive (see Fig. 1A), or into it if it's negative (see Fig. 1B). The arrows represent the direction a positive particle would tend to travel under the influence of the electric field. Another way to say it is the arrows point in the direction the force of attraction or repulsion would drive a positive particle, so the lines are sometimes called "electric lines of force." Also, the closer adjacent lines are, the stronger the electric field.

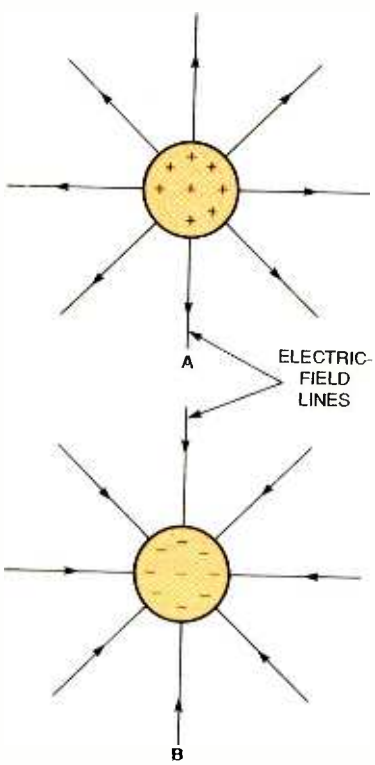

Fig. 1. To indicate the electric field generated by a charged particle or object, arrows are shown coming out of the object if it's positive (A), or into it if it's negative (B).

Magnetic-field lines are drawn quite differently. They are drawn perpendicular to the force of attraction or repulsion. They are also perpendicular to the current flow that generates them. However, just like lines of electric force, the more dense the lines, the stronger the magnetic field. Figure 2 illustrates the concept. There, the electrons flow in a straight line, producing a cylindrical magnetic field around the wire.

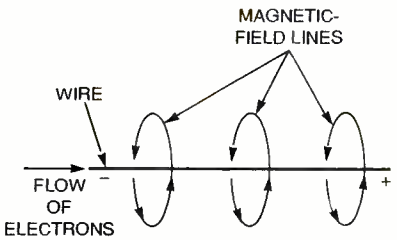

Fig. 2. Magnetic-field lines are perpendicular to the current flow that generates them.

Now, imagine slowly bending the wire from a straight line to form a loop or circle. What would the magnetic-field lines look like? They'd look something like those in Fig. 3. Note how the magnetic-field lines harmoniously converge at the center—they all point in the same direction. That means we can continue adding turns to this primitive component; each turn will increase its magnetic field strength. This assembly is called a coil or inductor, and it exhibits a field like that illustrated in Fig. 4A. The simple coil is called an "air-filled inductor" because there's only air in the center or core.

As with capacitors, the space within a coil can be filled with various substances—called "core" materials or "coil forms"—to enhance the properties of the inductor (see Fig. 4B). Core materials concentrate the magnetic field lines, allowing designers to build what would otherwise be a large inductor in a small space.

Another trick is to wind a coil in multiple layers. In other words, once you've wound enough turns of wire to completely cover a form, you can continue adding more turns on top of the windings touching the form. That might not seem right because the second set of turns winds its way back toward the beginning of the first set of windings, but what's important is that the windings share the same rotation (clockwise or counter-clockwise) around the form, not the direction in moving from end-to-end on the form.

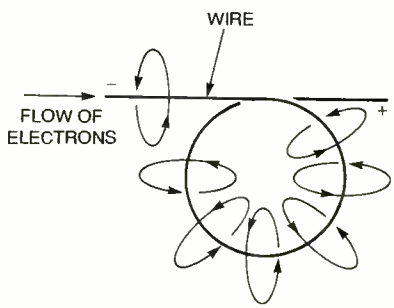

Fig. 3. In a loop of wire with current flowing through it, magnetic-field lines converge at the center and all point in the same direction.

You can prove all these things to yourself by wrapping 100 or so sloppy turns of insulated wire around an iron nail of some sort. Connect the ends of the wire to three or four D cells connected in series. The coil then attracts bits of iron (like filings or metal paper clips) just like a plain magnet. Note how the iron nail seems to be the most magnetic part of the assembly. If you can remove the nail, note that the coil still attracts objects, but in a less-powerful way.

That's enough to digest for now. Let's get to the letters.

ALARM MAKEOVER

Having built the alarm circuit by Gorden Reeder featured in *Think Tank*, April 1991, I have experienced many false alarms due mainly to re-

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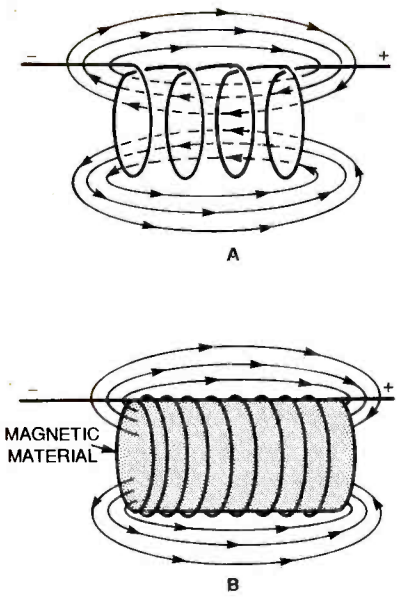

Fig. 4. Several loops or turns in a row make a coil (A); each turn increases the magnetic field strength. Another way to increase the strength of the field is to add a magnetic-material core (B).

boots after intermittent power outages and/or surges on the AC power lines. I decided to see if it would be possible to overcome the problems and add a few features.

My first priority was to use parts readily available and reasonable in cost. The parts I used are in stock at RadioShack, Hosfelt Electronics (2700 Sunset Blvd., Steubenville, OH 43952; Tel. 800-524-6464), and other suppliers.

To hold DC voltages constant I used a 12-volt-DC, 500-mA, wall transformer that floats to 17-volts DC with no load. The transformer's output is regulated by a 7812 regulator and a couple of electrolytic capacitors in my circuit (see Fig. 5). The false alarms were prevented by adding a 1000-ohm resistor (R12) in series with C2, the entry-timing capacitor.

The following are other changes and additions I made: The output from pin 4 of IC1-d was used to drive a 2N3904 transistor (Q1), which inverts the positive-going signal from the IC. The negative signal at the collector of Q1 is coupled through a 0.22-µF capacitor to the trigger (pin 2) of 555-timer IC2. The purpose of IC2 is to control the length of the relay's on-time when power is fed to the siren. With the values shown, that is adjustable (using R3) from three seconds to four minutes. For those who wish to have the siren on continuously, simply use switch S2 to short out capacitor C4. Now the siren can only be stopped by flipping S1 to the "safe" position.

Components C3 and R17 prevent IC2 from coming on during power-up; LED3 was left in to verify relay operation as I was developing the circuit. From the relay output contacts I used an SPDT switch, S3, to select between the external siren or a chassis-mounted 12-volt piezo-buzzer, BZ1, used for neighbor-friendly verification. I also included a panic switch, S12, which

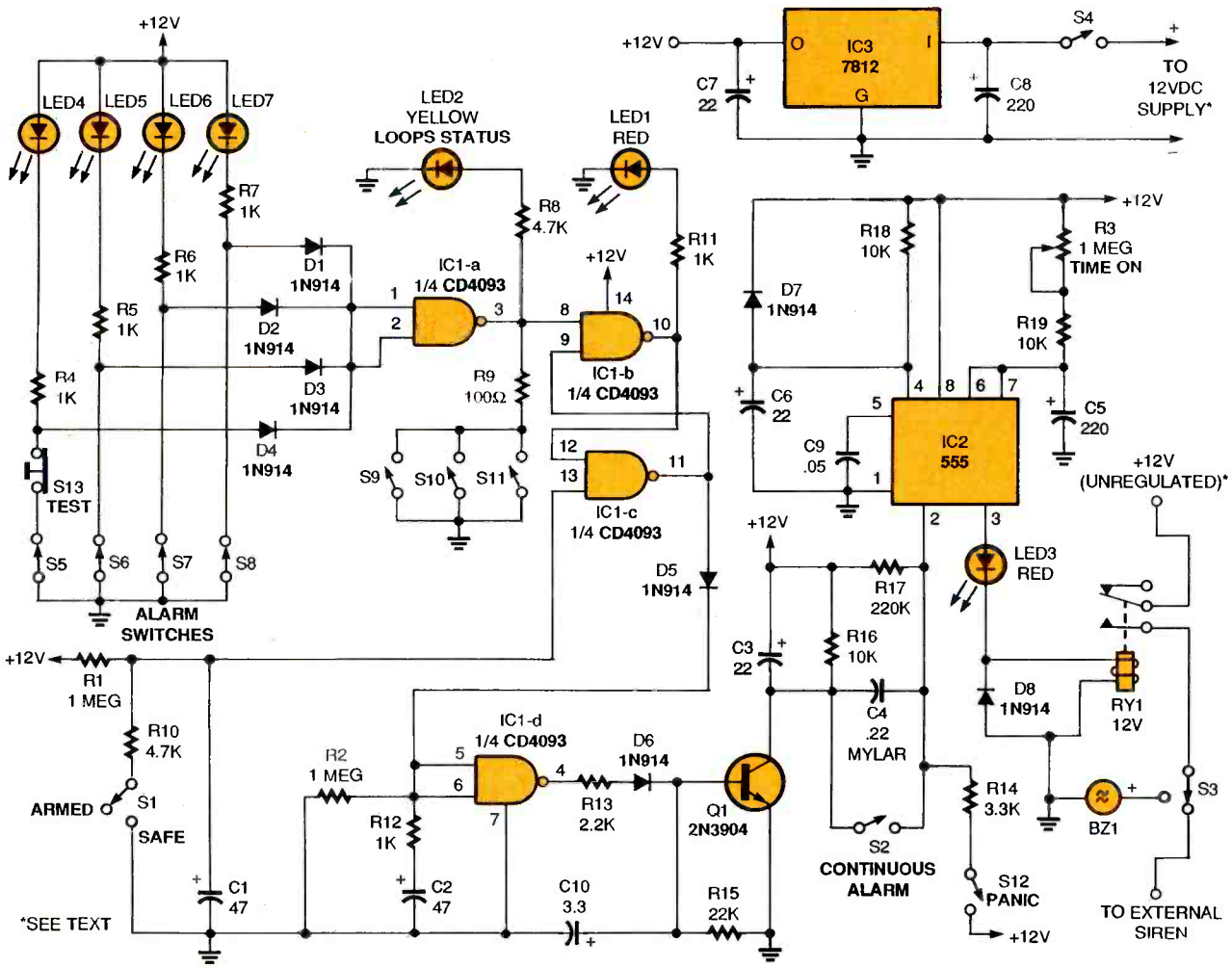

Fig. 5. This alarm circuit contains some excellent features, including a panic switch and adjustable siren.

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activates IC2 when S1 is in the "safe" position. It will immediately turn the siren on.

A red, blinking LED, LED1, was added as a visual indication that the circuit needs to be reset (by switching S1 to safe). I used four, normally closed, trip switches. If you wish, you can add more. Each has a status indicator. The first normally closed loop is broken by a normally closed test switch on the chassis for testing.

Be sure to run 12 volts from the unregulated wall supply to the relay contacts that power the siren voltage. The wall transformer should be sized to handle the current demand of the siren you use.

To operate the alarm, switch S1 from "safe" to "armed" when leaving the premises. You will then have less than 30 seconds to close any alarmed doors. On entering, you will have up to 30 seconds to switch S1 to the "safe" position. When on the premises, move S1 to the "safe" position to enable the panic switch.

I built the circuit using sockets for IC1 and IC2, and mounted it on a RadioShack No. 276-168 board. Hosfelt has magnetic alarm switches (No. 51-351) and for the relay I used, a 12-volt unit with a 720-ohm coil (No. 45-346).

What I ended up with is an alarm that features readily available parts, loop-status indicators, 30-second exit and entry times, a panic switch, adjustable siren, and no false alarms on AC power interruptions.

Many thanks.

—Roger W. Hamel, Cedarville, MI

Wow, you took a simple circuit pretty far!. This column is really bringing back memories for me: The April 1991 column, for those that don't recall, was my first one. It's also where I mentioned the MCL1010 chip that we currently give away as a premium.

CONTESTANT-LOCK-OUT IMPROVEMENTS

After one of my students assembled the "Contestant Lock-Out Circuit" published in the December 1995 *Think Tank*, we experienced two problems: If two switches were activated almost at the same time, no LED would come on, yet there was sound. Also, when an LED was on for a few seconds, a second contestant could re-trigger the circuit.

The solution was to change the value of R10 through R17 from 330 ohms to 100,000 ohms (see Fig. 6). That eliminated both problems. The

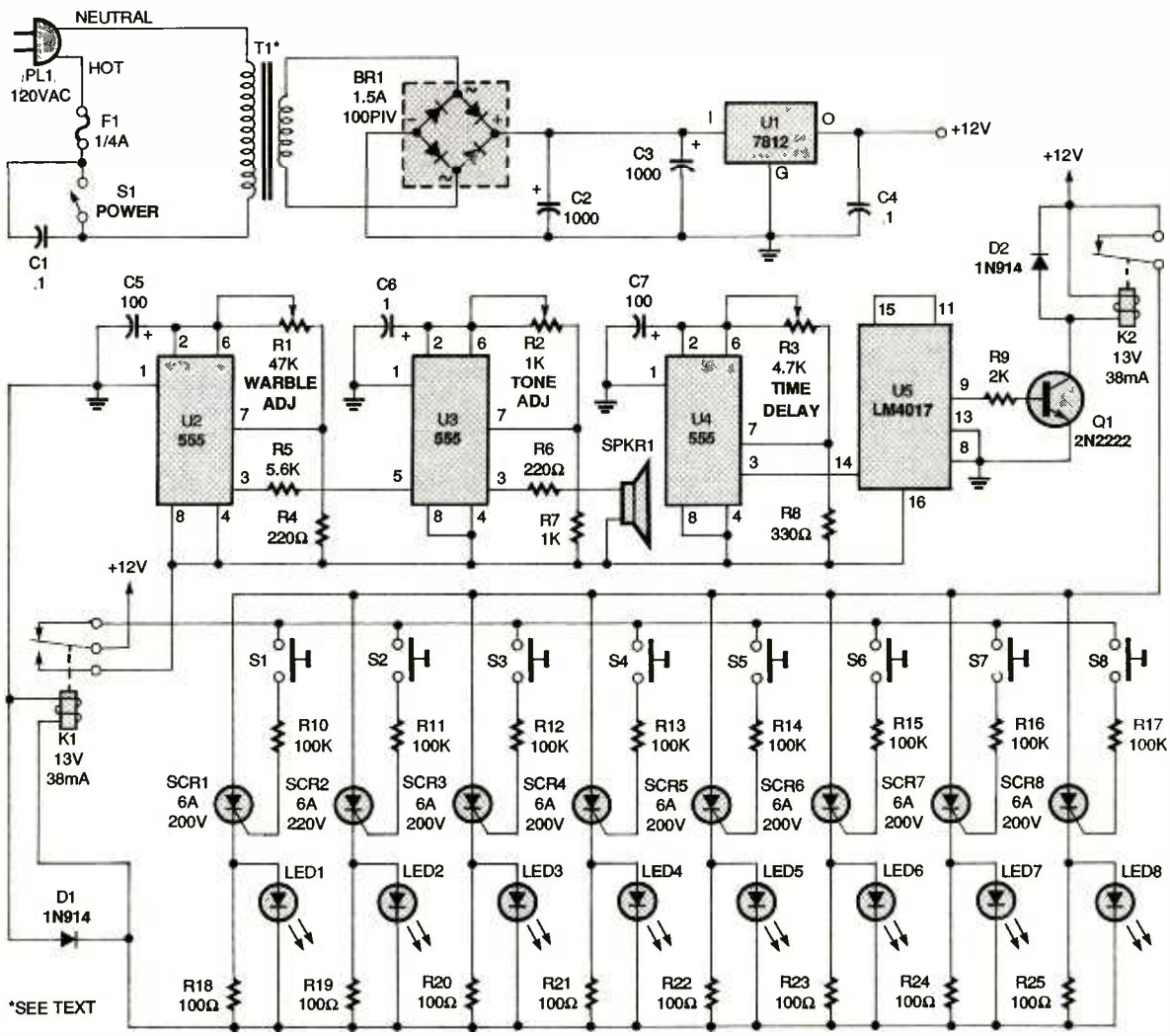

Fig. 6. Do you enjoy game shows like Jeopardy*? This improved contestant lock-out circuit indicates which of up to eight players rings in first.*

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original value supplied a trigger voltage that is slightly higher than required and provided only a little isolation between the SCR circuits.

—Ron Navarro, Ontario, Canada

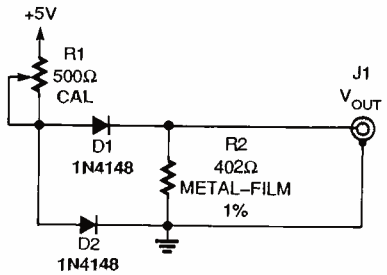

Fig. 7. This simple circuit uses two 1N4148 diodes to form a temperature-compensated millivolt reference.

Nice work and thanks for the tip. It's naturally impossible for me to build and test all the circuits I get here, and as you've shown, even something that looks good on paper can have a glitch or two. Keep in mind that T1 is a 120- to 12.6-volt, 1.2-ampere transformer. Hope your class enjoys the circuit.

MARCH AND JUNE CIRCUIT UPDATES

I just received my June 1996 issue of **Popular Electronics** and once again, I must thank you and the staff of the magazine for the excellent presentation of my work in *Think Tank*. I appreciate that there were no errors, and the kit and other goodies, also!

Here's another note on my "Simple Reference" featured there. By selecting two 1N4148 silicon diodes with, say, a 10-millivolt difference in forward voltage, and using them in place of D1 and LED1, you can make an excellent temperature-compensated millivolt reference (see Fig. 7). If the diodes are from the same lot and manufacturer, you can expect a negligible temperature coefficient.

The "L/C Oscillator" from that issue ended up driving my "THD Adapter" from your November 1994 column. By the way, I made a small glitch in the inductance equation for the oscillator circuit. Here's what it should read:

$$L = C1 \times R1 \times R2$$

Also, after submitting the circuits in the March 1996 **Popular Electronics**, I discovered that at certain low frequencies, with slow rise and fall times, IC2 (LM311) in the frequency counter (see Fig. 8) would tend to oscillate, giving an abnormally high output indication. That is easily corrected by adding a small amount of positive hysteresis to the comparator. Just connect a 2200-ohm, 1/8-watt, 5-percent resistor from pin 2 to pin 7 on IC2 (that resistor is shown as R24). As specified in my original article, Digi-Key (P.O. Box 677, Thief River Falls, MN 56701; Tel. 800-344-4539) carries a multiplexed display (#P454) that should work just fine in the circuit.

—Skip Campisi, South Bound Brook, NJ

Thanks for the updates! Skip freely offers help on his circuits; you can write directly to him at: 143 Cedar Street, So. Bound Brook, NJ 08880.

INFRARED SWITCH

I have enjoyed your column and have used some of the projects that have been in it. Now I need some help with a project that I'm building. I'm trying to activate a relay with an infrared remote, which is only a 9-volt battery, a resistor and an IR diode. I found a relay circuit that uses a 2N2222 transistor and a phototransistor, but I can only activate it from about six-inches away. I need to activate the relay from about ten-feet away, and want the relay to act like a momentary switch.

I also have an IR detector module (RadioShack no. 276-137) if needed. I hope you can help me with my problem; I always look forward to your column, it has really helped me out.

—Karl Jondahl, Glasgow, MT

To make a remote detector that operates over that kind of distance,

continued on page 71

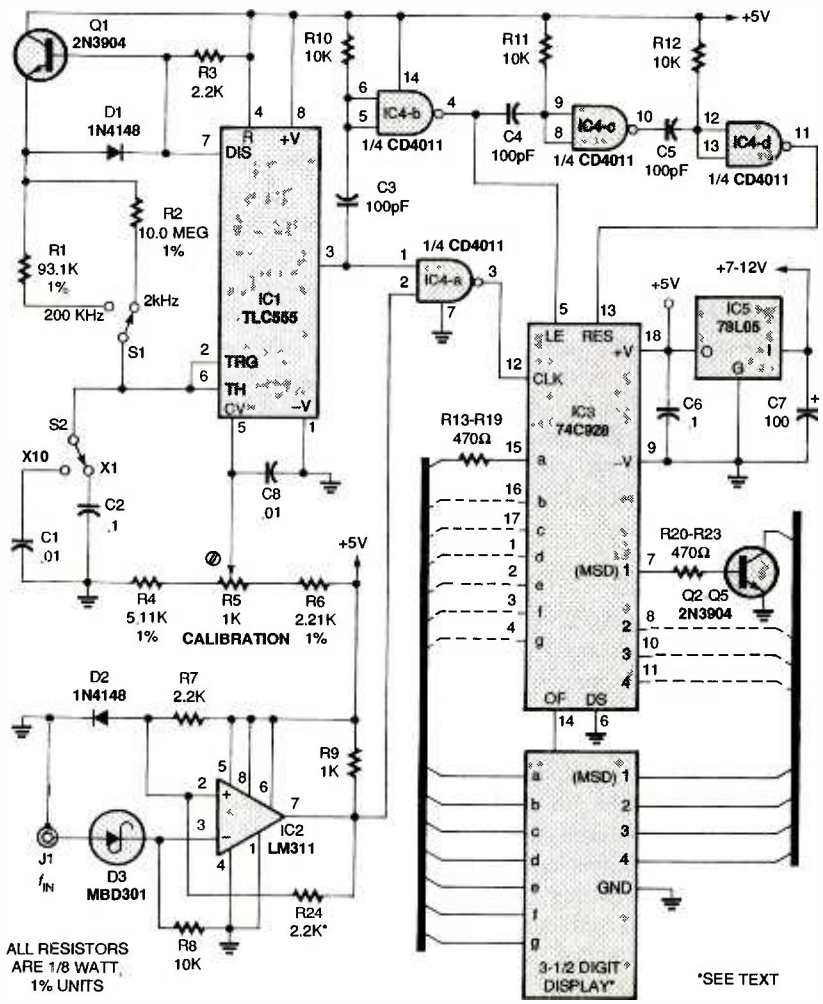

Fig. 8. While this frequency counter is very simple, it has 2000-Hz, 20.00-kHz, 200.0-kHz, and 2.000-MHz ranges, and will work with almost any waveform.

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Help!

BY JEFF HOLTZMANN

In the previous column we started a discussion on hypertext. I'm sure that you remember that hypertext is the loose principle by which the World Wide Web operates. The concept behind hypertext is deceptively simple: Rather than depending on strict linear narrative, hypertext allows associative jumps among several topics. Click here, jump there, click here, jump there.

Before widespread availability of multimedia computers, hypertext referred strictly to text. The next evolutionary step added graphics, sound, video, and other elements—hypermedia. The third step goes beyond the ability to just *goto* different places (i.e., display different Web pages or different topics in a help file), and adds *activity (or interactivity)*, the ability to cause something to happen when a user clicks on a hypertext link.

You may have caught some of the buzz about Java, the new programming language (and programming paradigm) from Sun Microsystems. That's one technology where activity comes in. There are others. But that's for a future discussion.

In this column and the next, we're primarily going to look at hypertext tools for the Windows environment. And, in particular, tools for creating Windows Help files.

THE PROCESS

Before we talk about tools, let's talk about the overall process for creating a help file. Basically, you need three things: a help compiler, a file to be compiled, and a project file that specifies options for the help compiler. The help compiler reads the project file and source file, and produces a help file. The project file specifies options that might include file location(s), graphics, compression options, and macros.

The source file (or files, there can be several) is maintained in Rich Text Format (RTF), a text-only (ASCII) format created by Microsoft that allows formatted text to be interchanged among applications and platforms. You can write RTF in a text editor, but doing so is like programming in assembly language. To move to a higher-level language, most help authors use Microsoft Word, which has a save-as RTF option. You can also create RTF with Word Perfect and other word processors, but for the best compatibility use Word.

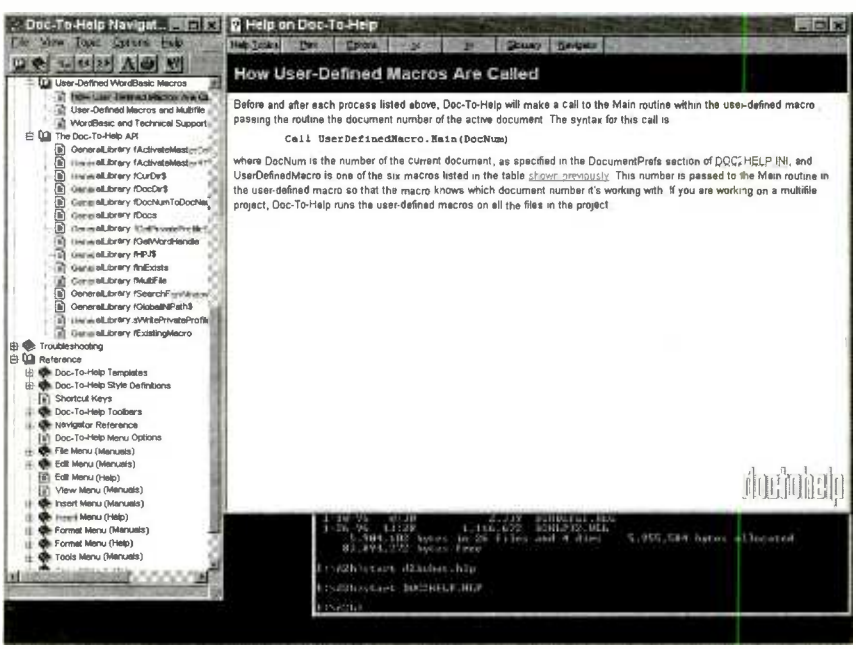
There are several help compilers, all made by Microsoft. HC30 creates Windows 3.0 help files. HC31 and HCP create Windows 3.1 files. HCRTF creates Windows 95 help files. In most cases, help files created for a previous version can be displayed just fine by a subsequent version of the Windows help engine. In Win95, it's called WinHelp32. In prior versions, it's simply called WinHelp.exe. Windows NT 3.5x supports the 3.0/3.1 help system; NT 4.0 will support the Win95 help system.

A help compiler usually comes with a software-development tool, including C/C++ compilers, Visual Basic, Delphi, etc. The older versions are also available from Microsoft's Web site, on CompuServe, and elsewhere. The legality of downloading and using a help compiler without ownership of a software development tool is murky, so if you create a help file that suddenly starts making you millions of dollars, don't be surprised if you get a call from Microsoft's lawyers. I wouldn't worry about it for personal and experimental use although such unlicensed use is not legal.

You can also obtain help compilers with the third-party help-development tools we'll be discussing next time, and in some of the books that specialize in Windows help authoring.

YOUR FIRST HELP FILE

It's traditional when learning a new programming language to first write a program that simply displays the message "Hello world!" To create your own hello-world help file, you need three things: A help compiler, a source file, and a project file. If you have no other access, search for HC*.* on CompuServe or Microsoft's Web site.



DocToHelp is a tool for creating both print and electronic (hypertext) documents from a single source. The DocToHelp Navigator provides a Windows 95-like tree view of document structure.

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You should find a file called HC505.ZIP. That is the final version of the Windows 3.11 help compiler. Download it, unzip it, and put HCP.EXE and HC.ERR in a directory on your path. Help files created by this version will run just fine under Windows 3.1x, Windows 95, and Windows NT.

Then create a directory called TEST. In it, create two ASCII files using DOS EDIT or your favorite text editor. One is called TEST.RTF; the other is called TEST.HPJ. The contents of the two files are shown in Listing 1. Then run the help compiler on the project file by typing:

```
C:\TEST\>HCP TEST
```

If all has gone well, you'll see no error message. Then run the help file. If you're running Windows 95, you can start the program by typing:

```
C:\TEST\>start test.hlp
```

If you're running an earlier version of Windows, run WinHelp, then do a File/Open and load TEST.HLP from your test directory. However you start it, after you open TEST.HLP, you should see a single-topic help file containing the magic words.

LISTING 1—TEST.RTF

```
{\rtf\ansi
Hello World!
}
```

The RTF file we created was acceptable to the help compiler, but was lacking certain header information that should be included in a real help system. When you do a Save As from a word processor, the additional header information will be included automatically. In addition, when your RTF file contains stylized text (different fonts, spacings, etc.), you will see additional codes. Your document may also contain graphics and tables (but don't try to use table borders).

BEYOND THE BASICS

It's a big step from our Hello World file to the elaborate help systems that come with most Windows applications. The reason is that setting up and linking the overall information *structure* in WinHelp depends on the use of some really ugly formatting conventions in the RTF file. Even if you use a good Word processor, creating a clean help file is messy. You have to use unusual formatting (underlining and hidden text), along with a set of totally unintuitive footnote codes to define the jump from and jump to points.

LISTING 2—TEST.HPJ

```
[FILES]
TEST.RTF
```

Creating hotspots (as they're called) on graphics requires converting a graphic file into a proprietary format, using a special tool to draw rectangles around the hotspot areas, and then specifying the action that is to occur when the user clicks on the hotspot. There are all kinds of rules (technotrivia) about things you can and cannot do in help source files. There are few good sources of organized information, so you really have to hunt around, experiment a lot, or both, to become expert.

The help system has a macro "language" that has no data types and can return only Boolean (True/False) values on certain very limited tests. You can register and call external DLLs from a help file, and that gives you the ability to surmount some built-in limitations. For example, you can play WAV and AVI files after clicking on a WinHelp hotspot.

To help manage that complexity, a mini-industry has sprung up that offers a wide variety of shareware and off-the-shelf WinHelp development tools. Mostly they help automate the tedium of entering the hypertext coding. A few move into a higher-level plane where you can focus more on the design of the information structure, and less on the footnote codes. Butnone goes far enough.

And then there's the Web. Over time, it's going to obsolete everything about the WinHelp system. But until the Web becomes truly ubiquitous, WinHelp will continue to be a viable solution. Next time we'll examine several of the best current-generation tools: RoboHelp, Doc-To-Help, and the HyperText suite. Following that, we'll show why they're all doomed. ■

THINK TANK

(continued from page 69)

you have to make it very sensitive. That makes it susceptible to activation by other sources of IR, unless you build it to discriminate a signal issued only by a special remote. To that end, check out the "Remote-Controlled Outlet" in the November 1991 ***Popular Electronics****. In the article, Marc Spiwak and I describe how to build two remote-controlled power outlets complete with IR remotes. They are based on the IR-detector module you have.*

PARTS FOR THE MEGOHM ADAPTER

Regarding the Megohm adapter in the March 1996 issue of **Popular Electronics**, where can the teflon-insulated stand-offs and BNC units be purchased?

—Edwin C. Smith, Ocala, FL

Try Digi-Key, whose address and number were listed earlier. They've got a very thorough catalogue.

WHICH IS RIGHT?

I am going to put some more status lights on my modem. Looking through all my magazines, I came across a problem. Herb Friedman's "Breakout Box" (*Hands-On Electronics*, Summer 1984) lists line 21 as the Ring Detector, but "More On Modems" by Herb (July 1986, *Computer Digest*) lists line 22 as the Ring Detector, and "Programming Serial Ports," **Popular Electronics**, August 1993 by John Yacono also lists line 22 as the Ring Indicator. Which is right?

Also in "More On Modems," line 5 is listed as DSR and line 6 as CTS, but "Programming Serial Ports" lists 5 as CTS and 6 as DSR. Please tell me which is right so I can mark my lights.

—Joseph W Baldwin, Warren, MI

I looked the definitions up just to be sure. The ring indicator (RI) is line 22, CTS is line 5, and DSR is line 6. By the way, thanks for reminding me of Herb. He was a consummate hobbyist, friend, and mentor of mine, and thinking of him always makes me smile.

As always, send your best circuits to *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

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ANTIQUE RADIO

A New Restoration

BY MARC ELLIS

It has been a while since we started a new restoration project. Up to now, I hadn't really had any ideas that captured my imagination. Although I certainly have a backlog of several sets I'd like to work with, a few of them are missing critical and hard-to-get parts; others lack documentation or a source for same. The problem was solved about a week ago when a friend came visiting.

"I have something for you," my friend said, opening his trunk. Reaching in, he pulled out a trim little shortwave receiver with a black-and-gray front panel and a blue-and-white slide-rule dial. Taking the set from him, I peered at the panel with interest. It turned out to be a Knight (Allied Radio) *Star Roamer.*

"And there are a couple more things," said Gary, opening the back door of his car. The intriguing little boxes he pulled out turned out to be a Heathkit Q-Multiplier (a device for increasing the selectivity of a receiver) and a Holstrom Associates preselector (broad-band RF amplifier), covering 3.5—30 MHz. That range includes the 80-, 75-, 40-, 20-, 15-, and 10-meter ham bands.

It had happened to be a trash pickup day in Gary's neighborhood. That morning, he'd spotted these items in a neighbor's garbage container and thought of me. *Voila*! Looking at them, I immediately envisioned a new series of *Antique Radio* columns.

STAR ROAMER BACKGROUND

I'm assuming that because they were found together, the three units were used together. Additional evidence is the RCA phono jack jury-rigged to the back of the receiver, apparently to receive the phono plug from the Q-Multiplier or preamplifier. The original owner had probably purchased the (very basic) receiver first, then added the enhancements later to improve performance. One can't help but wonder how much better off he might have been if he'd used the total sum spent on the three units to purchase a more advanced receiver in the first place!

I also spent some time wondering who the original owner was and why his little trove of equipment was in the trash. Perhaps he was a young man who left home to begin a career, eventually losing interest in his hobby and his gear. Perhaps he was a more mature person who wanted to explore short wave listening or ham radio—but either didn't take it any further or progressed to a much more sophisticated setup. Well, we'll never know.

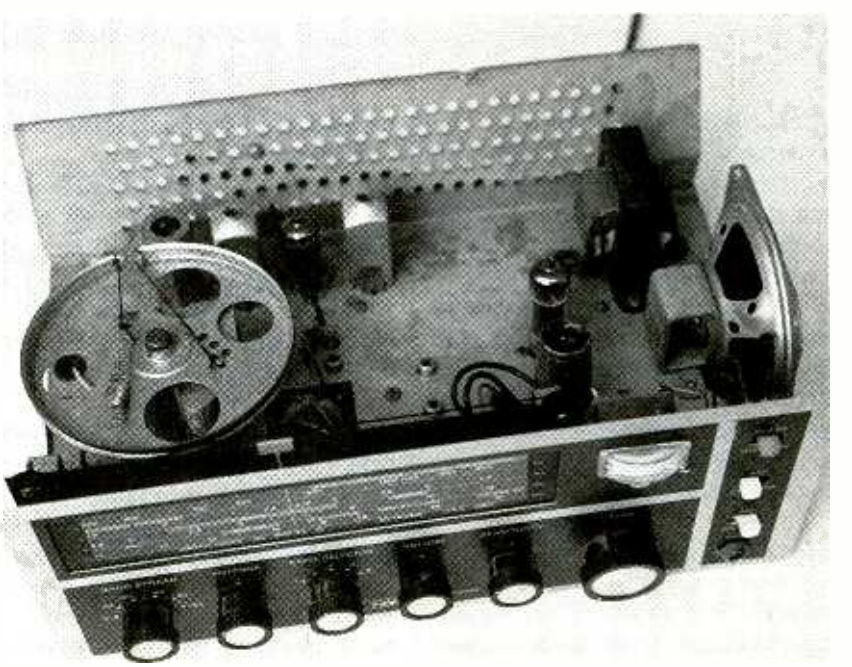
I happen to have a small collection of vintage mail-order electronics catalogs (primarily Newark, Allied, and Lafayette). Allied was the manufacturer of Knight equipment, and—taking a guess—I started to look through the catalogs from the mid-1960s. I hit paydirt in the 1966 catalog. There was a two-page spread on the Star Roamer. Priced at $39.95, it was the "top of the line" of Knight shortwave receiver kits.

As a mid-60's set, this radio will be the newest piece of equipment ever restored in the column. But at 30-some years old, it's still a very respectable antique and, let's face it, it's about time we had something for the baby boomers in the crowd!

The catalog also contained write-ups on the lesser sets in the line. While the Star Roamer was a superhet, the Ocean Hopper ($15.95), Space Spanner ($18.95), and Span Master ($24.95) were regenerative models. Those are all names that I see often in classified "want lists." Although they are minimal radios, they seemed to have captured the buying public's imagination when new, and are sought after by collectors now. The Ocean Hopper was perhaps most like a classic 1920's shortwave set, with its plug-in coils, plain styling, and pointer knobs.

INSPECTION

Realizing that the Star Roamer was a kit radio, the first thing I did was to pop the covers and take a look at the



Here's the Star Roamer as found, with its cabinet removed for inspection.

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wiring. It had obviously been done with skill and care. The wiring of the Q-Multiplier had also been done by the same careful hand. Later, when I get my hands on the documentation for these units, I'll check the connections against the schematic on a component-by-component basis.

And speaking of documentation, I was pleased to discover that the manuals for both the Knight and Heath units are available from my usual source: Hi Manuals, P.O. Box 802, Council Bluffs, IA 51502. They are a little more expensive than I would like but I suppose that's because both units were kits and the manuals not only have construction information, but also more alignment and adjustment information than usual. I hope to have both of those manuals on hand by the time I'm ready to put together next month's column.

To do business with Hi-Manuals, by the way, one must first order their current catalog (which happens to be catalogue "M," price $2.00 U.S.; $3.00 elsewhere). The catalog contains complete availability and ordering information.

Cosmetically, the receiver, Q-Multiplier, and preamp are in pretty good shape. I put aside the latter two units for detailed inspection later and concentrated on the Star Roamer itself. The gray enamel on its case is in pretty nice shape, showing only some grime and faint traces of corrosion. It should clean up nicely.

The composition-board back panel is cracked along a line of ventilating holes, but it looks as if the repair will be almost invisible from the outside. A loopstick antenna, which does *not* look original, is mounted on the rear of the panel. There is also a set of screw terminals for an external antenna and ground.

The front panel and chassis underside look almost mint. The rear apron of the chassis has a fine coating of rust, but it's not too bad. The plating on the upper deck has started to develop those unpleasant dark blotches of corrosion, but will certainly look a lot better after a light polishing.

Under the grime, I noted that the original owner had scribed his name and the date he completed the kit (January 1, 1965). I won't give the full name. But Ken, if you see this and recognize the set, you know who you are! And if you received the radio as a Christmas present, you obviously lost no time putting it together!

This ad for the Star Roamer appeared in a mid-1960's Allied catalog. The attractively designed set offered lots of value for the money.

TUBES AND CONTROLS

The Star Roamer has a four-tubes-plus-rectifier circuit. The rectifier is a half-wave selenium stack and the tubes are mostly seven-pin miniatures: 6BE6 pentagrid converter; 6HR6 IF amplifier; 12AX7 (the lone 9-pin miniature) detector/first audio; 6AK6 audio output.

The front-panel controls include bandspread, antenna trimmer, bandswitch, volume, sensitivity, and the flywheel-weighted tuning control. There are also slide switches for power, noise limiter, and AVC, as well as a phone jack and "s"-meter. The bands marked on the slide-rule dial are 200–400 kHz (marine/aircraft beacon), 550–1800 kHz (broadcast band), 1.8–4.8 MHz, 4.8–12 MHz, and 12–30 MHz.

The rear panel holds a fuse, a meter-calibration control, antenna and ground terminals, a BFO switch (disconnected), and a square opening labeled "key" (c.w. practice key) with the jack it once held removed to make way for the previously-mentioned jury-rigged phono jack. According to the catalog specifications, the set is supposed to have a BFO pitch control—but I don't see any sign of it. It might have been removed in connection with the phono jack modification. We'll know more when I get the schematic.

All in all, I'd say this was a lot of set for the $40 price tag. In addition to the marine/aircraft beacon and broadcast bands, the radio provided complete shortwave coverage from 1.8-30 MHz, which included all HF amateur bands. The most inexpensive comparable set was the Hallicrafters S-120, the successor to the famous S-38. It sold ready-built for $70 and did not include the marine/aircraft band.

PRELIMINARY TESTS

I started with the tubes, as I usually do. Breaking out my trusty military TV-7 tube checker, I found that the 6BE6, 12AX7, and 6AK6 tested good. The 6HR6 was a bit too new for the TV-7, not appearing on its 1962-era charts. That meant I had to fall back on a newer Eico tester I keep around for

continued on page 92

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NEW PRODUCTS

(continued from page 12)

that exhibits the range setting selected by the user. A rotary dial makes function selection easy.

The D-388, complete with test leads, detachable clips, GM and Ford adapters and coil clips, a 9-volt battery, and a detailed instruction manual that covers all diagnostic procedures, costs $84.95. For additional information, contact HC Protek, 154 Veterans Drive, Northvale, NJ 07647; Tel. 201-767-7242; Fax: 201-767-7343; e-mail: hcprotek@aol.com; Web: http://www.techexpo.com/www/hcprotek.

CIRCLE 82 ON FREE INFORMATION CARD

DOLBY PRO LOGIC DECODER WITH LLC

Movie soundtracks are mixed for loud volume levels used in theaters; because the home-theater environment calls for much lower levels, much of the information is lost in the front and surround channels. To compensate for that loss, AMC's Model PRO7 Dolby Pro Logic decoder uses a proprietary low-level compensation (LLC) circuit that allows users to listen to movie soundtracks at significantly lower volume without losing sonic details.

By pressing the LLC button on either the remote control or front panel, the LLC circuit corrects all channels when volume markings fall below 12 o'clock on the level. The LLC circuit adjusts each channel progressively in both amplitude and frequency, so there is no loss of the Dolby sound field when volume is reduced.

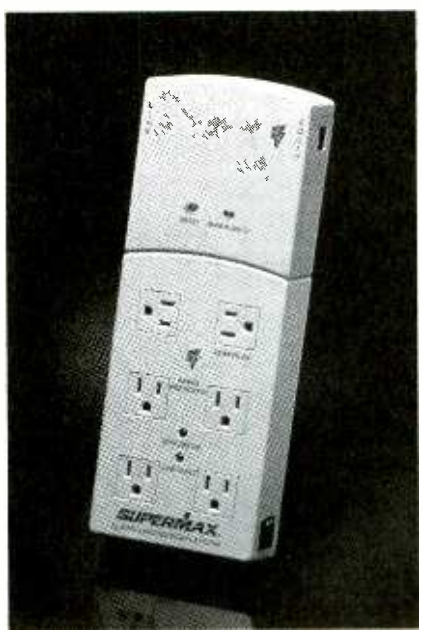
The PRO7 also features a theater-compensation filter to acoustically balance soundtracks that are mixed excessively bright. The amplifier section offers 40 watts for the center channel and 40 watts for the surround channels.

The PRO7 decoder has a suggested retail price of $399.95. For further information, contact AMC, Weltronics Corp., P.O. Box 80584, San Marino, CA 91108; Tel. 800-321-6396.

CIRCLE 83 ON FREE INFORMATION CARD

AC-/TELECOMMUNICATIONS-LINE SURGE PROTECTOR

The *Supermax AllPath* surge protector from *Panamax* safeguards both AC and telecommunications lines for applications sensitive to over/under-voltage. Power is automatically disconnected during over-voltage conditions, such as surges or spikes, or during under-voltage conditions, such as sags or brownouts. The surge protector features the expandable AllPath design, which allows it to be combined with different modules for a variety of applications.



Supermax includes "ground OK" and "line fault" diagnostic lights, an always-on outlet, a master on/off switch, and a six-foot power cord. It has six receptacles plus two modular phone jacks. The Supermax offers an automatic or manual reset when voltage returns to a safe range. It also has a thermal fuse that, in the event of extended overvoltage, shuts off power to connected equipment.

Supermax has a UL 1440 Surge Protection Rating of 330 volts, with an initial clamping level of 200 volts, where the lower the voltage, the better the protection provided. The unit also improves line quality by reducing noise with an EMI/RFI filtration level of 50 dB from 100 kHz to 1 MHz. It is covered by the Panaxax lifetime guarantee and includes a $5-million warranty on properly connected equipment.

The Supermax AllPath has a suggested retail price of $149. For more information, contact Panamax, 150 Mitchell Blvd., San Rafael, CA 94903; Tel. 800-472-5555 or 415-499-3900 (in Canada: 800-443-2391); Fax: 415-472-5540; Web: http://www.panamax.com/panamax.

CIRCLE 84 ON FREE INFORMATION CARD

VEHICLE SECURITY ALARM SYSTEM

The *RF-502* alarm system from *AutoPage* comes with two stylish, two-button, three-channel remote control transmitters. The remote controls give the car owner control of arm/disarm, chirp mute, and optional second- and third-channel functions. Code-rolling technology guards against code-grabbing thieves.

Standard features include a plug-in dual-stage electronic shock/glass sensor with passive/manual arming; parking-light flash; valet/override switch; remote panic alarm; positive and negative trigger inputs; and 120-dB electronic siren. User-selectable functions include ignition-control door locks, door-lock control in passive arming, chirp defeat, and 60-second automatic rearm after disarm.

The RF-502 vehicle security alarm system has a manufacturer's suggested retail price of $149.95, not including installation. For further information, contact AutoPage, Inc., 1815 West 205th Street, Suite 101, Torrance, CA 90501-1525; Tel. 800-922-2527 in California, 800-262-2527 outside California; Fax: 310-533-0258. ■

CIRCLE 85 ON FREE INFORMATION CARD

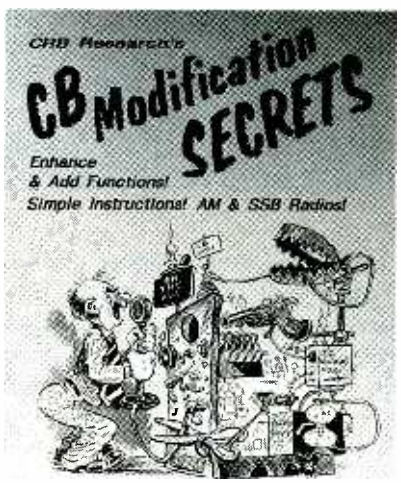
www.americanradiohistory.com

Electronics Library

CB MODIFICATION SECRETS

by Kevin Ross

Recommended by The SSB Network, the world's oldest and largest Single Sideband operator's group, this book shows how to expand, enhance, and add to the usefulness of current and recent AM and SSB gear. Its simple instructions and large, clear illustrations are geared to the average hobbyist using readily available tools and equipment. Tech tips make everything as straightforward as possible.



The book details such enhancements as frequency expansion, SSB clarifier and voice-lock modifications, adding voice control (VOX), a variable frequency oscillator (VFO), an anti-theft transmitter disabler, IF gain control, and a microphone sensitivity control. Other enhancements include a switch to change "Instant Channel 9" to "Instant Channel 19," a receive preamplifier, and a channel-display automatic dimmer and shut-off.

Some of the modifications are designed for specific radios. The others are virtually generic and—to the extent that individual models can be modified—are applicable to more than 200 current and recent CB radios from manufacturers including Cobra, Courier, G.E., Midland International, RadioShack, SBE, Uniden/President, and Wards.

CB Modification Secrets is available for $21.95 plus $5 shipping and handling ($6 to Canada) from CRB Research Books, Inc., P.O. Box 56, Commack, NY 11725; Tel. 800-656-0056 (from Canada, Alaska, and Hawaii, call 516-543-9169). New York state residents must add $2.22 sales tax.

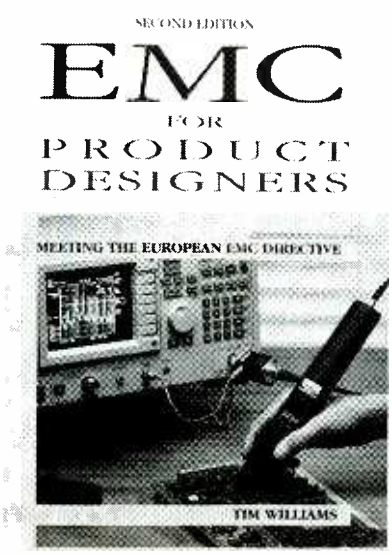
CIRCLE 90 ON FREE INFORMATION CARD

EMC FOR PRODUCT DESIGNERS
Second Edition

by Tim Williams

This book provides all the information needed to design products that meet the requirements of the new European EMC (Electro Magnetic Compatibility) Directive. It shows how to incorporate EMC design principles into products, to avoid cost and performance penalties, meet the needs of specific standards, and create a better overall product.

The second edition has been updated to include the latest developments as they affect compliance to the regulations. Particular attention is devoted to new basic, generic, and product-specific test standards; new standards on measurement methods and revisions to existing standards; and changes to the standards generation process. New measurement techniques are also described. The book contains new sections explaining requirements on systems design; the layout of large systems; earthing, grounding, and bonding practices; cable layout, routing, and termination; and components specification. Another new chapter deals with EMC management, covering management requirements, company policy, quality assurance needs, the role of the EMC coordinator, and test and control plans.



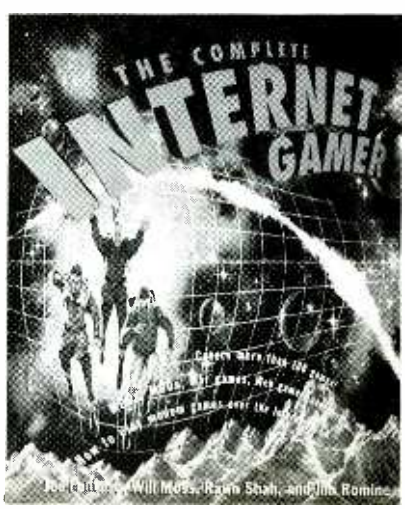
EMC for Product Designers, Second Edition, costs $47.95 and is published by Butterworth-Heinemann, 225 Wildwood Avenue, Unit B, P.O. Box 4500, Woburn, MA 01801; Tel. 617-928-2500.

CIRCLE 91 ON FREE INFORMATION CARD

THE COMPLETE INTERNET GAMER

by Joe Pantuso, Will Moss, Rawn Shah, and Jim Romine

The Internet contains a whole world of interactive games, and this book lets you know precisely where to find more than 100 of them. Written by four well-traveled Internet gamers, the book reveals what hardware and software



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you'll need, the latest online tips and tricks, and where to find game magazines ("zines") on the Internet.

The book tells you how to play commercial games over the Internet—even ones that weren't originally designed to be played over the Internet. You'll learn how to play Doom, Descent, and Command & Conquer for free with Kali software. The book shows you where to find the best games—from MUDs to games on the Web—and where to find new games and related software. It provides the complete instructions, rules, and strategies for Netrek, and explains where to find game discussion and news groups. The book offers information on how to get Internet access, tips for surfing the Net, and a brief look at the future of the Internet.

The Complete Internet Gamer costs $24.95 and is published by John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012; Tel. 800-CALL-WILEY.

CIRCLE 92 ON FREE INFORMATION CARD

A PRACTICAL INTRODUCTION TO ELECTRONIC CIRCUITS
Third Edition

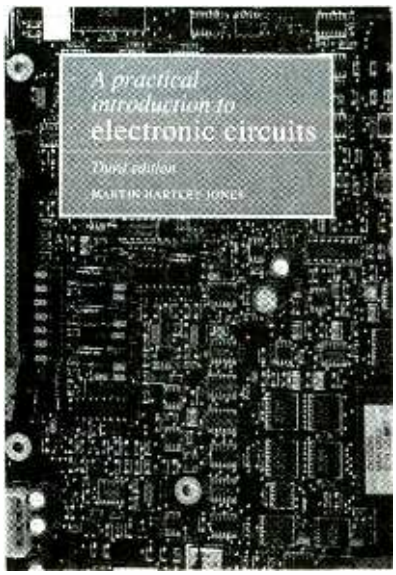
by Martin Hartley Jones

Aimed at anyone with some basic knowledge of electrical circuits, this book provides a practical explanation of electronics. It can be used as a text book for electronics students and as a reference for hobbyists.

The book begins with basic concepts such as amplification; and it's progresses to analog and digital IC applications, including a lucid account of microcomputers. All the topics are illustrated with hands-on experiments, and mathematics is kept to a minimum.

The subject presentation reflects the author's belief that effective learning of electronics must be based on the practical experience of building circuits and experimenting with them. To this end, the circuit diagrams in the book contain sufficient information, such as component values, to allow the reader to learn by experience. Computer experiments are also included.

The third edition maintains the style



and logical subject development of its predecessors, yet reflects recent changes in the field. In those circuits where components have become obsolete, suitable replacements have been introduced. The book includes new sections on switch-mode power supplies, phase-locked loops, and analog-to-digital conversion, and the PC is used in several practical interfacing experiments.

A Practical Introduction to Electronic Circuits, Third Edition, costs $32.95 and is published by Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211.

CIRCLE 93 ON FREE INFORMATION CARD

MICROCOMPUTER REPAIR
Second Edition

by James L. Antonakos and Tom Adamson

This book provides a comprehensive tutorial in microcomputer repair. Intended for use in technical classes, it can also be used for do-it-yourself training. Each chapter is a self-contained study exercise complete with hands-on activities, questions, a self-test, and a review quiz. Every exercise begins by stating the new skills and knowledge you will learn by completing it, and describing the required materials (equipment, tools, parts, and software).

The background information section, generally the longest portion of each exercise, presents all the information you'll need to perform the exercise and take the quiz. A self-test, with several different types of questions, helps you check your understanding of the subject; the correct answers are given at the end of the exercise.

Next, a familiarization activity encourages you to gain practical experience. It is followed by questions and other activities designed to reinforce the important concepts you should have learned while completing the hands-on activity. Finally, a review quiz restates the performance objectives.

The second edition features more emphasis on software control; new exercises on CD-ROM, sound modems, and new CPUs; and coverage of new DOS versions.

Microcomputer Repair, Second Edition, complete with companion disk, costs $64 and is published by Prentice-Hall, P.O. Box 11071, Des Moines, IA 50336; Tel. 800-947-7700 or 515-284-6751; Fax: 515-284-2607; e-mail: orders@prenhall.com.

CIRCLE 94 ON FREE INFORMATION CARD

REAL-WORLD INTERFACING WITH YOUR PC:
A Hands-On Guide to Parallel Port Projects

by James "J.J." Barbarello

These days virtually all electronics hobbyists own a personal computer.

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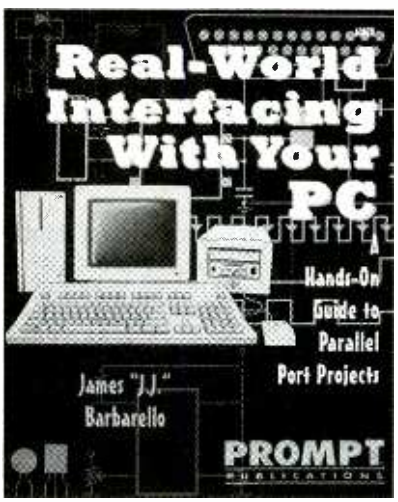
And most hobbyists would like to use their PCs for more than just word processing and game playing. What's needed is a basic understanding of how to get electronic signals in and out of the PC.

This book provides electronics hobbyists with all the information they need to use the computer's parallel port as a gateway to real-world electronic interfacing. It begins with an introduction to the computer as an interface device, and describes the parallel port in detail. After presenting the hardware fundamentals, the book explains the basics of writing software to control that hardware.



Next, the book shows readers how to design, build, and test an actual project—an analog-to-digital converter. It helps readers learn how to put that new-found knowledge to practical use designing and building their own projects, and even offers advice on how to market those original ideas.

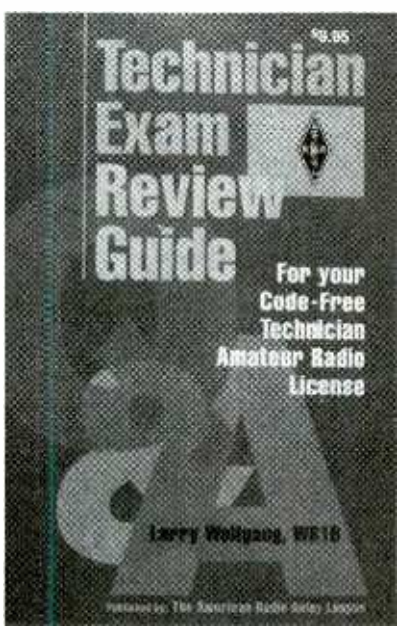
For readers who are not experienced project builders, there's a chapter on construction techniques and a builder's checklist for quick reference. The book also recommends a "starter" inventory of electronic parts to have on hand.

Real-World Interfacing with Your PC costs $16.95 and is published by Prompt Publications, Division of Howard W. Sams & Company, 2647 Waterfront Parkway East Drive, Suite 300, Indianapolis, IN 46214-2041; Tel. 800-428-7267.

CIRCLE 95 ON FREE INFORMATION CARD

TECHNICIAN EXAM REVIEW GUIDE
For Your Code-Free Technician Amateur Radio License
by Larry Wolfgang, WR1B

Now that Morse Code is no longer a requirement, there's never been a better time to get into the exciting hobby of ham radio. And it's easier than ever to prepare for your license exam. The Element 2 and 3A (Novice and Technician) exams required for the Technician class license contain no difficult math, and an electronics background is not necessary. Yet passing those exams entitles you to full operating privileges on every frequency above 50 MHz that is assigned to the Amateur Radio Service. Those include packet radio and even amateur satellites.



This book helps you prepare for the Element 2 and 3A exams. It reviews every question in the Novice and Technician question pools, and provides the answers. In addition, brief explanations help you understand the correct answer to each question.

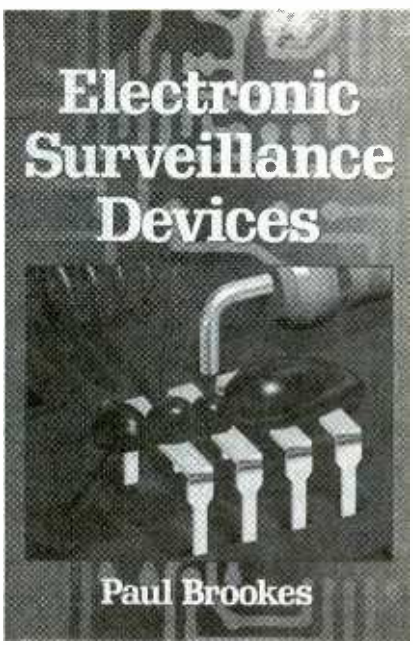
Technician Exam Review Guide costs $9.95 and is published by The American Radio Relay League, 225 Main Street, Newington, CT 06111; Tel. 203-666-1541; Fax: 203-665-7531.

CIRCLE 96 ON FREE INFORMATION CARD

ELECTRONIC SURVEILLANCE DEVICES
by Paul Brookes

By balancing theoretical principles with practical instruction, this book meets the needs of a wide audience, ranging from gadget enthusiasts to anyone involved in corporate security or surveillance.

The book opens with an introductory chapter outlining why various types of devices are used. Two case histories serve as practical illustrations. The second chapter describes all the different types of devices available, and outlines their performance and potential uses.



In the next several chapters, the book provides actual circuit diagrams of various transmitters, recording switches, video devices, and counter surveillance devices. Construction techniques and tips, as well as many thorough parts lists are included. Finally, the book covers the topics of receiving equipment and self-bugging quite well.

Electronic Surveillance Devices costs $29.95 and is published by Butterworth-Heinemann, 225 Wildwood Avenue, Unit B, P.O. Box 4500, Woburn, MA 01801; Tel. 617-928-2500. ■

CIRCLE 97 ON FREE INFORMATION CARD

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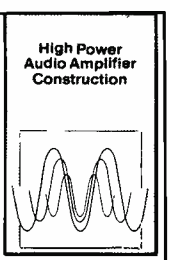
THE COLLECTED WORKS OF MOHAMMED ULLYSES FIPS

#166—By Hugo Gernsback. Here is a collection of 21 April Fools Articles, reprinted from the pages of the magazines they appeared in, as a 74-page, 8½ × 11-inch book. The stories were written between 1933 and 1964. Some of the devices actually exist today. Others are just around the corner. All are fun and almost possible. Stories include the Cordless Radio Iron, The Visi-Talkie, Electronic Razor, 30-Day LP Record, Teleyeglasses and even Electronic Brain Servicing. Get your copy today. Ask for book **#166** and include **$16.00 (includes shipping and handling)** in the US and Canada, and order from **CLAGGK Inc., P.O. Box 4099, Farmingdale, NY 11735-0793.** Payment in US funds by US bank check or International Money Order. Allow 6-8 weeks for delivery. MA05

TRANSISTOR EQUIVALENTS GUIDE

BP85—Designed to help the user find possible substitutes for a popular use-oriented selection of modern transistors. Includes devices produced by more than 100 manufacturers. Wherever possible, equivalents are sub-divided into European, American and Japanese types. Material type, polarity and manufacturer are also shown. To order BP85 send **$9.95 (includes shipping and handling)** in the US and Canada to **Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.** US funds only. Use US bank check or International Money Order. Allow 6-8 weeks for delivery. MA08

HIGH POWER AUDIO AMPLIFIER CONSTRUCTION



BP277—Here's background and practical design information on high power audio amplifiers capable of 300±400 watts r.m.s. You'll find MOSFET and bipolar output transistors in inverting and non-inverting circuits. To order your copy send **$6.25 plus $3.00** for shipping in the U.S. and Canada to **Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.** U.S. and Canada only. Payment in U.S. funds by US bank check or International Money Order. Please allow 6-8 weeks for delivery. MA03

REFLECTOR ANTENNAS

(Continued from page 44)

9A). Use 300-ohm twin-lead to connect the antenna to the receiver. Or, if you prefer to use coaxial cable, use a 4:1 BALUN transformer between the coax and points X1/X2 (Fig. 9B). A standard television-style 4:1 BALUN transformer is well suited to this application, even though you will have to supply an "F-type" connector at the transformer end of the coaxial cable, and whatever the scanner receiver needs at the other end.

If you don't want to use a TV-style BALUN, then it's possible to use a coaxial cable BALUN as in Fig. 10. The BALUN is made from 75-ohm coaxial cable for 300:75-ohm conversions, and 52-ohm cable for 200:50-ohm conversions. The BALUN section is a half-wavelength long. Calculate the length of the BALUN section as before ($L = 5904/f_{MHz}$), but then multiply that result by the velocity factor (V) of the cable. Typically, regular polyethylene coax has a velocity factor of 0.66, while polyfoam-dielectric cable has a factor of 0.80. Some Teflon cables used at VHF/UHF and microwave frequencies have a velocity factor of 0.70.

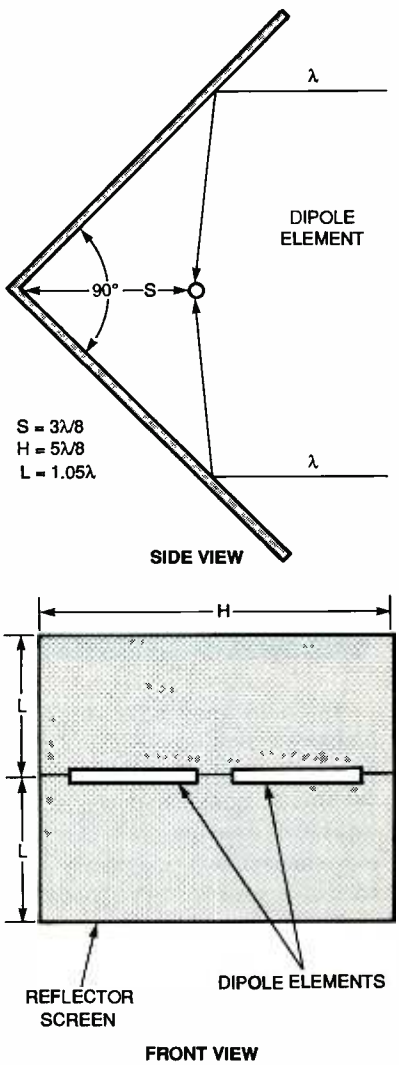


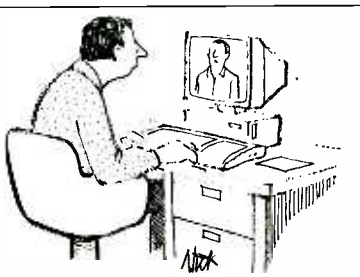
Fig. 11. Here are the front and side views for a corner reflector antenna.

Corner Reflector Antennas. The corner reflector, popular for UHF television reception, also could be designed and built for scanner frequencies. Figure 11 shows the basic corner reflector. It consists of an angled reflector with an angle between 60 and 90 degrees (the 90° version is shown here). When the angle is 90 degrees, the antenna provides about 10 dB of gain, and has a feedpoint impedance of around 72 ohms (which makes a good match to 75-ohm coaxial cable).

The radiator element is a standard half-wavelength dipole (Fig. 2A), placed ⅜-wavelength from the apex of the reflector (distance S in Fig. 10). The width (H) of the reflector is 5λ/8, and the length of each panel (L) is 1.05λ.

As was true with similar antennas that were discussed earlier, the reflector for the corner reflector antenna can be made of either sheet copper or a grid of wires.

Conclusion. Reflector antennas are a way to obtain gains of 3 to 10 dB at low cost and a minimum of effort; all it takes is the use of some handiwork skills. All of the materials are readily available, and there is enough flexibility to allow you to work with the materials you feel most comfortable with. Give one a try and see how much better your scanner's reception can become! ■



"Hello. My name is Kevin, and I'm an Internet addict."

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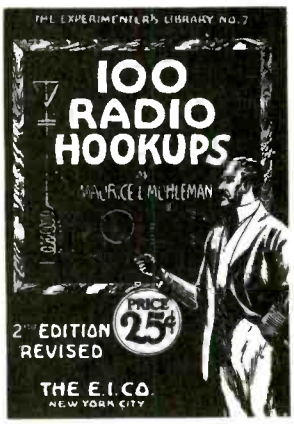
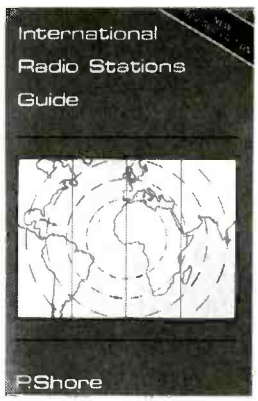
☐ 100 RADIO HOOKUPS —#7—$3.00

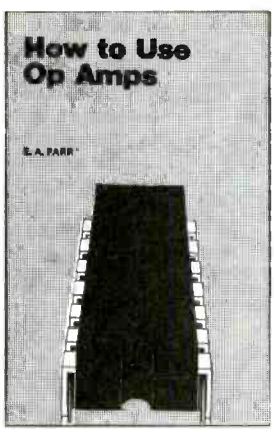
First published in May, 1923 this popular booklet went into reprint editions nine times. It is packed with circuits, theory, antenna installation and tips on consumer radio receivers that were popular in the early 1920's. Antique radio buffs and those inquisitive about the early days of radio will find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



☐ INTERNATIONAL RADIO STATIONS GUIDE—BP255 —$9.95

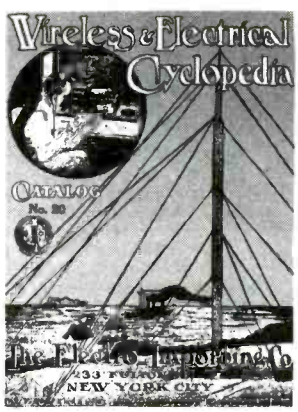
Provides the casual listener, amateur radio DXer and the professional radio monitor with an essential reference work designed as a guide for listening tothe complex radio bands. Includes coverage on Listening to Shortwave Radio, ITU Country Codes, Worldwide Radio Stations, European Long Wave and Medium Wave Stations, Broadcasts in English and more.





☐ HOW TO USE OP AMPS —BP88—$5.95

The engineer's best friend is the op amp. This basic building block is found in many circuits, analog and digital alike. The op amp finds many useful purposes such as: oscillators, inverters, isolators, high- and low-filters, notch and band-pass filters, noise generator, power supplies, audio, MIDI, and much more. Prepared as a designer's guide, some limited math is used, however engineers and hobbyists alike find it a useful text for their design needs.



☐ WIRELESS & ELECTRICAL CYCLOPEDIA —ETT1—$5.75

A slice of history. This early electronics catalog was issued in 1918. It consists of 176 pages that document the early history of electricity, radio and electronics. It was the "bible" of the electrical experimenter of the period. Take a look at history and see how far we have come. And by the way, don't try to order any of the radio parts and receivers shown, it's very unlikely that it will be available.

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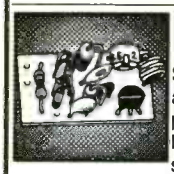

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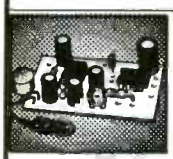

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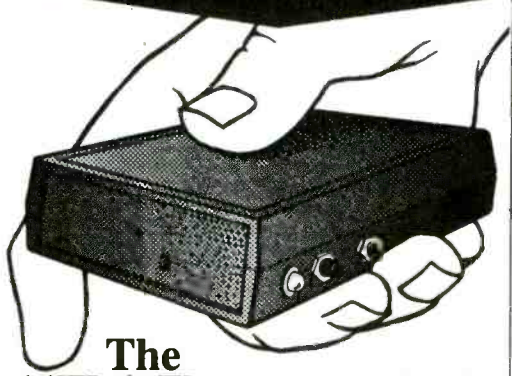
Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. Power requirement 6 to12v DC. SIZE:1.75"x 1"

AA-1 BUILT $29.95 KIT **$10.95**



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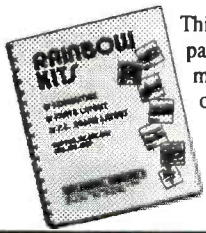

This Manual contains schematics, parts lists & P.C. board layouts for many of the Rainbow Kits. Use your own parts to construct our kits.

KIT BOOK $14.95

$9.95 with the purchase of any kit.

WIRELESS FM MICROPHONE

Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-2 kit is a buffered wireless mike that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. 6 to 12v DC. SIZE: 1.25" x 1"

WM-2 KIT **$14.95**

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"

MMPT2 KIT **$29.95**

MICRO-MINIATURE WIRELESS MIKE

So small you could hide this one on some real bugs! It's the smallest we've ever seen. With it's super sensitive mike it transmits a whisper or a room of conversation to an FM radio, tunable from 88 to 108MHz FM. With a proper antenna it transmits about 1/2 mile. The kit is made with surface mounted parts, we have already mounted these parts. You install the leaded parts. Power requirement 6 to 12v DC. Size .35"x.9"

MMWM5 KIT **$34.95**

STROBE LIGHT

Do you need an attention getter, warning light,or flashing light for model airplanes? Then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate. Power requirement 6 or 12v DC . Size 3.5"x1.9"

ST-1 KIT **$11.95**

Press a button and learn every number dialed on your phone

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- Records credit card numbers entered through your phone key-pad.
- Records Voice mailbox, answering machines, and modem access numbers.
- Records Cellular or repeater phone numbers heard over your phone. Even hook to a scanner, and learn scores of emergency phone numbers. Also decodes tones stored on a tape recorder. Never before has such sophisticated gear been available to the public. And not at this price.

Power requirement 9v DC.SIZE: 3.5" x 4" x 1" **BLACK ANODIZED ALUMINUM CABINET**

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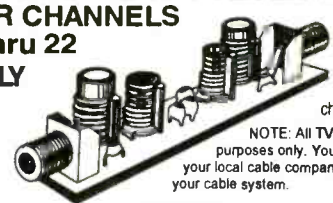

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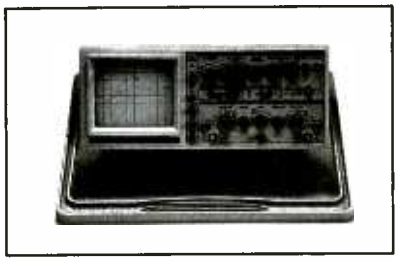

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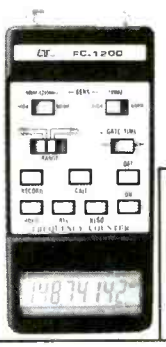

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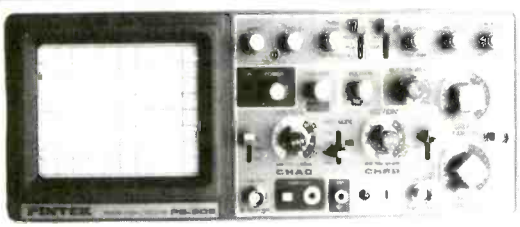

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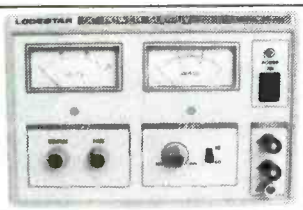

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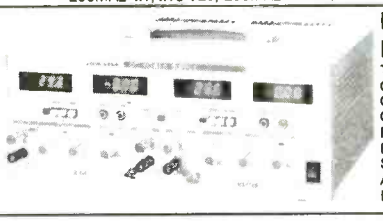

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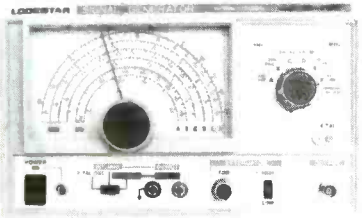

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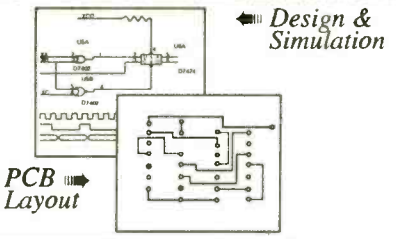

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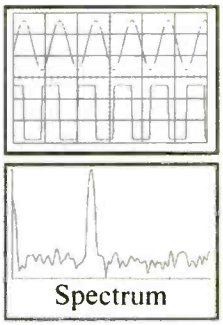

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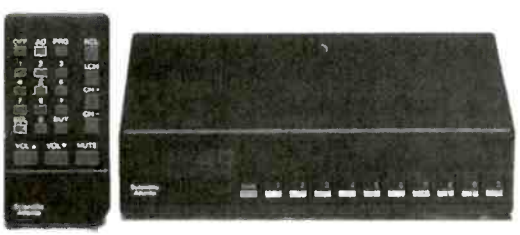

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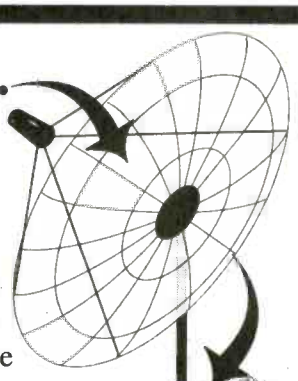

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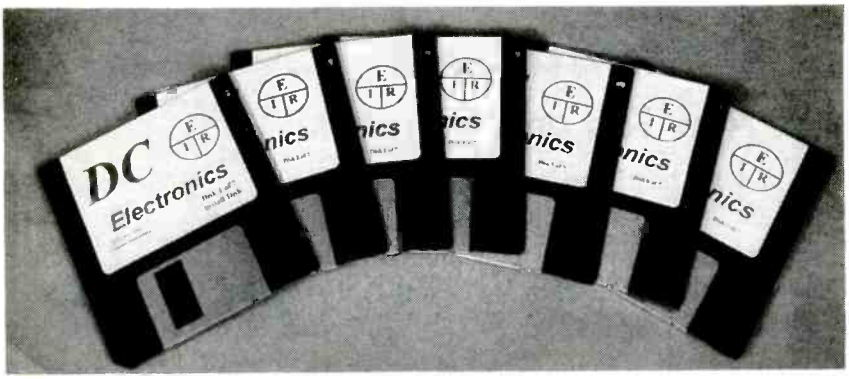

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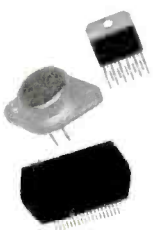

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ANTIQUE RADIO

(continued from page 73)

later tubes. The Eico is not as sophisticated as the TV-7, being just a simple emission tester. But then, I don't run into many newer-than-1962 tubes either. In any case, the Eico gave the 6HR6 a clean bill of health.

The next thing I normally check when going through a radio is the power transformer (if present). Normally I pull out the rectifier tube before doing this because I do not want voltage applied to the vintage filter caps, which are likely to be leaky. The Star Roamer was a little too new to have a rectifier tube, being equipped with a selenium-stack diode instead. So I just went ahead and clipped one of the leads to the diode. I'll probably want to eventually replace it with a more reliable silicon diode, anyway.

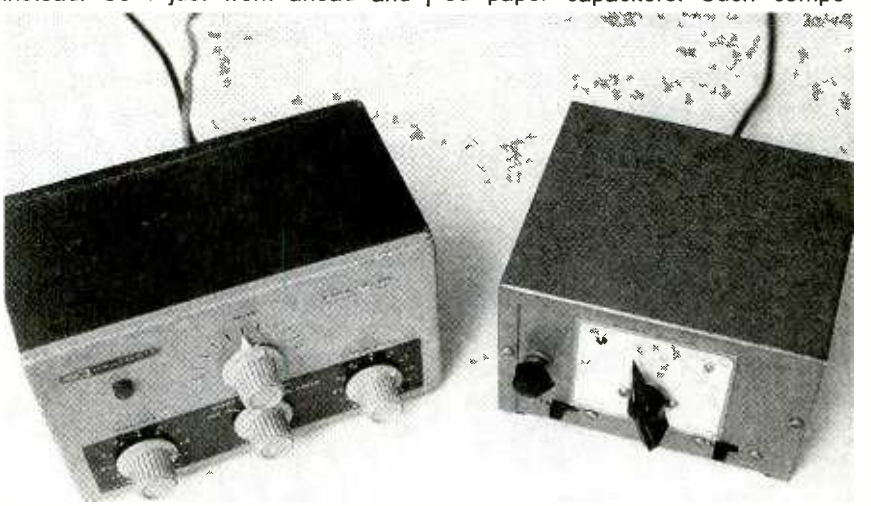
Plugging in the set, I switched it on and was pleased to see the glow of the twin pilot lights (one on either side of the slide-rule dial). That meant that the transformer's filament winding was okay. Then I connected a multimeter to the transformer's high-voltage secondary and read a voltage of 127. It seemed a little low, but transformer secondaries are usually good or bad—not in-between—so I'm assuming we are okay here. More on this when the documentation arrives.

WHAT'S NEXT?

My next moves on the Star Roamer, as with any vintage radio, will be cosmetic cleaning, housekeeping, and correction of obvious physical problems. I'll clean and polish the cabinet and front panel, remove the grime from the top of the chassis, and treat all of the potentiometers and switches with contact cleaner. There's a split control knob that needs attention, not to mention that cracked rear panel.

This is also the time for replacement of doubtful components. If the line cord and/or plug were defective (not a problem in this case), now would be the time to change it. All electrolytic filter capacitors are replaced on sight, as are all wax-coated paper capacitors. Such components are prone to leak—degrading set performance—or even fail, taking difficult-to-replace power or IF transformers with them. Luckily the Star Roamer's bypass and filter capacitors are ceramic-disc types, so wholesale recapping will not be required. There *is* a multi-section filter capacitor that will have to be replaced by four individual units (an exact replacement would be virtually unobtainable, of course).

Taking care of details like those up front greatly increases the odds that your radio will play the first time you plug it in. And, even if it doesn't, I can guarantee you that the troubleshooting process will be greatly simplified. ■



The Heath "Q Multiplier" (left) and the Holstrom Associates preselector, found along with the Star Roamer, were apparently used as accessories for it.

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200V	100mV	
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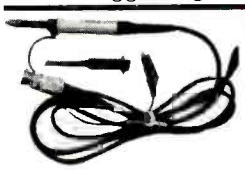

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GS114	114mm x 185mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80

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.

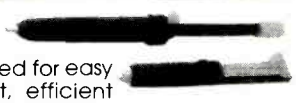
CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50

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

!!!!!!! SEE OUR ON-LINE CATALOG AT http://www.cir.com !!!!!!!

www.americanradiohistory.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.

AS LOW AS $50.00

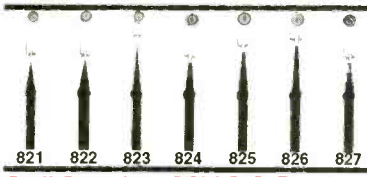
CAT NO	DESCRIPTION	PRICE EACH 1	5
SL10	Temp Controlled Soldering Iron	$56.00	$50.00
SL24V	Spare 24V Soldering Iron	10.50	7.50

Electronic Soldering System with LED Display

Deluxe temperature controlled system with LED display for maximum accuracy. Temperature is adjustable from 160°-480°C (320°-900°F). Iron heating power is 48 Watts. Runs on 24V from controller unit. Replacement irons and tips are available. Tip size is 5.3mm.

AS LOW AS $75

CAT NO	DESCRIPTION	PRICE EACH 1	5
SL30	Deluxe Soldering System w/LED	$86.00	$75.00
SL24V	Spare 24V Soldering Iron for SL10 or SL30	10.50	7.50



Replacement Tips for SL10/SL30

We now offer a variety of replacement tips for the SL10/SL30 soldering stations.

CAT NO	DESCRIPTION	PRICE EACH 1	5
821	1/32" Pencil Tip	$1.39	$1.19
822	1/32" Pencil Tip	1.39	1.19
823	1/64" Pencil Tip	1.39	1.19
824	1/16" Chisel Tip	1.49	1.29
825	1/8" Chisel Tip	$1.49	$1.29
826	3/64" Chisel Tip	1.49	1.29
827	3/64" Pencil Tip	1.59	1.39

Ball Bearing 12V DC Fans

These High Quality Fans feature Ball Bearings and Brushless DC Motors. All of them are designed to meet UL, CSA & VDE Standards. Design these fans into power supplies, computers or other equipment requiring additional air flows for heat removal. These fans are regular Circuit Specialists stock items — they are not surplus.

INDUSTRY BEST PRICING!

CAT NO	PRICE EACH 1	10	25	100
CSD 4010-12	$ 9.88	$ 6.38	$5.48	$4.87
CSD 6025-12	9.38	5.91	5.41	4.71
CSD 8025-12	8.88	5.85	5.19	4.49
CSD 9225-12	8.95	6.14	5.29	4.59
CSD 1225-12	11.45	8.96	7.82	6.85

Specifications

CAT NO	DIMENSIONS (MM)	RATED VOLTAGE (V)	START VOLTAGE (V)	INPUT CURRENT (A)	AIR FLOW (CFM)	STATIC PRESSURE (INCH-H_2O)	SPEED (RPM)	NOISE LEVEL (dB)	WEIGHT (g)
CSD 4010-12	40x40x10mm	12	7	0.06	5.1	0.19	5,500	26	20
CSD 6025-12	60x60x25mm	12	5	0.13	13.7	0.165	4,500	28	65
CSD 8025-12	80x80x25mm	12	5	0.16	37.8	0.177	3,000	31	80
CSD 9225-12	92x92x25mm	12	5	0.32	42	0.18	2,800	37	95
CSD 1225-12	120x120x25mm	12	5	0.35	62	0.180	2,500	42	135

• SOLDER • SOLDER • SOLDER • SOLDER • SOLDER • SOLDER •

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 connectiong three wires: red to 12V, black to ground (power & video) and brown to video signal output.

CAT NO	DESCRIPTION	PRICE EACH 1	5
CA-H34A	PCB Mounted IRCCD Camera	$125.00	$109.00

!!!!!! SEE OUR ON-LINE CATALOG AT http://www.cir.com !!!!!!

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TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). If you do not specify a category, we will place your ad under miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but, in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $1.75 per word. Minimum charge is $26.25 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues. **Sorry, no discounts on credit-card orders. Boldface (not available as all caps),** add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad,** add 25%. **Tint screen plus all boldface ad,** add 45%. **Expanded type ad,** add $2.25 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. POPULAR ELECTRONICS is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in POPULAR ELECTRONICS is limited to electronics items only. All ads are subject to the publishers approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $1.75 per word, Minimum $26.25

Send you ad payments to:
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100 – Antique Electronics
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Place this ad in Category #_____ **Special Category $20.00 Additional** _____

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9 - $26.25	10 - $26.25	11 - $26.25	12 - $ 26.25
13 - $26.25	14 - $26.25	15 - $26.25	16 - $28.00
17 - $29.75	18 - $31.50	19 - $ 33.25	20 - $35.00
21 - $36.75	22 - $38.50	23 - $40.25	24 - $42.00
25 - $ 43.75	26 - $45.50	27 - $47.25	28 - $49.00

29 - $50.75	30 - $52.50	31 - $ 54.25	32 - $56.00
33 - $57.75	34 - $59.50	35 - $61.25	36 - $63.00
37 - $64.75	38 - $66.50	39 - $68.25	40- $70.00

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CRYSTAL TRANSMITTER KITS
- Ultra-miniature surface mount construction.
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- Miniature battery and holder mounted directly to the circuit board.
- Transmit to any scanner type receiver

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TRACKING TRANSMITTER KIT
Transmits continuous beep-beep-beep
Ideal for locating lost or stolen items
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Sensitive built in microphone
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XTL1000
TRANSMITTER KIT
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BUG DETECTOR

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$149.95

- **Professional quality.**
- **Not a kit**, ready to use.
- Covers 1 to 2,000MHz.
- Uses new Microwave Integrated Circuit amplifier.
- Adjustable sensitivity.
- Audio jack for privacy ear phone.

Any intercepted signal causes an audio tone that increases from a low pitched growl to a high pitched squeal as the signal strength increases.

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- As small as a hearing aid.
- Weighs less than 1/4 oz.
- Digital touch tuning.
- Ideal for use with our 88-108MHz FM transmitters

88-108 MHz FM TRANSMITTER KITS

XST 500 $44.95 | **XWB 1000** $46.95 | **XFM 100** $21.95

XSP 250 $28.95 | **XTR 100** $29.95 | **XTT 100** $19.95

XST 500 Voice transmitter. Range up to 1 mile. Supersensitive mic. Uses 9 volt battery. Uses surface mount components.

XWB 1000 Voice transmitter. Range up to 1/2 mile. Includes mic and battery on circuit board. Uses surface mount components.

XFM 100 Voice transmitter. Range up to 1 mile. 9 v battery and leaded components.

XSP 250 Super-miniature telephone transmitter. Range 1/4 mile. Powered by phone line. Uses surface mount component.

XTR 100 Tracking transmitter. Range up to 1 mile. Uses 9 volt battery. Transmits a BEEP - BEEP - BEEP tone

XTT 100 Telephone transmitter. Range up to 1 mile. Uses 9 volt battery.

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TV CAMERA
400 LINES OF RES
- Use any TV or VCR with a video input connector.
- Includes power cube.
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- See entire room through pin sized hole.

Assembled $269.95

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- Use with XPC400, VCR, Camcorder, etc.
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- Transmits video and audio.
- Up to 100 foot range.

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16 levels of digital voice changing. Sound tougher, older or younger, female or male. Both use modular phone jacks.

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Use as regular or voice changing phone

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- TouchTone coded for secure operation.
- Stop burglars and intruders.
- Reliable 24 hour protection.

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- Uninterrupted coverage of the 800 to 950 MHz band!.
- Works with any 400-550MHz scanner.
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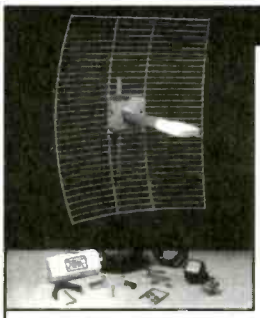

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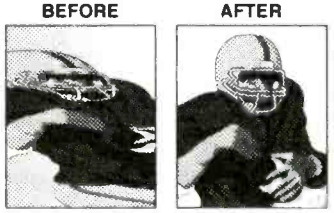

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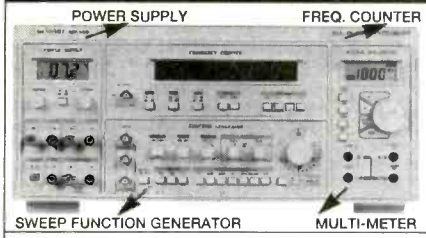

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1 Function Generator
- Sine, Square, Triangle, Pulse, Skewed Sine, Ramp, TTL
- 0.2 Hz ~ 2MHz

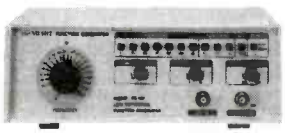
2 Frequency Counter
- 8 Digit LED
- 1 Hz ~ 100MHz
- ± (1 Hz + 1 dgt. + Time Base Error)

3 Power Supply
- 3-1/2 Digit LCD
- Triple output: #1. 0~50V, 0.5A MAX #2, 15V, 1A #3. 5V, 2A

4 Digital Multimeter
- 3-1/2 Digit LCD
- DCV, ACV, Ω, DCA, ACA
- ± (0.5% + 2 dgts)

FG-140 2MHz Function Generator

Reg. $249. **$149.00**



- 0.2 Hz ~ 2.0 MHz, 7 Decades
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- VCF, Symmetry
- Variable DC Offset Control

2MHz Sweep Function Gen. w/Freq. Counter

FG-150

Reg. $399. **$229.00**

- 4 Digit LED Display
- Sine, Square, Triangle, TTL, Pulse, Ramp, Skewed Sine
- Linear/Logarithmic Sweep
- 10 MHz Freq. Counter

1.0GHz Frequency Counter, High Resolution

FC-200

Reg. $399. **$219.00**

- 1.0 Hz ~ 1.0 GHz
- 8 Digit LED Display
- Auto & Manual Range
- 4 Selectable Gate Times
- 1MΩ & 50Ω Input Impedance

Oscilloscope Probe Set

Switch Selectable X1/X10

HP-9060, 60MHz Reg. $29. **$17.00**
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PS-500 DC Power Supply

Reg. $249. **$159.00**

- 0-30 VDC
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- Short & Overload Protection

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- Short & Overload Protection

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OS-3304 Reg. $499. $349.00

OS-3324 Reg. $599. $429.00

OS-3344 Reg. $899. $649.00

OS-3304 25MHz, Dual Trace

1 • DC to 25 MHz. Dual Channel
- 6" Rectangular CRT with Internal Graticule 10x8cm (Phillips P31)
- Uncalibration LED.
- High Sensitivity 1 mV/div to 2mV/div X-Y modes, Z Axis (intensity modulation)
- Rise time 14n Sec. or less.
- Full TV Trigger for TV-V & TV-H
- Acceleration Potential 2kV
- 60MHz (X1.X10) Probe Kit: 2 sets
- Power: 115/230V AC

OS-3324, 3 Function

1 • OS-3304

2 • Dual Component Tester/Comparator

3 • Triple DC Power Supply 5VDC, +12 VDC, -12VDC

OS-3344, 5 Function

1 + 2 + 3 • OS-3324

4 • Frequency Counter 100MHz, 7 Digit LED Display

5 • Function Generator 0.02 Hz to 2.0 MHz

OS-3315 40MHz, Dual Trace Sweep Delayed

Reg. $799. **$549.00**

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- Delayed Sweep 100nS to 1.OS 7 decade
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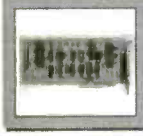

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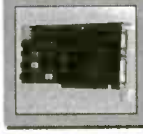

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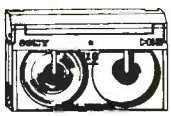

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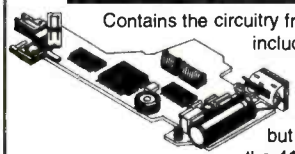

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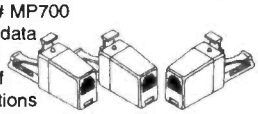

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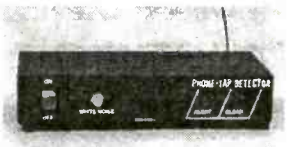

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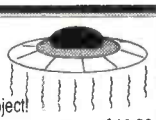

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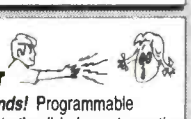

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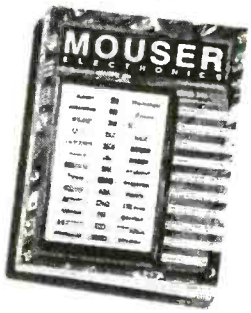

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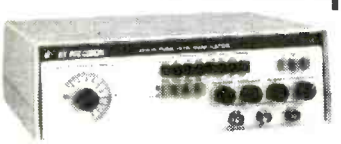

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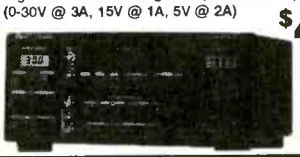

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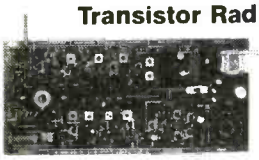

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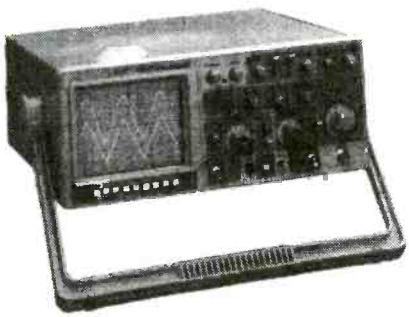

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S-1360	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1345	40	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1340	40	1mV/div	2	10ns/div	No	Yes	No	No	1
S-1330	25	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1325	25	1mV/div	2	10ns/div	No	Yes	No	No	1

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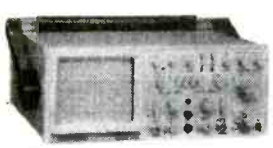

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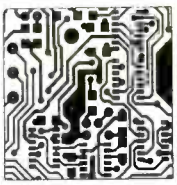

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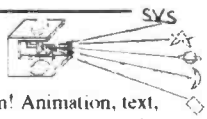

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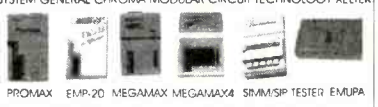

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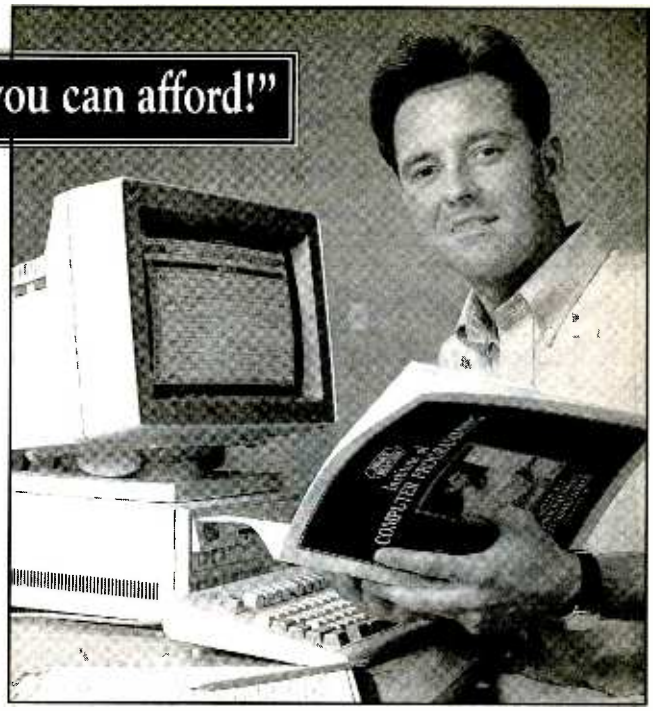

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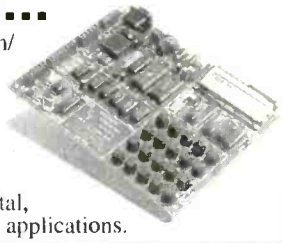

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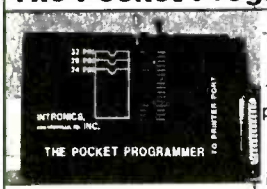

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POPULAR ELECTRONICS magazine does not assume any responsibility for errors that may appear in the index below.

Free Information No.		Page
33	Ace Communications	88
—	AES	110
26	Alfa Electronics	84
28	All Electronics	101
—	Allison Technology	85
—	Allstar Electronics	93
39	AMC Sales	102
—	American Innovations	103
—	Andromeda Research	111
—	Basic Electrical Supply	105
30	Bel Merit	99
—	Black Feather	111
32	C&S Sales	106
—	Cable Discount	86
—	Circuit Specialists	94
—	Cleveland Inst. of Electronics	37
—	Command Productions	86
—	Computer Business Services	102
—	Comtrad Industries	CV3, 5, 28
—	Consumertronics	100
139	Dalbani	91
—	DC Electronics	90
137	Electronic Rainbow	80
—	Foley-Belsaw	109
—	Forest Electronics	88
—	Fotronic Corporation	81
—	General Device Instruments	108
—	Grantham College of Engineering	4
—	Greenleaf Electronics Inc.	110
—	Halcyon Group	105
—	Home Automation Systems	111
158	Home Controls Inc.	11
—	I.E.C.	104
—	Information Unlimited	103
13	Interactive Image Technologies	CV2
—	Intronics	112
—	KDE Electronics	103

Free Information No.		Page
—	Learn, Inc.	65
—	M&G Electronics	110
151	MCM Electronics	83
—	MD Electronics	87
—	Mega Electronics	113
48	Mendelson's	104
—	Mental Automation	85
157	MicroCode Engineering	3
—	Millennium Enterprises	112
—	Modern Electronics	102
138	Mouser	105
—	NESDA	50
—	NRI Schools	17
—	Ohio Automation	108
43	Optoelectronics	CV4
—	Orion Electronics	108
150	Parts Express	104
149	Phillips Tech	98
47	Prairie Digital Inc.	100
46	Print	85
45	Print	93
—	Protocol Electronics	104
—	Quality Entertainment	88
159	Radio Shack	7
—	Show Time	100
—	Silicon Valley Surplus	108
—	Skyvision Inc.	89
—	Tab Books	13, 53
—	TKA Electronics Inc.	82
136	UCANDO Videos	86
—	US Cyberlab	102
—	Vision Electronics	98
—	Visual Communications	113
—	Weeder Technologies	108
—	World College (Div. of C.I.E.)	9
—	WPT Publications	98
134	Xandi Electronics	97

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

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

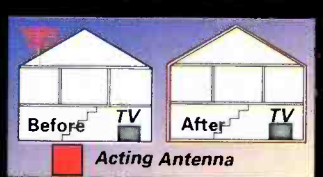
by David Evans

Technology corner

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

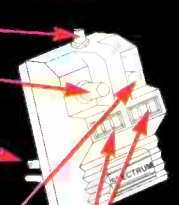
- When TV signals are tuned at the TV channel's center frequency, optimum tuning has been achieved.
- Other antennas can't offer center frequency tuning like the Spectrum Antenna can. They only offer such tuning up to the edge of the center frequency. As a result your TV picture remains snowy.

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



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

3. Spectrum antenna features



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For selecting multiple antenna configurations

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

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

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

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

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

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

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

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

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

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

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