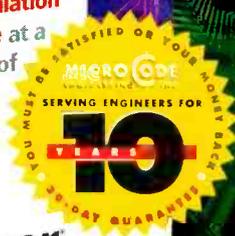
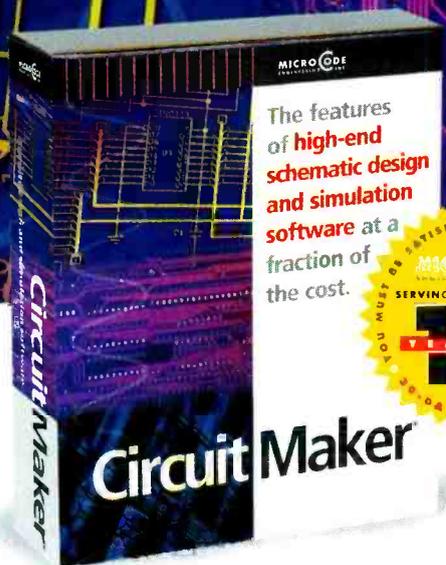


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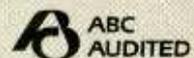
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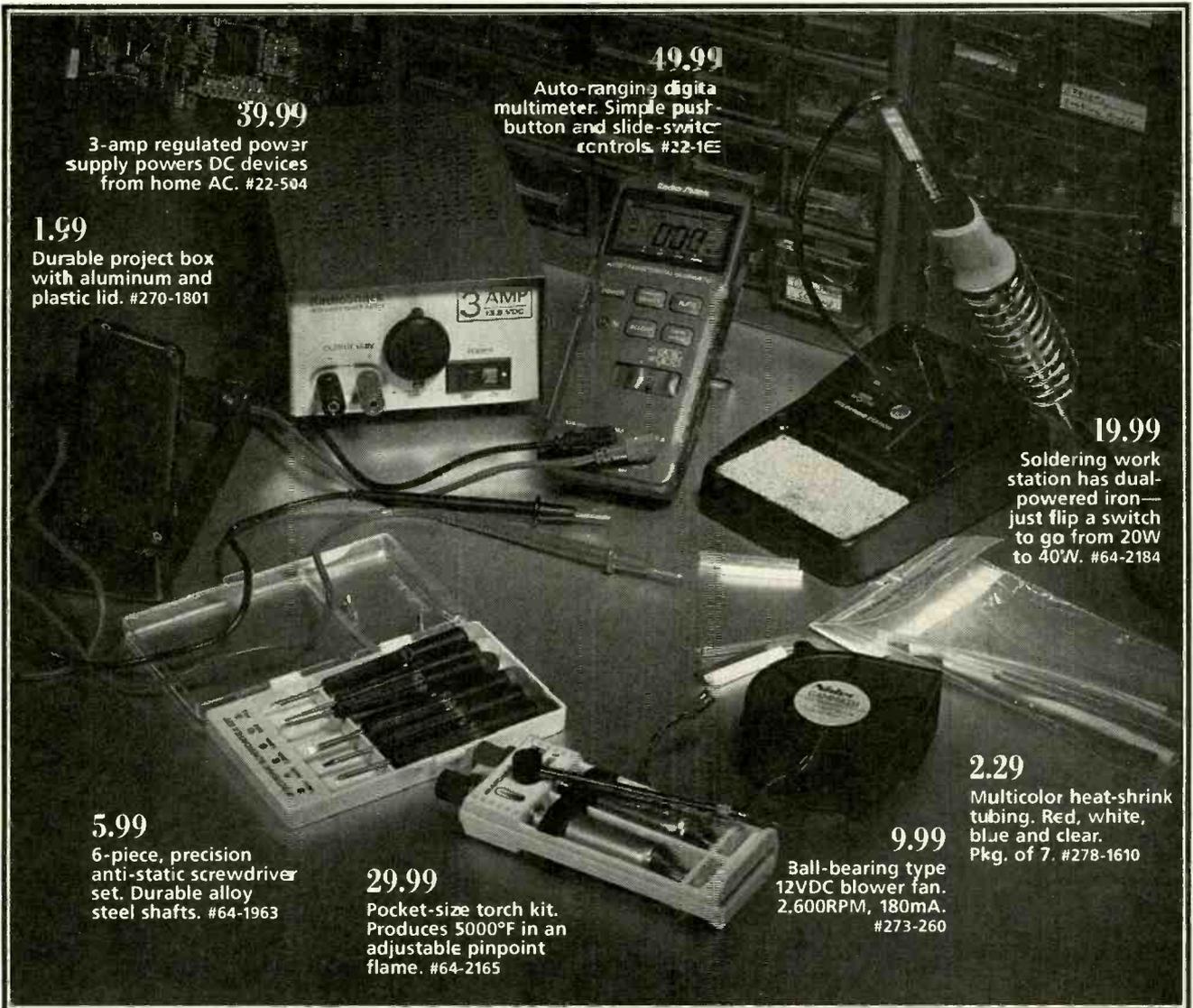
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EDITORIAL

Military Spin-offs

As we approach the end of 1998, we are being bombarded with next year's breakthroughs—new styles, new electronics, new models and, of course, new automobiles. Jumping one full year ahead of the pack, *General Motors* announced that an option starting in its year-2000 *Cadillac DeVille* would be a "Night Vision System." This system uses infrared technology to detect people or animals in the dark or to improve driving visibility beyond the glare of an oncoming car's headlights. The system then projects these images in black and white on a virtual screen superimposed on the windshield. While viewing this virtual display, the actual driving scene is still in the driver's vision. This system is unique, since it is a direct application of two developments from the military world; namely *Forward-Looking InfraRed (FLIR)* and *Head-Up Display (HUD)* systems. Both of these technologies, introduced in the 1970s, were extensively used in the military arena; notably in major fighter aircraft. In particular, infrared, or thermal-imaging technology, has also spilled over into the local law enforcement and fire department agencies, and many commercial enterprises.



In a similar fashion, think about the benefits that we have derived from other military spin-offs. The *Global Positioning System (GPS)*, which has placed 24 satellites in orbit about the earth, was originally developed by the military for precise missile deployment, and exact personnel location and positioning on land, water, and in the air. Now the GPS is widely available for world-wide communications, is a key element in personal location and direction-finding equipment, is used in aeronautical and vehicular navigation, is an integral part of the smart highway system (see this month's cover story), and is used or will be used in countless other applications.

How about the funding for development of all the small electronics gadgets that we enjoy in our homes today? Would the micro-miniaturization we currently see in our commercial products have evolved with research and development funds from commercial entrepreneurs? I think not. Going back to World War II, do you think commercial industry would have naturally developed atomic energy or even radar if it were not that the government felt that it was in national interests to fund these projects? So let's remember that money spent on military spending today may reap benefits for the consumer in the future.

On a much lighter theme, be sure to examine this month's "Gift-Giving (-or Getting) Guide" in our *Gizmo*® section when you plan your holiday shopping. Also described throughout the columns in this issue are many other novel items that should find their way under your holiday tree, on your library shelf, inside your PC, or in your ham shack. On behalf of the staff at **Popular Electronics**, I would like to wish you and yours a very joyous Holiday season and a very happy and healthy New Year.

Ed Whitman
Managing Editor



Philips Magnavox WebTV Plus Internet Receiver

*Integrate TV viewing and Web browsing
with a system that is user friendly.*

Philips Magnavox put common sense into television viewing and Web browsing by combining both activities with a new high-performance, user-friendly Internet receiver.

The result makes television more entertaining, and the Internet more widely available to the family—all viewable on the largest TV screen in your home. The *Philips Magnavox WebTV Plus Internet Receiver* is not just Web surfing—it's enhanced TV! Imagine surfing the Internet *without* a personal computer, having the World Wide Web as accessible as your antenna and cable television programs, and viewing everything over your 29-inch, 32-inch, or larger TV set. Philips makes this possible with their *WebTV Plus Internet Receiver*.

With easy access to both television programming and to the Internet for unique program information, WebTV lets you watch your favorite television shows while connected to the Web. You can instantly access Web-site links embedded in television programs and commercials (it's happening now), and enjoy enhanced graphics and performance every time you log on to WebTV. And, there is e-mail, too!

The WebTV Plus is the first to offer a picture-in-picture (PIP) feature. You watch a television program while simultaneously maintaining a connection to the Web, even if your television set does not have PIP capability. Watch your favorite TV show and retrieve your e-mail at the same time without ever having

to leave your living room couch. The WebTV Plus comes with a built-in electronic program guide that allows you to receive text and video information about all the pro-

grams available on your TV system. This guide is updated daily from the Web and is continuously available to the user, both while online and offline.

being incorporated into broadcast programs and commercials and will become more prevalent throughout the year. Imagine you are watching a TV documentary on the space program and simultaneously link up to the NASA Web site for additional information on a specific topic. Or, if you are in the market for a new car, you can click on the Web-site link in an advertiser's TV commercial and instantly get more information on the automobile's availability, options, and local dealers. The possibilities are endless and exciting. WebTV crossover links is revolutionary technology that puts a humongous source of information at your fingertips with a click of the remote control.

Additional Features. The *Philips Magnavox Web Eye* remote infrared receiver and LED display is a small unique companion unit that comes with the WebTV. This Web Eye is a saucer-like receiver that sits on top of your television set, allowing the larger WebTV Plus receiver cabinet to be placed behind a couch or plant, be hidden behind the television, and be out of view. Messages are then sent to the main receiver through a thin cable, which connects the Web Eye to the receiver. Communication through the Web Eye to the WebTV Plus receiver are initiated by on-screen commands, a universal remote control that accompanies the unit, or an optional remote wireless keyboard.



It looks like an audio component! It is the Philips Magnavox WebTV Plus Internet Receiver that combines TV viewing with Web browsing. The saucer-shaped component is the Philips Web Eye that receives infrared control signals from the remote control and remote wireless keyboard.

TV Crossing Link. The unit's integrated WebTV crossover links feature provides instant access to Web sites when you click on embedded links in television programs or commercials. A "1" appears in the upper right corner of the screen to indicate that a TV crossover link is available. By engaging the TV crossover link, you have the option to access a related Web site, while still watching TV. TV crossover links are a revolutionary technology that puts a virtually unlimited source of information at your fingertips with a click of the remote control or wireless keyboard. These crossover links are now

All home-theater equipment is just a click away when using the remotes, which connect you to the television, VCR, DVD video, stereo unit, and the *Philips Magnavox WebTV Plus*. Communications is accomplished with infrared light pulses that you cannot see or hear.

A built-in printer port on the WebTV Plus connects directly via a DB25 parallel port to selected *Hewlett-Packard* and *Canon* printers, for printing e-mail messages and Web-site information. Other printer models and manufacturers will be supported as software drivers become available.

You can expect quick Web connections and downloading of Web pages thanks to a 167-MHz 64-bit mips RISC processor and a 56-kbps modem. A built-in 1.08-GB internal IDE hard drive allows offline Web caching and enhances the performance of the system. The WebTV Plus also offers highly advanced graphics and video performance, providing full-screen, full-motion video, and customized graphics acceleration. Even experienced Web users will be thrilled by the enhanced performance of online visuals, from Web pages to animated graphics. Of course there is unbeatable Web-sound coverage.

The WebTV Plus has parental control features that allow parents to block a child's access to inappropriate Web sites. Furthermore, parents can also restrict their child's ability to send and receive e-mail or use the chat feature.

A line-share feature allows incoming telephone calls to ring through, while WebTV Plus is in use on a call-waiting-equipped phone line, enabling users to put the Web on hold and not miss important incoming phone calls. Line share inhibits WebTV Plus activation when phones are in use and eliminates the need for a second phone line. When you have children at home, this feature is invaluable.

A silent message watch feature automatically dials in to see if there is new e-mail regardless of whether the WebTV Plus is activated or not. It lights a "message" LED on both the WebTV Plus and the Web Eye when e-mail is received. With the optional remote keyboard, e-mail can be

written and sent whenever you like while viewing TV or the Web.

This reviewer believes that the most important feature of the WebTV Internet Plus is that the system is welcome in any room of the house where a TV monitor is located and a bulky desk-top computer is not. Additionally, for those who have to forgo the purchase of a computer, the WebTV Plus is a bargain purchase considering the horizons it opens. The *Philips Magnavox WebTV Plus Internet Receiver* is available for \$199.95 plus \$49.95 for the remote wireless infrared key-

board (manufacturer's suggested list prices). Contact *Phillips Consumer Electronics Company*, 64 Perimeter Center East, Atlanta, GA 30346; Tel. 888-813-7069, or circle no. 120 on the Free Information Card for additional details. Visit the *Philips Magnavox* site at www.philipsmagnavox.com/.

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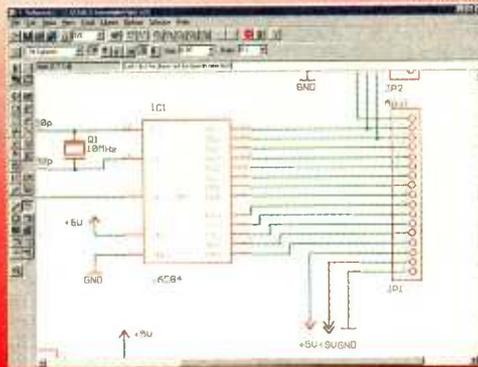


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All About Antennas

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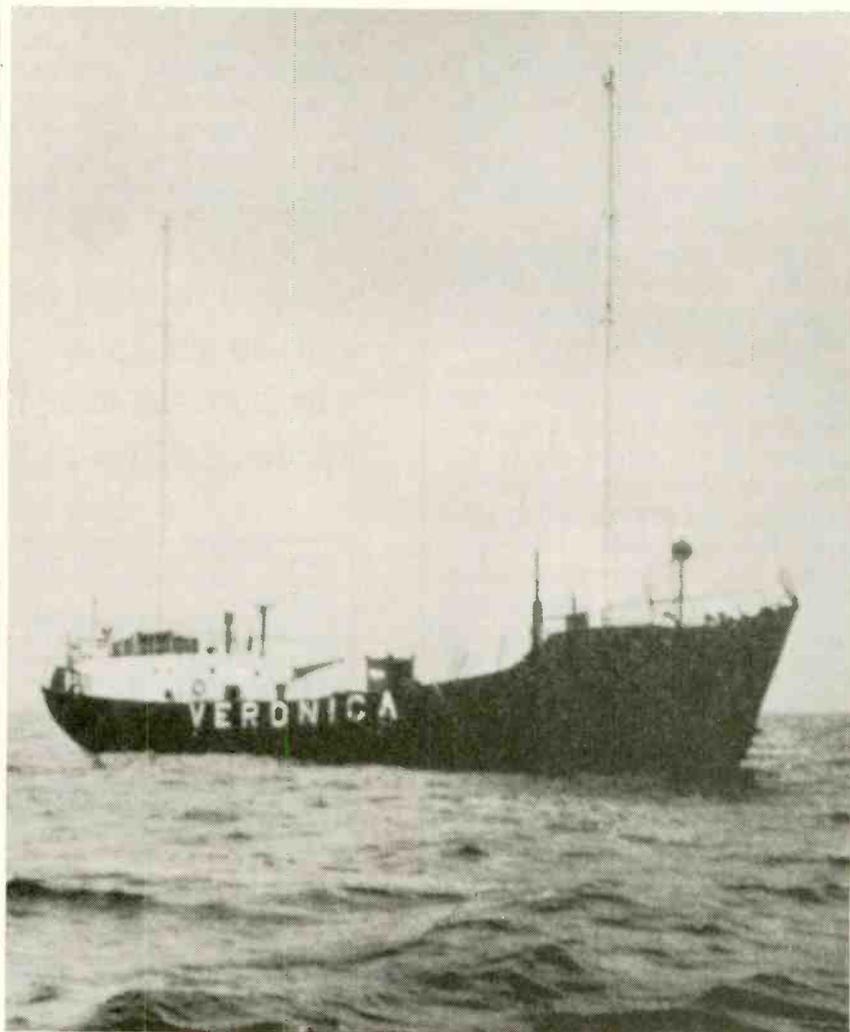
Antennas—that is a subject that brings in quite a bit of mail from our readers. What sort of antenna should I use for shortwave listening? Indoor? Outdoor? How long should it be? What about directionality? Do I need some fancy antenna design? These are typical of the queries received.

A shortwave antenna captures electromagnetic energy—a radio signal—transmitted from a distant station and converts it into an electron flow to your receiver. Then, of course, your radio changes this into an audible signal, which is the programming you hear. Antenna design can be a very complex subject. There are books, primarily intended for ham-radio operators, which have detailed information on constructing antennas. But because they emphasize transmitting antennas and get all involved with things like standing waves, baluns, *etc.*, SWLs often are turned off or scared off. Fortunately for the less technically minded, a receive-only shortwave antenna can be a lot simpler.

Portable SW receivers come with some type of built-in telescoping antenna. For many listeners, especially apartment dwellers and others unable to install an outdoor antenna, this is the only choice. And while these “whip” antennas often work reasonably well, the serious shortwave DXer will generally fare better with an outdoor antenna.

What would an ideal SWLing antenna be like? It would be broadband; that is, it would work well on all, or at least most, of the shortwave-frequency bands. It would be directional and have “gain.” This means it would receive signals better from one direction than others, and when compared to a simple dipole antenna, the signals from that direction would be stronger. Being directional, the ideal antenna would

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The Dutch pirate broadcaster Radio Veronica was one of the 1960's unlicensed shipboard stations that introduced European radio audiences to American-style commercial radio, with distinctive promotional jingles.

have to be rotatable, so it could be “pointed” in the direction of the desired signal, or away from an interfering station to minimize its interference. The ideal SW antenna also should be of a convenient size and, finally, inexpensive to buy or construct.

There are SW receiving antenna designs that are broadband, directional, have gain, are rotatable, compact, and cheap to build. There are antennas that have several of these characteristics. But there are no antennas that have them all. For example, beam antennas

with directors and reflectors—parallel elements fore or aft of the active portion of the antenna—offer gain and directionality. (If you still have a TV antenna, rather than a cable hookup, you will see what a small beam antenna looks like.) Then consider that the elements of, say, a 49-meter band (approximately 6000 kHz) SW beam would be about 80 feet long!

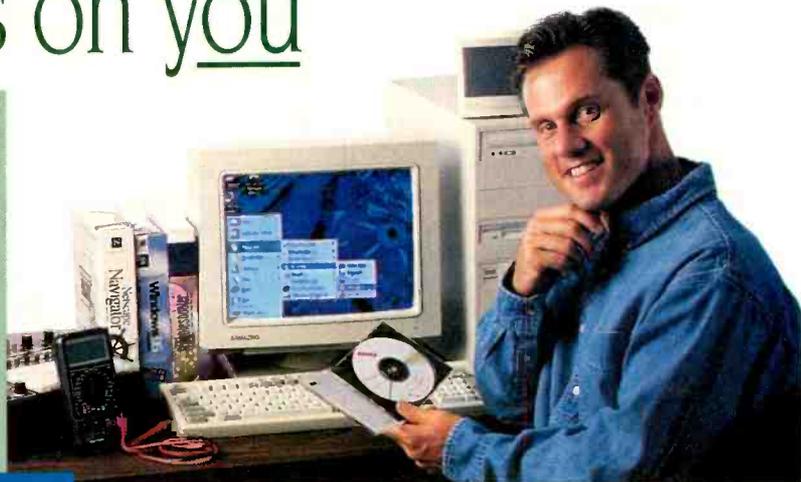
Veteran DXers dream of rhombics, diamond-shaped wire antennas that can offer a maximum of signal strength, plus directionality. Rhombics are even

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more impractical than beam antennas for most SWLs. A near ideal rhombic antenna for the shortwave 60-meter band (the frequencies around 5000 kHz) would be well over 1000 feet from end to end, and use more than two-thirds of a mile of wire! It would be impossible to "rotate" such an antenna toward various target stations in order to take advantage of its directionality and gain.

SIMPLE SKYWIRES

Practically, most shortwave listeners must content themselves with less elaborate outdoor wire antennas of more limited size. Perhaps the simplest of these is the old SWL standby, known variously as the single wire, the "long-wire," the inverted-L (because of the shape of the horizontal "flat top" and the vertical lead-in), or, rarely in this modern era, the Hertz antenna.

The "flat-top" of this antenna is a random length of wire, preferably more than about 25 feet and less than 150 feet, as high above the ground as practical, away from noise-makers such as

busy streets, power lines, and neon signs. While the "flat-top" typically is parallel to the ground, it may slope. The "flat-top" wire is terminated at each end with non-conducting glass or ceramic insulators. It is end-fed by a single lead-in wire leaving the horizontal "flat-top" at roughly a right angle. This lead-in, connected to the antenna terminals of your receiver, should be as short as possible.

Here are a few more practical tips on erecting a simple single-wire antenna:

- Use good, sturdy wire, such as No. 14 enameled copper wire. Stranded copper antenna wire is stronger, but even aluminum clothesline wire will work, though soldering a lead-in to aluminum can be a difficult task.

- If possible, have your antenna run at right angles to any power lines in your area, but for goodness sake, do not have your antenna cross any electrical service lines. Otherwise, don't worry about which way the antenna is oriented. Essentially it will receive equally well from all directions.

- Solder all exterior antenna connections for strength and electrical integrity, and spray solder joints with a clear plastic spray to protect against corrosion. Even so, in areas of high humidity and urban industrialization, figure on replacing your antenna wire every couple of years.

- In earlier times, I would have suggested installing an air-gap lightning protector along the lead-in. That's still not a bad idea, but the old-fashioned air-gap lightning protector alone usually doesn't offer enough protection for the delicate solid-state components in a SW receiver's "front end."

- If you live in an area where thunderstorms are common, you probably should consider a special equipment-protection device such as *Alpha Delta's TransiTrap LT* or *Design Electronic Ohio's (DEO) Receiver Guard 2000*. An expenditure of around \$30 can save a \$300 SW receiver. *Universal Radio Inc.* is a source for these items.

- A random length single-wire antenna will work best with an antenna tuner to "match" it to the receiver and frequency you're tuning. Some receivers have antennas built right in. A check of amateur-radio and electronic-project handbooks may turn up plans for a simple antenna tuner. Or you can buy one, such as the *MFJ-901B*.

Experimenting with antennas can be

a lot of fun. Your degree of success or failure—and few homemade antennas produce "bad" results—can be easily determined in a very practical way: by shortwave listening!

ANOTHER APPROACH

The seat-of-the-pants approach to antenna construction may not be for you, however. There are some easy-to-understand books available that shun the complicated formulas and give straightforward details on building receiving antennas specially designed for the SWL. These books include: *Build Your Own Shortwave Antenna* by Andrew Yoder (*McGraw Hill*), and *The Easy Wire Antenna Handbook* by Dave Ingram (*Universal Electronics*) both books are available from *Universal Radio Inc.* (see Sidebar). Also we have *Easy Shortwave Antennas* and *Limited Space Shortwave Antenna Solutions* (*Tiare Books*). Both of these books are by Frank P. Hughes and are available from the publisher *Tiare Books*.

There also are ready-made or easily-assembled shortwave antennas, simple or elaborate, on the market. Among them are the full-spectrum *Alpha Delta DX-Ultra* antenna, the shorter *Alpha Delta DX-SWL Sloper*, or its baby-brother, the *DX-SWL-S*; *Antenna Supermarket's Eavesdropper SWL Sloper*, and *Eavesdropper SWL Dipoles*; and *RF Systems Inc. MLB Mark 1* and *Mark 2*. There also are mini-loop receiving antennas by *Palomar Engineers* and *Kiwa*. These all can be found in *Universal Radio's* catalog or by contacting the manufacturer directly.

JINGLE ALL THE WAY

Some organization, previously unknown to me, the *Dutch Society of Radio Jingles and Themes*, has issued a 65-minute CD, apparently the first in a planned series, titled *The History of Offshore Jingles, Part 1*. Though common promotional gimmicks by U.S. AM broadcasters, station jingles weren't heard in Europe until the 1960s, when the first unlicensed medium-wave pirate stations began broadcasting illegally, though successfully, from shipboard stations off the Scandinavian coasts. Radio jingles soon were popular attractions on the then-new European commercial stations. Apparently, as the Dutch group's CD suggests, they remain so today.

Mike Barraclough, writing in the

FOR MORE INFORMATION

Alpha Delta Communications, Inc.

P.O. Box 620
Manchester, KY 40962
888-302-8777

Kiwa Electronics

612 South 14th Avenue
Yakima, WA 98902
509-453-5492
Web: www.kiwa.com

MFJ Enterprises, Inc.

P.O. Box 494
Mississippi State, MS 39762
800-647-1800
Web: www.mfjenterprises.com

Palomar Engineers

Box 462222
Escondido, CA 92046
760-747-3343

Tiare Publications Group

P.O. Box 493
Lake Geneva, WI 53147
414-248-4845
Web: www.tiare.com

Universal Radio Inc.

6830 Americana Parkway
Reynoldsburg, OH 43068
800-431-3939
Web: www.universal-radio.com

World DX Club's monthly publication, *Contact*, observes that most European shortwave stations are jingle-free. "One exception," he writes, "is Radio Netherlands' Media Network, which includes several promos linking (program segment) items..."

Anyone interested in more information about the jingle CD may write *Offshore Echoes*, P.O. Box 1514, London W7 2LL, England.

DOWN THE DIAL

Looking for some interesting listening? Try these on cold winter nights:

CHINA—6937 kHz, China Radio International broadcasts in English around 1515 UTC, when it has been heard with political and economic talks. Though programming originates in Beijing, the transmitter may be at Kunming in Yunan Province.

GUATEMALA—4799 kHz, Radio Buenas Nuevas has a brief half hour transmission in Spanish between 1200 and 1230 UTC, with news and band music.

IRAQ—11785 kHz, Radio Iraq International's English service has been logged at 0410 UTC with news and commentary, and then Middle East music. Interference begins shortly before the hour.

NICARAGUA—5770 kHz, Radio Miskut has been heard here in Spanish with popular rhythms and ballads until sign off at 0201 UTC.

PERU—6675 kHz, Radio Ondas del Rio Maranon (Waves of the Maranon River) has a program of dedications and huayno music, typical of the Peruvian Andes, until shortly before sign off at 0107 UTC.

RUSSIA—7315 kHz, Germany's Deutsche Welle is relayed by a Siberian transmitter at Novosibirsk. It has been heard with German programming, including beer-hall melodies, at 1145 UTC. The program is broadcast in parallel on 7340 and 9480 kHz.

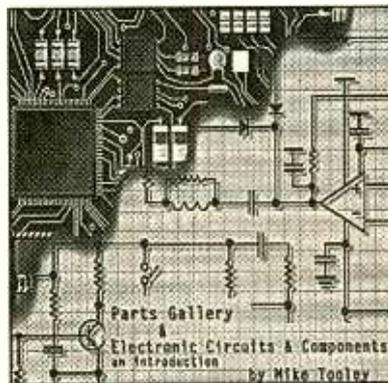
SLOVAKIA—5930 kHz, Radio Slovakia has English programming at 0100 UTC. News and a trade talk follow the station's tuning signal and identification.

TANZANIA—11734 kHz, Radio Tanzania, Zanzibar, broadcasting from the fabled spice island in the Indian Ocean, programs in Swahili until 2100 UTC sign off. It has been heard with Islamic prayers, Afro-pops, and sign-off anthem. ■

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- Self-test Component and Symbol quizzes • Hundreds of electronic symbols

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A series of interactive CD ROMs provides a comprehensive and up-to-date introduction to the world of electronics. The series provides a sound understanding of the principles and behavior of electronic components and the circuits to which they are connected. Two new CD ROM disks are to be released in the very near future. They are **Analog Electronics** and **Digital Electronics**. As soon as they are released, information on their contents and availability will be published.

Claggk Inc., PO Box 4099
Farmingdale NY 11735-0792
e-mail: claggk@poptronix.com



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Address _____

City _____ State _____ Zip _____

Enclosed is \$56 for each Student version of **The Parts Gallery** and **Electronic Circuits & Components** on a single CD ROM, shipping included inside the U.S. Shipping costs to Canada an additional \$3.00. Overseas orders please contact CLAGGK, Inc. for shipping costs.

I am ordering (....) copies at \$56 each. NY State residents must include sales tax.

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Visa MasterCard Discover Expiration Date: ___/___/___

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(Name on order and signature must be same as on Credit Card.)

MULTIMEDIA WATCH

A Different Printer and Lots More High-Tech Gadgetry

MARC SPIWAK
TECHNICAL EDITOR
COMPUTER RESELLER NEWS

I've been making color printouts from my computer at home using an unusual printer that's not laser, ink-jet, solid-ink, or even dot-matrix. This printer, the new *ALPS MD-1300*, is actually a dye-sublimation printer, which uses technology that delivers continuous-tone images. Colors blend smoothly into each other without the abrupt color shifts of inkjet printers. Graduations are smooth and seamless, detail is sharp, and colors are vivid.

What is neat about the MD-1300 printer compared with the *Olympus P-300* photographic printer that I love so much is that the MD-1300 can print on 8 × 10 and 8 × 13-inch paper, while the P-300, which uses similar technology, cannot print on anything larger than album-sized sheets.

The *ALPS MD-1300* requires special *ALPS* "ink" cartridges, as well as special paper for getting the best quality results. It uses the proprietary "Micro Dry" ink in a dye-sublimation printing process. The cartridges look like small cassette tapes, and you load up to four of them into the printer with the colors required for what you're printing (standard: cyan, magenta, yellow, black; or metallic: cyan, magenta, gold, silver). There are special clear-coat ink cartridges, metallic ink, white ink, and more. You can see the color of the print material on each reel. Though I can't seem to get quite the same photo print quality out of the MD-1300 as I can from the P-300, the *ALPS* printer has a lot more functionality.

When you don't have to print special color output, you can change to standard ink cartridges and print draft proofs and documents up to 1200 dpi. The Micro Dry inks resist fading and smearing and are waterproof. Specialty print media such as stickers, photo labels, T-shirt transfers, tattoos, and bumper stickers are available. The printer is 19 inches wide by 11 inches deep by 7.5 inches high, and it weighs 14 9.9 pounds. The MD-1300 costs \$549.



The *ALPS MD-1300* uses *ALPS*' proprietary Micro Dry ink in a dye-sublimation printing process. The Micro Dry inks resist fading and smearing.

and Micro Dry inks are each in the \$12 price range. If you're into arts and crafts printing, you'll like this printer.

OLYMPUS DIGITAL PHOTO STUDIO

I've been saying for a long time that *Olympus* seems to be one step ahead of the pack in digital photography. This time they've got one foot each in two separate races with the first camera system that combines traditional film and digital photography in a single package. The package offers 2.1 megapixel digital images, a 4× optical zoom, and negatives, all for \$899. How is that possible when *Olympus*' best digital camera has a lower maximum resolution and costs more? Read on.

The *Olympus Digital Photo Studio* package combines the *Olympus Centurion S Advanced Photo System* camera (the type of camera that uses *Kodak Advantix* film or compatible brand) with an *Olympus ES-10* film scanner. The camera gives you true

photographic quality pictures. I had never used an Advanced Photo System camera before, so it was about time I tried out this new technology that's already a few years old.

Any Advanced Photo System camera requires a relatively recent type of film that provides modern perks over the age-old 35 mm film that we're all familiar with. Depending on the camera, Advanced Photo System film records images and data for each print, such as the date and time. The cartridge even indicates whether the roll is unexposed, partially exposed, completely exposed, or if it has been developed. The film cartridge indicates if it has been developed, because you get the cartridge back with your prints. Your negatives are stored safely inside the cartridge for future reprints, and you get a color contact sheet back with your prints so you know what's on the roll. The Centurion S camera also lets you compose images in three different aspect ratios—regular, bigger than regular, and panoramic.

I tried taking several examples of each size image on a 15-print roll and paid less than \$7 to get the film developed at a local drug store. Though I hear that the actual film inside these new cartridges isn't as wide as 35 mm, and thus not quite as high resolution, the print quality was good. Although I swear that none of these "new" do-it-all cameras take pictures as well as my nearly 20-year-old *Canon AE-1* does, the *Centurion S* does take nice pictures. It also does a lot that my old *Canon* can't.

The *Olympus Centurion S* looks similar to the *Olympus IS* series of 35-mm cameras as well as the D-500L and D-600L. The *Centurion S* has an 11 element all-glass 4× zoom SLR lens with a focal length from 25 mm to 100 mm, which is equivalent to 32 to 125 mm on a 35-mm camera. It has autofocus capability from 2 feet to infinity and a close-up macro function. Also offered are shutter speeds from 4 seconds to 1/2000 second and automatic exposure modes including full auto, stop action, portrait, night scene, and landscape.

The *Centurion S* allows for mid-roll film change, which not all Advanced Photo System cameras can do. You can use one film cartridge for a particular theme, or type of film for a particular setting (different speeds, slide, print, etc.), and change it before it's finished. Or you can take your film out and let someone else put film in the camera.

With the Advanced Photo System negatives safely stored inside a "smart" canister, it makes sense that a relatively smart device could talk to the negatives and perhaps even scan them—and the ES-10 film scanner can. It scans color or black and white Advanced Photo System film in a single pass with 24-bit color. You simply drop an exposed film cartridge into the ES-10 film holder and the film is automatically fed through the scanner. A contact sheet appears on the computer screen in minutes.

Photos taken with the *Centurion S* and scanned with the ES-10 provide 2.1 megapixels, or a resolution of 1910 × 1090. Compare that to the top-of-the-line *Olympus D-600L* digital camera with its lower resolution of 1.4 megapixels. A preview scan on the ES-10 quickly shows all images on a roll of film. Full-resolution scans take about 90 seconds, which yields a six-megabyte image file. The ES-10 connects to a computer through the parallel port. The scanner is plug-and-play, and you don't



Digital Photo Studio combines an Olympus Centurion S Advanced Photo System camera and an Olympus ES-10 film scanner. The package offers 2.1 megapixel digital images.

need to open the computer. A pass-through connector port on the scanner lets you hook up a printer or other device to share the port.

One neat benefit of this system is that you don't have to save scanned images on your hard drive. The negatives always remain in the film canister, so you can just scan them when you need them, and then delete them to free up drive space. The package comes with all the software you need to scan, manipulate, and catalog images on your computer. You can have a lot of fun with the *Olympus Digital Photo Studio*, plus get great photos and high-resolution digital images from one package.

CANON MULTIPASS L6000

When you're at work you never have to worry about faxing and copying because most offices have these appliances. It's only at home, or perhaps in a very small office, where those tasks become impossible because of a lack of equipment. Most people with home computers probably have a printer and fax/modem, but that's usually it. Sometimes it's a lack of funds and other times a lack of space that prevents being able to fax and copy.

In comes *Canon*, and of course many other manufacturers, with a solution to the cash/space shortage problem. It's called a multifunction printer, and *Canon's MultiPASS L6000* is a beauty. The MultiPASS L6000 features plain paper faxing and copying in a compact laser printer that delivers 600-dpi resolution at up to six pages per minute. It measures only 14.4 inches wide by 14.4 inches deep by 9.5 inches

high and weighs 19 pounds—so it's ideal for the home office.

The L6000 prints faxes up to six pages per minute, and internal memory can hold up to 20 separate documents totaling 122 pages. One-touch speed dialing for six locations and coded speed dialing for up to 50 more locations is plenty for most needs. Copying is simple, with single copies ready in 25 seconds. An automatic paper feeder holds up to 100 sheets. Separate pages can be copied or scanned automatically with the automatic document feeder. Images can be reduced to 70%, 80%, and 90% original size, but enlargements aren't possible.

The unit scans with 300-dpi optical resolution and 600-dpi software enhanced resolution in 8-bit grayscale. It takes about 20 seconds to scan a page, depending on content. You get all the software you need, plus OCR software that turns scanned documents into text. This very capable office appliance sells for around \$599.

ADDONICS' POCKET ZIP

ZIP disks are quite popular these days, but not necessarily with notebook computer users. *Addonics Technologies* is trying to change that with their *Pocket ZIP*, a 100-MB ZIP drive that connects to notebook computers through the PCMCIA slot, and is powered from the computer battery. That's good in that you can access ZIP cartridges anywhere, but it does shorten the run-time of your notebook computer. The drive is 4.4-inches wide × 7-inches deep × 0.9-inches high and weighs 13 ounces, so it's easy to pack and carry.



The Addonics Technologies ZIP 100 PocketDrive connects to notebook computers through the PCMCIA slot. It weighs only 13 ounces.

Any time you have to transport files larger than 1.4 megabytes, removable 100-megabyte ZIP disk cartridges will do the trick. The *Pocket ZIP* has a maximum data transfer rate of 1.4 megabytes per second and an access time of 29 milliseconds. The single PCMCIA connection to the computer provides for data transfer and power. The drive can also be powered from the included AC power adapter. This neat drive has a street price of around \$249.

POWERMAX ISDN

Lots of people are starting to use ISDN for faster access to the World Wide Web. And now there's a product that protects PCs from transients on both ISDN and AC power lines. The *Powermax ISDN* from *Panamax* provides protection for high-speed ISDN lines and AC lines against power surges, spikes, and lightning. An auto-resetting fuse prevents unnecessary downtime. Six protected AC outlets are featured. This unit has a suggested retail price of \$99.

NEW SOFTWARE

I've always been curious about shipwrecks, though I'm not sure why. Of all the different types of shows on the Discovery Channel, I think I enjoy watching the ones about exploring shipwrecks the most, though I have never done anything more than snorkeling myself. This CD-ROM I checked out is naturally quite interesting to me. Dan Berg's *Wreck Valley* CD-ROM from *Aqua Explorers* is filled with multimedia files on hundreds of shipwrecks, many in the local waters where I live.

Dan Berg is a noted wreck diver and marine researcher, and he has put together data on 500 shipwrecks from Delaware to Maine. The disc includes photos, history, some video, maps, sonar images, sketches, and more on shipwrecks for \$44.95.

Palm Pictures is busy publishing movies in the DVD format, and they sent me some samples of their latest products. I love DVD movies because my *Creative Labs Encore* PC-DVD lets me watch these movies on my PC. And an RF transmitter from *RF-Link* lets me watch the movies on any TV in my house. Anyway, *The Basketball Diaries*, with Leonardo DiCaprio, is a story about a high school basketball hero headed for trouble—pressures from mom, the coach, and school, plus what goes on in the streets of New York, make it difficult for him. Another DVD, *Mandela, Son of Africa, Father of a Nation* covers the life of the leader imprisoned for 27 years. We also have *Gravesend*, a story about four kids, three bodies, and two fights, all in one night. It's a violent but exciting movie about friends in an Italian neighborhood on a night gone out of control. There's also Japanese animation movies such as *Ninja Scroll*, the story of a beautiful female ninja, the only one left alive after all others are wiped out by a man-monster. *Ghost in the Shell* combines traditional animation with computer graphics in a sci-fi story that questions our existence in this hectic day and age. All these DVD titles cost \$29.95 each.

Pajama Sam is back as the world's youngest super hero, this time con-

(Continued on page 66)

WHERE TO GET IT

Addonics Technologies

48434 Milmont Drive
Fremont, CA 94538
800-787-8580
www.addonics.com

CIRCLE 60 ON FREE INFORMATION CARD

ALPS Electric, Inc.

3553 North First Street
San Jose, CA 95134
800-825-ALPS
www.alpsusa.com

CIRCLE 61 ON FREE INFORMATION CARD

Aqua Explorers, Inc.

980 Church Street
Baldwin, NY 11510
516-868-2658

CIRCLE 62 ON FREE INFORMATION CARD

Canon Computer Systems, Inc.

2995 Redhill Avenue
Costa Mesa, CA 92626
800-OK-CANON
www.ccsi.canon.com

CIRCLE 63 ON FREE INFORMATION CARD

Humongous Entertainment

16932 Woodinville-Redmond Rd. NE
Woodinville, WA 98072
800-499-8386
www.humongous.com

CIRCLE 64 ON FREE INFORMATION CARD

LucasArts Entertainment Company

PO Box 10307
San Rafael, CA 94912
415-472-3400
www.lucasarts.com

CIRCLE 65 ON FREE INFORMATION CARD

Olympus America, Digital & Imaging Systems Group

Two Corporate Center Dr.
Melville, NY 11747
516-844-5000 or 800-347-4027
www.olympus.com/digital

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Palm Pictures

727 North Hudson Street, Suite 100
Chicago, IL 60610
312-751-0020
www.palmpictures.com

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Panamax Power Protection Products

150 Mitchell Blvd.
San Rafael, CA 94903
800-472-5555
www.panamax.com

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NET WATCH

Holiday Shopping with Ease

KONSTANTINOS KARAGIANNIS

The rush is on, and if you're like most people, you have a list of names with very few specified gifts or check marks next to those names. What are you waiting for? Time's running out, and you don't want to be one of those poor unfortunates stuck shopping on Christmas Eve, do you?

Fortunately, there's a way to buy reasonably priced and terrific gifts right on the Web. We've said it a dozen times, and we'll say it again: e-commerce is safe! With a secure server (provided by every site we cover this month) and a browser like Navigator or Explorer, both of which support Secure Socket Layer (SSL) transactions, you can send your credit-card number out into cyberspace as safely as over an 800 number.

Now, e-commerce has broadened its horizons. You can buy computers and even arrange for decent prices for new automobiles online. Obviously, unless you're as wealthy as Bill Gates, you'll be looking for gifts priced somewhat more modestly. For this reason, all the sites we focus on feature gifts in the approximately \$20 range. It's no wonder that books, CDs, and videos are some of the most popular gifts around, and they're the focus of most of our examined sites. Also, for those of you who want more product variety and low prices, we've even got an online store that may give the two big "marts"—*Kmart* and *WalMart*—some hefty competition.

But wait, what about shipping costs? Don't they add up to a fortune? Actually, no. Most Web stores offer significant discounts (they have little or no overhead, after all), and these not only make up for any shipping fees you'll incur, but often still save you money. Some sites with sales offices located outside your state will also spare you the hassle of sales tax, furthering your savings.

So what are you waiting for? Afraid you'll miss the hassle of looking for parking spots? Can't handle the idea of avoiding lines that rival those found in *Disney World*? It took three hours to



The popular bookstore chain Borders has finally moved into the e-commerce arena with a wonderfully complete site. Choose from books, music, or movies, and even get help from real live employees.

get in and out of a mall on a certain December 24th—and that was just to get one gift! With the Net, it's possible to do all your shopping in that time.

BOOKS AND MORE

For some time now, the world of online bookselling has been dominated by two Big Guns: *amazon.com* and *barnesandnoble.com*. We covered these sites quite some time ago, but their recent changes warrant inclusion again. Before we briefly examine what's new with these e-commerce goldmines, let's take a look at the newcomer to the game.

If you live in an area where superstores abound, you might have noticed that *Barnes & Noble* is not the only big bookstore around. *Borders*, that large store and cafe that serves up a wickedly good fruit smoothie, is now a viable online presence, too.

Borders, actually named after its founders Tom and Louis and not some vague geographical reference, started with one store in Ann Arbor, Michigan in 1971. It grew into a national chain in

the following years, and in the early 1990s expanded to music and video sales, too. *Borders* has grown to become one of the nation's leading book, music, and video retailers. Now merged with *Waldenbooks*, *Borders Inc.* owns over 200 superstores, and one terrific Web shop.

Because *borders.com* has access to the same main warehouses that supply the huge chain, a Web surfer can shop from a stock of over 10 million books, CDs, and movies, both in DVD and VHS format. All these goodies are in stock, ready to be placed in a stocking. Why go to a local store and agree to let them order a hard-to-find title when you can have said title appear in your mailbox? The powerful search engine at the *borders.com* site is similar to those used by the other Big Two. Search by Author, Title, Keyword, and even ISBN number. There are general categories you can peruse as well.

What's interesting about *borders.com* is that it goes out of its way to maintain the helpful human element that made the real-world chain a success. 17

While you can easily navigate the site and search for titles on your own with the aforementioned engine, you can also either e-mail or call for assistance (there's an 800 number). The site has a NetCafe where you can chat with other browsers who have similar interests, or even a famous author or artist. It's just too bad you can't have one of their delicious beverages while you do so!

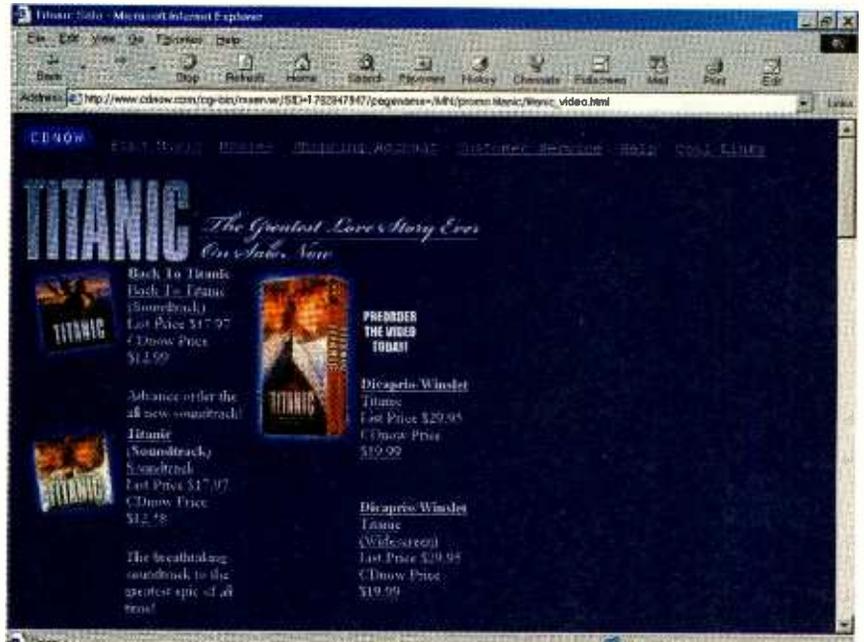
The all-in-one nature of *borders.com* is giving *amazon.com* a good reason to up the media ante. *Amazon.com* recently purchased a site we mentioned here before—*The Internet Movie Database*. This could lead to an incredible video search functionality at *amazon.com* in the near future, perhaps even by the time you read this, but at the time of this writing, *amazon.com* doesn't sell videos yet. The company does deal in music, though, making the online bookstore an even more interesting place to visit now. Prices are very competitive with *borders.com*, and we can't recommend one over the other, either for books or music. Be sure to shop around at both to find the best prices.

Amazon.com is known for its easy-to-use shopping interface, and it has passed these same benefits to its music half as well. Whichever of the two media you're shopping for, you'll enjoy Bestseller Lists, Celebrity Picks, Instant Recommendations, Shoppers' Reviews, and Expert Reviews.

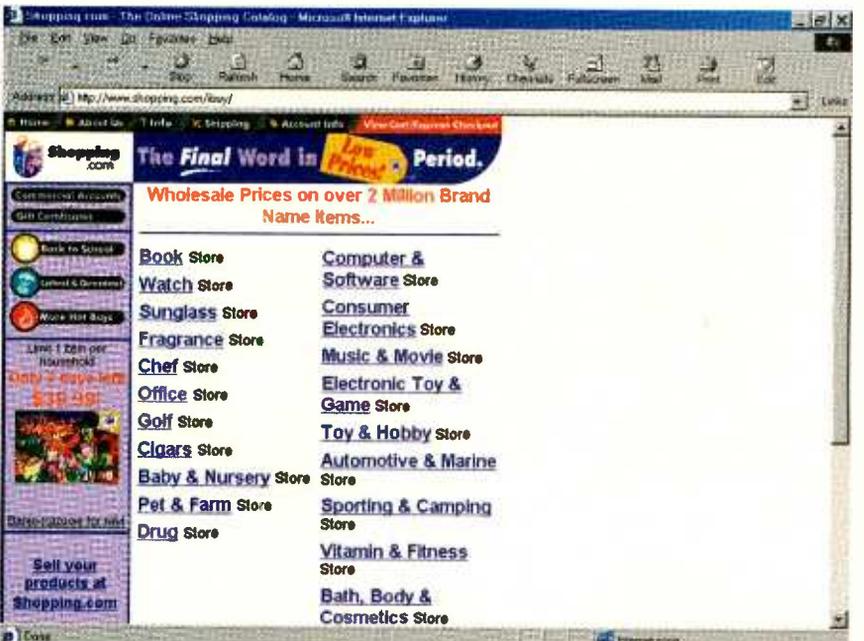
Barnesandnoble.com, is still primarily focusing on what it does best—selling books—but has a few additions. With its new, improved interface (which should look subtly familiar to *amazon.com* users), the site is becoming a joy to use. One-click ordering is a particularly nice enhancement. Bargain hunters will be happy to know that *barnesandnoble.com* has a huge discount "bin" of approximately 5000 books, with prices as incredible as 90 percent off list. We're not implying that the site hasn't spread its horizons a bit. *Barnesandnoble.com* now has a software store, featuring about 1000 games and productivity titles, as well as a magazine discount-subscription service that lets you choose from over 450 magazines. Nice.

MUSIC BIZ

Here's another category with just a Big Two for now. If you're looking to buy primarily music, you might want to check out one of these sites that focus on just that.



CDnow knows how to bundle goodies at its site. Shown here are items that are certain to still be titanic gifts come the Holidays.



Shopping.com is an impulse shopper's dream come true. Enter the site without the slightest idea what you're looking for and leave with all your gift buying complete.

CDnow is one of the first sites we looked at when this column was born years ago. One of the features we covered back then was its fast access to a Telnet (!) version of the store. While Telnet has lost popularity with the decline of the text-based online games that depended on it, *CDnow's* Web store is better than ever. Ordering from its huge selection of CDs and videos (yes, they have movies, too) couldn't be easier. The FastFind search box lets

you enter either the artist, album title, song title, or record label. The Find It button grabs what you're looking for in an instant.

Need some recommendations or a little more info about a selection? *CDnow* has "discographies" that leave little to the imagination. There are even reviews from magazines like *Rolling Stone* and *CMJ*, and popular music channels MTV and VH1. For those who

(Continued on page 65)

Times Are Tough...



Today's headlines scream of the lack of qualified individuals to fill new and existing high-tech job openings. If you feel the robust economy is passing you by, there is something you can do about it. **Become CIE Qualified.** Since 1934, The Cleveland Institute of Electronics has been providing its students with the necessary technical and academic credentials employers are seeking. In fact, CIE was started in 1934 to fill a similar void in the radio/television industry.

Since then, CIE boasts of over 150,000 worldwide graduates who have benefited from a patented, independent-study program that lets the student complete a Career Course, Associate Degree program, or through our affiliate school

World College, a Bachelor Degree program.

If you are currently "under-employed" and want to increase your level of income, the most proven method is an education. With CIE's independent-study program you study when and where you wish with no time constraints on how quickly you can proceed. And though it is an independent-study program you have the full support of the faculty and staff at CIE's Cleveland Campus.

To discover all the Benefits, Career Courses and Degree Programs available from CIE send for your Free Course Catalog Today!

The Cleveland Institute of Electronics has been approved for the training of eligible veterans and active duty military service members, under the G.I. Bill. Military tuition assistance (Up-Front and Basic) is also available under the DANTES Distance Learning Program.

...For Employers

MAIL THIS CARD TODAY!

Yes! Send me my FREE CIE course catalog and details on a CIE associate's degree. (For your convenience, a CIE representative will contact you with more information. There's no obligation.)

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<input type="checkbox"/> Active Duty <input type="checkbox"/> Veteran	

I'm most interested in:

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|--|---|
| <input type="checkbox"/> Electronics Technology with Laboratory | <input type="checkbox"/> Computer Programming |
| <input type="checkbox"/> Broadcast Engineering | <input type="checkbox"/> Electronic Communications |
| <input type="checkbox"/> Electronics Engineering | <input type="checkbox"/> Industrial Electronics |
| <input type="checkbox"/> Electronics Technology with Digital & Microprocessor Labs | <input type="checkbox"/> Automotive Electronics |
| <input type="checkbox"/> Associate Degree | <input type="checkbox"/> Electronics Technology and Advanced Troubleshooting I & II |
| | <input type="checkbox"/> Bachelor Degree |



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GIZMO®

GIZMO'S GIFT-GIVING (OR -GETTING) GUIDE



The holidays are just around the corner, and whether you're playing Santa Claus or just writing a letter to him, it helps to know what's out there. Gizmo's gift choices are guaranteed to please anyone with a love for things electronic.



Happy holidays to you all!

VIDEO DELIGHTS

Think of these big-ticket items as gifts for your whole family—you're all sure to enjoy them!

Dual-Duty Digital Video

What to get for the videophile who's accumulated a huge collection of laserdiscs but is dying to get into DVD? Pioneer's DVL-909 (\$1099) covers all the bases: It's compatible with DVD, LD, Video-CD, and audio CD formats. A hands-free two-sided LD mechanism eliminates the need to get up and manually flip the laserdisc in the middle of a film. Both coaxial and optical Dolby Digital audio outputs are provided for DVDs, along with an AC-3 RF output for Dolby Digital LDs. The deck's 20-bit conversion system uses Pioneer's built-in Hi-Bit processor to deliver improved signal resolution and extremely low noise from standard 16-bit audio CDs. ★



Fast-Paced VCR

How often have you found yourself with a half hour left to watch on a video—15 minutes before Blockbuster closes? Or had to turn off a kid-vid in mid-stream so that you could get the children out of the house or off to bed in a timely fashion?

The Fisher FVH-T668S VCR (\$189.99) can solve those dilemmas. With SPEEDWatch, which allows you to watch videos at two times the normal speed while the dialog remains fully comprehensible, the sound track is slowed down, then played back at normal speed. Although there is some minimal loss of audio, it won't usually affect comprehension. Because the feature works in forward or reverse play, it makes it easy to scan for a specific tape segment based on dialog. Besides using SPEEDWatch to beat the video-shop closing time, you might consider taping a sporting event (four-hour baseball games come immediately to mind!) and playing it back at double time. ★



The four-head, hi-fi FVH-T668S also provides busy video watchers with a couple of other time-saving features. Ad Jump commercial eliminator lets you press a button to fast-forward through taped commercials. And the Record List features helps you quickly find the recording you want to watch. It creates and displays a menu of recordings that includes the channel, date, start time, and program type of the last seven programs you've taped. Select the



program's assigned number from an on-screen menu, and the VCR will automatically find the beginning and start playback.

The VCR comes with a "moonlight" backlit remote control keypad. VCR Plus+ is included, along with a one-year/eight-event tri-lingual on-screen timer, and a child lock-out feature. ★

Video Hang-Up

Flat screen TV has made its debut, and Philips' 42-inch Plasma Technology FlatTV (\$15,000) is an im-

pressive (albeit expensive!) example of the technology. Plasma, sealed between two glass plates, conducts a charge that lights up phosphors within tiny individual chambers.

Each of the set's more than one million pixels is formed by a red, a blue, and a green chamber. Advanced electronics control the individual chambers to produce over 16 million colors. The result is a high-resolution, incredibly

realistic picture that can be viewed under any lighting conditions.

The FlatTV is one big-screen set that won't dominate the living room (until you turn it on, that is). Measuring just 4.5 inches deep, the set is intended to be hung on the wall like a picture. (The electronics, power supply, and connectors are housed in a separate TV receiver that can be tucked out of sight.) In fact, when you're not using the monitor to watch TV or videos, you might want to display your favorite digital photographs within its sleek gray frame.

The FlatTV boasts a 160-degree viewing angle, providing every seat in the house with a clear view of the picture. The plasma technology behind the set delivers clear pictures even right up to the edges of the screen. Designed to display data as well as television images, the FlatTV is also DTV-ready (with the addition of a digital decoder, when available). Think convergence: The FlatTV can serve as a standard television, display digital video from DSS or DVD, be used for multimedia applications ranging from business presentations to game playing, and can

handle future digital broadcasts.

The set is chock-full of the high-end television features and functions you'd expect in this price range. It offers six widescreen modes and automatic aspect-ratio detection to determine which one to use, and split-screen and mosaic-screen modes. Dual tuners allow you to view two equal-sized images, presented side-by-side. FlatTV is com-

patible with PAL, SECAM, and NTSC material.

Philips didn't neglect the audio portion. An integrated Dolby Pro-Logic amplifier delivers up to 109 watts rms output power to drive the 15 included speakers. Most of those speakers are located inside the frame that surrounds the screen; a separate subwoofer can be placed anywhere in the room. ★

TV Guides

If you prefer to stick with an analog TV until the prices of digital, flat-panel sets drop significantly, you might want to consider one of the *KCA Thompson Premiere Series* or *Home Theater Series* direct-view models that feature the *Guide Plus+ Gold* on-screen programming guide. Available on one 27-inch, three 32-inch, and three 36-inch models, the two-day *Guide Plus+ Gold* displays program listings for the upcoming 48 hours and offers one-touch tuning and VCR record features. A picture-in-picture window allows you to see the selected show in progress while reading a description of the program. The Guide also provides an instant summary of favorite programs, and can list movies by theme for a seven-day period.

The *Premiere Series* sets also offer a twin-tuner PIP system that allows you to place the window anywhere on the screen, and to "commercial skip"—move the main picture to the window during commercial breaks. Suggested retail prices range from \$599 for a 27-inch *Home Theater Series* set to \$1699 for the two 36-inch *Premiere Series* televisions. ★

1 Watch 2 GoTo 3 Record

NFL Monday Night Football
St. Louis Rams vs. San Francisco 49ers
WCVB [5] 9:00pm (3h) Acc

Grid Sort Schedule Messages

Mon	10:00 pm	10:30 pm
LAST CHANNEL	Cosby	The Closer
abc	NFL Monday Night Football	
Fox	Columbo	
	Cosby	The Closer
OPN	Deadly Games	
	Nova	This Old Hou
HBO	Batman And..	Contact
	SportsCenter	
	Spice Girls concert tonight	

10:03

Watch the WNBA Exhibition Game from the RCA Dome
Tuesday 9:00

DENNIS MILLER LIVE
HBO

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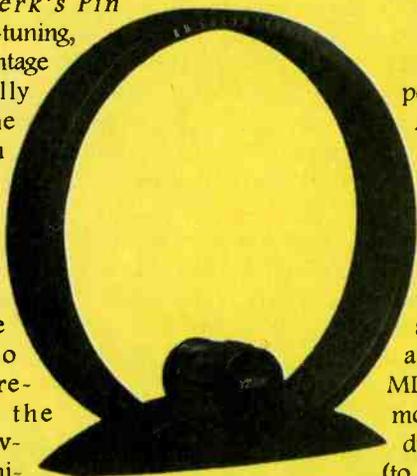
AUDIO GOODIES

Here's an assortment of gifts for anyone who likes the sound of music!

AM Oomph!

Give your AM reception a boost with the *Terk AM Advantage Antenna* (\$49.95). Its attractive design will appeal to the occasional listener, while its performance will turn the heads of radio enthusiasts. The sculpted black and gray loop rests on an arched base and is topped with a lavender dial. It can be used with a portable radio without physical connection or can be hard-wired to a stereo system.

Using *Terk's Pin Dot* pre-tuning, the AM Advantage electronically adjusts to the AM station that you're trying to receive. That function allows you to fine tune the antenna to match the frequency on the tuner or receiver while minimizing noise and interference caused by unwanted signals. The technology improves the quality and clarity of reception as well as the quantity of stations that you can pull in. ★



Merry MiniDisc!

Sony dubbed 1998 "The Year of the MiniDisc," and it's still not too late to get into the action. Here are a couple of items that take full advantage of the format's easy portability and recordability.

From *Sharp* comes the *MD-MS702* portable MD recorder (\$399.95), with a chassis footprint the size of a MiniDisc jewel-box case. The player/recorder offers a shock-resistant memory buffer to prevent skipping or mis-tracking. Its rechargeable lithium-

ion battery provides five hours of playback time, or 3.5 hours of record time; with an optional AA battery case, you can get up to eight hours of playback or four hours of recording time. The unit comes with a wired remote control with backlit LCD, allowing tracks to be viewed, selected, paused, or skipped without removing the MD player/recorder from your pocket, backpack, or briefcase. ★



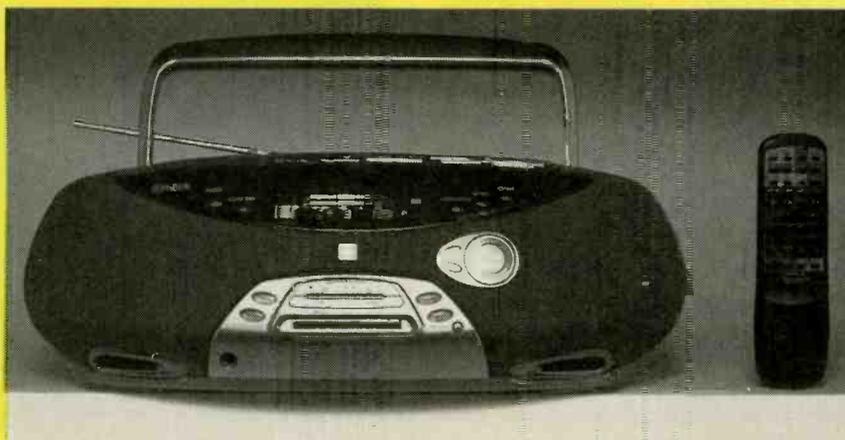
Boombox

Somewhat larger, but still portable, the *Fisher PH-MD100* boombox (\$399) offers on-the-go music from several sources: MD, CD, tape, or radio. It also provides a host of recording options: CD-to-MD, CD-to-tape with high-speed/synchro dubbing, and MD-to-tape. Digital MD editing functions include move (to change track order), divide (to split tracks), erase (to remove a specific track), and erase all (to delete all the tracks). Jog-dial operation simplifies the input of alphanumeric characters for labeling discs and tracks. The mono recording mode allows up to 148 minutes of recording time on one disc. ★

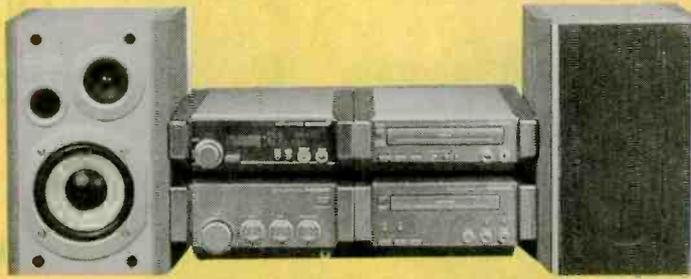
The boombox has a rounded silver body with a wrap-around blue grille cloth. Its auto-reverse cassette deck offers AMSS for rapid location of favorite taped tracks, and the digital AM/FM tuner provides 20 user-selectable station presets. The *PH-MD100* has a four-position electronic equalizer and four-position electronic bass enhancement. The included remote controls virtually all MD, CD, cassette, and programming functions. Headphone, external mic, and line-in jacks are provided. ★

(DIS)Playin' The Blues

The *Technics SC-HD55* micro-system (\$699.95) features a burnished aluminum panel with blue side-light-



ing that casts a “moody” blue tint on the front control panel. That indirect illumination is complemented by an advanced “floating blue” display that shows operational status at a glance. The stylish, modern look of the system’s stainless-steel top contrasts nicely with the retro look of the front-panel toggle switches and knurled volume knob. The compact components are free-standing and can be arranged vertically or horizontally to suit your space.



The SC-HD55’s sound is as distinctive as its appearance. A feature called “Synchro-Bias” keeps the Class A amplifier circuit’s power transistors in a ready state, so they don’t switch on and off. According to *Technics*,

that not only eliminates switching distortion and reduces crossover distortion, but also allows the system to offer the sound quality of Class A, while providing the power efficiency of Class B, amplifier designs. The speaker cabinets each house a

4³/₄-inch woofer made of polypropylene mica and a 2¹¹/₃₂-inch tweeter. The tape deck’s horizontal orientation provides easy tape loading and smooth tape transport, and high-speed fast-forward/rewind is provided. The CD player offers a variety of play modes, and CD Text allows disc information, such as album, track, and artist name, found in the disc’s Table of Contents to be displayed on the minisystem’s front panel.

Slim Sound System

1999 might just be the year when you start clearing out that old entertainment system. First, the flat-screen TV has arrived, and now Fisher is offering a wall-mountable mini-system. The SLIM-1000 (\$249.99) combines a CD player, a cassette deck, and an AM/FM radio in a one-piece, slim-line system designed to be hung on the wall using the included mounting bracket.

Equally at home in the family room, bedroom, kitchen, or home office, the attractive system features a transparent housing that allows you to see the vertically oriented CD during playback. The slightly arched top of the system matches the curved tops of the detachable two-way speakers.

The digital AM/FM tuner offers 10 AM and 20 FM station presets. The system includes an electronic equalizer with four user-adjustable settings. The SureWake System alarm can be set to wake the user to either a CD or the radio. The remote control handles the power, CD player, tuner, volume control, and alarm function.



Gold-Plated Stocking Stuffer

What to get the audiophile on your list? Why not give the big lug the *Big Lug Model SL-8* gold-plated spade lugs (\$12.50/pair) from *Tributaries*. The Big Lug features two 1/2-inch gold-plated spade lugs with 3/8-inch openings for easy connection to five-way binding posts. They are designed for quick installation of 10 AWG to 16 AWG speaker wire and are made of gold-plated solid-brass for reliable, long-term, low-resistance connections.

Two opposing set screws on the base of The Big Lug ensure secure speaker-wire attachment. For additional protection, a soft insulator cover slides over the wire and the base of the lug. The insulator covers are color-coded to indicate polarity.



Cinema-Style Speakers

Turn your at-home movie watching into a cinematic experience by adding a matched set of home-theater speakers. Atlantic Technology's *System 270* (\$2396) is a six-piece set consisting of an adjustable center-channel speaker with boundary compensation, left and right front speakers, two dipolar surround speakers, and a 225-watt powered subwoofer.

Atlantic's home-theater speakers are designed from the ground up to meet the demands of reproducing both movie soundtracks and music. The *System 270* maintains tonal consistency—all three front speakers are said to have essentially identical timbre. The low-profile, multi-stage, timbre-adjusting center-channel speaker has controls for high-frequency level, midrange presence, and boundary compensation. The left and right front speakers use dual 5 1/4-inch woofers mounted above and below the tweeter to provide controlled vertical dispersion. The surround speakers use a dipolar design to enhance ambiance and reduce unwanted localization. The subwoofer, with its built-in 225-watt power amplifier, sealed cabinet, and 12-inch driver, provides the power and the low-frequency response needed to recreate those thumping, roaring, shaking, crashing action sequences. *



High-Fashion CD Player

For today's fashion-conscious teens, how about a personal CD player with interchangeable, neon-color, translucent lids? The *RCA Model RP-2240* (\$89) comes in basic black (actually, a dark gray), and comes with two extra "swap top" lids in trendy purple and lime green.

The *RP-2240* has more going for it than good looks alone. It features Smart ESP, which allows the user to continue listening to music from the buffer memory after the CD has been removed

from the player. If the CD is reinserted before the buffer empties, the music continues without missing a beat. In addition, the 40-second ESP feature provides shock protection for on-the-run listening. *

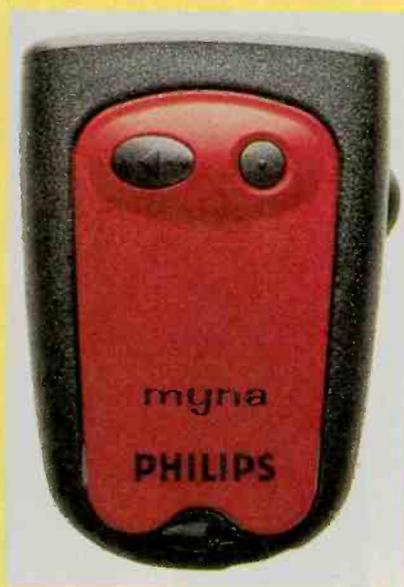


ODDS & ENDS

Some items—and most people—just can't be placed in any broad category. Here's an assortment of fun gifts for the hard-to-categorize people on your holiday list.

Musical Beeper

Teens might also want their pagers to be more stylish, and *Philips' Myna* (\$49.95) would certainly fit the bill. Not only does it come in four fashionable colors—onyx, emerald, ruby, and ash—but it also offers a unique "melody maker" feature. You can assign tunes to certain messages by programming number sequences to mean specific phrases, or you can recognize the caller by memorizing the "tune" played by specific phone numbers. Teens can program in riffs from the latest hit songs—a decidedly cool way to be alerted to messages. The *Myna* has nine user-selectable alerts/melodies, two programmable alarms, and a vibrate option for silent message alerts.



The numeric pager is the smallest and lightest in its class. It stores up to 32 time-stamped messages, with up to 20 messages protected. Messages can be deleted individually, and duplicate messages are automatically eliminated. *

Dabbling In Digital Images

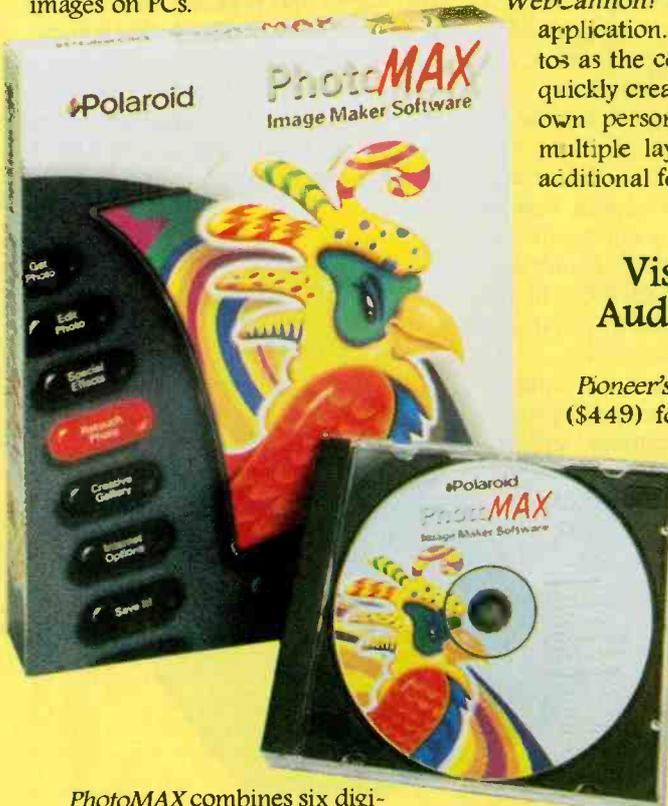
You've been downloading images from the Internet or from your digital camera—now what do you do with them? Plenty, if you've got *Polaroid's PhotoMAX Image Maker Software* (\$59.95). Developed with the consumer in mind, the software makes it easy to capture, edit, and use digital images on PCs.

Instant on-screen help is available by right-clicking the mouse within any area of the software.

Dogbyte Development's Sticker Store software, used in the program's Creative Gallery, allows do-it-yourselfers to add quality images to cyber and printed greeting cards, insert cool backgrounds and borders, and apply images to T-shirts. PhotoMax also includes *AltaVista Technology's WebCannon!* web-page builder application. Using digital photos as the cornerstone, you can quickly create and publish your own personal web page with multiple layers, hot links, and additional features. ★

channel line-level output with built-in subwoofer crossover. The AVM-P505R also houses the Supertuner V tuner, which offers both RDS and ID Logic technology.

The RDS and ID Logic data can be easily viewed on one of two types of monitors. The AVX-505 (\$999) is an ultra-thin 5.5 inch monitor that resides in a DIN-size chassis. It can be flipped out and up to reveal its screen. It can be used in combination with a single-CD DIN-size player in double-DIN openings. It has a detachable panel and blinking LED for security. The stalk-mounted AVD-505 (\$669) is a 5.6 inch monitor that can be added without modifying the OEM system.★



Visual Car Audio System

Pioneer's Visual Audio System (\$449) for cars combines a

hide-away main unit with an RDS tuner and four-channel high-power speaker outputs, and adds your choice of two monitors to serve as a visual interface for the system. At the heart of the system is the compact AVM-P505R, designed to be hidden under a

seat. It is host to a series of flexible audio and video inputs and outputs, and provides 40 watts × four-channel high power, and three-way/six-

Pocket Navigator

For the hiker or hunter on your gift-giving list, *Magellan's GPS Pioneer* (\$99.99) is an affordable portable Global Positioning System (GPS) receiver. The handheld device helps you find your way into (and back out of) the woods. It lets you store locations to keep records of bird sightings, new trails, and favorite places that are off the beaten path.

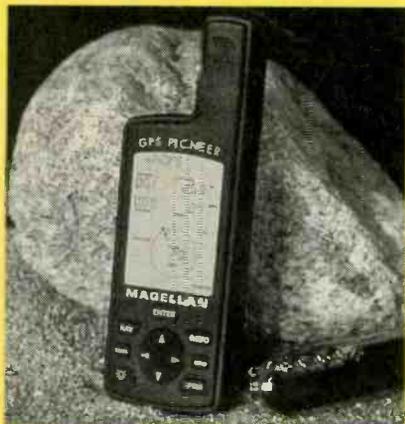
Using signals transmitted by the U.S. government's GPS satellites, the receiver can calculate its position—and yours—anywhere on earth. It can help you navigate from point to point, and also performs other location, tracking, mapping, plotting, and timing functions. The *GPS Pioneer* can tell you how fast and in what direction you're moving, and how far it is to your destination. Use it to set up treasure hunts, to monitor your speed

and distance in a canoe or kayak, or to find your way around the countryside or city.

The easy menu interface uses three different screens to display a steering arrow along with bearing, heading, distance, speed, and time to go. Up to 100 landmarks and one route of up to 10 legs of a journey can be stored. Weighing less than seven

PhotoMAX combines six digital-imaging applications in one easy-to-use graphical user interface. Polaroid's unique active image technology is used to move acquired and edited images throughout all applications, eliminating the need to open and close multiple applications or to hunt for edited images. In *PhotoFantasy*, you can put your face on a magazine cover. Photo templates allow you to add your pictures to calendars or T-shirts. The program also lets you make and send e-mail post cards, create your own web site, and share digital photos with family and friends via the web. The *Special Effects* feature provides 18 different effects that can alter your images, and the *Retouch Photo* option provides one-click image editing.



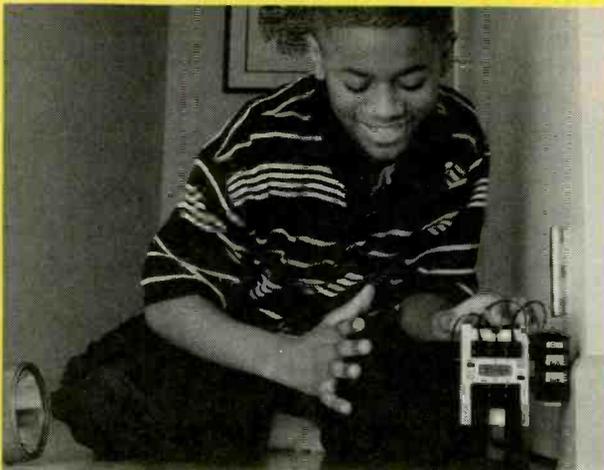


ounces, the *GPS Pioneer* is said to be the world's lightest GPS receiver. It runs continuously for 24 hours on two AA batteries. ✨

Robotic Lego

You remember *Legos* from your own childhood, we're sure, and probably quite fondly. Those little plastic pieces could (and still can) be snapped together to form buildings, cars, planes, people, whole cities, for that matter—whatever your imagination could devise and your little hands could build.

Now get ready for the *Lego MindStorms Robotic Inventions System* (approximately \$200). It still uses those familiar little plastic pieces, but now, when you finish building your creations, you can animate them and control their movements. At the heart of the system is the RCX microcomputer, which can be programmed using a PC. Serving as the brain of *Lego Mind-*



Storms creations, the RCX uses sensors to take input from its environment, process data, and to signal output motors to turn on and off.

Build a *Lego Robot*, and then make it come to life. The RCX code is a simple, powerful programming language that can be downloaded from your PC to the RCX microcomputer via a special infrared transmitter. The computer's role is finished: You now have a completely autonomous, fully programmed robot (or whatever other device you've designed) that can interact with its environment.

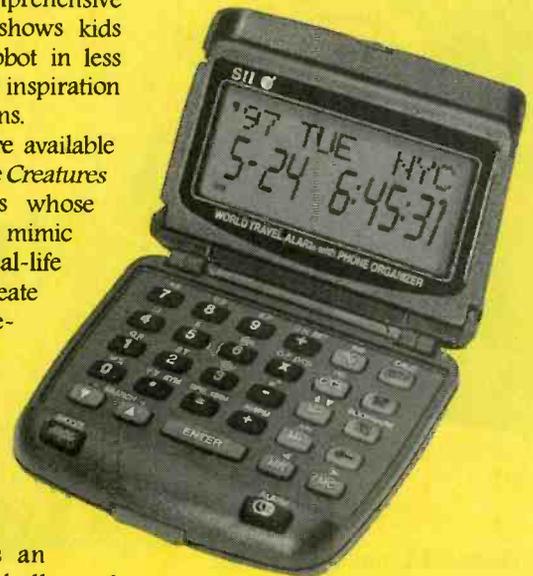
The *Lego MindStorms Robotic Invention System* includes more than 700 *Lego* pieces, the RCX, the infrared transmitter, light and touch sensors, motors, gears, and a comprehensive instruction manual that shows kids how to build a simple robot in less than an hour, and provides inspiration for more complex inventions.

Three expansion sets are available for about \$50 each. *Extreme Creatures* lets kids build creatures whose movements and behavior mimic those of just about any real-life animal they select, or create fantasy creatures that resemble nothing living on earth. The set comes with flashing fiber-optic strands, a snapping claw, a pincer, and a tail-like wagging mechanism. The *RoboSports* set, which offers an extra motor, three foam balls, and two hockey pucks, allows children to

build robots that can shoot hoops, flick pucks, and dart through an obstacle course. Build a Mars Rover with the *Exploration Mars* set. Using the on-screen control panel, kids can control the rover directly from their PC. The rover surveys the terrain and sends sensor readings back to the computer. ✨

Smart World Travel Alarm

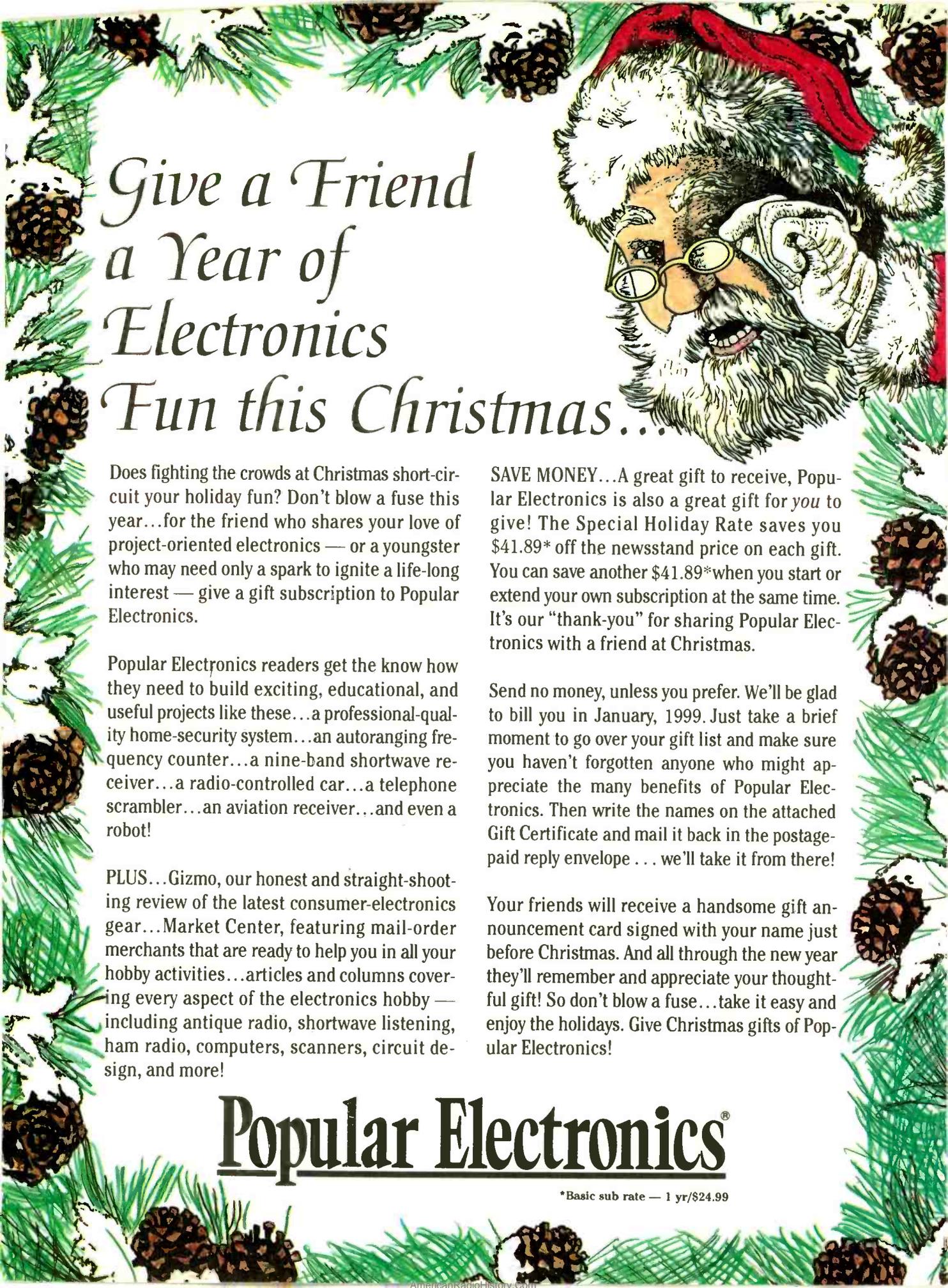
The world traveler on your list will love to take along the *Seiko DF-4022 World Travel Alarm and Personal Organizer* (less than \$30). The handheld device includes an alarm with snooze button and phone organizer that alphabetically stores more than 160 names and numbers, allowing up to 48 characters per line so that you can add addresses or notes as well. A 10-digit calculator with memory, percent, and 16 metric and currency converters is built in, as is a memo function. A password keeps private data secure.



The pocket-sized DF-4022 comes in a protective case with flip-top lid. The unit's large, backlit display shows day, date, and world time for 27 major cities. A permanent instruction label under the display makes it easy to operate any of its function, any time, any place. ✨

FUN & (VIDEO) GAMES

What would the holidays be without toys? And what kind of toys do today's kids of all ages crave?



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Videogames, of course. Here are a few titles and accessories sure to appeal to the whole family.

Enter The Dragon

Dragons have been getting a lot of play in 1998: First, the two-headed version in *Camelot*, then Eddie Murphy's MuShoo character in *Mulan* graced our movie screens (and Happy Meals). Now, from Sony Computer Entertainment America (SCEA), comes *Spyro the Dragon* (\$40-\$60 price range). He might not be very big, but he gets into some huge adventures in this 3D-action game for the Sony PlayStation.



Spyro flies, glides, rolls, jumps, and plays—and shoots out flames, too, of course—as he frolics through more than 30 interactive fantasy worlds. The player's job is to set free dragon fami-

lies that have been trapped by the evil spells of Gnasty Gnorc. Along the way, you collect treasures, recover stolen family jewels, and discover hidden kingdoms. The bad guys are challenging, but humorous. Play is enhanced by a soundtrack composed by ex-Police member, Stuart Copeland. ★

Get Warped!

That perennial Sony PlayStation favorite, Crash Bandicoot, is back again in *Crash Bandicoot: WARPED* (\$40-\$60 price range). Developed in partnership with Sony Computer Entertainment America, Universal Interactive Studios, and Naughty Dog, Inc., the third-generation game introduces new and enhanced features, but retains the appeal of the title character. Once again, Crash must stop the nefarious Dr.



Neo Cortex from setting his diabolical plans into motion. This time around, however, Crash is accompanied by his little sister, Coco.

In the latest adventures of Crash Bandicoot, players travel through time and space to swim through the underwater world of Atlantis, ride on the back of a dinosaur in the Jurassic era, or time-warp to a futuristic world in the new millennium. All the while, players are faced with 3D-challenges and tricky plot twists. ★

Desktop Driving Station

For those who do their racing at their desks, Microsoft offers the *SideWinder Force Feedback Wheel* (\$209.95), a PC accessory that resembles a steering wheel and creates a realistic driving experience when used with force-feedback enabled PC driving games. It comes with floor pedals and full versions of two Microsoft driving games: *CART Precision Racing* and *Monster Truck Madness*.

The SideWinder generates robust effects allowing players to feel road surface textures, crashes, bumps, centrifugal force, engine and tire vibra-

Your Mission

should you choose to accept it, is to survive through the five different spying adventures presented in Infogrames Entertainment's *Mission: Impossible* (\$59.95) for the Nintendo 64. The game closely mirrors the Tom Cruise film of the same name. The player takes on the role of Ethan Hunt, as he develops cunning schemes, makes stealthy maneuvers, and uses expert marksmanship to outwit an evil assortment of enemies. The game takes the movie's premise to the next dimension, as Hunt embarks on five different missions with more than 20 different levels of play. The action is set in a variety of intriguing locales, including the Russian Embassy in Prague, CIA Headquarters in Langley, Virginia, and London's Waterloo Station. At your command is an array of gadgets and weaponry, including blow darts, exploding chewing gum, laser deflectors, and face-makers. You can interact with other members of the Impossible Mission Force. The thriller features movie-quality graphics and fast-moving action. ★



tions, and other driving conditions. All forces are driven by an onboard coprocessor and a high-torque motor, freeing the CPU to deliver smooth on-screen action. The wheel has eight programmable buttons, including two shifters/triggers on its back sur-



face. A quick-release cam-lock clamp is used to attach the SideWinder to a desk top. Slip-resistant pedals are designed for one- or two-foot use. The included software allows gamers to customize wheel settings, including sensitivity, dead zone, and force-effects strength. ★

PC PRESENTS

Full-Service, Pint-Sized Notebook

Did you, or someone on your gift-giving list, buy a notebook computer because it offered portability—and now it sits at home because it's too big and heavy to lug around? *Mitsubishi* offers a truly mobile computing solution in the form of the *AMiTY CN Model 2* mini-notebook (\$1999).

MANUFACTURERS LIST

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TERK TECHNOLOGIES

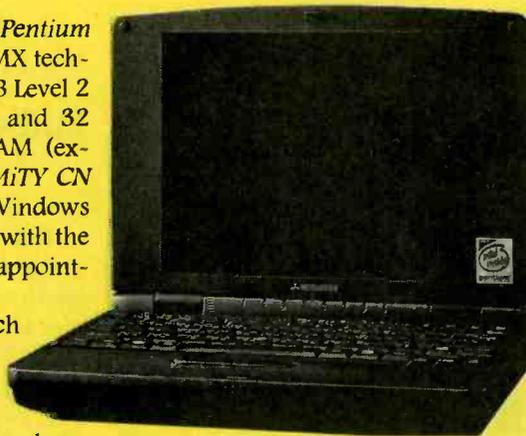
63 Mall Drive
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TRIBUTARIES

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Powered by an *Intel Mobile Pentium* 166-MHz processor with MMX technology, and offering a 256-KB Level 2 cache, a 2.1-GB hard drive and 32 MB or high-speed EDO DRAM (expandable to 96 MB), the *AMiTY CN Model 2* combines the full Windows functionality of a desktop PC with the form factor of a mid-sized appointment book.

The ultra-bright, 8.4-inch active matrix color LCD displays an 800 × 600-pixel SVGA image. The external video port supports monitors and projectors with resolutions up to 1024 × 768 pixels. The *AMiTY CN Model 2* supports Zoomed Video and CardBus to allow use of the latest modems, LAN adapters, ZV cards, and removable storage cards. Built-in *SoundBlaster PRO* hardware, a 4-Mbps fast infrared port, two stacked PC card slots, built-in speakers and microphone, and a full complement of standard ports (including USB) round out its features. An external 1.44-MB floppy drive is included. ★



Affordable Portable

For those who don't need quite so much portable power or such a high price tag—students, for instance—*Brother's* color *GeoBook* (less than \$600) fills the gap between portable organizers and full-function notebook PCs. Its *Brotherworks '98* software suite provides all the computing applications needed by most people on the go: web browser, e-mail, scheduler, desktop publisher, word processor,

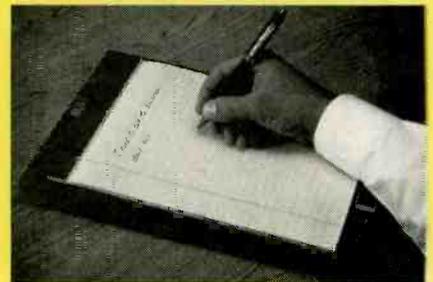
and spreadsheet. Utility programs include *PUMA Technology's Intellisync* software that allows synchronization with PC PIM applications. PC files from programs such as *MS Word*, *Word Perfect*, and *Lotus 1-2-3* can be imported and exported.

On the hardware side, the “hard drive” is actually an electronic drive based on *AMD's Am29F800T* flash memory. Applications reside on a 5-MB ROM drive. The *GeoBook* boasts an internal 33.6/14.4-kbps modem, a built-in 1.44-MB floppy drive, a backlit color VGA display, and a full-size keyboard. Technophobes take note: Everything is factory-installed, -tested, and -configured, so the *GeoBook* is ready to use right out of the box. ★

Take Note!

Does someone you know spend as much time searching for the notes they've jotted down as they actually spend writing them? How about giving them a way to electronically organize all those little pieces of paper?

From the *Pen Computing Group of A.T. Cross Company* comes the *CrossPad* (\$399), a portable digital notepad that bridges the gap between paper and the PC. The *CrossPad* takes notes that you write on a standard pad and transforms them into “digital notes” by uploading the handwritten words to a PC where they can be filed, reorganized, faxed, e-mailed, printed in handwritten form, or converted to standard ASCII text for use in *Windows 95* applications.



Using a digital pen equipped with an RF transmitter, you take notes on a standard 8 1/2" × 11-inch lined notepad affixed to the *CrossPad's* digital notepad. Meanwhile, signals from the digital pen are stored as digital notes in the pad's memory. The keyword feature allows you to circle a word and search for it later, making it easy to retrieve your notes. Change pages by flipping the page over.

Up to 50 pages of handwritten notes can be stored in the *CrossPad*. Need more storage? Transfer digital notes to a PC using the included serial cable. *IBM Ink Manager* displays the notes on the PC screen in seconds. A PC equipped with *Windows 95* and a *Pentium* or better processor, 20 MB of hard disk space, 16 MB RAM minimum, a CD-ROM drive, and one available 9-pin COM port are required. ★

Brother GeoBook NB80C

GeoBook
The Simpler Notebook.

We're at your side

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AUTOMATED HIGHWAY SYSTEMS

By 2020, highway travel is expected to double from 1990 levels. Because of the high cost of construction, the lack of available real estate, and environmental concerns, it's doubtful that current highways can be expanded or new ones built to keep pace with the growing demand. Thus, "smarter" use has to be made of existing roadways. That's the objective of Automated Highway Systems (AHS).

With AHS, vehicles would robotically travel in "platoons" at close intervals. That, in itself, could double or even triple road capacity. Greater traffic volume could be handled since vehicles would move at higher speeds than are now legal or practical. No longer would gridlock occur as people gawk at roadside incidents; thus, the stop-and-go ripple effect would be virtually eliminated. Accidents would be significantly reduced because flawed human decision-making (which reportedly accounts for 90% of motor vehicle crashes) would be taken out of the driving equation. AHS has the potential to eliminate the stress of driving in congested traffic and even prevent road rage.

Recognizing the problem of growing urban traffic congestion, Congress mandated the development of a prototype AHS by 2002 as part of the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). The National Automated Highway System Consortium (NAHSC)—an industry-government-academia collaboration—was created to accomplish the development. Core participants include General Motors, Delco Electronics, Lockheed Martin, Hughes, Bechtel, Parsons Brinckerhoff, the California Department of Transportation (CALTRANS), the University of California, Berkeley, Carnegie Mellon University, and the Federal Highway Administration. There are over 100 associate participants. While fully automated highways are still several years in the future, many pieces of AHS are road-ready or near road-ready. Those AHS technologies, which were demonstrated in August 1997 as part of the NAHSC

Smart highways and smart cars may be nearer than you think

BILL SIURU

Demo '97, included adaptive cruise control, obstacle/collision avoidance, lane keeping, and blind-spot warning. Adaptive cruise control detects vehicles ahead and adjusts vehicle speed to maintain a safe following distance.

Obstacle/collision avoidance detects other vehicles and obstacles and warns the driver or automatically applies the brakes.

Lane keeping keeps vehicles in their own lane. Demo '97 was aimed at showing how close smart vehicles and highways are to every day use already. Indeed, several automakers will soon be introducing adaptive cruise control. Both obstacle/collision and blind-spot warning are already available for trucks and buses.

Some twenty vehicles were involved in Demo '97 on a modified 7.6-mile section on I-5 north of San Diego, CA. The section consists of two reversible, express commuter HOV lanes that are used during weekday mornings and evenings to handle rush-hour traffic.

"Smart" Buicks. Ten specially equipped Buick LeSabres were the primary demonstration vehicles. Experimental electronics were installed for lane keeping, speed and distance control, and both vehicle-to-vehicle and vehicle-to-roadside communications. Two ordinary 166-MHz Pentium PCs plus other electronic boxes filled the trunk. Demo '97 was a demonstration of technical feasibility, not an AHS prototype, which will not be ready until 2002. Probably the most spectacular parts of the demonstration were when several Buicks traveled in a platoon

at 13 to 33 foot intervals with the driver being merely a passenger or when a Buick stalled between orange cones while the driver waved with both hands.

Lane keeping uses six magnetometers located under the Buick's front and rear bumpers. The magnetometers "read" a line of magnets installed just under the surface of the road. The magnetometers keep the vehicles in the middle of the lane and let them travel at very close intervals by providing feedback control to maintain lateral (steering) and longitudinal (speed and spacing) control. Information from those sensors is fed to two computers, one each for lateral and longitudinal control. Within a millisecond, the software determines the car's precise location in the lane and issues commands to the steering throttle, and brake actuators to keep the car precisely on track.

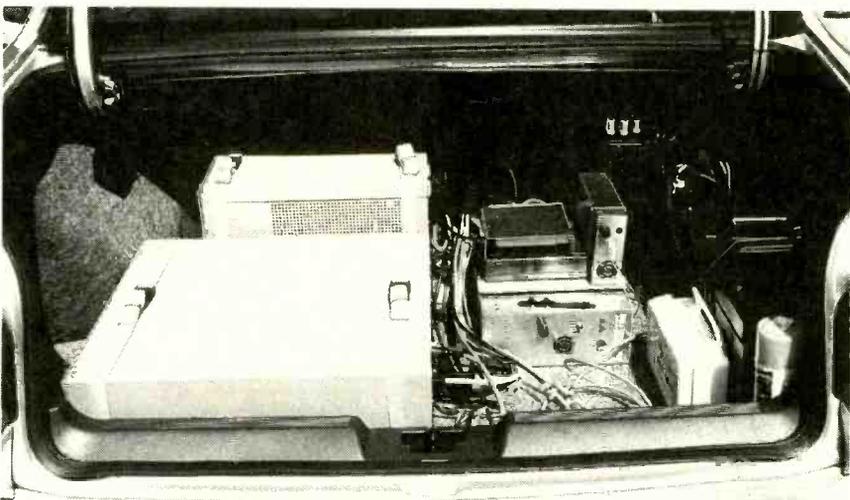
Tens of thousands of 1- x 4-inch, high-strength, ceramic magnets were installed at four-foot intervals down the center of two lanes of the I-15 test section. The magnets represent the only major alteration needed to convert an existing road to an automated one. At 83 cents per magnet, it costs \$5,000 to \$10,000 per mile, including labor, to create an AHS. The permanent magnets can provide information on roadway features such as curves, merging traffic lanes and exit lanes.

The major expenditure is the magnetometers, which now cost about \$1,500 each. That price should be reduced significantly if they're reproduced in large volumes. For example, Honeywell has developed a magnetometer that should cost about \$5 when mass produced.

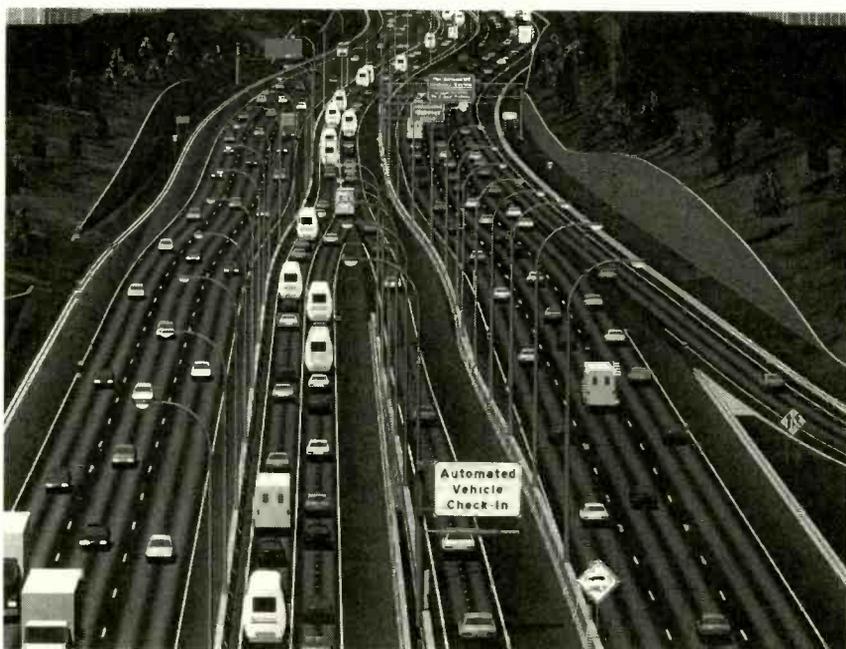
A very sensitive radar installed behind the grille provides the range to preceding vehicles. Distance is fed to the computer, which commands brake and throttle actuators to maintain vehicle speed and safe distance from other vehicles. Another system, either using radar or vision sensors, is being developed to detect obstacles in the road, such as debris fallen off a truck. Displays



AHS technology used on the Buicks allowed them to be driven "hands-off" and "feet-off."



The Buicks' trunk was filled with electronic gear including two Pentium PCs. In the future, the technology would be made much smaller and integrated into the car's on-board computer.



AHS would use dedicated HOV lanes separated from regular traffic lanes. Note the closer vehicle spacing allowed by AHS.

keep the driver and passengers informed on the status of the AHS. The driver views a heads-up display while a flat-panel LCD is used by front- and rear-seat passengers.

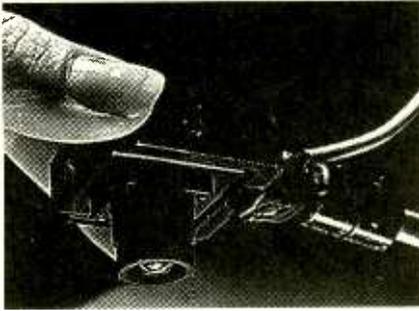
Vehicle-to-vehicle and vehicle-to-infrastructure communications are an important part of AHS. Vehicle-to-vehicle communications ensure that as vehicles travel in groups every vehicle knows the precise whereabouts of every other vehicle in that group. While on the AHS, vehicles are in constant two-way communication with Transportation Management Centers, which collect information about collisions, road closures, and emergencies. Information from roadside cameras and inductive-loop detectors embedded in the highway monitor traffic flow. Eight centers already exist in California; the most sophisticated one is near San Diego.

Prior to entering the AHS, vehicles pass through a check point where a transponder on the vehicle sends a signal to road sensors located in the validation lane to furnish them with the status of all onboard computer systems. If all systems are functioning properly, the vehicle is commanded to automatically merge into a particular lane and accelerate to a precise cruising speed to join up with a platoon of vehicles traveling to similar destinations. Vehicles traveling faster and farther will be automatically directed to the left lanes.

The AHS maintains safe control of the vehicle's speed and steering until the destination is reached, then control is returned to the driver. Part of the validation includes having the vehicle GPS-based navigation system note the precise destination.

As the destination is approached, the driver is automatically advised to resume manual control. A transponder in the vehicle sends signals to other cars to create a space so the vehicle can exit. The validation could also include payment of any tolls by automatically debiting the driver's credit card, and could even check to see if there was enough gasoline to complete the trip.

If there was an accident on the AHS, it would quickly be detected so platoons of vehicles could be automatically rerouted around an



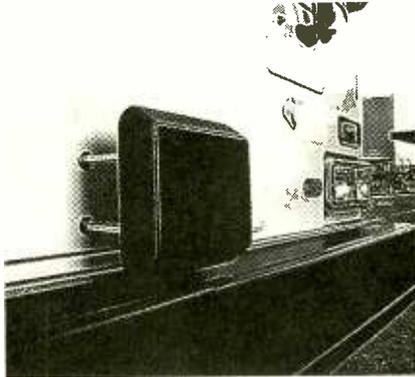
Micro video camera, mounted high on the front windshield, is used for lane keeping on the Houston METRO buses.

accident. Incidentally, AHS would use dedicated roads with high barriers isolating it from conventional roads, just like the I-15 demonstration lanes.

Other Vehicles and Techniques.

While the *Buick LeSabres* got most of the media's coverage during Demo '97, other vehicles demonstrated alternative AHS techniques. They also allowed interaction between different types of vehicles and technologies just like in a real-world AHS. Specially equipped *Honda Accords*, *Oldsmobile Silhouettes* and *Delta 88s*, *Pontiac Bonneville*s, *Toyota Avalons* and *Camrys*, *New Flyer* buses and a tractor/trailer truck rig were showcased in Demo '97. A *Chevrolet Lumina Minivan* served as an infrastructure diagnostic vehicle.

Two *Honda Accords* used two approaches, one where vehicle and road were equipped with AHS equipment and another where the



Radar sensor mounted above the front bumper is used for Obstacle/Collision Avoidance on the Houston METRO buses.



The Delco electronic display used in the Buicks.

AHS gear was only in the vehicle.

Ohio State University demonstrated an alternative to the magnets placed in the roadway. Four miles of the test section were equipped with radar-reflective tape. Here a single camera-based vision system was used for lateral control, a low-power radar was used for side vehicle detection, and a laser system was used for longitudinal control.

Mass transit agencies are interested in AHS to increase throughput on HOV lanes. Besides being able to meet schedules on time, AHS can reduce wasted time, fuel, pollution, and accidents. Houston METRO

turned to Carnegie Mellon University to fit two of its *New Flyer* buses with hardware and software to demonstrate lateral control (steering and lane following) and longitudinal control functions (speed control and headway maintenance). For lane tracking, the buses were equipped with the RALPH vision system with a micro video camera mounted near the top center of the windshield. The camera feeds its view of the road to a computer, which determines lane position and provides automated steering via an actuator located at the base of steering column.

A radar unit mounted on the front bumper detects other vehicles ahead and obstacles in the buses' path. Ranging data from the radar is used by the computer to calculate the distance between the bus and vehicles ahead. The computer commands the bus to accelerate or brake as needed. A pair of single stripe laser range finders mounted on the buses' side cover blind spots. The system uses a *Pentium* PC behind the driver's seat.

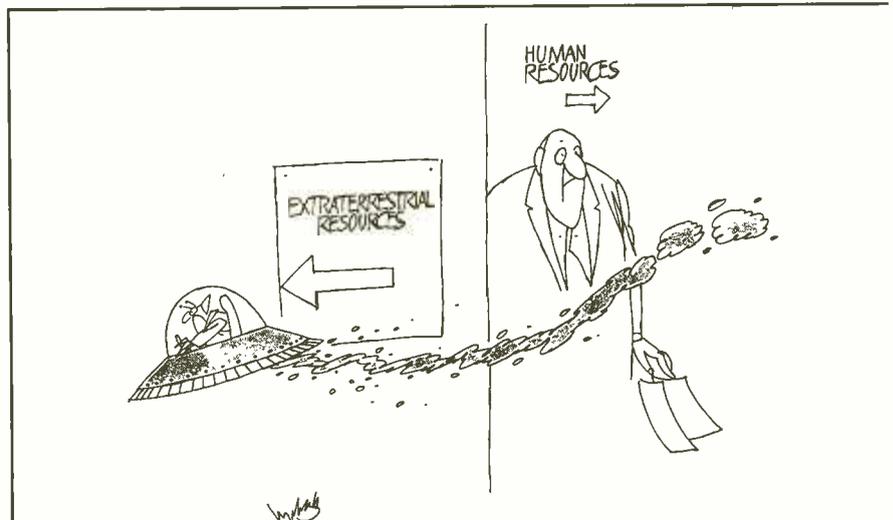
Automated highway systems hold a lot of promise for the future of the commuting public—fewer accidents, less congested roadways, greater traffic density and speedier travel, etc. And while the cost of some major components of the system (particularly the magnetometers) carry a high price tag at the moment, that's sure to change as more manufacturers join the challenge, offering their company talent and expertise to help bring this enterprise to fruition. ■

FOR MORE INFORMATION

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Tel. 810-236-4635

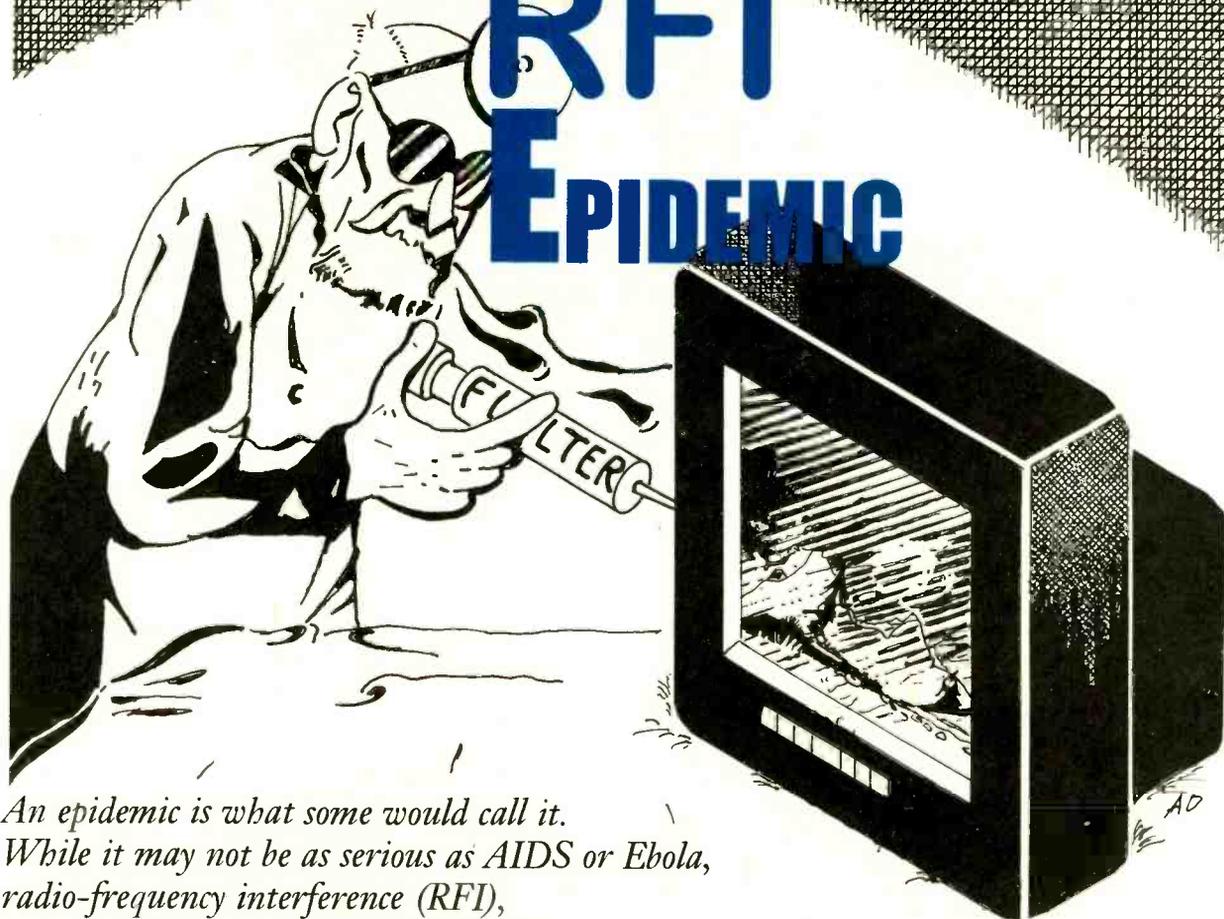
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INOCULATING AGAINST THE

RFI EPIDEMIC



An epidemic is what some would call it. While it may not be as serious as AIDS or Ebola, radio-frequency interference (RFI), nonetheless, has reached epidemic proportions.

KARL T. THURBER, JR., W8FX

In the early years of radio, interference (called broadcast interference, or BCI) was caused by nearby AM or FM broadcast stations. As if BCI weren't enough, in the 1950s along with the arrival of television, TVI (or television interference) began to appear, causing much unpleasantness. Even with CATV (community antenna television, or "cable TV") and direct digital satellite (DDS) TV, TVI is still with us. And as more and more technologically sophisticated appliances fill our homes, the greater the chance for interference problems. While BCI and TVI are still alive and well, we tend to use the term RFI (a broader term than BCI or TVI) to describe interference of all kinds.

There are three modes by which RFI travels from its source (emitter) to its victim (susceptor): electromagnetic radiation, magnetic induction, and conduction (i.e., transmission through a circuit over signal and AC power lines). The actual transmission mode can be complex, since signals can simultaneously travel from the emitter to the susceptor by different paths.

The interference can be either differential-mode or common-mode signals. There are several distinctions between differential-mode and common-mode signals. Because of those differences, cures that are effective for differential-mode interference don't work for common-mode signals, and vice-versa.

Differential-mode interference usually involves a pair of conductors (a two-wire transmission line like coaxial cable). In differential mode, the center conductor of the cable is electrified and the shield maintains its neutral (ground) integrity. The signal travels down the center conductor and uses the shield as its return path. The problem can easily be retarded or eliminated through the use of a high-pass filter, which would shunt unwanted signals to the return line, while passing desired signals.

With common-mode interference, the offending signal simultaneously enters multiple circuit paths (a multi-conductor cable, for instance); the interference in all of the circuit

paths (wires) is in-phase. The wires act as a single wire seeking a return path to ground—they are radiators or receptors of unwanted signals. As an example, common-mode conduction occurs where the shield and center conductors of a coaxial line are both electrified by an unwanted, locally-generated signal. In such cases, a high-pass filter can be ineffective in reducing or eliminating the problem.

RFI Sources. Many interference problems have multiple causes. Still, the causes of RFI can be grouped into four broad categories: fundamental overload; external-electrical and power-line noise; spurious emissions and harmonics; and intermodulation, nonlinear rectification, and related effects. Table 1 gives a summary of interference sources.

Fundamental overload is caused by the strong fundamental signal of a transmitter. While properly designed equipment should select

only the desired signal(s) and reject others, some consumer equipment is incapable of rejecting strong, out-of-band signals. The most common points of entry are TV antennas and feedlines, power lines and cords, and speaker and telephone wiring. Fundamental overload is usually caused by a design deficiency—often, the manufacturer didn't install the necessary filters and shielding in the equipment.

A differential-mode high-pass (as illustrated in Fig. 1), band-pass, or RF notch filter can be placed in series with the TV's antenna feed line to suppress the offending signal. An AC line filter (like those shown in Fig. 2) can also be used to reduce signal feed-through from the AC power line. Common-mode ferrite chokes connected in the antenna lead-in and AC line can also help. But none of those remedies can cure TVI if the set is directly picking up the signal, or if the transmitter generates harmonics

and/or spurious signals.

External electrical and power line noise comes from many sources, including electrical appliances, switches, motors, generators, power lines and wiring, doorbells, lamp dimmers, and even computers. Electrical noise can be identified by looking at the TV or listening to a radio. On a radio, electrical noise usually sounds like a buzz or arcing (often punctuated with pops and crackles). Electrical noise can have a 60- or 120-cycle hum component that changes in intensity. Such noise must be cured at its source.

If the noise varies with the time of day, it could be related to whatever family members or the neighbors are doing at the time. On the other hand, if the noise changes with the weather, the source is probably external, and may be associated with corona discharges and spark-gap noise on outdoor power lines. (Close-up diagnosis and repair of power lines is best left to professionals due to the dangers involved.)

An AC power-line filter can control both conducted and radiated electrical noise, especially if placed at the noise source. The filter can be as simple as a small capacitor, or it might be considerably more complex. Figure 3 shows three simple filtering arrangements.

For electrical noise entering a set via the power line, a common-mode choke (mounted close to the device to be protected) can help. The choke can be as simple as several turns of the AC power cord wrapped around a toroid or ferrite core.

Then there is the case of spurious emissions and harmonics. Ideally, transmitters generate signals on the intended frequency only. Unfortunately, the ideal is never realized. All transmitters (including consumer devices not usually considered transmitters) generate signals outside the desired frequency band. Those signals (known as spurious emissions, or spurs) can be mixing products; parasitic oscillations; harmonics occurring at exact multiples of the fundamental; or even wideband noise, which must be suppressed at their sources.

Intermodulation, nonlinear rectification, and related effects are sort

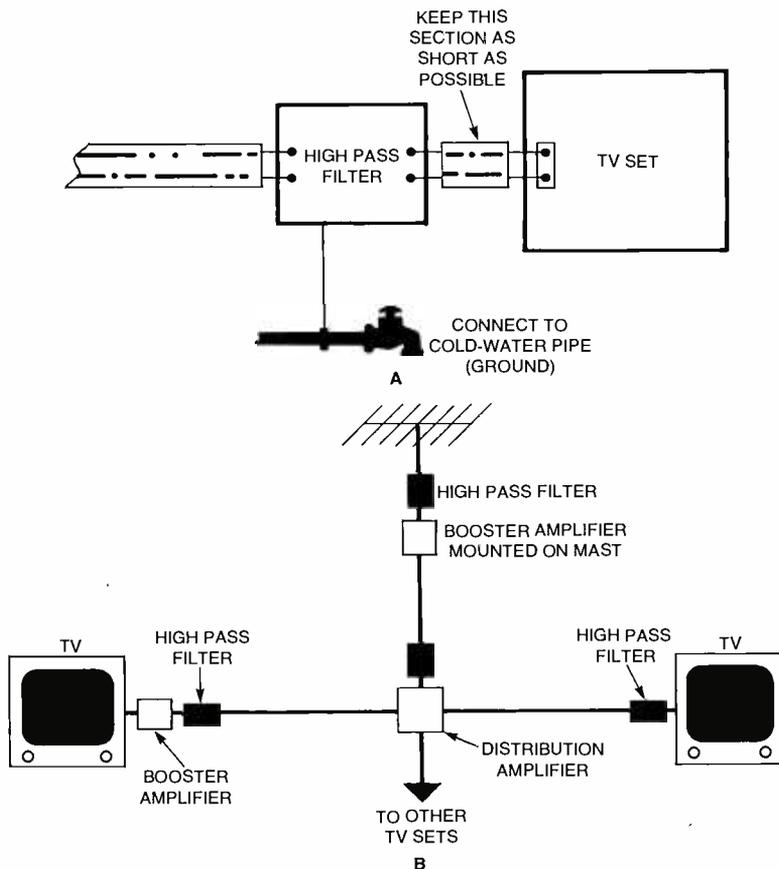


Fig. 1. Fixing TVI problems involves eliminating the most likely sources of RFI, one step at a time. A first step to reduce fundamental overload is to install a highpass filter on your TV set. Two examples of basic (non-CATV) installations are shown here, one using twin-lead and the other coax.

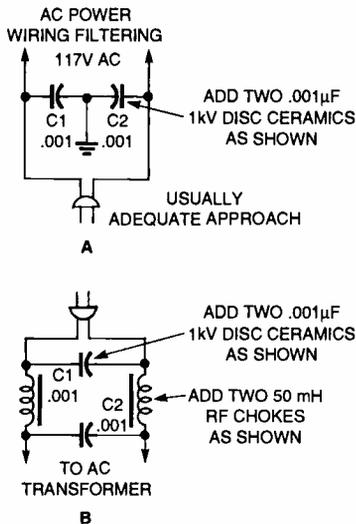


Fig. 2. An AC power-line filter can prevent RFI from a nearby transmitter from entering the TV or other device via the power cord. The filter may be purchased or you can build a simple unit yourself. Note that the filter circuits shown here aren't the same as surge suppressors, although both functions may be combined in a unit.

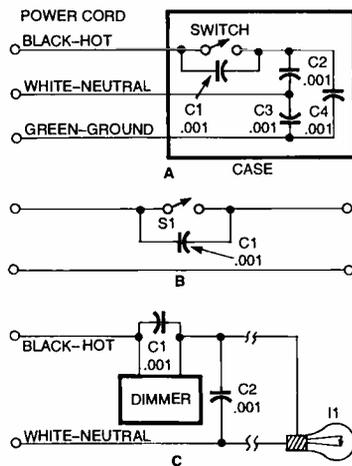


Fig. 3. Electrical interference from motors, drills, saws, and other AC-powered devices and appliances is best eliminated at the source. One of the simplest and quickest fixes is to bypass the device with a small capacitor, as shown in these three sketches.

of a "grab bag" of deleterious effects. Intermodulation refers to false-signal reception caused by various intermodulation products. Transmitter intermodulation distortion (IMD) is internal intermodulation that is caused when nonlinear transmitter stages produce undesired harmonics.

External IMD is difficult to eliminate because it's external to the equipment; it's generated when signals mix outside a receiver or trans-

mitter. In urban areas, it's difficult to resolve RFI from nonlinear devices—a spurious signal and harmonic-generating process, called nonlinear rectification—that occurs in the presence of a strong RF field. Oxides, such as rust and other corrosion byproducts, can generate and reradiate harmonics-rich signals. Such effects can be caused by corroded or wet antenna lead-in, tower, mast, and guy wire connections; bad solder joints; rusty bolts; poorly bonded rain gutters, ductwork, pipe, and plumbing joints; rickety metal fences; and other "conducting structures."

Sometimes even components in antenna rotator-control boxes, RF probes and monitors, and power supplies, as well as power lines and hardware, can cause nonlinear rectification and intermodulation-related effects.

There's also external cross-modulation—the transfer of intelligence from a strong, unwanted signal to a weaker, desired one. In external cross modulation, the stronger signal's modulation is imposed on the wanted signal even if it is outside the receiver's passband. Such effects can be produced by any external nonlinear device.

The FCC's Position. Consumer-electronics devices should respond only to the signals that they're designed to receive: the FCC holds that RFI is the unintended byproduct of deficient equipment design. Because of a lack of up-front prevention, the devices (besides performing their expected tasks) often act as unintentional radio receivers. What that means is that the equipment receiving the interference wasn't designed and manufactured with adequate RFI protection, so in a sense it's "broken" or "defective."

Consequently, the FCC places responsibility for interference resolution on the manufacturer. The FCC asserts that the manufacturer should assist with "defectively designed" equipment—although manufacturers' compliance is voluntary. In practice, they often assert their standards don't provide for equipment operation in close proximity to strong transmitters.

Translation: As the owner of equipment receiving RFI, you ultimately have the responsibility to diagnose, identify, track down, troubleshoot, and resolve the problem. To resolve RFI problems, it is often necessary to contact the dealer and/or the manufacturer for help. While some seriously try to resolve RFI in the interests of good service and customer satisfaction, many couldn't care less. If you have RFI problems with consumer-electronics equipment and you're not satisfied with the manufacturer's response, you can contact the Electronic Industries Association (EIA)—a manufacturers' trade group.

Since interference problems can involve both equipment and people, comprehensive solutions require that both be effectively dealt with. While our focus is on the hardware, it is often necessary to deal with RFI as a people problem as well. Interference issues won't be resolved if an emotional approach followed, or blame is automatically fixed on the "other guy," regardless of what the "other guy's" strict legal responsibilities may be.

Working with the Symptoms. Resolving RFI is a sequential, three-step process: identify the problem, diagnose it, and then eliminate it. Before you dig deeply into suspected RFI, be sure that the symptoms are actually caused by external forces. Various equipment malfunctions or a poor signal can look like RFI.

A TV should have a good picture to start with. If the TV is fed from an inside antenna, replace it with an outside antenna or a CATV connection. When you're sure that the set is receiving a good signal, only then look at ways RFI occurs. Simplify the problem: The more complex the system, the more difficult it is to isolate a problem. Always begin with the simplest, "cleanest" system possible. Begin by disconnecting all equipment from the device that's to be examined. If the TV shows signs of RFI, disconnect all accessories—such as video games, VCRs, stereo receiver, booster amplifiers, and other accessories—from the set. If the set is connected to a CATV system, connect the cable directly to the TV, bypassing the cable box.

If the RFI stops when you disconnect the cable or any device, but reappears when it's reconnected, you've likely found the problem. Gather information about the interference. Keep your eyes open, look around, and ask questions about the RFI. Basic information about the interference helps to identify its source. There are three basic questions you should ask about the RFI:

1. What does the interference look like? Electrical interference often appears as horizontal lines on the TV screen and may be accompanied by a buzzing or sizzling sound. In severe cases, the entire screen may be covered with riling horizontal lines. If the RFI is coming from a nearby transmitter, vertical, horizontal, or crosshatch lines may move in synchronization with the audio. Low-power radio devices, such as garage door openers, can cause similar RFI.

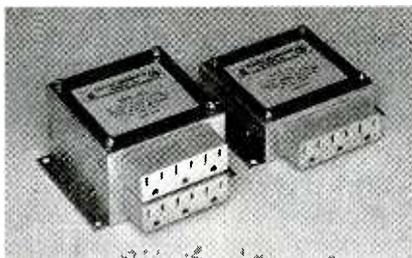
2. What does the interference sound like? If you can hear the interference, listen to it carefully. Do you hear music and voices from a broadcast station? If so, try to identify which station. Do you hear radio-operator voices? If the interference is intermittent and you hear voices, it's likely that you're picking up a nearby CB, amateur-radio operator, or a two-way FM service.

Do you hear static or a buzzing sound? You may be picking up interference from an electrical device in your house or your neighbor's house, or interference from outdoor power lines. If the noise only occurs for short periods, you may be receiving interference from a household appliance.

Do you hear both voices and tones? If so, you may be picking up signals from a paging system. Such systems usually operate 24-hours a day, so you may experience this RFI at any time.

3. When do you get the interference? Keep track of the times when you receive the interference. Does it always occur at the same time, or is it unpredictable? Is it tied to some action of your neighbors, such as the neighbor opening their garage door?

If your equipment is reacting to a nearby radio operator, the interference will be apparent only for



The ICE line filters shown here provide inductive isolation, overvoltage control, capacitive decoupling, and interference control of both common mode and differential mode signals across a broad frequency range. (Photo courtesy Industrial Communication Engineers, Ltd.)

periods when the operator is talking. But if the interference is constant, you may have electrical, AM or FM broadcast, or paging-system interference.

A simple way to determine if the interference is emanating from within your home is by going to the main fuse or circuit breaker box, and then, using the TV set or a portable AM radio, determine whether interference is present. Assuming it's present, you can identify the circuit in your home that's powering the device causing the interference by removing one fuse or shutting off one circuit breaker at a time; avoid contact with any wiring in the box. If the interference continues, turn the circuit breaker back on and try the next one.

If the RFI stops when a fuse is removed or a circuit breaker is tripped, go to the area supplied by the disconnected circuit, turn the power back on and wait until RFI is present. Unplug each device in the suspect circuit one at a time. If the RFI stops after unplugging a device, you've found the culprit.

Another way to locate electrical interference is to use a portable AM radio tuned to a quiet frequency at the low end of the band. If you hear static or buzzing, determine whether it corresponds with the TV interference. If it does, use the portable radio to locate the interference source. The noise will be loudest in the room where the interference originates. Unplug each electrical device one-by-one until the interference disappears.

If you can't locate the interference source in your home, check with neighbors to see if they're

experiencing the same problem. The house that has the worst interference most likely is its source. With the cooperation of neighbors experiencing interference, you can track it down with a portable AM radio or run the fuse/circuit-breaker procedure.

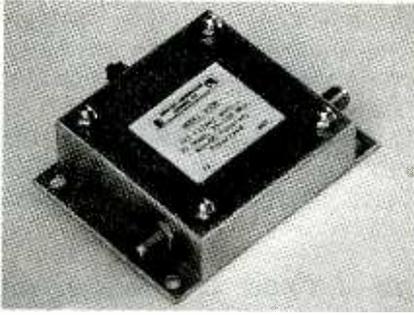
Basic TV-Set RFI-Analysis Techniques.

There are two main entry points for local unwanted signals. The first is through the TV antenna or CATV lead-in; the second is through the AC power line. To determine which is causing the RFI, disconnect the antenna lead-in from the back of the set. With the offending signal on the air, observe the screen. If the RFI disappears, it was entering the TV through the antenna line. Installing a highpass filter is the next step. If, on the other hand, the interference is still present, the AC line is part of the problem, and a line filter should be tried.

If the RFI interrupts many or most channels, the set is probably experiencing fundamental overload; a highpass filter can be effective in such cases. But if interference occurs to only one or two TV channels, then the cause may be harmonic signals from the transmitter. That problem can only be solved at the transmitter, usually with a low-pass filter in the case of an HF transmitter, or a band-pass filter in the case of a VHF or UHF transmitter.

Check the "RF Plumbing." Installation problems cause their share of RFI. Look for corroded antenna lead-ins, AC power, and telephone lines; loose or corroded connections; breaks in coaxial cable; and the like. Also make sure that all cables are properly connected and in good condition; if loose or broken connections, or damaged cables are found, replace or repair them. Antenna wires, interconnecting cables, and power cords often act as antennas, so they should be as short as possible.

Antennas and Lead-in. Antenna lead-in cable (even coax) and the antenna itself deteriorate over time and with weather exposure. If the antenna is corroded, clean or replace it. Also check the antenna



The ICE Model 430B TV highpass filter, shown here, passes signals from 54 to 500 MHz and employs a variety of techniques, including a deep-notch, low-end cutoff attenuation slope below TV frequencies. A similar unit, the Model 436B, eliminates FM broadcast interference. The Model 437B incorporates a notch filter for the two-meter amateur band.

lead-in for physical damage. If the lead-in is unshielded twin-lead, consider replacing it with coax. Coax is universally used in apartment master-antenna television (MATV) systems and CATV installations. Using coax helps prevent leakage from the system as well as the absorption of unwanted signals.

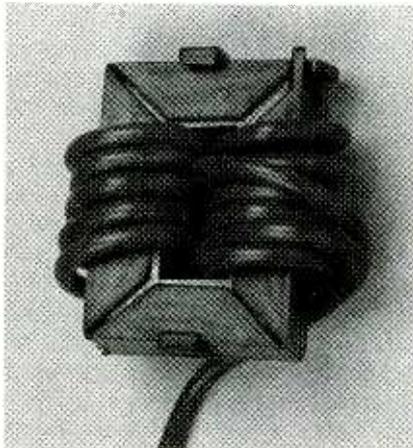
CATV Systems. If your TV shows signs of TVI, remove the converter box from the circuit and connect the lead-in directly to the TV set to make sure that the converter itself isn't responsible for the interference. Also check the cable from the converter to the TV. Try a different 300-ohm/75-ohm transformer (if used) or use the built-in F-connector found on most TVs for antenna input. Ensure that any antenna jumpers on the TV are in the correct place. Examine the signal splitters (if used) in the system. To test a splitter, bypass it—hooking the antenna/cable connector directly to one TV. If signal quality is improved or the RFI goes away, replace the splitter.

Also disconnect all antenna leads from the TV to see if you have a picture and sound on a strong local station. If you get good reception, the set may be letting RFI in directly through a lack of shielding. Finally, check for excessive cable-system leakage, and report it to the CATV company.

Boosters and Preamplifiers. TV boosters or preamplifiers—which are often used to receive weak, distant TV signals—should only be used in

weak signal areas since they can generate fundamental-overload-like interference when used near strong RF signals. If a booster is used in the antenna system, disconnect it and turn it off, and connect the antenna directly to the TV. If the RFI disappears, repair or replace the booster, or try to do without it. It may be necessary to place a notch or highpass filter and a common-mode choke on the preamp's antenna input, as well as a common-mode choke on the preamp's AC power cord. If your TV set is connected to a MATV system that contains boosters, contact building management for assistance.

Eliminating TVI. There are several guidelines you should follow when applying TVI cures. First, observe all safety precautions to avoid shocks when working with electrical and electronic equipment. Second, try the easiest and simplest RFI cures first, before trying more complex solutions (often the simplest cure is a high-pass filter and AC line filter on your TV). Third, you may have to simply try a possible RFI cure (preferably a simple one first) and see what happens to the RFI. Fourth, before you attempt a solution involving an expenditure of time and/or money, try moving the TV or other affected device to see if that simple action eliminates the interference. As a rule, the farther away the device is from the RFI source, the less severe the RFI.



Snap-together toroid chokes can be effective in curing RFI; you can use them on telephone, computer, power, audio, and coax lines. With this core, you don't have to cut the cable—simply wind the wire or line through the core. (Photo courtesy Radio Shack)

Eliminating Interference to VCRs. VCRs are like TV sets without a screen, and they're just as susceptible to TVI. Assuming you've determined that the VCR is responsible for the RFI by temporarily disconnecting or bypassing it, you may have to apply to the VCR the same set of cures that are recommended for the TV, such as a highpass filter on the antenna input and common-mode chokes on both the antenna input and AC power lines. Also replace unshielded RF and audio wires with shielded wire or coax. But if the interference doesn't disappear with all those corrective measures, it's likely that there is direct signal pickup by the VCR and you'll probably have to consult the manufacturer for assistance.

Eliminating CATV Interference.

When CATV became popular, radio amateurs, CBers, and two-way radio system operators cheered. They thought it would mean the end of TVI. But, as we now know, things haven't quite worked out that way. Sure, cable TV can be a blessing, but the cable also can serve as a very long antenna. Cable TVI can be particularly difficult to cure since most CATV systems use large chunks of the VHF and UHF spectrum, right on or near frequencies used by radio amateurs and two-way radio systems.

Since CATV cable is shielded, external signals shouldn't be getting in through the cable. A highpass filter is usually unnecessary, except possibly in stubborn situations. Common-mode chokes can eliminate unwanted signals from outside of the coax and other cables around the TV set.

In addition, CATV RFI can be minimized by ensuring that all connectors on the CATV cable are properly crimped and screwed down securely. Check that the CATV ground block is connected to a good ground, that all splitters and couplers are shielded, and that the coax itself isn't damaged along its length. If you suspect leakage, contact your cable company—they often have leakage problems, which include damaged hard line or coax, loose connectors on the drop (or down) lead or on taps or amplifiers, or line

amplifiers in the system running with too much gain. Self-installed, extra TV outlets (especially if wired with twin-lead) are responsible for much leakage and RFI.

While we're concerned here with RFI to the cable system, CATV leaks work both ways. All CATV systems are required to hold leakage to certain minimum levels. The FCC can discipline systems that are found to be in violation of its standards, since leaky systems can interfere with a variety of RF-communications services.

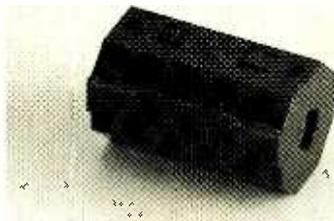
Amateur Radio or CB Interference.

The cure for fundamental overload is usually to install a highpass filter at the TV's antenna leads. Highpass filters are passive devices that are used to block frequencies below about 54 MHz, while allowing signals above that limit to pass unobstructed.

The highpass filter mounts as close to the TV set's antenna connector as possible. If other devices are connected in the system, it's generally best to place the filter between the incoming antenna or CATV lead and the first device to which the lead-in is connected. Keep all leads short and connections tight. It may also be necessary to install a common-mode choke on the antenna or CATV coax near where it enters the TV. If you have RFI even with the antenna disconnected, try installing an AC line filter at the outlet into which the TV is plugged. Also try wrapping several turns of the TV's power cord through a ferrite core as close to the TV set as possible.

Two-Way FM Interference. If you're receiving two-way FM transmissions, such as police or taxi, or VHF/UHF amateur stations, it may be necessary to install a notch or band-reject filter on the TV; the filter should be designed to reject the frequency of the unwanted transmissions. If interference still gets through after installing the filter, you may also need to install common-mode chokes on the antenna lead-in and AC power cord.

FM Broadcast Interference. There are three common interference



Common-mode ferrite chokes can be effective RFI fighters, eliminating unwanted signals from the outside of coaxial and other cables around the TV set or stereo system. This easy-to-use device is simply snapped over the coax, AC power, or audio cables.

problems that involve FM broadcast stations. The first problem arises when you're receiving a distant TV signal, and a strong local FM station overpowers the weak TV signal.

The second FM problem is "blanking," or fundamental overload, which occurs when the TV set is close to the transmitter. Installing an FM rejection filter at your TV antenna input, as well as using a highly directional antenna, could fix those problems. The third FM problem occurs when a TV booster or preamp is used to boost signals from distant stations. The boosters frequently react to strong FM band signals. If you suspect that's the case, you should install an FM band-rejection filter or a tunable-rejection trap between your antenna and the booster or preamp.

Eliminating Electrical System Interference. Doorbell transformers are a common source of TVI, from both your own home and that of neighbors' homes. The interference looks like electrical interference, but doesn't cover the whole screen. An intermittent frying or sizzling sound can also be heard. If you've determined that the interference is coming from within your own or a neighbor's home, disconnect and replace or repair the offending device.

A variety of devices such as electric razors, hair dryers, electric drills, and saws can cause annoying but temporary interference problems. However, you may choose to tolerate that type of interference since it's temporary in nature.

If you determine that the electrical interference isn't caused by a

device in your home or a neighbor's home, contact your local power company. Most power companies will investigate the problem and take steps to correct it.

Interference to Telephones. Interference to telephones from nearby transmitters is a major RFI problem. Telephones are considered to be "non-radio devices" by the FCC—devices that shouldn't intercept radio signals. Telephone RFI is caused by signals intercepted by the telephone wiring in the home and outside. Signals work their way into the telephone circuits and the telephone itself, resulting in voice distortion or noise.

FCC regulations don't specify how well a telephone must block out radio communications, although they encourage manufacturers to consider RFI susceptibility. The industry has begun to develop voluntary standards for interference protection.

The Nature of the Telephone RFI Problem. Before the "deregulation years" of the 1980s, most telephone equipment was owned, installed, and maintained by *Ma Bell*. It usually was a simple matter to resolve telephone RFI. You simply called the telephone company, and they'd send out a technician to install a bypass capacitor across the telephone mouthpiece. Problem solved.

Today, the telephone company usually is responsible for the telephone system only up to the connection point, or drop, at your house. Generally, you own the telephones rather than lease them, and you may be responsible for the house wiring, as well. (Contact the telephone company if you're using a leased phone. They may have the responsibility for correcting interference.)

With the popularity of computer-aided telephones comes an increase in telephone RFI. Modern telephones, with their many electronic features, have a high sensitivity to RF and resultant probability of interference. Potential problems begin when the telephone is built: if the manufacturer doesn't build in RFI protection, the device may react to nearby radio communica-

tions. Few manufacturers give much consideration to RFI resistance.

Cordless Telephones and Accessories. Cordless telephones aren't protected from RFI. Most have wide receiver front ends, making them sensitive to electrical noise, radio interference, and even the communications of other, nearby cordless phones.

Sometimes, if you're lucky, you can install telephone line and AC line RFI filters on the cordless base unit that will cure the problem. But common RFI remedies may not be of any use. If you receive nearby radio transmissions on a cordless unit, your only recourse may be to contact the manufacturer for assistance.

With the proliferation of telephone accessories such as fax and answering machines, telephone-line home alarm systems, and like devices, telephone-style interference also may occur with them. The troubleshooting techniques and cures are similar to those for regular telephones, and you also may need a common-mode choke or an AC line filter on the accessory's AC power cord.

Identifying and Diagnosing the Source of Telephone Interference.

Once again, simplify the problem, looking first at possible installation defects. Some common installation problems include corroded connections, deteriorated wiring, bad telephone company lightning arrestors, and poor grounding. Working on indoor wiring is OK, but leave working on outside wiring to the telephone company (only a small percentage of telephone interference problems originate in the outside lines).

As in troubleshooting RFI in TVs and radios, start identifying and diagnosing telephone RFI by disconnecting things first, to isolate the point where the interference is being generated. Disconnect all extension telephones, fax, and answering machines, modems, and other accessories. If the problem goes away when a device is disconnected, you probably have found the culprit. Since some interference may be present only on

FOR MORE INFORMATION

RFI RESOURCES

American Radio Relay League, Inc.
225 Main Street
Newington, CT 06111
Tel. 860-594-0200

Electronic Industries Association

2500 Wilson Blvd.
Arlington, VA 22201
Tel. 703-907-7500

Federal Communications Commission

1919 M St. N.W.
Washington, DC 20036
Tel. 202-418-0200

RFI FILTER SOURCES

Amidon Associates
3122 Alpine Ave. P.O. Box 25867
Santa Ana, CA 92799
Tel. 714-850-4660

Channel Master

Industrial Park Dr.
Smithfield, NC 27577
Tel. 919-934-9711

CoilCraft

1102 Silver Lake Road
Cary, IL 60013
Tel. 800-322-2645

Engineering Consulting

583 Candlewood St.
Brea, CA 92621
Tel. 714-671-2009

Industrial Communication Engineers, Ltd.

P.O. Box 18495
Indianapolis, IN 46218
Tel. 800-423-2666

K-Com

P.O. Box 82
Randolph, OH 44265
Tel. 330-325-2110

Kilo-Tec

P.O. Box 10
Oak View, CA 93022
Tel. 805-646-9645

MFJ Enterprises, Inc.

PO Box 494
Mississippi State, MS 39762
Tel. 800-647-1800

Microwave Filter Company, Inc.

6743 Kinne St.
E. Syracuse, NY, 13057
Tel. 800-448-1666

Opto-Tech Industries, Inc.

P.O. Box 13330
Ft. Pierce, FL 34979
Tel. 800-334-6786

Palomar Engineers

P.O. Box 462222
Escondido, CA 92046
Tel. 760-747-3343

PRO Distributors

2811-B 74th St.
Lubbock, TX 79423
Tel. 800-658-2027

RadioShack

1 Tandy Center, Suite 300
Ft. Worth, TX 76102
Tel. 817-390-3011

SNC Manufacturing Co., Inc.

101 W. Waukau Avenue
Oshkosh, WI 54901
Tel. 800-558-3325

Star Circuits

P.O. Box 94917
Las Vegas, NV 89193
Tel. 800-433-6319

TCE Laboratories, Inc.

2365 Waterfront Park Dr.
Canyon Lake, TX 78133
Tel. 210-899-4575

Telecom Industries

1385 Akron St.
Copiague, NY 11726
Tel. 516-789-5020

Ten-Tec, Inc.

1185 Dolly Parton Parkway
Sevierville, TN 37862
Tel. 800-833-7373

Winegard Company

3000 Kirkwood Street
Burlington, IA 52601-1007
Tel. 319-754-0600

RADIO-PROOF TELEPHONES

PRO Distributors

2811-B 74th St.
Lubbock, TX 79423
Tel. 800-658-2027

TCE Laboratories, Inc.

2365 Waterfront Park Dr.
Canyon Lake, TX 78133
Tel. 210-899-4575

certain telephones, you need to check each instrument separately.

Plug each unit back in, one at a time, taking them all to one of your

wall jacks, listening for the unwanted radio communications. If you hear interference through only one telephone (or just when an acces-

TABLE 1—INTERFERENCE SOURCE SUMMARY

Broadcast and Communications Transmitters

AM radio station
 FM radio station
 TV station
 Citizens band (CB) radio station
 Amateur radio station
 Taxi
 Police
 Business or other two-way services
 Airports and aircraft
 Paging system transmitters
 Community Antenna TV (CATV) cable systems

Electrical Devices and Other Noise Sources

Doorbell transformers
 Toaster ovens
 Electric blankets
 Ultrasonic pest controls (bug zappers)
 Motors and fans
 Refrigerators
 Heating pads
 Light dimmers
 Touch-controlled lamps
 Fluorescent lights
 Aquarium or waterbed heaters
 Furnace controls
 Computers and video games
 Neon signs
 Power company electrical equipment
 Alarm systems
 Electric fences
 Sewing machines
 Hair dryers
 Electrical toys
 Calculators and cash registers
 Lightning arrestors
 Electric drills, saws, grinders, and other power tools
 Air conditioners
 TV and radio booster amplifiers/preamplifiers
 TV sets
 Automobile ignition systems
 Sun lamps
 Smoke detectors

sory such as an answering machine or fax is plugged in), then the interference is being generated in that unit. Either stop using the unit, replace it with a so-called "radio-proof" model, or install a filter on the device. Contact the manufacturer for help; some will supply a filter.

Eliminating Telephone Interference. About the only realistic way you can resolve telephone RFI short of making internal circuitry changes to the telephone is to choke the RF signals before they enter the de-



The ICE Model 460 series telephone RFI filters are claimed to be highly effective telephone RFI blockers. The Model 465, at left, is a basic 30 dB loss unit, while the Model 467, at right, is a multi-stage unit that offers 50 dB loss.

vice. Much telephone interference can be remedied or at least reduced by the simple installation of a telephone filter that plugs into the rear of the telephone.

There are two ports of entry through which RFI can enter a telephone. The first, and most common, is through the house wiring. The second is through the handset cord that attaches the handset to the telephone body. In some cases a telephone line filter alone, installed at the wall jack or on the cord at the end nearest the telephone, will eliminate the RFI. In difficult cases, another filter in the handset lead may also be needed.

Inexpensive filters are available widely. For best results, obtain a filter with at least 30 dB RF attenuation in the desired frequency range (Photo H). The filter should be designed to prevent both common mode and differential mode interference.

Eliminating telephone RFI is frustrating. You may have to experiment with filters or change telephone locations and line lengths to cure the problem. In stubborn cases, try filtering the incoming telephone line with ferrite beads and/or snap-together ferrite cores. You may need to experiment to find the best style of bead or core and the best location for it on the cord.

Alternative Telephone RFI Solutions. If both a line and a handset filter are installed, and you've tried

ferrite beads or cores, but RFI persists, then the telephone itself may inherently be hypersensitive to RFI. Possible cures include replacement of the phone with a different type or make, or internal circuit modifications. Both can be expensive alternatives.

With some telephones, filters won't resolve the RFI problem due to the internal design, especially if it uses integrated circuits (ICs) and other semiconductors. If you can't eliminate the RFI, consider purchasing a different type or make of telephone, or one designed to be resistant to interference.

Interference-resistant telephones are less susceptible to RFI than others, but there's no guarantee they will be completely free of interference. "Radio-proof" telephones are available from at least two sources, PRO Distributors and TCE Laboratories, Inc.

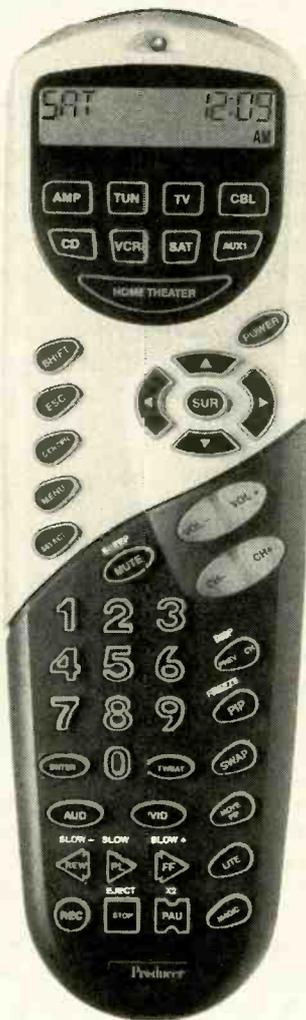
Another, low-tech telephone-RFI solution is to use an older AT&T, Western Electric, ITT, or other phone of the type that uses a carbon microphone and has no semiconductors. Such naturally RF-resistant telephones are no longer manufactured but often are found at flea market and garage sales at attractive prices.

RFI and Personal Computers. Personal computers (PCs) and other microprocessor-based equipment—
(Continued on page 47)

NEW PRODUCTS

HOME-THEATER REMOTE CONTROL

Part of the "One For All" line of high-end universal remotes for home-theater and DSS systems, the *Home Producer 8* comes equipped with special macro keys that activate a string of personalized home-theater commands at the touch of a button. They are the first universal remote controls on the market with the power to operate both DSS and DVD systems.



The *Home Producer 8* features Timed Macros that allow users to program up to ten different macros seven days in advance, including Timed Recordings and Sequencing. The remote control includes an advanced

radio-frequency and infrared (IR/RF) Command Center that controls DSS, A/V components, and home-automation systems from anywhere in and around the home—even through walls, floors, and doors, as well as outside from the deck, patio, or pool—up to 100 feet away. It offers a blue electroluminescent LCD status screen and keypad for easier operation in dark or dimly lit rooms.

The HOME THEATER button provides an extra mode key that allows the remote to be customized. With the touch of one key, the user activates a string of personalized commands that control the favorite settings for each component. The system is upgradable and will never become obsolete. The remote (9¹/₈ by 2³/₄ by 1¹/₂ inches) also contains a permanent memory retention program so that the batteries can be replaced without losing any pre-existing programs. Its suggested retail price is \$119.99.

For more information, contact Hudson Access Group, 1864 Enterprise Parkway West, Twinsburg, OH 44087; Tel. 330-405-8660; Fax: 330-487-1131.

CIRCLE 80 ON FREE INFORMATION CARD

INSULATION TESTER/METER

The *Extech Model 380360 Insulation Tester/Megohmmeter* performs insulation resistance measurements in three test ranges: 2000 megohms at 1000 volts, and 200 megohms at 500 volts and at 250 volts. It also measures resistance up to 200 ohms, plus AC voltage measurements up to 750 volts. The unit provides a fast response for both continuity and low-resistance testing.

Designed for use in motors, cables, power tools, and appliances, this instrument ensures that there is no voltage drop at low resistance, and it provides full-function indication. The *Safety Power Lock* allows for three minutes of hands-free operation. The tester automatically discharges when the PRESS TO TEST safety button is released. Other automatic features are power off and data hold, zero adjustment, and overload protection.

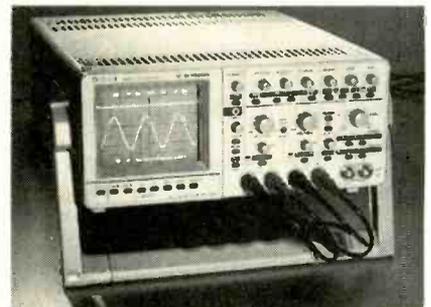


The Model 380360, which weighs 13 ounces and measures 3.8- by 6.3- by 2.3 -inches, comes with a large 0.65-inch LCD readout, six AA batteries, heavy-duty 30-inch test leads, alligator clip, large probe, and a carrying case. The *Model 380360 Insulation Tester/Megohmmeter* retails for \$199. For more information, contact *Extech Instruments Corp.*, 335 Bear Hill Road, Waltham, MA 02154; Tel. 781-890-7440; Fax: 781-890-7864; Web: www.extech.com.

CIRCLE 81 ON FREE INFORMATION CARD

DIFFERENTIAL OSCILLOSCOPE

Providing all the benefits of a full-function analog, digital storage, and differential oscilloscope, the *B&K Precision, Model 5034 30MHz Differential Oscilloscope* is capable of measuring motor control circuits, switching power, 3-phase power, and high common-mode voltages. It also performs direct viewing of line voltages, safe from the hazards of "hot chassis" equipment.



Dual-channel capability includes functioning as a dual-trace scope in the differential mode. The 5034 includes full differential inputs on both channels and external trigger input. The oscilloscope features a digital refresh rate of 0.1 μ s to 200s/div, 40-MHz sampling frequency, and sweep speed of 0.2 μ s/div in 1-2-5 sequence, 20 positions. DC-coupled frequency response ranges are to 20 MHz (channel 1) and 30 MHz (channel 2). An RS-232 port enables hard-copy and remote programming (SCPI).

The 5034 measures small signals superimposed on high AC or DC voltages by using one differential input to reference the common mode voltage, and it allows phase analysis of multi-phase systems. In the differential mode, full sensitivity is provided from 10mV/div to 200V/div. It is powered directly from a 120-volt AC source. Compact in size (6.1- by 13.4- by 17.7-inches), the unit's large 6-inch CRT display offers 8-bit resolution. Among its other features are 8K memory, autose, and cursors/readout.

The 5034 is priced at \$2330. Two probes (PR-150 or equivalent) are provided. For more information, contact *B&K Precision*, 4353 West Lawrence Avenue, Chicago, IL 60630; Tel. 773-725-9252; Fax: 773-725-9385; Web: www.bkprecision.com.

**CIRCLE 82 ON FREE
INFORMATION CARD** ■

RFI EPIDEMIC

(continued from page 45)

including digital clocks, various kitchen appliances, video games, and the like—are susceptible to RFI, and they also can generate RFI on their own account. The good news is that, usually, applying RFI techniques to fix either “inbound” or “outbound” interference also will resolve the other.

PCs are covered under Part 15 of the FCC regulations as “unintentional emitters,” and must meet a minimum-emissions standards. Although computer interference normally disrupts only your own TV, it does occasionally transmit RFI to your neighbor's TV; that's rare given the strict FCC standards for PCs used in residential environments. If that occurs, you should discontinue using your computer system until you can resolve the interference

problem—you're responsible for interference you cause to others.

Computer-generated RFI usually is the result of inadequate filtering of PC data and AC power leads as well as inadequate shielding. In sleuthing computer RFI, you again should simplify the problem by isolating the source of the interference to the computer and/or its peripherals, such as mouse, printer, monitor, external disk drives and modems, and keyboard. Disconnect and reconnect each device to see the effect on the interference.

Check all PC and peripheral equipment connecting cables carefully; whenever possible, they should be shielded. Be on the lookout for loose, poorly shielded, and unterminated cables. Placing a distance between the TV and PC may resolve the problem.

You can minimize interference to radios and TVs by using common-mode chokes (including even simple clip-on units) on signal and control leads to peripherals and on AC power lines to the PC and each peripheral. The chokes and beads sold by RadioShack, Amidon Associates, Palomar Engineers, and others are popular. You also may have to improve the computer's shielding.

RFI From AC Power Lines. The problem of RFI from outdoor power lines can be severe and troublesome, not just for consumers, but for radio amateurs and shortwave listeners (SWLs). There are some things you can and should do—as well as some things you shouldn't do.

AC power-line noise in business and industrial areas typically is associated with motors and various types of heavy-duty, AC-powered equipment. But in residential areas, the main problem generally is a form of amplitude-modulated arcing or crackling noise produced by corona discharge around high-voltage insulators in the overhead high-voltage power lines.

Most such interference can be reduced or eliminated with the power company's cooperation. As a rule, power companies have a small interference team that uses a van or truck equipped with receiving sensors to detect and locate

offending noise sources.

Nevertheless, it's helpful for you to do some preliminary sleuthing so you can provide the power company technicians with general information to help them locate the problem. That may involve riding around the neighborhood with a portable AM broadcast-band or shortwave receiver (preferably one equipped with an S-meter) to help you search for the “hot spots.”

Look for signs of arcing on power company equipment using binoculars; at dusk, often you can see a corona discharge—a faint blue haze—around a dirty or broken insulator. You should record the pole number or location of the suspect hardware and notify power company technicians of your findings.

Warning: In AC-power line sleuthing, don't pound on or shake the pole or its guy wires, and never climb the pole and try to fix the problem yourself. While it's one thing to pinpoint neighborhood RFI, it's quite another to attempt to fix a suspected power-line problem yourself. **DON'T DO IT!**

Summary. This article surveyed the growing problem of RFI in the home. The article discussed the nature of RFI and the role of the FCC. It also covered identifying, diagnosing, and eliminating TVI and interference to non-radio devices such as telephones and audio equipment. Troubleshooting and technical solutions were offered. Special emphasis was on RFI from computers, amateur radio and CB stations, and AC power lines. Various resources also were identified.

Don't get discouraged if early results are not satisfying. Bear in mind that each case of interference is different, and that experimenting with various combinations of protective devices is normal in the pursuit of satisfactory results. While we've focused on the tough cases, most RFI is amenable to resolution without undue investment of time, money, or effort.

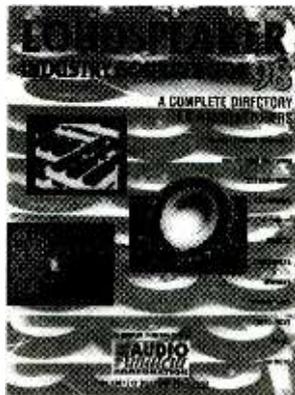
RFI has been a very perplexing and frustrating problem for years, and it likely will continue to be in the future. Hopefully, the suggestions in this article will help you locate and resolve the RFI problems that you may encounter. ■

ELECTRONICS LIBRARY

LOUDSPEAKER INDUSTRY SOURCEBOOK98

from Audio Amateur Corporation

The 1998 edition contains over 800 companies who manufacture, supply, or service components and materials used in the manufacture of loudspeakers. It is read by engineers from the consumer audio, professional audio, car audio, and industrial applications fields.



The sourcebook is broken down into color-coded sections, listing manufacturers of OEM speakers and drivers, speaker parts, enclosures, test and manufacturing equipment, and software, and suppliers of books and periodicals. This year's directory contains additional listing categories, easy-to-use table formats, a company compendium, and a complete address list.

Loudspeaker Industry Sourcebook 98 is mailed free to qualified subscribers, but it is also available for purchase at a cost of \$34.95; and it is published by Audio Amateur Corporation, P.O. Box 876, Peterborough, NH 03458; Tel. 888-924-9465 or 603-924-9464; Fax: 603-924-9467; E-mail: custserv@audioxpress.com; Web: audioxpress.com.

CIRCLE 90 ON FREE INFORMATION CARD

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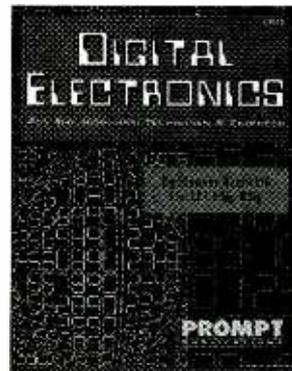
1998 EEM/Electronic Engineers Master Catalog costs \$99 and the CD-ROM costs \$115 (US only) and is published by Hearst Business Communications, Inc./UTP Division, 645 Stewart Ave., Garden City, NY 11530; Tel. 516-277-1314; Web: <http://hearstselectroweb.com>.

CIRCLE 91 ON FREE INFORMATION CARD

DIGITAL ELECTRONICS

by Stephen Kamichik

Designed to supplement an introductory course in digital electronics, the book can be used as a guide and handbook for independent study, as well as serving as a review for engineers and technicians. Since it does not assume a prior knowledge, the hobbyist can also learn about the subject.



Some of the topics covered include analog circuits, logic gates, flip-flops, and counters. Detailed instructions are provided so that readers can build the circuits described in the book. Building and testing a circuit is the best way to fully understand its operation. There is also a problem set at the end of each chapter. The book ends with a discussion of the future of digital electronics.

Digital Electronics costs \$16.95 and is published by Prompt Publications, a Division of Howard W. Sams and Company, 2647 Waterfront Pkwy. E. Drive, Indianapolis, IN 46214-2041; Tel. 800-428-7267; Fax: 800-552-3910; Web: www.hwsams.com.

CIRCLE 92 ON FREE INFORMATION CARD

TRAVELPLUS FOR REPEATERS: 1998-1999 EDITION

from The American Radio Relay League

Designed for those who are traveling on business or on vacation, this CD-ROM enables users to locate VHF/UHF repeaters along the way and to access data. With a click of the mouse, hobbyists can pre-program their rigs or take

(Continued on page 60)

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ANTIQUE Radio

Weston's Tinker-Toy Set Analyzer

MARC ELLIS

Always, I spend a lot of time in the flea market looking for ideas for this column. One of the items I had the opportunity to examine in detail, sitting neatly packaged in its original box, caught my eye because of its unusual appearance. It was a *Weston Model 666 Type 1A Socket Selector*. This was obviously a type of "set analyzer," a test instrument very popular with the old-time radio repairman.

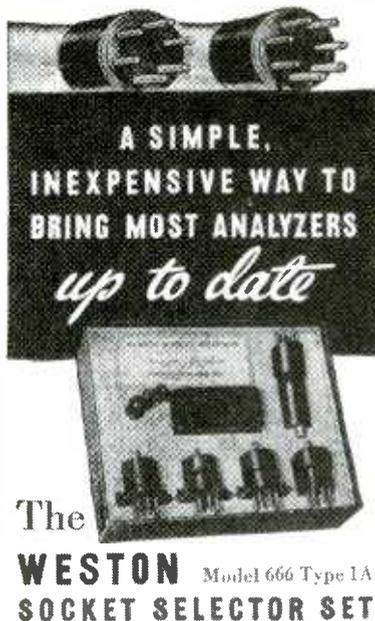
In spite of its ominous model number, the Model 666 had no sinister overtones. In fact, with its parts and color-coded adapters nestled in their die-cut holes in the storage box tray, the instrument looked a little like a children's game—something reminiscent of a *Tinker Toy* set. I immediately hit the books to find out more about it.

PHYSICAL DESCRIPTION OF THE 666

The instrument incorporates a cylindrical "probe" made of *Bakelite* or other thermoplastic material; it is fitted with a small-configuration 7-pin tube base at the bottom and a metal piece that looks like a grid cap at the top. Also emerging from the top is one end of a substantial cloth-covered cord about four feet long.

The other end of the cord terminates in a small *Bakelite* block with an integral small-configuration 7-pin tube socket. Connection to the tube's grid cap, if present, is made through a wire terminated in a grid cap connector. The socket holes are numbered from one through seven in the conventional manner and each socket connection, as well as the grid cap, is equipped with pin jacks for testing. The block also contains a set of pin jacks marked GND.

Even if you've never seen a "set analyzer" before, you've no doubt guessed how to use this device. Remove a tube from the set and plug it into the socket on the test block. Plug the cylindrical adapter probe into the set in place of the tube. If the tube has a cap, slip the set's cap connector onto the probe's "cap." Then slip the test block's cap connector onto the cap of the tube plugged into the socket.



The Weston Model 666 Type 1A Socket Selector was hyped as a means of upgrading other set analyzers.

Now, without even removing the set from its cabinet (a boon for any serviceman working on a large console), one can use the test jacks to make voltage measurements from any tube element to any other element—or from any element to ground—while the set is operating. Of course, how well the set might operate with an RF amplifier, oscillator, or defector tube stuck out on the end of a four-foot cable is anyone's guess.

With power removed from the set, point-to-point resistance measurements could also be made using these same jacks. But I wondered why all tube elements (except for the heater), as well as the ground connection, were provided with a pair of pin jacks rather than just one. So I dug a little deeper into the literature.

What I discovered was interesting. The inner jack of each pair is equipped with a switch that opens the circuit to its associated tube element when a pin is inserted into the jack. Connect the test pins of a multimeter to the pair of jacks, and the meter will bridge the open circuit. Set the multimeter at one

of the milliampere ranges to read the current in that circuit.

This certainly simplifies testing around tubes having small-configuration 7-prong tube bases, you say. But what if the base has 4, 5, or 6 pins—or perhaps 7 pins in the larger "medium" configuration? I thought you'd never ask!

Included with the *Weston Model 666 Type 1A Socket Selector* kit are four adapter pairs, each configured in one of those four tube base types. One adapter of each pair slips over the pins at the bottom of the "probe" and locks into place; the other plugs into the integral socket on the block. Now the adapter on the end of the probe will plug into a tube socket of the selected configuration and the removed tube will plug into the adapter on the block.

The 4-, 5-, and 6-pin block adapters each have a wide base flange engraved with element numbers for the tube type involved. The flange covers up the numbers engraved on the block, which are appropriate for the 7-pin configuration. The 7-pin adapter has no flange because the numbering system for its medium base is the same as that for the small 7-pin base molded into the block.

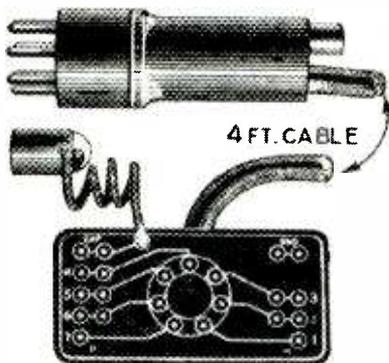
OTHER ANALYZER DESIGNS

Set analyzers were also manufactured by companies such as *Readrite*, *Dependable*, *Supreme*, and *Triplett* during this instrument's heyday in the mid-1930s. Like the 666, these generally had a "probe" that could substitute for any tube in the set via one of the provided adapters. However, in most of the models I was familiar with (primarily *Readrite*), the other end of the probe cable terminated in a test panel equipped with a range of standard tube sockets and two or three test meters.

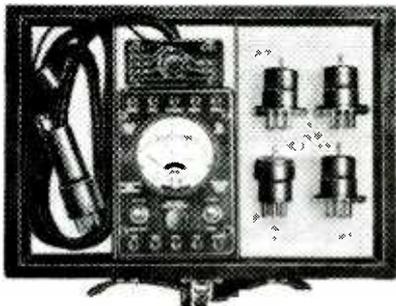
The removed tube was plugged into this panel, and the voltages at its elements could be measured on the integral meters by manipulating various switches. Of course, pin jacks were usually provided so that the meters on the instrument were accessible for use in other test situations.

Studying the literature on set analyzers, I found that the instruments incorporating meters represented one design extreme and the *Weston 666* the other; there were other types in between. For example, one *Triplett* model included a test panel having 4-, 5-, 6-, and 7-prong sockets but no meters or switches. The like numbered pins of each socket were connected in parallel, enabling a single set of test jacks (numbered one through seven) to access any element of a tube plugged into any socket. Just select the correct pair of jacks and plug in the test meter. The jacks were provided in sets of two, as on the 666, with one member of each set containing a circuit-opening switch for current measurements.

Another model, produced by *Dependable*, was also equipped with the four sockets. However, it included a couple of rotary switches wired so that a multimeter (set to the appropriate range as required) connected to a single pair of jacks on the panel could be hooked up between any two tube elements to measure voltage or resistance. However, a special set of circuit-opening jacks was provided for current measurements.



The 666's "probe" (above) had a tube base at one end and a grid cap at the "other." It was connected via cable to the "test block" (below).



Here you see the 666 as packaged with the Weston Model 698 Selective Set Servicer.

A WESTON WITH NO METERS?

Obviously, the *Weston 666* could be used with any external multimeter, but why would this major instrument company produce a test set without any meters on it? The answer is that, in spite of appearances, they didn't. The 666 is actually an accessory for use with other *Weston* instruments, notably the *Model 698 Selective Set Servicer* or the *Model 665 Selective Analyzer*.

Extending out from the back of the test block are a couple of long metal pins. They look like pins intended for insertion in jacks, but there is no electrical connection to them inside the block. These are mounting pins, intended to slip into dummy jacks provided at a dedicated location on such instruments as the 665 or 698.

As far as I can tell from its schematic, the 665 is nothing more than a small, simple multimeter with a few basic AC, DC, and resistance scales accessed via individual pin jacks. The 698 was also essentially a multimeter, though with additional ranges and provision for conducting a "grid shift" tube test. (The "grid shift" test, an indication of the tube's mutual conductance, measures the change in plate current for a given change in grid voltage.) This instrument was available with a rotary range selector switch (Type 1) or with the ranges accessed via test jacks (Type 2).

The 666 Socket Selector could be used with other *Weston* instruments not specifically designed to accept it. Since its mounting pins were set at standard spacing, it could be plugged into a pair of "live" jacks on the panel. In that case, a couple of right-angle extenders could be slid over the pins to allow electrical connection to the jacks pressed into service for mounting.

It's not immediately obvious what advantage the *Weston* analyzer system had over more conventional instruments having a complete set of standard tube sockets mounted on a panel. *Weston* advertising claimed their "single-socket" system was easiest to update—and indeed the company was very quick to come up with an adapter set for the newly-developed octal tubes. However, the female adapter of the set obviously had to plug into the 7-pin socket on the test block—just like any of the other similar adapters. I don't see what would have kept other manufacturers from producing similar adapters

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WRITE FOR LITERATURE

READRITE METER WORKS
172 College Ave. Bluffton, Ohio, U. S. A.

The Readrite 720-A test panel was equipped with a complete range of sockets and had its own meters. The probe and adapters, very similar to the *Weston* units, are stored in the top compartment.

for insertion into their own 7-pin sockets, or any other appropriate socket present on the panel.

Weston advertising also pushed the idea of using the 666 to update obsolete analyzers, suggesting that the unit could be installed on almost any instrument if holes were drilled for the mounting pins. This argument is also hard to follow unless the term "analyzer" referred to what we today would call a multimeter. In which case (providing you didn't mind drilling holes in your instrument), you would be able to add the convenience of tube element testing to your existing tester without taking up a lot of extra space in your tool kit.

As an interesting exercise, I decided to put myself in an old-time service man's shoes and imagine what type of set analyzer I might choose for my own shop. I think I would have been immediately attracted to the *Weston* product because of its outstanding construction quality—both of the molded parts and

(Continued on page 53)

COMPUTER BITS

Microcontrollers VII

JEFF HOLTZMAN

Last time we talked about generating time delays in software. This time, let's do it in hardware. By the way, last month I said that a 1-MHz clock has a period of 1 μ s, and a 4-MHz clock has a period of 4 μ s. Actually, I really do know the difference between multiplication and division. The correct answer is... you guessed it, 0.25 μ s. OK. On to interrupts.

In October's issue, the program showed how to generate a pretty precise 1-second time delay by making the CPU spin its wheels, literally looping around doing nothing. This time we'll look at how to generate precise time delays, while the CPU performs other tasks. We'll also discuss how to use the AVR sleep mode.

AVR chips have built-in timer-counters. (The 1200 has one, but other family members have several.) As the name implies, you can use the timer-counter to keep track of how long something takes or to count the number of occurrences of some event. In our discussion, we'll use it in the timer mode. As part of the chip's initialization process, you can enable a timer in such a way that after so many clock cycles have occurred, an interrupt occurs. What's an interrupt?

The AT90S1200 supports four interrupts: "reset," "external interrupt," "timer/counter," and "analog comparator." When an interrupt occurs, the CPU stops what it is doing, pushes the current address on the stack, loads the address of a special interrupt-service routine (ISR) into the program counter, and continues execution at the loaded address. When the ISR is complete, it executes a return-from-interrupt instruction, which does two primary things: it re-enables interrupt processing, and it pops the address it pushed back when the interrupt occurred, and continues execution from where it left off.

How does the CPU know where to go when an interrupt of a particular type occurs? There is a table of interrupt vectors beginning at address 0 of program memory. Each vector occupies two bytes. In order, they are the reset, timer, external, and comparator. Note that the



AVR chips have built-in timer-counters that can be used to keep track of how long something takes or to count the number of occurrences of some event.

reset vector comes first. That allows you to just place your executable code starting at address zero—but only if you don't use any of the other interrupts.

If you do use other interrupts, you create a simple table of vectors, or pointers, to the appropriate routines. (See the example in Listing 1.) Note the four lines of code following the "org 0" statement. Each statement is simply a jump to one of the interrupt routines. However, since we're only using the reset and timer interrupts, the other two vectors point to a single dummy routine that simply performs a return from interrupt. In our case, the "IRQ" and "comparator" interrupts never occur, so the "reti" instruction is really unnecessary. However, setting up the code that way gets us in the habit of making sure that we account for the interrupt vectors and the space they occupy from the beginning.

Apart from the interrupt vectors, the program consists of two ISRs: one to handle reset, and one to handle the timer. Let's look at each.

THE RESET ROUTINE

Again refer to Listing 1. Note that we use four of the AVR's 32 registers. Register 16, which we've renamed "Acc" (for accumulator), is used for general-purpose tasks. Register 17, called "DispCnt," is a counter that is incremented periodically. The program continually displays the value of "DispCnt" on the LEDs, while the program is running. Registers 18 and 19 provide 16-bits of space in which to specify the number of interrupts that must occur in

order for "DispCnt" to be incremented.

The reset routine executes at power up or when the reset pin of the MCU is temporarily pulled low. When reset occurs, execution begins at memory location zero. As we saw, there is a jump instruction there that causes execution to continue at the line labeled "V_Reset." There, we initialize the display and tick counters, and set up the I/O ports: port B for output and port D for input.

The microcontroller has a special register called the "control register." If we set bit 5 (counting from 0, moving right to left) high, we enable the device to go into a sleep mode. Setting that bit does not put the MCU to sleep; for that a sleep instruction must occur. Bit 4 of the control register allows selection of sleep mode. There are two modes: idle and power-down. In the idle mode, when the MCU goes to sleep, it remains partially active—in particular, the timer-counter continues running, as do some other subsystems. In the power-down mode, even more of the MCU sleeps, including the oscillator and the timer-counter system.

Those power-down modes are extremely important in power-sensitive applications. For example, the 3Com PalmPilot handheld computer can operate for six weeks or more from a pair of AAA batteries only through the use of power-down modes. On the Pilot, the CPU actually sleeps most of the time—even when the display is active.

After setting the sleep mode, the program then sets up the interrupt clock, enables it to generate interrupts, and then globally enables the interrupts. In that section of the program, we write a constant value, "CLK_DIV," to timer-counter control register 0 (TCCR0). Depending on the value of "CLK_DIV," the basic clock frequency is divided by 1, 8, 64, 256, or 1024. Other bit combinations written to that register can stop the timer-counter, or trigger it on the rising or falling edge of an external signal. In our case, "CLK_DIV" is set to a value of 4, which corresponds to a divisor of 256.

LISTING 1—COUNTER/TIMER TEST PROGRAM

```

.device          AT90S1200
.include         "1200def.inc"

.def            Acc      = R16    ; general purpose accumulator
.def            DispCnt  = R17    ; display counter
.def            TickCntLo = R18   ; tick counter
.def            TickCntHi = R19   ; tick counter

.equ           CLK_DIV = 4       ; divide timer clock by 256
.equ           CNT_LO  = 61      ; provides 1 sec delay @ clk/256
.equ           CNT_HI  = 0

.cseg
.org           0                ; code begins here

Reset:         rjmp      V_Reset ; set up interrupt vectors
IRQ:           rjmp      V_IRQ
Timer:         rjmp      V_Timer
Comparator:    rjmp      V_Comp

V_IRQ:         ; dummy
V_Comp:        reti           ; dummy

V_Reset:       ldi      DispCnt, 0        ; reset display counter
               ldi      TickCntLo, CNT_LO ; reset tick counter
               ldi      TickCntHi, CNT_HI

               ldi      Acc, 255         ; set PORT B for output
               out      DDRB, Acc
               out      PortB, Acc
               ldi      Acc, 0           ; set PORT D for input
               out      DDRD, Acc

               ldi      Acc, 0b00100000 ; set bit 5 to enable sleep mode
               out      MCUCR, Acc

               ldi      Acc, CLK_DIV     ; set up interrupt clock
               out      TCCR0, Acc
               ldi      Acc, 2           ; enable timer interrupt
               out      TMSK, Acc
               ldi      Acc, $80         ; enable global interrupts
               out      SREG, Acc

Rst_Loop:      sleep              ; reset comes here

               in       Acc, PinD       ; input Port D
               andi     Acc, $7f
               cpi     Acc, 0b01111010 ; if S0+S2 pressed,
               brne    Rst_Loop ; reset display and tick counters

               ldi      TickCntLo, CNT_LO
               ldi      TickCntHi, CNT_HI
               ori      Acc, $80
               out      PortB, Acc
               ldi      DispCnt, 0
               rjmp     Rst_Loop

V_Timer:       ; timer interrupt comes here
               subi     TickCntLo, 1     ; decrement tick counter
               sbci     TickCntHi, 0

               brne     Exit
               cpi     TickCntLo, 0
               brne     Exit             ; exit if not = 0

               inc      DispCnt          ; else increment display counter,
               mov      Acc, DispCnt
               com      Acc
               out      PortB, Acc       ; display it,
               ldi      TickCntLo, CNT_LO ; and reset tick counter
               ldi      TickCntHi, CNT_HI

Exit:          reti

```

It does not appear to be documented, but it is evidently true, that there is an additional scale factor of 256, regardless of the selected prescale factor. The following formula allows you to calculate the exact time between interrupts in seconds, where $cpt = 256$, CLK_DIV is the value of the clock divisor, and f is the clock frequency.

$$\text{Delay(s)} = \text{cpt} \cdot \text{CLK_DIV} / f$$

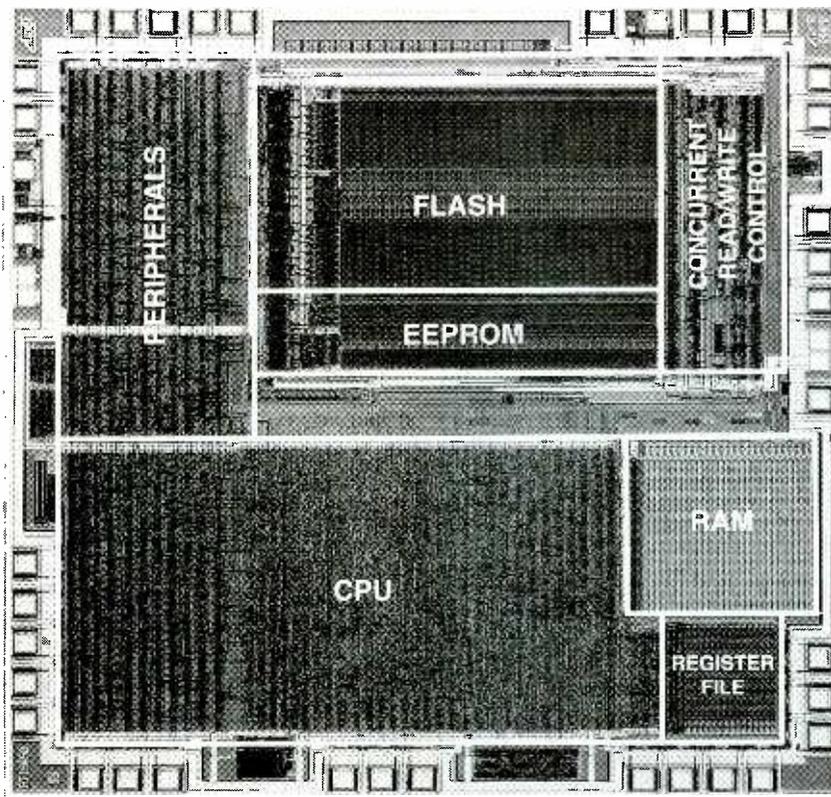
In our case, given the 4-MHz clock of the evaluation board, we get a delay of

$$\text{Delay(s)} = \text{cpt} \cdot \text{CLK_DIV} / f = 256 \cdot 256 / 400000 = 0.016384$$

Table 1 shows the delays obtained for each of the valid values of "CLK_DIV." The right columns of the table show the number of delays we would have to count to get a one-second overall delay. All but the first row are inexact, so the table shows the closest values higher and lower than the target. Note that the larger the divisor, the greater the error. However, the smaller the divisor, the more work the CPU has to do, and the more power it will use, because it is interrupted more often. In our application, it doesn't matter; but in the real world, it may well matter. To see the effects of the different values, reassemble the program with different values of "CLK_DIV," and for "TimCntHi" and "TimCntLo."

Finally, after all the setup, we put the processor to sleep at the point labeled "Rst_Loop." When it goes to sleep, it stays asleep until an interrupt occurs. In our case, the interrupt occurs after $256 \cdot 256 = 65536$ cycles. The timer interrupt routine, discussed next, does its thing, then executes its "reti" instruction. At that point, program execution continues at the instruction following the sleep instruction. In our case, we check to see whether any switches have been pressed. If switches S0 and S2 are pressed, the display and tick counters are reset, the LEDs corresponding to those switches light, and the MCU is put back to sleep. Otherwise, it is put to sleep immediately. The cycle continues forever, or until the batteries run out, whichever occurs first.

By the way, the display reset feature was included in order to show that real work could be done in the main loop of the program.



The AVR chips (sporting RISC architecture) are comprised of several subassemblies, including FLASH memory, EEPROM, CPU, RAM, a register file, and a section for concurrent read/write control.

THE TIMER ROUTINE

Whenever the timer-counter counts the number of clock cycles specified by "CLK_DIV * 256," it generates an interrupt. When that happens, the MCU begins execution at address 04, which, in turn, jumps to the point labeled "V_Timer." At that point, the program simply subtracts one from the tick counter, and if it reaches 0, the program increments the display counter and shows the results.

The subtraction routine is a little tricky, because it's a double-precision (16-bit) routine. When I originally wrote the code for this program, I calculated that a delay of 390 would be required.

(That was before I empirically discovered the additional factor of 256 delay.) Of course, you can't store more than 255 in an 8-bit register, so I needed more bits, hence this routine. It's still useful if we use the lower values for "CLK_DIV" (1 or 8). The routine works like this.

First we subtract one from the low register. Then we subtract 0 from the high register. The trick here is that if the low subtraction generated a borrow (i.e., the value went below 0), we end up de-incrementing the high register by 1. For the time limit to be up, both the hi and lo registers must be 0. So right after the second subtraction, we check

TABLE 1—AVR DELAYS AT 4 MHZ AND VARIOUS CLOCK DIVISORS

CLK_DIV	Delay (s)	Counts for 1 Sec Delay	Delay(N)	Delay(N+1)
1	0.000064	15625 (exact)	1.000000	1.000000
8	0.000512	1953.125	0.99936 (1953)	1.000448 (1954)
64	0.004096	244.140625	0.999424 (244)	1.00352 (245)
256	0.016384	61.03515625	0.999424 (61)	1.015808 (62)
1024	0.065536	15.258789063	0.98304 (15)	1.048576 (16)

whether the high register is zero. If not, we branch to the point labeled exit, and exit. If it is, we check the low register for 0. If not, again we exit. Otherwise, we increment the display counter and display it, and we reload the tick counters to begin a new count-down.

If you want to experiment with tick counts greater than 256, the number of times 256 goes into the desired number is entered into the high register and any remainder is entered into the low register. For example, if the desired number is 1953, the number 7 is entered in "TickCntHi," and 161 in "TickCntLo" ($1953 = 7 \times 256 + 161$).

That's it for this month. Next we'll look at reading some analog values in from the real world. In the meantime, stay in touch: jeff@ingeninc.com. ■

ANTIQUE RADIO

(continued from page 50)

the cordage. I would have also liked the neat engraving of the identifying numbers on the main panel and adapter flanges.

I don't think I would have been tempted to buy a product with integral meters. Many of those included meters were of lesser quality than the instrument built into a good multimeter. And I would have balked at laying out cash (and allocating tool kit space) to duplicate the functions of an instrument I already owned.

If I were happy with the quality of my existing multimeter, I think I would have purchased a 666 and removed its mounting pins so it would sit flat on my shop bench. For service calls, I could roll up the little unit in its cable so it could be tucked into a small compartment of my tool kit.

If I were equipping a new shop and hadn't yet purchased a multimeter—or if I were in the market to replace an existing one—I think I would have acquired one of the *Weston* instruments designed to accept the 666 as a plug-in. Once again, I would have been drawn to the *Weston* quality. I would also have been attracted to the convenience of the modular construction (no need to have your tube socket adapter cluttering up your bench if you only needed the multimeter that day). So, though I would have chosen *Weston* over the competition, it wouldn't exactly have been because of the features and benefits stressed in the advertising! ■

SCANNER SCENE

This Handheld Tracks Trunks!

MARC SAXON

They say an elephant's trunk is his hand. *RadioShack* says with their new *PRO-91* that your hand is a trunk; well at least it's a handheld scanner that lets you access trunked communications. And, sure, you can also monitor standard VHF/UHF communications.

The *PRO-91* is set up with 150 memory channels (30 channels in 5 banks), plus five additional locations to temporarily store active frequencies discovered during searches. It is adept at monitoring 800-MHz *Motorola* Type I and Type II (such as *Smartnet* and *Privacy Plus*) and hybrid analog trunked systems.

The frequency range spans 29–54, 137–174, 406–512, and 806–956 MHz (minus the cellular bands), plus the 108–137-MHz VHF aeronautical band. There are bands with preset frequencies used by police, fire, emergency, aircraft, ham, maritime, and NOAA weather to make it easy to quickly access each of these station categories.

It can scan at 50 channels/second and search at 100 channels/second (300 per second in Hypersearch mode). There are five user-set priority channels.

A data signal skip feature lets you set the scanner to ignore unmodulated or data signals during searches. This stops the scanner from hanging up on radiopaging and other non-voice signals, thus allowing frequency searches to proceed without delays. Triple-conversion circuitry virtually eliminates interference from IF images, so you hear only the desired frequency.

Conventional scanning is simple and straightforward. Trunktracking is accomplished when you program in the frequencies authorized for a given system. The *PRO-91* automatically determines which of those is the data (control) channel. It can follow individual conversations on each of the system's various talk groups as the conversations continually shift frequency. You can then follow a complete conversation without missing anything. This is a trick that's virtually impossible on a standard (non-trunking) scanner.



RadioShack's PRO-91 TrunkTracker allows you to monitor conventional VHF/UHF systems as well as most of the popular 800-MHz trunked systems.

This unit operates on internal rechargeable batteries, or from an optional external AC power supply (and charger), or a DC power cord. There's an alert to warn you when the internal batteries need a recharge. The

stored memories remain viable for an extended period of time even if the batteries do go dead.

Pick up the new *PRO-91* at any *RadioShack* store, as their part 20-521, with a price of \$249.99.

WHEN THE WALLS HAVE EARS

It's a fact that the police must go to a lot of trouble to secure a court order to plant a hard-wired or wireless bug in someone's home or office. Of course, millions of dollars are spent every year as individuals and companies hire people to place illegal bugs to eavesdrop on what's taking place behind closed doors. It's tricky as well as dangerous. Remember those guys who bugged the Watergate back in 1972? The public was indignant.

What seems so strange is that today, millions of folks are nice enough to go out and buy a room bug, then go that extra mile by placing it in their home where it can very efficiently pick up everything said within the premises. Before they lock their doors to ensure their privacy, they make certain to turn on the bugging equipment, and very often they never bother to turn it off. And, yup, it's wireless equipment that transmits everything said right over the airwaves. It's all on frequencies you can hear, and it's legal to monitor!

Yes, the popular and wonderful little gadgets generally known as wireless baby monitors are sold at electronics shops, toy stores, and department stores. They are very good at doing what they're supposed to do, in fact, much better. Many are advertised as having a transmitting range of 200–300 feet, but that seems very conservative. A scanner with a decent antenna can pick up signals from some of these units from a mile or more away. That area can include a lot of units. (For a commentary on this, read the editorial, *Is Big Brother Listening to You?* in the February *Popular Electronics*—Editor.)

The frequencies that have produced the best results include 49.83, 49.845, (Continued on page 57)

HAM Radio

The QRP Transmitter

JOSEPH J. CARR

In the November issue of this column I discussed the Ramsey Electronics direct-conversion receiver. It is the "ears" of my QRP 30-meter station. This month, we will give the QRP station a voice by building the transmitter.

The photo shows the front panel of the Ramsey QRP-30 transmitter. It is built in the same plastic case as the receiver (and a lot of other Ramsey kits). In both the transmitter and receiver projects, the case is provided separately at additional cost. There are only two controls on the front panel: CHANNEL SELECTOR (selects XTAL A or XTAL B crystals) and TUNE. The latter control does not peak the output, as you might expect, but rather is a VXO (variable crystal oscillator) tuning control.

The rear panel of the Ramsey QRP-30 transmitter contains jacks for the DC power (12 - 15 volts), the telegraph key, the antenna, and the receiver. The latter jack routes the antenna signal to the receiver whenever the key is up, allowing break-in operation with only one antenna. The RF output of the QRP-30 transmitter is on the order of 1 watt across the 30-meter ham band.

Figure 1 shows the block diagram of the transmitter. It is a classic Master Oscillator Power Amplifier (MOPA) design, with a buffer amplifier between the oscillator and final power amplifier. There is also a diode transmit/receive (T/R) switch to allow operation of the receiver. During transmit, the signal path to the receiver is blocked, preventing it from being overloaded. When the transmitter is not putting out RF power, the signal path to the receiver is completed, allowing the antenna signal to reach the receiver.

The buffer amplifier is placed between the final amplifier and the oscillator for two purposes. One is to boost the oscillator power to the point where it can successfully drive the RF power amplifier. But more importantly, the buffer amplifier protects the oscillator circuit. Heavily loaded oscillators and oscillators that look into varying imped-



Ramsey QRP-30 transmitter front panel.

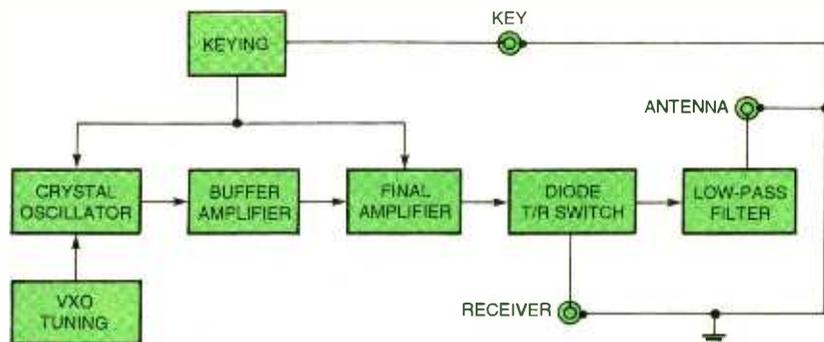


Fig. 1 Block diagram of the QRP-30 transmitter.

ances tend to "pull" the frequency. When the frequency pulls (*i.e.*, changes slightly) during dots and dashes of CW operation, other operators hear a "chirp" (bad crystals also produce chirp...as I found out too many times with 25-cent surplus World War II crystals when I was a kid).

The keyer is a simple one-transistor circuit that applies power to the final amplifier and oscillator. Although turning the oscillator on and off during keying is not ideal, it would otherwise interfere with the receiver.

The oscillator circuit is a single-transistor Colpitts variable-crystal oscillator. The circuit is actually a VXCO because there are a pair of back-to-back voltage variable-capacitance diodes ("varactors") in series with the crystal. By applying a DC voltage to the varactors through a potentiometer (the TUNE control on the front panel), a 5- to 8-kHz

change of the transmit frequency can be achieved. This feature makes it possible to slip out from under QRM on a crowded band.

The next photo shows the top interior view of the QRP-30 transmitter. Note that there is only one crystal in the circuit (CRYSTAL A), and one crystal position is blank. The crystal supplied with the kit is 10.108 MHz, which is the international QRP frequency. An additional crystal can be supplied if you want to operate on two different frequencies (highly recommended). A popular alternate is 10.116 MHz.

ASSEMBLY TIME DETAILS FOR RX AND TX

The Ramsey Electronics assembly manuals rate each kit by the estimated assembly time and effort required. These ratings are given for both the HR-30 receiver and QRP-30 transmitter.

HR-30 Receiver

Solder Points—84

Assembly Times:

Beginner—3 hours

Intermediate—2 hours

Advanced—1 hour

QRP-30 Transmitter

Solder Points—159

Assembly Times:

Beginner—4.7 hours

Intermediate—2.7 hours

Advanced—2 hours

ADDITIONAL STUFF FOR QRP

Twenty-Watt Linear RF Amplifier.

Operating with one watt of RF power is a daunting task. Our next photo shows an interior view of the *Ramsey Model QAMP-30* RF power amplifier. This amplifier boosts the output of the QRP-

30 transmitter from one watt to 20 watts. It has a built-in T/R relay to automatically switch between transmit and receive. It also provides an effective low-pass filter at the output to produce a clean, smooth signal. Between the filtering and the lower power levels, it is unlikely that this rig will cause TVI. The amplifier is linear, by the way, so it will work for all modes including AM, SSB, NBFM, and CW.

Audio Filter Unit. A problem with nearly all direct conversion receivers is a lack of selectivity. The last photo shows the *Ramsey Model AF-1* CW audio filter kit. It uses a switched-capacitor filter circuit to produce four selectable audio bandwidths: 750 Hz, 500 Hz, 250 Hz, and 100 Hz. These bandwidths are centered on 1000 Hz. The 100-Hz bandwidth makes this a very narrow filter (CW signals at nor-

mal speeds are only 100- to 200-Hz wide). In general, the idea is to listen using the widest bandwidth (or with the AF-1 switched out of the circuit) and when a desirable signal is heard, then narrow down the bandwidth to whatever level eliminates QRM.

FOR MORE INFORMATION

QRP RESOURCES

Buckeye Electronics

10213 Columbus Grove Road
Bluffton, OH 45817

E-mail: buckeye@alpha.wcoil.com

Dan's Small Parts and Kits

Box 3634

Missoula, MT 59806

406-258-2782

Web: www.fix.net/dans.html

Kanga U.S.

3521 Spring Lake Drive

Findley, OH 45840

419-423-4604

Web: www.bright.net/~kanga/kanga

Milestone Technologies, Inc.

3140 S. Peoria St., Unit K156
Aurora, CO 80014

800-238-8205

Ramsey Electronics

793 Canning Parkway

Victor, NY 14564

716-924-4560

800-4-HOBBY KITS

S & S Engineering

14102 Brown Road

Smithsburg, MD 21783

301-416-0661

Web: www.xmetric.com/sseng

Small Wonder

Dave Benson, NN1G

80 East Robbins Avenue

Newington, CT 06111

E-mail: bensondj@aol.com

BOOKS ON QRP

American Radio Relay League, Inc.

225 Main Street

Newington, CT 06111

888-277-5289

Web: www.arrl.org/

Dave Ingram, K4TWJ

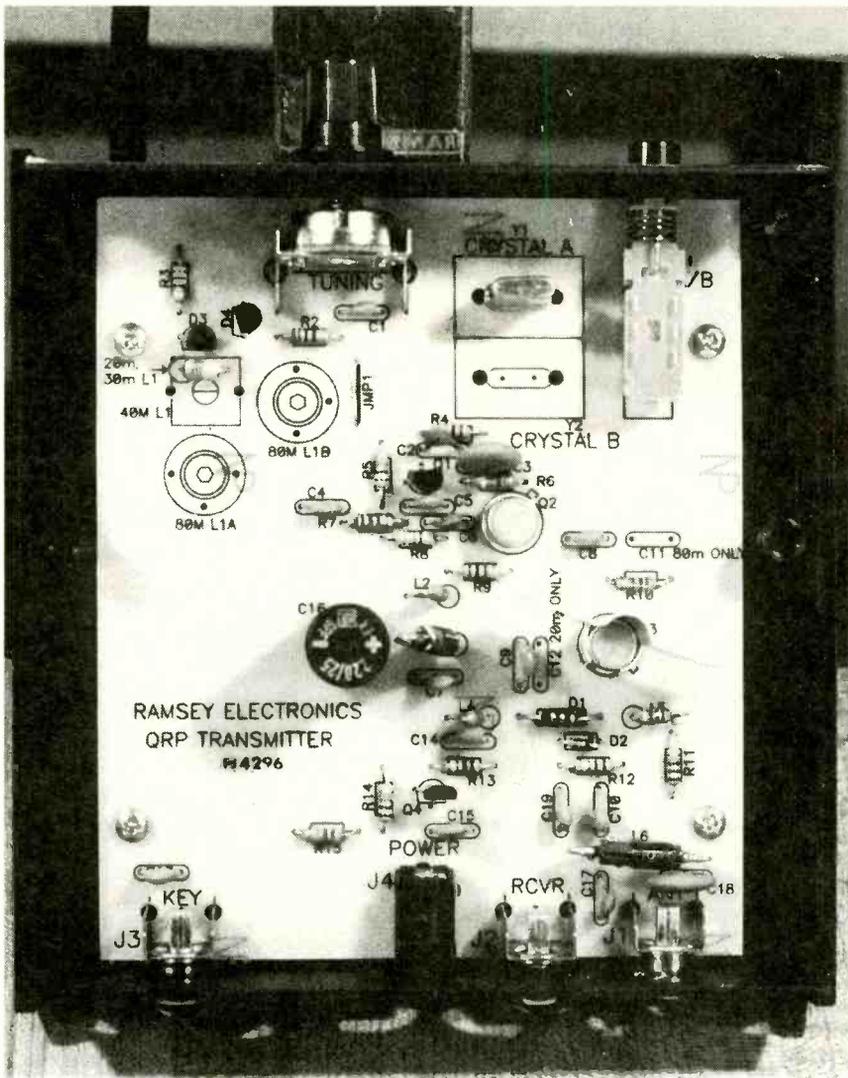
4941 Scenic View Drive

Birmingham, AL 35210

Adrian Weiss, WØRSP

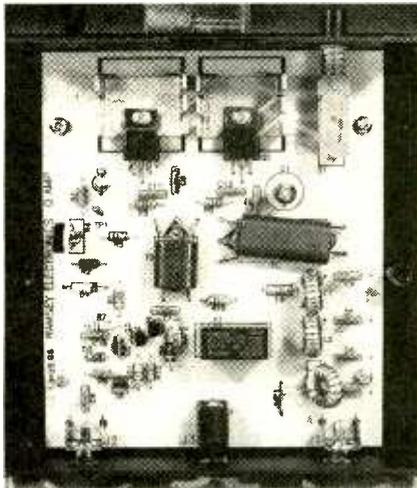
526 North Dakota Street

Vermillion, SD 57069



QRP RESOURCES

One of the things that I find interesting about the QRP scene is the number



Ramsey QAMP-30 20-watt amplifier board, top interior view.

of builders. Although there are some first-rate rigs out there that can be purchased already built, the number of kit and project builders is amazing. Although many readers will want to build the Ramsey kits, others may prefer to "roll their own." You can either design a QRP rig yourself, or use one of the popular designs from the books listed in the sidebar.

One of the constant complaints of project builders is the lack of small parts. There are many, many distributors who will gladly sell you a ton of some part or that have a \$25 to \$100 minimum order; the person who wants to buy one or two of an item is often out of luck. That's one reason why *Popular Electronics* usually demands authors of project articles provide the kits and key parts themselves, arrange for others to do so, or identify reliable parts

sources. In searching the Web for QRP sources, there are a number of firms willing to provide small quantities of small parts (see sidebar).

BOOKS ON QRP

There are many books on the subject of QRP. Among some that I recommend are the following: *W1FB's QRP Notebook 1*, *W1FB's Design Notebook*, and *Your QRP Operating Companion*, all distributed by the ARRL (see sidebar). Also there is *How to Get Started in QRP* by K4TWJ, and *The Joy of QRP* by WØRSP.

QRP CONTESTS

One of the things that many people enjoy in amateur radio operations is a contest. The ARRL DX Contest, ARRL Sweepstakes and the CQ WW DX Contest are well known. Others also exist. There are also a number of contests for QRP operators. I only have the 1998 calendar, which will be out of date by the time you read this article. A place where you can get information, however, is from Peter Barville, G3XJS, Communications Manager for the *G-QRP Club in England*. Their Web site is www.barville.demon.co.uk/qrpinfo.htm/.

Questions? I can be reached by snail mail at P.O. Box 1099, Falls Church, VA, 22041, or by e-mail at carrjj@aol.com. You might also find me hanging around 10.108 MHz (or nearby). ■



Front panel of the Ramsey AF-1 CW audio filter.

SCANNER SCENE

(continued from page 54)

49.86, 49.875, 49.89, and 49.93 MHz, although it's entirely possible to occasionally come across units operating on other frequencies within the lower/upper limits of this range. If you place your scanner into search/scan mode, you may find that you're within receiving range of one or more of these devices.

A 6-meter ham band (50 MHz) antenna, or one specially designed for eavesdropping in this and the cordless band, will produce maximum reception. We got great results using the *MAX-46-CORD Super Snooper* antenna from *CRB Research*, P.O. Box 56, Commack, NY 11725; Tel. 516-543-9169; E-mail: sales@crbbooks.com; Web: www.crbbooks.com.

Don't forget that room monitors send out a continuous signal, so your

scanner will stop and remain on every signal until you cause it to move on.

Note that these monitors aren't necessarily always placed in the baby's room. They're also placed in kitchens, garages, bedrooms, so that members of a household can keep a check on what's taking place at certain locations. Sometimes they are used to listen for a person confined to a particular room.

A reader recently wrote in telling of stumbling upon a signal from a room monitor that a couple probably placed in their bedroom because the infant's crib was there. Maybe they monitor the kid while they are elsewhere in the house. But they still leave the room monitor on all night, and that seems to have attracted the attention of a growing audience of area scanner owners. If I printed a transcript of the tape this reader sent of one night's monitoring results, the Postal Service wouldn't allow this issue to go through the mail!

Last year, another reader who is a fan of room monitors, wrote that he's heard the lady in some neighbor's house entertaining a male friend twice a week about an hour after hubby heads off for work.

Beware, the microphones in these monitors are very sensitive, picking up not only what's said in their immediate vicinity, but often broadcasting conversations and other sounds from adjacent rooms. So, you may also hear doorbells, one side of phone calls, the TV and stereo playing, the vacuum cleaner, plus arguments and other day-to-day small talk. Based upon the chatter, you might be able to identify who you're monitoring. Never a dull moment.

Please write and keep us posted. Our direct e-mail address is: Sigintt@aol.com. Or, write by snail-mail to *Scanner Scene*, **Popular Electronics**, 500 Bi-County Blvd, Farmingdale, NY 11735. ■

Circuit Circus

Generator Circuits

CHARLES D. RAKES

This visit we're going to take a look at a few square-wave and pulse-generator circuits. These generator circuits are found in just about all of today's digital circuitry. They supply clock pulses to counters, steppers, and other circuits that require a timed or pulsed input. Also the generator's fast-rising output pulse, which produces many harmonics, can be a useful signal source for testing the frequency response of analog amplifiers. As we look over the following circuits, see how many other applications you can find to use these generators in your ongoing or future project.

All of our generator circuits shown, but one, use the popular CMOS (Complementary Metal Oxide Semiconductor) line of ICs as the active device. Let's take a brief look at these CMOS devices and see how they operate and compare to bipolar TTL devices.

The active components in the CMOS devices are MOSFETs (Metal-Oxide Field-Effect Transistors), and in

the TTL ICs the active devices are bipolar transistors. The input impedance of the CMOS IC is very high and requires little drive current. The power requirement of the CMOS IC is considerably less, and in some cases near zero, compared to the current-hungry TTL devices.

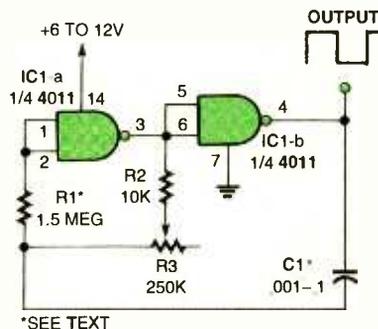
On the down side, the maximum operating frequency of the CMOS device is less than that of a comparable TTL device. The first popular line of CMOS ICs to hit the market was the "A" type, which offered no input circuitry protection and was easily damaged by electrostatic discharge (ESD). The "B" series came along a little later and solved the ESD problem by adding a resistor and diode to the input circuitry. The "B" series was also improved in other ways as well. They operate at a higher frequency and produce higher drive currents to a load. The "B" series is the IC of choice for most circuit applications and is the type used in our circuits.

cycle to produce a near perfect symmetrical output waveform.

A square-wave output can be taken from pin 3 as well, which is a complementary output of the waveform at pin 4. IC1's unused inputs (pins 8, 9 and 12, 13) should be tied to ground. Failing to do so can cause some unusual circuit effects—none of which are good!

SIMPLE 4049 IC GENERATOR

The circuit in Fig. 2 is similar to our first generator design, but uses two inverting buffers from a 4049 hex-inverting buffer IC in place of the NAND gates. The 4049 oscillator produces a greater output drive current than the previous circuit and is capable of driving TTL circuitry. The circuit can output 3 mA to a load while operating from a 5-volt power source. The oscillator's frequency range selection for capacitor C1 is similar to the previous circuit. Once again, unused inputs (pins 7, 9, 11, and 14) should be tied to ground.



*SEE TEXT

Fig. 1. The simplest pulse generator circuit uses two gates of a 4011 quad 2-input NAND IC. The frequency of oscillation is determined by components R2, R3, and C1.

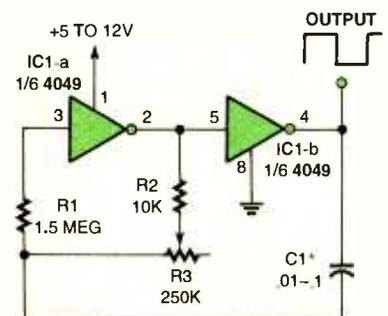
PARTS LIST FOR THE SIMPLE 4011 IC GENERATOR (FIG. 1)

- C1—0.001–0.1- μ F, ceramic-disc capacitor
- IC1—4011 CMOS quad 2-input NAND gate integrated circuit (NTE4011B, SK4011B, or equivalent)
- R1—1.5-megohm, 1/4-watt, 5% resistor
- R2—10,000-ohm, 1/4-watt, 5% resistor
- R3—250,000-ohm potentiometer

SIMPLE 4011 IC GENERATOR

Our first generator in Fig. 1 uses two gates of a 4011 quad 2-input NAND integrated circuit in a simple astable oscillator circuit. These are inverting gates. The output of IC1-a is direct-coupled to the input of IC1-b, and the output of IC1-b is coupled back to the input of IC1-a through R1. This completes a positive feedback path between the two gates, which allows the circuit to oscillate. The oscillator's frequency is determined by the values of resistors R2, R3, and C1. The oscillator's frequency range with a 0.1- μ F capacitor is about 50 to 1000 Hz, and with a 0.001- μ F capacitor the range is about 1000 to 50,000 Hz.

Resistor R1 helps to isolate the effect of the internal protection diode at the input of the gate from loading the RC network, during the oscillator's charging and discharging cycle. R1's value can be five to ten times the value of R2 and R3. Using a large resistor for R1 also helps to even out the oscillator's duty



*SEE TEXT

Fig. 2. Here's another simple generator circuit, but this time two gates of a 4049 hex-inverting buffer are used.

PARTS LIST FOR THE SIMPLE 4049 IC GENERATOR (FIG. 2)

- C1—0.001–0.1- μ F, ceramic-disc capacitor
- IC1—4049 CMOS hex-inverting buffer integrated circuit (NTE4049B, SK4049UB, or equivalent)
- R1—1.5-megohm, 1/4-watt, 5% resistor
- R2—10,000-ohm, 1/4-watt, 5% resistor
- R3—250,000-ohm potentiometer

The first two generator circuits are very similar in operation and in many cases can be duplicated from unused gates or inverters in an existing circuit.

VARIABLE PULSE-WIDTH SQUARE-WAVE GENERATOR

Our next entry, shown in Fig. 3, places two gates from a quad 2-input NOR gate IC (a 4001 IC) in a variable pulse-width square-wave generator circuit. The circuit's output pulse width can be varied over a very large range. At one end of the potentiometer's (R1), rotation, the positive output pulse will be less than 5% of the duty cycle, and at the opposite end of rotation, the positive pulse will be over 95% of the duty cycle. A 50/50-duty cycle waveform can be generated with this circuit by carefully adjusting R1. Also the oscillator's frequency changes very little with pulse-width variations. The values of components R1 and C1 determine the oscillator's frequency. Ground unused input pins 8, 9 and 12, 13 to avoid pickup.

If your circuit application requires a perfect waveform, with a 50/50-duty cycle, neither of these latter circuits will do. Adding a flip-flop divide-by-two circuit to the output of any of the generator circuits will produce a 50/50-duty cycle square-wave output at one-half of the oscillator's frequency. Double the oscillator's frequency and you are back in business, operating at the same frequency as before. This process also cleans up the output waveform's rising edge. In some of the gate and inverter oscillator circuits, the output waveform shows a slight rounding at the top of the leading edge. The diode network that protects the input circuitry of the IC causes this.

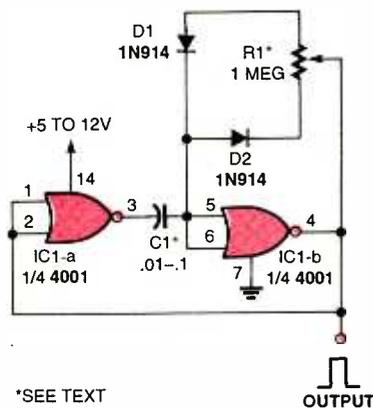


Fig. 3. This generator circuit uses potentiometer R1 to vary the pulse width from under 5% to over 95% of the duty cycle. Components R1 and C1 determine the oscillator's frequency.

PARTS LIST FOR THE VARIABLE PULSE-WIDTH SQUARE-WAVE GENERATOR (FIG. 3)

- C1—0.01–0.1- μ F, ceramic-disc capacitor
- IC1—4001 CMOS quad 2-input NOR gate integrated circuit (NTE4001B, SK4001B, or equivalent)
- D1, D2—1N914 silicon signal diode
- R1—1 megohm potentiometer

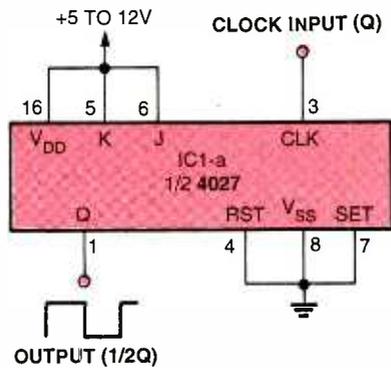


Fig. 4. In this circuit, a single IC, the 4027 dual JK flip-flop, operates in a divide-by-two configuration. The output is one-half of the input clock rate.

PARTS LIST FOR THE DIVIDE-BY-TWO-CIRCUIT USING 4027 IC (FIG. 4)

- IC1—4C27 CMOS dual JK flip-flop integrated circuit (NTE4027B, SK4027B, or equivalent)

DIVIDE-BY-TWO CIRCUIT USING A 4027 IC

A simple CMOS divide-by-two circuit, using a 4027 dual JK flip-flop IC, is shown in Fig. 4. The divider circuit uses only one of the IC's JK flip-flops, which is connected in the clocked mode. Each time the generator's output pulse goes high, the JK flip-flop changes state, and for every two input pulses the IC receives, it outputs a single pulse. The IC can divide input frequencies of 5 to 8 MHz when operating with a 12-volt supply. The IC's maximum operating frequency depends on its supply voltage. The higher the voltage, the higher the operating frequency. The maximum operating voltage for most of the 4000 series of CMOS IC is 18 volts.

CMOS DIVIDE-BY-TWO CIRCUIT USING TWO ICs

A second divider circuit, in Fig. 5, is complete with a slightly different oscillator driver circuit. Here we have two NAND gates of a quad 2-input NAND Schmitt trigger using a 4093 IC, connected in an oscillator buffer circuit that sends clock pulses to the input of a divide-by-two IC; a 4013 IC. This oscillator is probably the simplest of all gate oscillator circuits. Only one gate is required; the second gate operates as a buffer and may be excluded in most applications. The unused inputs of the 4093 IC, pins 8, 9 and 12, 13 should be grounded.

Let's take a quick look at how the 4093 IC differs from the standard NAND

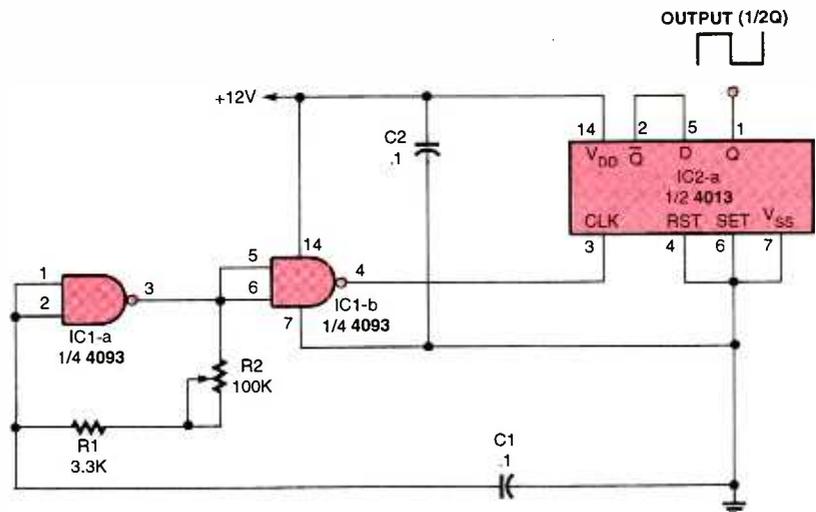


Fig. 5. Here we have a self-contained oscillator. The pulses, which are developed by the 4093 IC, are clocked into the 4013 IC, which is configured as a divide-by-two circuit. Resistor R2 sets the base oscillator frequency.

PARTS LIST FOR THE DIVIDE-BY-TWO-CIRCUIT USING TWO ICs (FIG. 5)

C1, C2—0.1- μ F, ceramic-disc capacitor
 IC1—4093 CMOS quad 2-input NAND gate Schmitt trigger integrated circuit (NTE4093B, SK4093B, or equivalent)
 IC2—4013 CMOS dual "D" flip-flop integrated circuit (NTE4013B, SK4013B, or equivalent)
 R1—3300-ohm, 1/4-watt, 5% resistor
 R2—100,000-ohm potentiometer

gate package. The input gates of the 4093 IC have a built-in hysteresis that makes the device an excellent choice for single-gate oscillator circuits, and an ideal device to use when input signals are noisy. As the gate input voltage rises to about 60% of the supply voltage, its output goes low, and when the gate input voltage drops to about 40% of the supply voltage, its output goes back high. This 20% difference in input level, where the output does not change state, is the 4093's dead-band or hysteresis figure.

Now back to the oscillator circuit in Fig. 5. A 0.1- μ F capacitor is connected

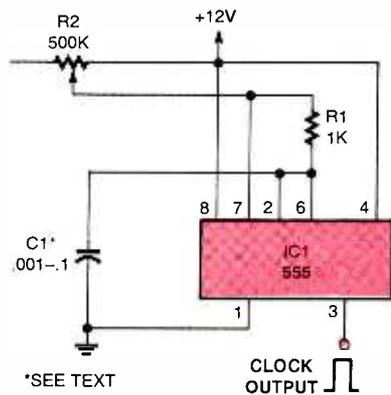


Fig. 6. Here the venerable 555 oscillator/timer IC is used as an astable oscillator. The frequency of oscillation is determined with resistor R1, potentiometer R2, and capacitor C1. The duty cycle is set with R1 and R2.

PARTS LIST FOR THE PULSE GENERATOR WITH 555 IC (FIG. 6)

C1, C2—0.001–0.1- μ F, ceramic-disc capacitor
 IC1—555 oscillator/timer integrated circuit (NTE955M, SK3564, or equivalent)
 R1—1000-ohm, 1/4-watt, 5% resistor
 R2—500,000-ohm potentiometer

between the gate of IC1-a and circuit ground. The output of IC1-a is fed back to its input through resistors R1 and R2. When power is first applied to the circuit, the gate voltage of IC1-a is at ground level and its output is high. The positive voltage at the output of gate voltage of IC1-a begins to charge capacitor C1 through resistors R1 and R2. When the voltage across C1 rises to within 60% of the supply voltage, the gate changes state and its output goes low. R1 and R2 are now tied to circuit ground and start to discharge C1. When C1 discharges to about 40% of the supply voltage, the output changes again going high, to start the cycle over. That's how the single gate oscillator operates. Varying the value of potentiometer R2 changes the oscillator frequency at pin 4. Maximum resistance produces the lowest frequency, and minimum resistance produces the highest frequency.

The divider circuit, in Fig. 5, uses a single D flip-flop stage from a 4013 dual D flip-flop CMOS IC. The interconnections between pins on the D flip-flop divider are different than the ones used on the JK flip-flop, but the output results are the same. Two pulses from the 4093 IC input at pin 3 clock in, and only one comes out (at pin 1). The D flip-flop changes state each time the input clock pulse goes high.

PULSE GENERATOR WITH 555 IC

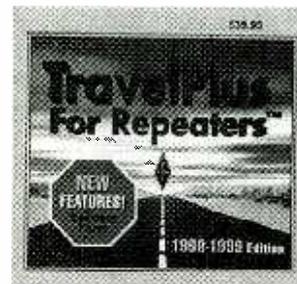
The last pulse-generator circuit uses one of the most popular ICs available to the experimenter, the immortal 555 oscillator/timer IC. This handy-dandy monolithic device (a CMOS version of the 555 is also available) is known worldwide, and it would be thoughtless to leave it out of our pulse generator mix. The circuit in Fig. 6 tells it all. Potentiometer R2 controls the frequency and capacitor C1 sets the frequency range. The 555's output waveform is the least symmetrical of all, but apply its output into one of the divide-by-two circuits, and that problem vanishes!

The old clock is ticking down on another session of the *Circus*, so may all of your circuits perform as "generated," and I'll see you here next month, same time, same station. I welcome your comments and suggestions via e-mail at cdrakes@ipa.net, or snail-mail at P.O. Box 445, Bentonville, AR 72712.

ELECTRONICS LIBRARY

(continued from page 48)

along a sequential list of repeaters for the entire trip. Colorful maps can be printed out that display major highways in the U.S. or Canada. Also available are more detailed maps of the U.S. that include state highways.



TravelPlus allows users to trace a route and find all repeaters within a specified range on whatever bands are selected. It can identify repeaters within 500 miles of any location. The disc includes the entire ARRL VHF/UHF Repeater Database. Information can be sorted alphabetically by state, in descending order, and in reverse sequence order for the return trip. Route files and repeater lists can be saved to a floppy for future reference, or a data file can be exported to be used with radio-programming software.

Among the new features in this edition are the options: to change ranges along the route; to plug in a GPS unit and track your current position route, and grid square; and to set your home location using city or latitude/longitude. A new addition is hundreds of listings from *The ARRL Net Directory*. Minimum system requirements are an IBM-compatible PC with a 386 or better processor; at least 8 MB of RAM; at least 4 MB of free space on the hard drive; and Windows 3X, 95, or NT.

TravelPlus For Repeaters: 1998-1999 Edition costs \$39.95 and is published by *The American Radio Relay League*, 225 Main Street, Newington, CT 06111; Tel. 800-243-7767; Fax: 860-594-0303; Web: www.arrl.org.

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Think Tank

Have Gunn—Will Oscillate!

ALEX BIE

This time we set out to answer the question "What is a Gunn diode?" Gunn diodes are semiconductor devices that are used as an easy and relatively inexpensive method of generating low power microwave signals. Operating at frequencies between a few gigahertz to over 100 GHz, they have been available for over 30 years after being discovered in the early 1960s by J. B. Gunn of IBM. These days Gunn diodes are well established and are commercially available in a variety of applications; such as in microwave data links, low-powered FM and CW radar, intrusion alarm systems, etc. Circuits employing these diodes can produce from 15 mW to 1 watt of output power and exhibit low noise and good frequency stability, under stable temperature and voltage conditions. For hobbyists, these devices are particularly popular for use in the 10-GHz amateur band (more on this later).

Construction

A Gunn diode is made from a single piece of N-type silicon. This consists of three main areas, as shown in Fig. 1. The areas at the top and bottom of the device are heavily doped to give N+ material, resulting in high conductivity for connection to the outside world. The device is mounted on a conducting base to which a wire connection is made. This base also acts as a heat-sink to dissipate the heat that is generated.

The connection to the other terminal of the diode is made via a gold lead deposited onto the top surface. Gold is required because of its relative stability and high conductivity. The center area is the active region of the device and this is less heavily doped, giving it lower conductivity. Typically this is about 0.5 ohm per cubic centimeter, which means that virtually all the voltage placed across the device appears across this layer in the diode.

("What is A...?" series by Ian Poole, G3YWX, reprinted by permission from *Practical Wireless*, Arrowsmith Court, Station Approach, Broadstone, Dorset BH18 8PW, England.)

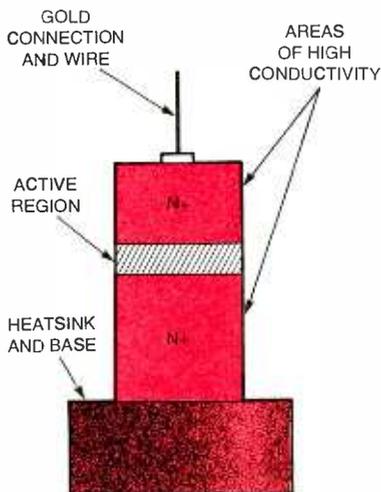


Fig. 1. The construction of a Gunn diode. Note that the diode consists only of N-type material.

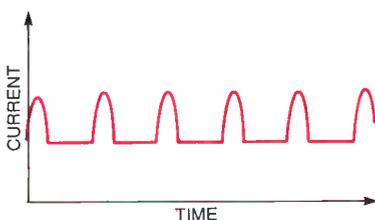


Fig. 2. The current consumption of a Gunn diode showing the current pulses.

Usually the active layer of the diode is about ten microns (0.001 cm) thick. As this largely determines the approximate frequency of operation, its thickness will naturally vary from one device to another. This also means that part of the specification for this device is its operating frequency. In an unusual construction, the Gunn diode consists only of N-type material—there is no P-N junction in the device. In fact, it is not actually a true diode, and it operates on totally different principles.

Operation

Although the operation of a Gunn diode can become complicated, it can be viewed from a basic level. When a voltage is placed across the device, most of this potential appears across the active center region. This is very thin,

and even a modest voltage means that the potential gradient or voltage change over a given distance is very large.

When the voltage across the active region reaches a certain point, a current pulse starts to travel across the active region, as shown in Fig. 2. When this occurs, the potential gradient across the rest of the active region falls, preventing any more current pulses from being generated. Only when the current pulse reaches the other side of the active region does the high potential gradient return, and another current pulse can be generated. The unusual current pulse action can be viewed in a different way if the curve for the voltage and current is plotted out. The diagram in Fig. 3 shows the curves of a normal diode and a Gunn diode.

For a normal diode the current increases with voltage, although the relationship is not necessarily linear. On the other hand, the current for a Gunn diode starts to increase, and once a certain voltage has been reached, it starts to fall before rising again. The region where it falls is known as a "negative resistance" region, which results in its oscillation characteristics.

Frequency Set

Although the approximate frequency of operation is set by the thickness of the active region, it is still possible to vary the frequency over a limited range. Being a microwave device, the Gunn diode is normally fitted into a waveguide cavity which forms a tuned circuit, and it is the resonant frequency of the whole assembly which governs the frequency of operation.

Tuning can be carried out in a number of ways. Mechanical adjustments can be made by placing an adjusting screw into the waveguide cavity, which gives a crude measure of tuning. However, some form of electrical tuning is normally required as well, using one of two methods.

The first is to use a varactor diode (see September *Think Tank* for more information on this device), which is coupled into the Gunn oscillator circuit.

By changing the voltage on the varactor diode its capacitance will change, and this will vary the frequency at which the whole circuit resonates. This method is cheap and easy to implement, but it has a number of limitations. In the first case, it only operates over a limited range. Secondly, this method gives rise to a high level of phase noise, which may not be acceptable in many applications.

A more satisfactory method of tuning uses a device called a YIG. This contains a ferromagnetic material called Yttrium Iron Garnet. The Gunn diode is placed into the cavity along with the YIG, which has the effect of reducing the effective size of the cavity. This is achieved by placing a coil outside the waveguide. When a current is passed through the coil, it has the effect of increasing the magnetic volume of the YIG and hence reducing the electrical size of the cavity. In turn, this increases the frequency of operation. YIG tuning gives much lower levels of phase noise, and it is found that the frequency can be varied over a wide bandwidth.

For amateur-radio use, the Gunn diode oscillator is available as part of a commercial transceiver from *Advanced*

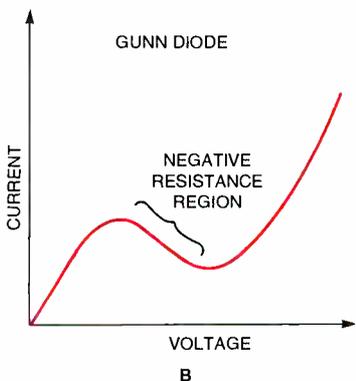
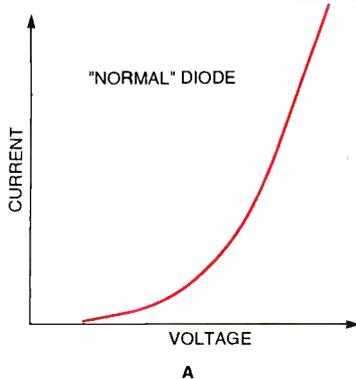


Fig. 3. Graphs showing the current and voltage for normal (A) and Gunn diodes (B).

Receiver Research (P.O. Box 1242, Burlington, CT; Tel. 860-485-0310). The unit, known as a "Gunnplexer," is used to generate and down-convert nominal 10-GHz amateur signals to the 2-meter (144-MHz) amateur band, or other lower intermediate frequencies (IFs). The Gunnplexer contains a Gunn diode, along with Schottky mixer diodes (see July *Think Tank* for more information on these devices) placed within a 10-GHz cavity, and in turn coupled into a high gain rectangular horn antenna. Varactor tuning produces frequency shifts of up to 60 MHz from the nominal resonant frequency. During operation, the Gunn diode acts simultaneously as a transmitter and a local oscillator for the down-converted 2-meter IF.

In next month's column, we will continue our "What is a ...?" series as we examine another unusual semiconductor device—the IMPATT diode—which is used for generating signals in the microwave region. Now let's get to the readers' circuits.

"WHO'S-ON-FIRST?"

Our first circuit is a "who's-on-first" circuit. If you want to settle once and for all who has the fastest hand reflex, give the circuit in Fig. 4 a try. Here we have two low current SCRs, with their gates cross-connected in a circuit, allowing only one of the two to be turned on at a time. When either SCR is triggered on, the gate voltage for the other SCR is removed and cannot be turned on. If S1 is closed first, gate current will flow through R2 and LED2 to SCR1's gate, turning it on and lighting LED1. The voltage at the anode of SCR1 is near zero and cannot supply gate current for SCR2. The circuit must be reset by momentarily pushing S3.—C. Rakes, Bentonville, AR

Nice circuit, Charles. This should be an easy project to build and fun to work with. Incidentally all resistors are 1/4-watt, 5% units, and an equivalent for the 2N5061 SCR is a Thomson SK3638 unit.

A S.T.A.R. OF AN INDUCTANCE TESTER

Quite often in radio and TV or computer-monitor servicing work, there is occasion to suspect a transformer, filter choke, flyback, or yoke to be malfunctioning. But unless it has a definite open winding or has obviously been shorted out, the only way to pinpoint

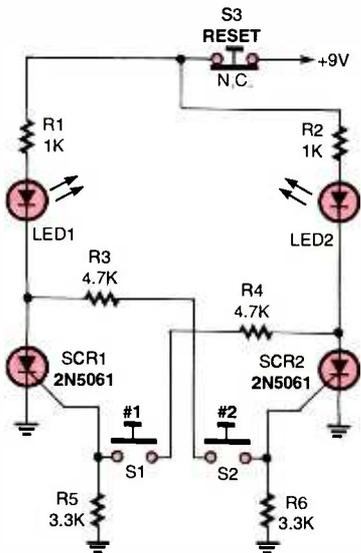


Fig. 4. Who has the fastest reflexes—operator #1 or #2? The first one to press the switch does! This circuit can be used to compare response times or as an indicator in a quiz show game—use your imagination to think up all the applications!

the trouble would be by substituting each unit or replacing it with a new one, which can be time-consuming and/or costly.

Here is a simple Shorted Turns and Ringing (STAR) inductance tester, which is easy to build and operate. This tester is designed to be an accessory to your oscilloscope to test transformers, yokes, flybacks, and other inductor-type devices. You can quickly locate the problem even if the inductor has only a few shorted-out turns in its winding that would not otherwise register on your volt-ohmmeter.

It is a well-known fundamental principle of AC circuit theory that a closed reactive circuit containing an inductor and a capacitor, when triggered momentarily by a DC pulse voltage, will oscillate for a defined interval of time. The number of cycles of oscillation and their frequency will depend on such factors as inductance, capacitance, and the quality factor, Q, of the inductor. Any leakage, any break in the circuit, or any partial or complete short will kill or dampen the oscillations before they have an opportunity to develop to any appreciable extent. This is the theory and principle behind the operation of the S.T.A.R. inductance tester.

In reference to Fig. 5, the required DC sources for the circuit is supplied by standard 117-volt AC house current, which is rectified through a voltage-dou-

other winding will reflect back to produce a faulty trace.

Connect the test leads to the high-impedance side of a known good audio output transformer, use the push-button TEST switch to trigger the tester, and note the spiral trace on the oscilloscope (Figs. 8A and B). This will give you some idea of the type of normal trace to expect. Some slight adjustment of the scope may be necessary to keep the pattern on the face of the CRT tube.

The number of spirals will vary with the particular inductance being tested. But one complete spiral or more is assurance that there are no shorted turns in either winding. You can prove the truth of this statement by shorting the low-impedance voice coil side of the transformer winding and observing the change in the oscilloscope's pattern.

The inductance tester may also be used for testing leakage between the windings, or leakage between a winding and the core of the transformer. Here the "no leakage" pattern is the inverted-L open circuit trace of Fig. 6C. Varying degrees of leakage are indicated by the slope of the horizontal line of the inverted-L of Fig. 6F. As leakage increases, the horizontal line becomes more vertical, until it achieves the typical shorted-turns pattern, see Figs. 6D or C. The yoke or flyback-transformer windings of TV receivers or computer monitors can be especially troublesome when shorted turns develop.

Because of their low impedance, the tester will not produce the customary spiral pattern when applied to a yoke winding. Instead, a characteristic ringing trace is produced (see Figs. 6G and H). However, each half of either a vertical or horizontal yoke winding may be checked separately, and then the traces for each windings compared for proper operation. If the two traces are very similar as in examples Figs. 6G and H, the winding is okay. If they differ, such as Figs. 6H and I, then an unbalanced condition exists that will cause faulty operation of the yoke in the TV set or computer monitor.

Remember that the winding being tested must be isolated from the rest of the circuitry; be sure to disconnect any parallel windings or damping resistors or capacitors before making this test, or this will affect the outcome of the scope pattern trace. Vertical to horizontal yoke leakage is not uncommon, and this should be checked.

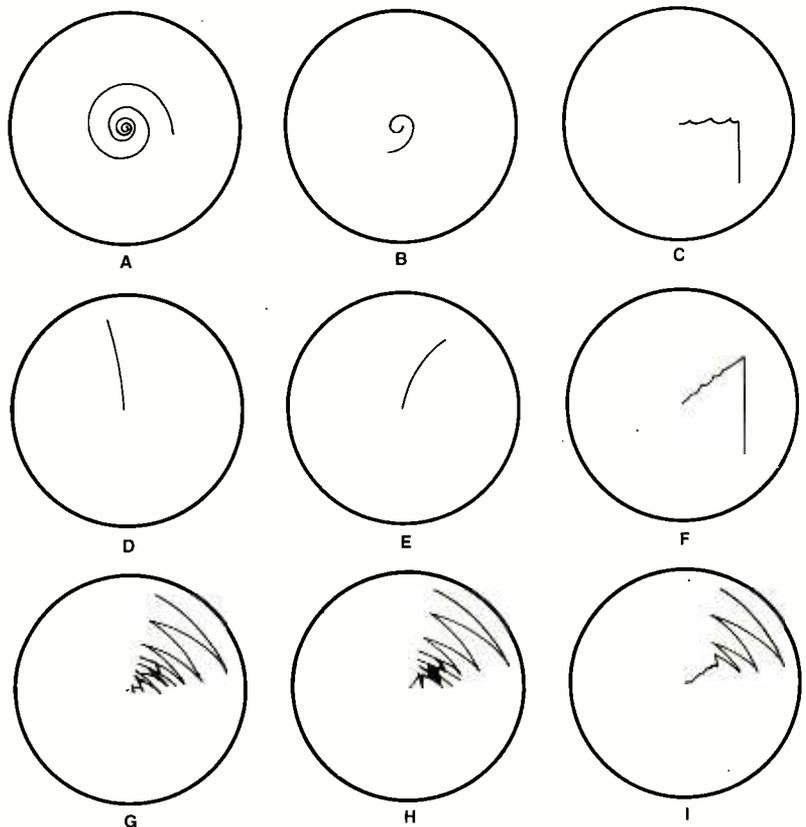


Fig. 6. Oscilloscope displays of some of the different traces obtained from the STAR tester. In trace patterns (A) and (B) are shown good inductors. Trace (C) shows an open winding, or no leakage. Traces (D) and (E) show shorted turns. Trace (F) shows leakage. Traces (G), (H), and (I) show typical yoke-winding patterns.

Like most simple inductance checkers, this tester has limitations. For example, it will not be of much help in testing the windings in RF and IF coils. Even though the direct checking of such low impedance windings as these devices, or the secondaries of output transformers, or the filament windings of power transformers is not feasible, their indirect testing through the high impedance side is definitely useful.

The inductance tester also will work well on such other devices as fluorescent-light ballasts; and the windings on many fractional, horsepower, or universal motors or even filter chokes on power supplies. It should be noted that it may be necessary to adjust the range switch, S2, on the low, medium, or high positions. The lower the impedance to be measured, the higher the range setting may become necessary.—Craig Kendrick Sellen, Waymart, PA

Another useful circuit, Craig. This tester is a fine addition to the hobbyist's, or repair-person's arsenal of test equipment. In the separate parts list for this circuit, Craig indicates that many of the

items can be obtained from Concord Components, P.O. Box 65, Concord, NE 68728. Tel. 800-871-1749 or 402-584-2310.

MAILBAG

In my *Think Tank* design of the "Easy-to-Build pH Meter" that appeared in the September issue, I noticed a couple of differences from my original manuscript. In the calibration section the phrase "...adjust potentiometer R2 until the meter needle is halfway,..." is incorrect. Resistor R2 is fixed, and a review of the schematic indicates that the potentiometer referred to is marked R7. Speaking of schematics, resistor R1 should be tied to ground. The resistor, R8, in series with the LED should go up to the +9 VDC supply.—Nick Cinquino, Schaumburg, IL

In the September issue, I read with interest the description of varactor diodes. I thought your readers would be interested in a little bit of background on the development of these devices, in which I was directly involved.

PARTS LIST FOR THE S.T.A.R. INDUCTANCE TESTER (FIG. 5)

SEMICONDUCTORS

D1, D2—IN4004 1-amp, 400-PIV, silicon rectifier diode
D3—IN4001 1-amp, 50-PIV, silicon rectifier diode

RESISTORS

(All resistors are 1/2-watt, 5% units, unless otherwise noted.)

R1—470,000-ohm
R2—1-megohm
R3—500,000-ohm to 1-megohm linear-taper potentiometer with SPST switch
R4—1000-ohm
R5, R6—See text

CAPACITORS

C1A—0.1- μ F, 400 WVDC, mylar
C1B—0.22- μ F, 400 WVDC, mylar
C1C—0.47- μ F, 400 WVDC, mylar
C2—0.1- μ F, 400 WVDC, mylar
C3—100-pF, 500 WVDC, silver mica
C4, C5—1- μ F, 200 WVDC, mylar
C6—470- μ F, 16 WVDC, electrolytic

ADDITIONAL PARTS

I1—6.3-volt AC pilot light with holder
RY1—6-volt DC relay with DPDT contacts
S1—SPST, normally-open momentarily pushbutton switch
S2—DP3T rotary switch (SP3T can be used also)
J1, J2—BNC-type jack connectors
T1—Power transformer (Stancor #PS-8415, or Thordarson Meissner # 26R37), or equivalent

In 1957, I was at a division of TRW, then known as *Pacific Semiconductors, Inc.* (PSI) and was working with RCA in Camden, NJ on various applications of our products. We had come out with a silicon diode, which was receiving a great deal of attention. This diode had very high forward conductance due to the large size of the aluminum junction. RCA asked if PSI could provide a given range of back-biased capacitance in order to apply the unit to the PRC34, which was a new compact military transceiver. In September 1957, we announced the new product as the "Varicap," which stood for "Voltage Variable Capacitance." As the author of the application and of the name, I expected this to become generic; unfortunately the company insisted on copyrighting the name, and other suppliers used the *Bell Labs* term, "Varactor." PSI went on later to develop a line of hyper-abrupt devices under

follow-up government contracts.—
Howard Sachar, Redondo Beach, CA
Very interesting background, Howard.
I am sure that as we publish tutorials on other semiconductor devices in this monthly column, other readers may have similar stories of their involvement in the research and development of additional products, which have remained buried with the confines of laboratories as the commercial usage and availability of these products evolved.

Well, that's all the space for this month's column. Remember—this is **your** column. Do you have a good circuit idea? Would you like to share your design with other hobbyists? Then write out a brief description of its operation and application, along with a legible schematic. Make sure all parts are available, and that the circuit is original and workable. For each of your circuits that are published in the column, you will receive a book from our library. Send in enough circuits to fill a whole column and you will get a nifty kit or electronics tool to make your construction easier. Write me—Alex Bie, *Think Tank, Popular Electronics*, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

NET WATCH

(continued from page 18)

need that final push, it's possible to listen to RealAudio samples of select albums before you buy. Speaking of buying, you'll need to create an account to do so (this is common at online shopping sites), but consider it a handy step. During future visits, each online store will know who you are, and where to send your goodies, making shopping a fast experience.

Music Boulevard is similar in many ways to *CDnow*. Note that as with the big online bookstores, pricing between these two music sites is really competitive. You'll find one CD that's more expensive at, say, *CDnow*, but a different one that's cheaper at *Music Boulevard*. Again, shop around.

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As we hinted earlier, this is one of those sites that charge no sales tax. That should make your Holiday dollars go a long way.

And that about wraps it up for now—good luck checking off those names on your list. Until next time, if you feel like dropping me a line, send e-mail to netwatch@comports.com or snail mail to *Net Watch, Popular Electronics*, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

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LETTERS

(continued from page 5)

column? But the reason for my mail concerns the *Automatic Blower Control* construction featured in the September issue. While the article looks like an interesting and a fun project to undertake, I really wonder about the premise that it's a money saver and adds to the furnace functionality. Over the years I have done enough work on my own furnace, including installation of a new one, to know that the plenum switches for the blower that I've seen allow you to have the fan come on at a very low bonnet temperature, and provide very adequate delay of turn-off to extract just about all the heat one might wish from the bonnet.

If the fan comes on at too low a temperature, anybody near an air vent will feel chilled even though the air temperature is slightly above the room temperature. I really wouldn't want my fan coming on until the air that will be blown feels warm, and likewise I wouldn't want the fan to stay on so long after the furnace goes off that the air feels cold.

I am wondering if this isn't an overkill and a relatively costly replacement for a mechanical device with a long proven history that already does a very good job?

Ian Webb
via e-mail

Fortunately we can help you with your first request. The Web address for our publication is www.gernsback.com (listed in the masthead). After you reach our colorful home page, click on the STAFF link by the "control knob." This will bring up e-mail addresses for most of our staff (usually first initial, last name (no spaces) @gernsback.com). Hope to hear from you soon!—Editor (ewhitman@gernsback.com).

UNTAPPED VOLTAGE SOURCE?

The other day my kids finished taking a pack of *Polaroid* pictures, and they wanted me to change the film packs for them. As I was swapping the film pack out, it occurred to me that something was providing power to make the flash go off and move the film out when a picture was taken.

Being curious, I took the used film pack apart and found a flat (approximately 3- x 3-inch) battery with two cir-

cular contacts on one side. I took out my VOM and found that the battery had a DC voltage of about 5.5 volts. I was amazed that the battery was still fairly strong after 12 film shots. I then connected this battery to an old RC servo I had, and found that it ran for about 2 hours. Not bad! I didn't have time to work out any other specifications for this new source of "Free Energy" (if only you didn't have to pay \$16 a pack for the film!).

Well, I will never throw one of those things away again. In fact, I've become some what of a pest—asking people to keep their used packs for me. (They think I have some secret to recharging the pack). One final note, the spring mechanism that pushes the film up is great material for making a flat-spring contact. If anyone knows of any other uses for these film packs let me know, because I've got a box full, and I keep telling my wife they are good for "something."

J.C.
via e-mail

Here's a valuable idea in recycling discarded parts—and perhaps saving some money too—Editor

HAVES & NEEDS

Thanks for helping me out in the past, but now I would like to know if one of your readers can send me the schematics for a "Call-Filter," which has almost the same functionality as the "Build the Telephone HangUp Module" construction article which appeared in the March 1998 issue. Although the device you described works great, it does not *filter out* telemarketers—just "politely" lets them know to leave you alone—a "Call-Filter" does filter out and eliminate unwanted telemarketers and wrong numbers at odd hours of the night!

I have two commercial versions of these products, and I sometimes change one with the other, since they are both powered from the phone line. One of them just beeps faintly after the first ring, whereas the other one has a message after the first ring requiring the caller to first: "Enter Your Four-Digit Password;" otherwise the caller is disconnected. Please have a construction article for this type of "Call-Filter," or just publish the schematics for such a device.

Don Gherge

9310 Northcote Avenue
Saint John, IN 46373

Designers and would-be authors—how about putting together this construction project for Don and other readers?—Editor

I am looking for a set of schematics and a manual for a *Heathkit* Oscilloscope, Model #06 or O-6, and for a *GPX AM/FM/CD Dual Cassette Boom-Box*, Model C986CD. Any assistance your readers can give would be greatly appreciated. Thanks. :-)

J. White
E-mail: jodieg@freenet.tlh.fl.us

Once again, I wish to make a request to my fellow **Popular Electronics** readers. I require a circuit that drives the LED portion of an optoisolator. My problem is the source from my sensor is only 0.25 volts—not enough to drive the LED of an optoisolator. Does anyone have a circuit that I can use to solve my problem? Thanks in advance for any help that can be offered.

Brenden McNeil
203 South Cleveland Avenue
Elsmere, DE 19805
or E-mail: alligator82@geocities.com ■

MULTIMEDIA WATCH

(continued from page 16)

fronting *Thunder and Lightning in Humongous Entertainment's Pajama Sam 2: Thunder and Lightning Aren't So Frightening*. The world's weather has gone awry, and the weather machines need fixing. Pajama Sam must help Thunder and Lightning fix the weather machines and confront his fear of thunder and lightning. Mini-games and hundreds of activities will keep kids busy for hours. This title costs \$29.99.

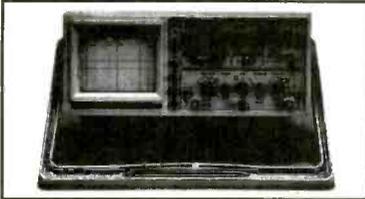
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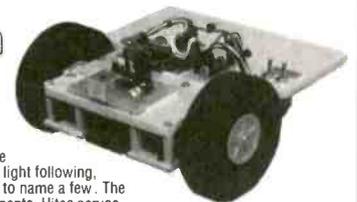
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Shown with the IRPD, no contact obstacle detector.

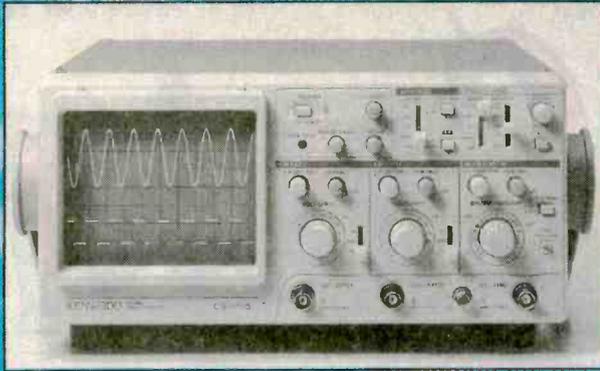
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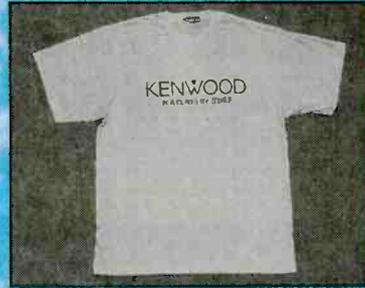


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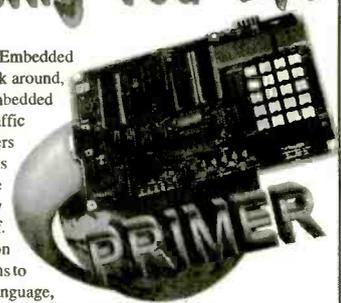
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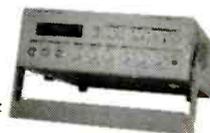


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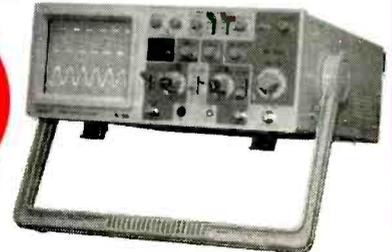
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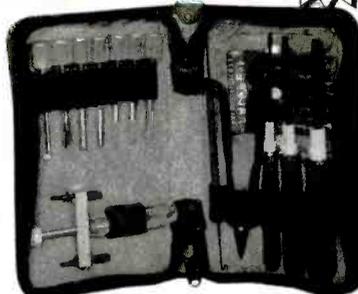
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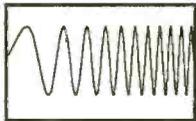


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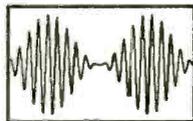
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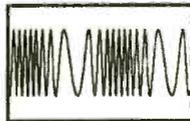
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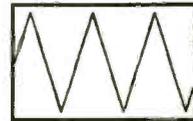
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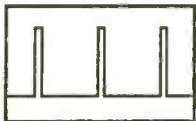
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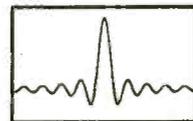
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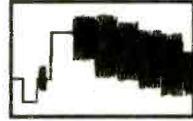
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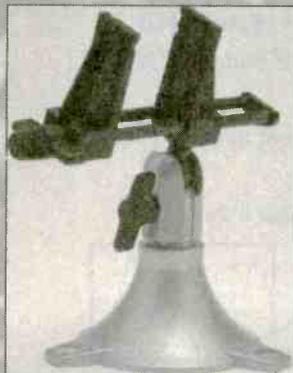
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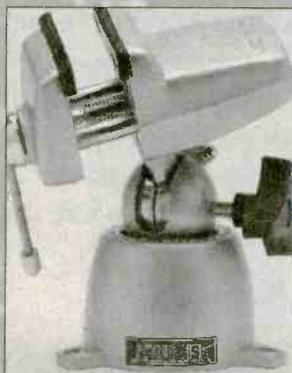
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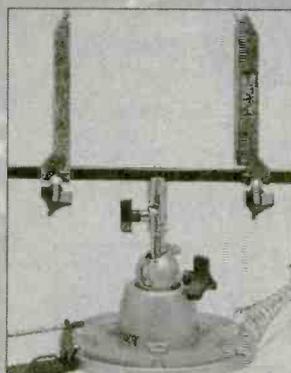
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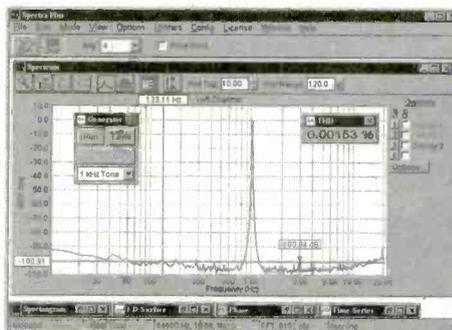
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- WF-3103A \$699.95 Freq. Range: 3KHz-10% LIS/CCIR,
3.15KHz±10% DIN.
Measurement: 0.3/1.3/1.3/3% full scale.
Accuracy: ±5% of full scale.
WF-3105A \$799.95, digital display;
Function: LIN/WOW/Flutter/WTD.
Freq. Counter: 10Hz-999MHz
Indication: CCIR/DIN/JIS

TOOLKITS - ELECTRONIC/PC

- 9245 \$29.99** U.S. Patented, 45-pcs. Contents: IC inserter/extractor
with securers & bows, 3-prong part retriever, #0 Phillips screwdriver,
1/8" flat screwdriver, self-hold tweezers, metal tweezers, extra
parts tube, soldering iron, solder, crimping tool, long-nose plier,
cutting plier, zipper vinyl case. Bits include: Phillips: #0/#1/#2/#3;
Flat: 1/8"/3/16"/1/4"/9/32"; PZ1/PZ2; T8/T9/T10/T15/T20/T25/
T27/T30/T40/T45; Hex: 5/64"/3/32"/1/8"/5/32"/3/16"; Sockets:
3/16" (5mm)/7/32" (5.5mm)/1/4" (6mm)/9/32" (7mm)/5/16" (8mm).
8G23 \$34.99 23-pcs Contents: IC inserter/extractor with securer &
bows, 3-prong part retriever, 3/16"/1/4" nutdriver, 3/16"/1/8" slotted
screwdriver, #0/#1 Phillips, reversible T10/T15 bits, re-versible
#2 Phillips/1/4" slotted bits, tweezers, long-nose plier, cutter, 6" adj.
wrench, soldering iron, solder, crimping tool, zipper case, manual.
Various packages available, call/write/e-mail/fax for details.

RF SIGNAL GENERATOR

- SG-4160B \$124.95, 100KHz-150MHz
up to 450MHz on 3rd harmonics in 6
ranges; AM modulation, Accuracy: ±5%.
RF Output: 100mVrms to 35 MHz,
Modulation: Int. 1KHz (AM) ±30%;
Ext. 50Hz-20KHz, at least 1V_{p-p} input.
Audio Output: 1KHz, 2V_{p-p} minimum.
SG-4162AD (with Freq. Counter) \$229.95, Spec. see SG-4160B.
COUNTER SECTION: 10Hz-150MHz, Max. Input: ±3V effective
Gate Time: 1, 1sec. Input Sensitivity: 35mV, 10Hz-200MHz.
Input Impedance: 1MΩ(HF), 50Ω(VHF) Display: 7-digit LEDs.

AM/FM STD SIGNAL GEN.

- SG-4110A \$1799.00, Freq: 0.1-110MHz, Display: 6-digit LED;
Resolution: 100Hz (0.1-34.999MHz); 1KHz (35MHz-110MHz).
Accuracy: $\leq 4 \times 10^{-1}$ ±1 count; Output: -19dBu-99dBu, 1dB steps.
Impedance: 50Ω VSWR 1.2; 100 preset frequency & store functions

AUDIO SIGNAL GENERATOR

- AG-2601A \$124.95, 10Hz-1MHz in 5
ranges; Output: sinewave 0-8V_{p-p}, square
10V_{p-p} Output Imped: 600 Ohm.
Distortion: <0.05% 500Hz-50KHz,
<0.5% 50KHz-500KHz
AG-2603AD \$229.95, with 6-digit,
Int/Ext. Freq. Counter, 10Hz-150MHz,
Output Control: 0/-20/-40dB & Fine adjuster. Spec. see AG-2601A.

FUNCTION GENERATOR

- FG-2100A \$169.95, 0.2Hz-2MHz in 7
ranges; sine, square, triangle, pulse &
Ramp; Output: 5mV_{p-p}-20V_{p-p}, 1%
distortion. VCF 0-10V/dec. to 1000:1.
FG-2102AD \$229.95 see FG-2100A,
4-digit counter display, TTL & CMOS
outputs, 30ppm ±1 output accuracy.

- FG-2020B \$159.00 0.5Hz-500KHz, Sine, Square, Triangle.
FG-2103 \$329.95, Digital sweep generator, 0.5Hz-5MHz in 7
ranges. Operating Mode: sweep, AM, gated burst, VCG.
Freq. Counter: Int. 0.5Hz-5MHz, Ext. 5Hz-10MHz
FG-513 \$769.95, 13 MHz, Microprocessor embedded digital sweep,
Sine, Square, Triangle, Pulse, Ramp, TTL & DC; $\leq 0.1\%$ 1-dgt.
Freq. Counter & TCXO 5Hz-100MHz, 6.5 digits, x1/x20 attenuation

AC MILLIVOLT METER

- MV-3100A \$159.95 wide band
5Hz-1MHz; 3 scales, mV, dB & dBm;
300μV-100V in 12 ranges, 10μV
resolution, -70-40dB in 12 ranges,
0dB=1Vrms, 0dBm=0.775V; ±3%
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Noise <2%. MV-3201B \$309.95 dual
channels, simultaneous measurement.

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- OS-7305B \$249.00 DC-7MHz, 3"
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in 4 ranges; Vert: 10mV/div; Int. &
Ext. Sync.; Input: 1MΩ/35pF.
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Horiz: 2V/div; Vert: 10mV-10V/div.
OS-622G \$389.95 20MHz, 2 CH/X-Y
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syn., 8x10 div., 1mV/div; Horiz: 2μs-5μs/div; Vert: 1mV-5V/div.
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OS-6101G \$1499.95 100MHz, 4ch/8 traces, delay sweep, cursor
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- RT-8815U (50Ω) \$299.00 / RT-8817U (75Ω) \$299.00, 950MHz,
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Input Sensitivity: 35mV/10Hz-200MHz
Input Imped.: 1MΩ(HF), 50Ω(VHF).
Display: 7-digit LEDs; 9V adapter (\$6)
FC-5260A \$129.95
10Hz-600MHz 7-digit LEDs.
FC-5270 \$149.95
10Hz-1.2GHz, 8-digit LEDs.
FC-5600B \$229.95
10Hz-600MHz, 10-digit LEDs.
FC-5700 \$299.95 10Hz-1.3GHz, 10-digit LEDs. Period measure.

SIGNAL TRACER/INJECTOR

- SE-6100 \$134.95
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Output Imped: 600Ω; Speaker: 8 Ω.
INJECTOR: ±1KHz Squarewave;
Output Level: Variable 0-4.5V_{p-p}; 9V battery or adapter (\$6.00).

LCR METERS

- MIC-4070D \$179.95, Induct.: 0.1μ-200H, Capacit.: 0.1p-20mF,
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Zero adjust, Surface mount device (SMD) test probe. LT-06 \$21.95

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- DMM-120 \$24.95, 3 1/2 digit, 600VDC, 2ADC
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MIC-39 \$129.95, Autorange/Bargraph, True RMS, 3 1/2 LCD, 40μF,
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- POCKET ANALOG MULTIMETER AMM-9810P \$44.95
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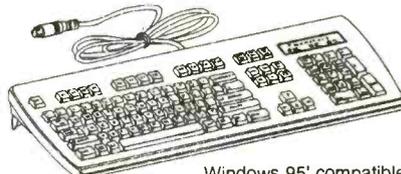


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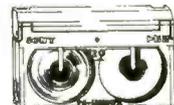
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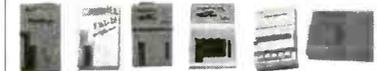
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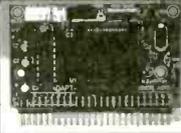
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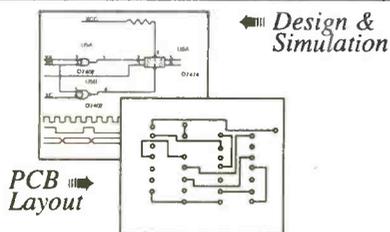
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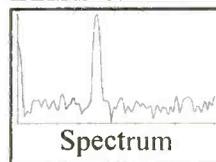
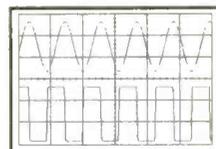
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2000mV 1mV ±(1%rdg+2dgt)

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200V 100mV

1000V 1V

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Range: Resolution: Accuracy:

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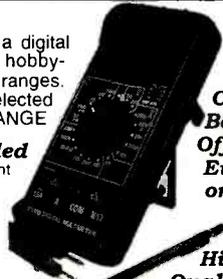
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Kit Includes

- 1 each 3"x5" pre-sensitized single sided PCB
- 1 each 4"x6" pre-sensitized single sided PCB
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- 1 each 500ml developer liquid
- 1 each 500ml ferric chloride etching liquid
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PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

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GS114	114mm x 165mm/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
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	1	10	50
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GD114	114mm x 165mm/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
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- Convenient acrylic sheet to hold board in place during exposure (12.5" x 8.5")
- Fluorescent light fixture with plastic cover designed to aid in proper light refractions for even exposure

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416-X	Fluorescent Exposure System	\$31.95
416-B	Extra Replacement Fluorescent Tube	16.95

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

Developer This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	1	10	25
POSDEV	Positive Developer	\$.95	\$.80	\$.50

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	1	5
ER-3	Makes 1 pint	\$3.50	\$2.75



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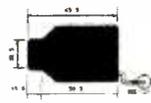


Color Weather Proof Bullet Camera

1/3" CCD with removable rotation capable mounting bracket

Specifications

Image Sensor: Interline transfer CCD 1/3" format
 Effective Pixel: 512(H)x492(V) pixels/NTSC
 512(H)x582(V) pixels/PAL
 Scanning System: 2 : 1 interlaced
 Sync System: Internal sync
 Sync Pulse: 15.734KHz +1%(H)/15.625KHz +1%(H)
 59.94Hz +1%(V)/ 50Hz +1%(V)
 Sub-Carrier 3.57 MHz +30ppm
 400 TV lines (H)
 More than 46dB (typ)
 Resolution: 0.45
 S/N Ratio: 1LUX (F1.2 10 IRE)
 Gamma Characteristics: 0.45
 Min. Illumination: 1LUX (F1.2 10 IRE)
 Video Out: Composite video signal : 1.0Vp-p
 White Balance: Auto white balance
 Electronic Shutter: 1/60 - 1/100,000 SEC(N) 1/50 - 1/100,000 SEC (P)
 Power Supply: DC 12V + 10%
 Power Consumption: 240mA (typ)
 Lens: 4mm (78 or 92 degree) F : 2.0
 Ambient Operating Temp: -5 deg. C +40 Deg. C
 Ambient Storage Temp: -10 Deg. C +50 Deg. C RH 95% MAX
 Dimension: 2 1/8" (L) x 1 1/4" (D)
 Weight: 3 oz.



DC 9V-12V INPUT (RED)

VIDEO OUTPUT (YEL)

PRICE EACH

CAT NO	DESCRIPTION	1	5
WDB-5407S	Color Water Tight Bullet Camera	\$299.00	\$269.00

(water tight for outdoor use, not suitable for sustained underwater use)

CCD Bullet Cameras

Available with standard or pinhole lens. Virtually indestructible bullet shaped casing. This sleek B&W camera can be mounted on walls or ceilings along narrow corridors or virtually any location for virtually any surveillance application. 0.5 lux minimum illumination with 380 lines of resolution. Even includes a built-in electronic iris for automatic light compensation.

Features

- Extremely low power consumption
- No blooming, no burning
- 0.5 LUX minimum illumination
- CCD area image sensor for long camera life
- Ultra small size allows for simple application and installation
- Built-in electronic auto iris for automatic light compensation
- Ultra compact camera

Specifications

Image Pick-Up Device: 1/3" CCD area sensor
 No. of Pixels: EIA = 512(H) x 492(V)
 Pixel Pitch: EIA = 9.6UM(H) x 7.5UM
 Scanning System: EIA=525 lines, 60 field/sec
 Sync System: Internal sync
 H. Resolution: 430 TU line
 V. Resolution: 400 TU line
 Usable Illumination: 0.5 Lux F1.6
 S/N Ratio: More than 48dB
 Gamma Characteristic: 0.45
 Video Output: 1.0 - 1.1 up-p 75 Ohm
 Electronic Shutter Time: EIA=1/60 - 1/50,000 sec
 Lens F No. Focal Length: STD : 1.6 Open / 4.3mm(78 deg) Pinhole: 4.3 fixed/ 2.8mm(91.4 deg)
 Power Consumption: DC 9V (8-10V), 110mA
 Operational Temp.: -10 deg - +50 deg C RH95% max
 Storage Temp: -20 deg - +60 deg C RH95% max
 Dimensions: STD : 22mm(W) x 22mm(H) x 38mm(D) Pinhole: 22mm(W) x 22mm(H) x 30mm(D)
 Weight: 35g max



PRICE EACH

CAT NO	DESCRIPTION	1	5
WDB-07S	Standard Lens Version	\$144.00	\$129.00
WDB-07P	Pinhole Lens Version	144.00	129.00
WDP-07S/water	Standard Lens Weather Proof	169.00	152.00

CCD Dome Camera with Audio

B&W DOME camera with integrated microphone. Ideal security system application. 12 VDC operation.

Specifications

Image Device: 1/3" interline transfer CCD
 Picture Elements: EIA=542(H)x492(V)
 Scanning System: 2:1 Interface
 Synchronization System: Internal
 Horizontal Resolution: 380 TV Lines
 Sensitivity: Under 0.3 LUX
 Electronic Iris (linear): EIA = 1/60-1/100,000 sec
 Video Output: 1.0Vp-p, 75 ohm
 S/N Ratio: More than 50dB
 Power Supply: 12V DC (±20%)
 Gamma: r=1
 Power Consumption: 110 mA max
 Operating Temp.: -10°C ~ +50°C
 Operating Humidity: RH 95% Max
 Weight: 100g
 Applied Lens: 3.6mm -92°, 4.3mm -78°
 A/E/E/Flicker Less/Mirror Image: Jump soldering selection
 Audio Pick-up Sensitivity: -60dB (0dB=1V/ubar)
 Audio Frequency Range: 20 Hz ~ 20 kHz
 Audio S/N Ratio: More than 40dB
 Audio Output Level: 1Vp-p/600 ohm
 Dimensions: 87 x 55.5mm



CAT NO	DESCRIPTION	1	5
WDDB-6500	B&W Dome Camera	\$144.00	\$129.00

1/3" CCD Board Cameras

Available with PINHOLE LENS with AUDIO; STANDARD LENS with AUDIO; and STANDARD LENS with INFRA-RED and AUDIO. These are the world's smallest commercially available CCD board cameras!

World's Smallest B&W Board Cameras

Specifications

Image Pick-Up Device: 1/3" CCD area Sensor
 Picture Elements: EIA=512(H) x 492(V)
 Pixel Pitch: EIA=9.6UM (H) x 7.5UM (V)
 Scanning System: 2 : 1 Interface
 Scanning Frequency: EIA=525 lines, 60 field/sec (II) 15.750 KHz x 60 HK
 Resolution: 430 Lines
 Minimum Illumination: 0.03LUX
 S/N Ratio: 45DB
 Lens Mounting: 4.3mm standard, 5mm pinhole
 Video Output: 1.0 VP-P/75OHM composite signal
 Power Requirement: 8-12 VDC (9VDC standard)
 Power Consumption: 100mA
 Operating Temperature: -20C ~ +70 C RH 95% Max
 Storage Temperature: -40C ~ +85 C RH 95% Max
 Audio Pick-Up Sensitivity: -60 DB (0DB = 1B/UBAR. 1KNZ)
 Audio Frequency Range: 20 Hz to 20KHz
 Audio S/N Ratio: More than 35DB
 Audio Output Level: 1VP-P/600 OHM

Dimensions

WDP-2000 30mm (H) x 30mm (W)
 WDS-2005 30mm (H) x 30mm (W)
 WDI-4000 44mm (H) x 30mm (W)

CAT NO	DESCRIPTION	1	5
WDP-2000	1/3" B&W Pinhole Lens with Audio	\$69.00	\$77.00
WDS-2005	1/3" B&W Standard Lens with Audio	89.00	77.00
WDI-4000	1/3" B&W Infra-RED with Audio	89.00	77.00
WDPH-55BW	Plastic Housing Option for B&W Board Cameras (WDP-2000 & WDS-2005 ONLY)	13.00	12.00



WDP-2000



WDS-2005



WDI-4000

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CAT NO	DESCRIPTION	1	5
136ESD	Electronic Temp Controlled ESD Safe Soldering Station	\$99.00	\$88.00
137ESD	Electronic Temp Controlled ESD Safe Soldering Station w/ Digital Readout	129.00	114.00

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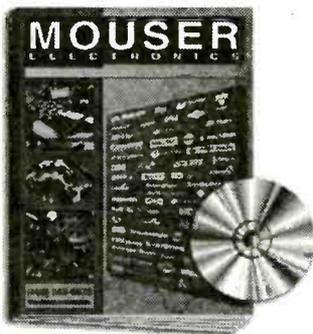
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We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but, in all cases, full payment must accompany your order.

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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.

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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.**

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9 - \$26.25	10 - \$26.25	11 - \$26.25	12 - \$26.25	37 - \$64.75	38 - \$66.50	39 - \$68.25	40 - \$70.00
13 - \$26.25	14 - \$26.25	15 - \$26.25	16 - \$28.00	Total words _____ \$1.75 per word = \$ _____			
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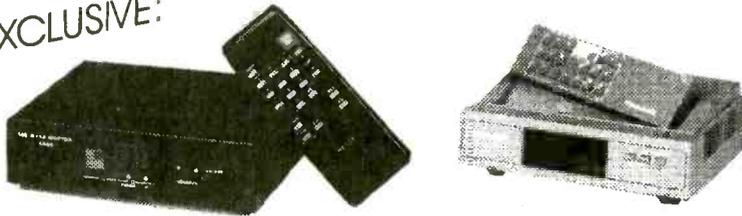
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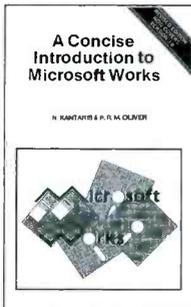
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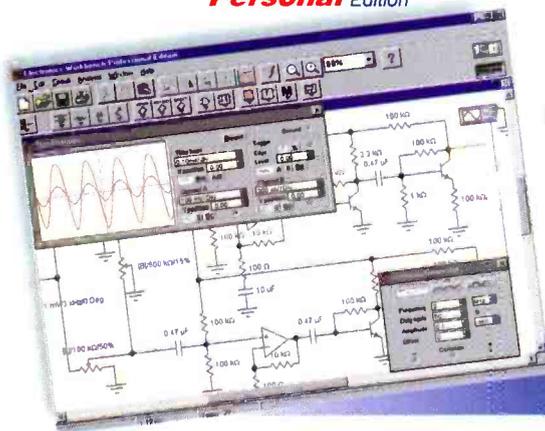
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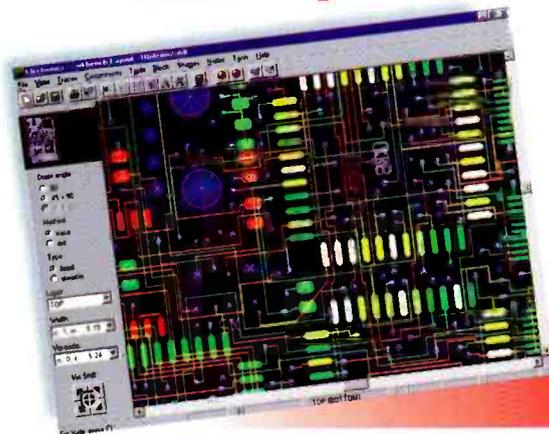
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