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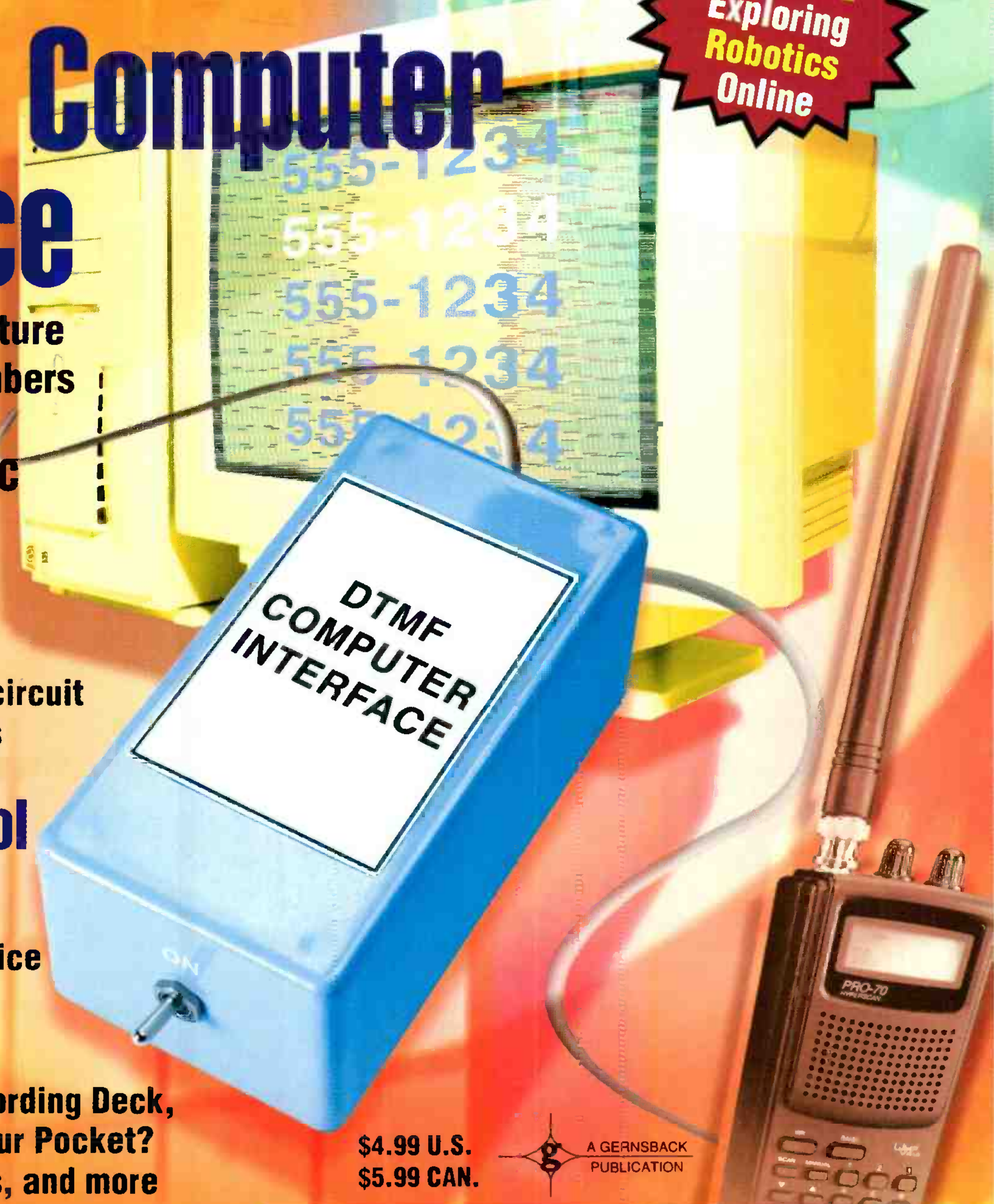


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**THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!**

## CONSTRUCTION ARTICLES



## PRODUCT REVIEWS



## COLUMNS



## DEPARTMENTS



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# EDITORIAL

## A Plethora of Projects

Most of you who regularly pick up or subscribe to this magazine want to do more than just read about electronics and gadgets. In recognition of all our readers who enjoy building projects, as well as those who'd like to get started doing just that, we're proud to bring you our Project Builders' Special. It's been a while since our last one, but we haven't forgotten about them.

We get things started this month with our cover story about a DTMF Computer Interface. With this innovative device, you'll be able to capture DTMF tones from the airwaves or any audio source, convert them to digits, and then feed them to your PC. A simple QBASIC program then lets you log the phone numbers and other strings of data for future use. Turn to page 31 to check it out.

Next up is a Super-Simple High-Voltage Circuit. As the article will show you, there's no need to invest big bucks to generate mega voltage. This HV circuit has a low (*really* low) parts count, but can still generate enough kilovolts to light a large neon tube. Proceed with caution, but do proceed, to page 38 for an enlightening, powerful learning experience.

The Wireless Control project is a transmitter and receiver pair that you can connect to a wide variety of circuits. Whether you want to trigger a gadget from across a room or set a sensor to do the same when you're not around, this is a great project to build. The story begins on page 41.

Want to build your own simple electronic game? Take a look at Tapper, an LED-filled version of those old tip-and-tap key-chain games of yesteryear. Turn to page 47 to get started.

Of course, there's also the usual plentiful do-it-yourself electronics advice in our columns. From Hall Effect magnet-sensing circuits in *Circuit Circus* to reader contributions in *Think Tank*, from hands-on reviews of the latest gear to tips from all our expert authors, this issue is packed with information for the electronics activist.

So read on, clear off your workbench, and get those soldering irons warmed up. We've got a terrific installment of **Popular Electronics** for you this month and look forward to bringing you some really groundbreaking stuff in coming issues. We can't tip our hand just yet, but promise that it will be worth waiting for some special theme issues this year.

See you next time.

Konstantinos Karagiannis
Editor

# LETTERS

## E-MAIL AWRY?

C'mon, you guys! If you are going to publish e-mail addresses so people can respond to requests in your *Letters* column, get them right! I responded to two of your letters under "Haves and Needs," (**Popular Electronics**, February 1999), namely to conway@pacbell.net and ucandonz@southern.co.nz only to have them bounce back at me as undeliverable! What's the story?

J.T.
*Burnaby, BC, Canada*

*Thanks for writing. There was an error in the e-mail address for Conway Chester. It should read conway-c@pacbell.net. Sorry for any inconvenience that the misprint may have caused, although there was a snail-mail address provided.*

*The e-mail address for Derek Rout in New Zealand was the one he supplied. Again, there was a snail-mail address published, and in this case maybe the snail will win the race!*
*—Editor*

## STRANGE PC

I know that this is probably a question I should be sending to a computer magazine, but seeing as I don't read any of them regularly, I decided to send it to you guys.

I have a Pentium 133 that I'm not quite ready to give up yet. Deciding to give it a bit of an extra boost, I invested in an extra 32MB of RAM to bring the machine to a total of 96MB. Since I installed the memory, however, the machine's been running even slower. It feels more like a 486 now than a Pentium. Did I do something wrong?

C.S.
*Little Rock, AR*

*We appreciate your thinking of us. To make a long story short, your problem is that pre-Pentium II machines cannot "handle" more than 64MB of memory, and more harm than good results by installing this much RAM. Only PIIs with a 440BX motherboard can properly address over 64MB of memory. To really enjoy a speed boost with your machine, return the extra RAM and invest in an overdrive processor.*

*Incidentally, you'll be able to address such concerns to our new computer-upgrading column, which should begin soon.*
*—Editor*

## HAVES & NEEDS

I am looking for old vacuum tubes, type VCH-1 and WY-2, for my antique radio receiver, a C. Lorenz (Germany) production from 1930–39.

Please send me any information about purchasing these vacuum tubes in the United States, or send me the addresses of any dealers who sell these tubes. Thanks for any help.

Jacek Spoczynski
*Munkhättegatan 186-V-16*
*Malmö, S-215-74*
*Sweden*

Do you know where I could get a scanner that receives 25–80 MHz? The rest of the frequencies are of no interest to me—25–80 MHz only. Thank you for your assistance.

Aaron Greene
*P.O. Box 141*
*Grandmanan Island*
*North Head, NB*
*E0G 2M0 Canada*

*Most commercial scanners cover the range of 29–54 MHz, and then pick up again somewhere over 100 MHz (usually 108 MHz or higher). Anyone know of any products that fit this reader's request? Or perhaps someone has a converter circuit that could do the trick?*
*—Editor*

I need a schematic diagram for a noise-reduction unit for LP records, or even a working or repairable unit. Any help on this matter would be greatly appreciated.

Jose Vitale
*414 E. Pine St., Apt. 208*
*Orlando, FL 32801-2875* ■

### KEEP IN TOUCH

We appreciate letters from our readers. Comments, suggestions, questions, bouquets, or brickbats ... we want to hear from you and find out what you like and what you dislike. If there are projects you want to see or articles you want to submit—we want to hear from you. And now there are more ways than ever to contact us at **Popular Electronics**.

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# Affordable Flat-Panel Monitors and New Peripherals

MARC SPIWAK
TECHNICAL EDITOR
COMPUTER RESELLER NEWS

I predict that flat-panel monitors will really take off with consumer sales by the end of this year. I also predict that you'll be able to buy a decent flat-panel display, or FPD, for about $500 by then. Here are my reasons:

Around the end of 1997, the *Computer Reseller News (CRN)* Test Center did its first FPD roundup. At that time, most displays were 14 or 15 inches diagonal, and cost somewhere around $3000 apiece. Some larger units, 16 to 21 inches, ranged in price from $6000 to $10,000 or so. Image quality was not so good in my opinion, and I couldn't see spending more than what I'd have to for a nice 21-inch CRT display to buy a 15-inch FPD—it seemed like the industry was going back in time with respect to screen size.

It is true that a given flat-panel display offers more screen space than its equally sized CRT counterpart, because FPDs always measure exactly what they're rated while CRTs always measure about an inch smaller than their rated tube size. In fact, a 15-inch FPD is almost as large as a 17-inch CRT. But I still couldn't make any sense of FPD prices. For applications where free space is at a premium and money is no object (such as stock exchange floors and medical centers), the flat panels were quickly accepted. But like myself, most consumers simply could not afford flat panels.

Fortunately, like all facets of computer technology, FPD technology did not stand still. Image quality has improved dramatically while prices have dropped just the same. Today you can buy a good FPD for around $1000—one that can display full-motion video and true color, which the early ones could not. Early FPDs were not multimedia-friendly. The FPD monitors sold last year probably set a record for losing value. A 15-inch FPD purchased in early 1998 could be replaced by a newer, better unit from the same manufacturer for maybe a third the price just one year later. So what's that used one worth now—maybe $300?

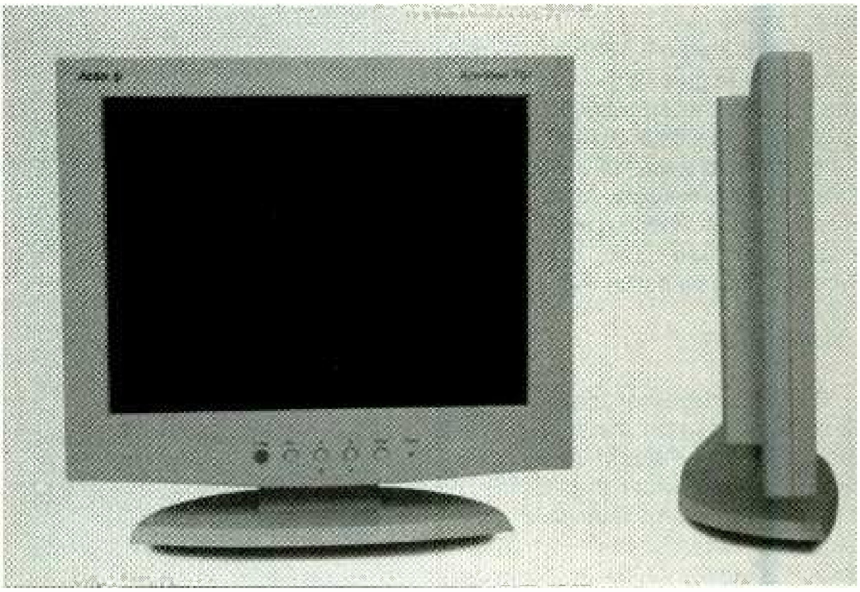
The main reason why I feel that you'll be able to buy a 15-inch FPD for $500 next year is because the 18-inch units have just arrived. Right now they cost several thousand dollars and have roughly the same screen space as 19-inch CRT displays, which can be had for between $500 and $1000. But I expect 18-inch flat panels to follow a price curve similar to 15-inch units and sell for between $1000 and $2000 a year from now. If I'm right about that, then low-end 15-inch units will surely sell for no more than $500. New technology always forces price cuts at the lower end.

## FLAT-PANEL DISPLAYS

Flat-panel monitors have some inherent advantages over CRTs. First of all, they are easy to bring home, and they fit quite well on those computer desks that are supposed to fit large displays but never do. FPDs are not affected by electromagnetic interference, and they never flicker. They have low power consumption, low heat output, emit no radiation, and cause less eye fatigue than CRT monitors.

My desk was actually sagging in the middle due to the 80-pound weight of a 21-inch CRT monitor. And poor planning led to my heavy fish tank being only inches away from my heavy computer desk, right next to where the monitor goes. Every CRT I tried showed some screen wobble, which wreaks havoc on the focus. The wobble was caused by electromagnetic interference from the pumps in and around the fish tank. Other image distortions were caused by powerful speakers being too close to the CRT. Finally I tried a flat-panel monitor, and all my troubles went away.

The 21-inch CRT was causing too many problems with my cheap computer desk that was never designed to house or support such a monitor. I had to drill new holes to raise a shelf higher than it was ever designed to go, and had to install an under-desk keyboard draw-



*Acer's AcerView F51 flat-panel display has a great picture in a 15-inch diagonal size for only $999.*

er because the 21-inch monitor didn't leave enough room for a keyboard on the desktop. I was also considering adding some sort of center brace to the desk because of the noticeable sagging. Instead I swapped monitors.

I do all my work on a pieced-together 266-MHz Pentium II, and have a test-bed system that I tinker with that's based on a 450-MHz Pentium II—more on that system later. I initially had a 15-inch FPD connected to the 450, and a 21-inch CRT on the 266. So now the 21-incher sits in the corner atop a reinforced shelf I built especially for it, used only when I tinker with the 450, and I "suffer" with the trouble-free 15-inch FPD when I work on the 266—but only until I can get my hands on an 18-inch FPD.

While I'm on the subject of flat-panel displays, I should mention three inexpensive units I recently tested. All three are 15-inch units, cost under $1000 on the street, and produce surprisingly good images. I examined units from Acer, KDS, and Panasonic.

Acer's *AcerView F51* has five buttons that control all of the on-screen display (OSD) functions. The controls default to brightness and contrast. The monitor automatically scales resolutions lower than 1024 × 768 to fill the screen. Its display is quite bright, and color and gray scales show up well. Text is sharp and easy on the eyes. The AcerView F51 costs $999.

KDS's *VS-F15* is taller than Acer's, with the bottom edge of the KDS monitor about six inches above the desktop. The OSD controls are on the back of the unit, which is a bit disconcerting. I also found the image quality to be not quite as good as the Acer unit, but the KDS is still quite acceptable. It, too, costs $999.

The Panasonic *LC50s* 15-inch FPD has some nice features that the others don't. The PanaFlat LC50s is equipped with built-in speakers and has a headphone jack on the front panel. The LC50s also has a built-in USB hub, with one upstream port and four downstream ports. It even has a built-in power supply and uses a standard AC power cord, while the Acer and KDS units use notebook-like external power supplies. Even with the extra frills, the LC50s costs only $999.

## WHERE TO GET IT

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## AOPEN TBS-M450

I was talking earlier about a 450-MHz Pentium II system that I tinker with at home, and I'm proud to say that it's made by Acer. One of the biggest vendors in the world, Acer is still not everybody's favorite brand. However, Acer systems are as fast and reliable as anyone else's with similar hardware. My *AOpen TBS-M450* Pentium II 450 from MicroOpen (Acer at heart) was part of a recent roundup I did at work. It was the second-fastest Pentium II 450 we tested, just behind a NextStar 450.

While MicroOpen and NextStar are brands that you might not have heard of, consider that brands such as Compaq, Dell, Hewlett-Packard, and IBM were also part of the roundup—NextStar and

MicroOpen beat them. Vendors were free to use any parts that met the basic requirements for the roundup.

For around $2000, the AOpen TBS-M450 comes with a 450-MHz Intel Pentium II CPU, 128MB of memory, a Matrox Millennium G200 AGP graphics adapter, motherboard-based SCSI, a 9.1GB 10,000-rpm Seagate Cheetah hard drive, a 40X CD-ROM drive, a sound card, and more. Chop all the goodies in half, and you can get a similarly fast system for around $1000.

The system initially came with Windows NT 4.0 Workstation, but I have since redone it with Windows 98 and made it my multimedia test bed. It seems only right to test the latest multimedia hardware and software in a state-of-the-art system. You can order a MicroOpen system exactly the way you want it—you can get a really cheap one or a full-blown, state-of-the-art workstation. You just have to know how to order.

## SOUNDMAN EXTREME

Now I need a way to output sound from my ultimate PC. One possibility is Logitech's *SoundMan Extreme*, a powerful new speaker system for PCs. This 50-watt, hi-fi system includes compact speakers that save desk space, plus a compact subwoofer that delivers good bass. Logitech's SoundMan Extreme's two satellite speakers have 12.5 watts of power each with a frequency response from 28 Hz to 20 kHz. The subwoofer packs in 25 watts. The speakers are magnetically shielded and automatically turn on and off when they detect an input. SoundMan Extreme costs about $150.

## 8X CD-R ROCKET

The perfect CD-R drive to go with my fast, new system is an 8X unit from Smart and Friendly. The *8 x 20 CD Rocket* records at speeds up to 8X and reads at up to 20X. It supports PC and Macintosh platforms and can burn a full CD in about nine minutes. This would be especially important to those who find themselves needing to burn more discs than their present drive can keep up with.

The 8 x 20 CD Rocket comes with all the software you need to use it. *Adaptec Easy CD Creator Deluxe Edition* lets you create music, audio, data, video, or mixed-mode CDs on a PC, and *Adaptec Toast* does pretty much the same for Macs. *Sonic Foundry CD Architect* lets you burn studio-quality audio CDs, while *Sonic Foundry Sound Forge XP* helps you compose sound tracks with more than 25 digital audio effects. *Diamond Cut Audio Restoration Tools 32* is for restoring audio for CD recording with various noise-removal and audio-enhancement tools. An external version of Smart and Friendly's CD Rocket costs $1099, and a less expensive internal model should also be available by the time you read this.

## EXP'S DVD AND HD TRAVELERS

I've also got a couple of peripherals for notebook computer users to help keep them as up-to-date, technologically speaking, as desktop users. EXP Computer's *DVD Traveler* is an external PC Card DVD-ROM player for notebook computers that lets you use DVD software and watch DVD movies. The base-model DVD Traveler is basically just a PC-Card-interfaced DVD-ROM drive for 233-MHz and faster MMX notebooks—the drive relies on a software MPEG-2 decoder. The *DVD Traveler Plus*, which is what you really want regardless of computer speed, works with notebooks of 133 MHz and faster. It comes with the DVD-ROM drive plus an MPEG-2-decoder PC Card.

*The DVD Traveler Plus, from EXP Computer, is a combo DVD-ROM drive/MPEG-2 decoder for notebook computers. It lets you use DVD software and watch DVD movies.*

All necessary power comes from the notebook, which is both good and bad. It makes for a completely portable solution, but it'll suck the life out of notebook batteries rather quickly. The drive is 6.5 by 5.5 by 0.75 inches (DWH) and weighs only 1.3 pounds, so it's easy to travel with. If you already travel with an external CD-ROM drive, swap it with the DVD Traveler, which also reads CD-ROM, CD-R, and CD-RW media. Rated at 2X (for DVD, that is), the DVD Traveler has a maximum data transfer rate of 2700 KB/s for DVD data and 2400 KB/s for CD-ROM data. The DVD Traveler costs $499 while the DVD Traveler Plus costs $699.

EXP's *HD Traveler* is a 2.1GB external hard drive for notebook computers, and for some reason it also has a game port. The HD Traveler is an ultra-slim external hard drive with a PC Card interface. The HD Traveler is convenient for moving data from one notebook to another or for backing up data. It's also perfect for those confidential files you don't want sitting on your laptop. Fast like any other hard drive, the HD Traveler has an average seek time of 13 milliseconds. The drive can be powered by a notebook's power or from an external 5-volt power adapter. The HD Traveler measures 2.8 inches long by 6 inches wide by 1.1 inches high, and weighs 12 ounces. It costs about $400 for the 2.1GB unit.

## SIDEWINDER FORCE-FEEDBACK JOYSTICK

So now I've got a full-blown PC, loaded with memory, a fast processor, awesome sound, and all the goodies. But I'm looking for a single item that will transform it from being just another fast PC into a true gaming console. Microsoft's *Sidewinder Force Feedback Pro* joystick could be the answer. This hi-tech joystick has a built-in 16-bit processor that generates dynamic force feedback. The game controller provides feedback that can be subtle at times and earth-shaking at others.

The SideWinder Force Feedback Pro comes with two games (Microsoft *Urban Assault* and Microsoft *Fighter Ace Online*), but it works with many other titles that are out there as well. The stick can provide feedback for things such as G-force when flying a plane, contact with the ball in a sports game, textures of walls in adventure games, and so on. Force levels are adjustable, or it can be turned off entirely.

The SideWinder Force Feedback Pro also features adjustable electronic spring tension, and eight programmable joystick buttons with a shift button for supported games. It will emulate a CH

*Lara Croft's back in* Tomb Raider III*—a sequel with sharper graphics, exciting new locales, and enhanced moves for its adventurous main character.*

Flight Stick Pro or ThrustMaster when necessary under Windows 95. Digital optical technology ensures accuracy, fast response, and drift-free operation. There are no moving parts, so calibration is never required. The SideWinder Force Feedback Pro costs $139.

## NEW SOFTWARE

That lovable archaeologist/adventurer is back. No, not Indy ... Lara Croft. Eidos Interactive's *Tomb Raider III: Adventures of Lara Croft* has taken 3D gaming to a new level with its new graphics engine that's so sharp you'll almost think you're watching a movie at times. Explore five new locations—the dark streets of London, the jungles of India, a South Pacific island, the Nevada desert, and a mysterious island near Antarctica—with a newly outfitted character. And we're not just talking about Lara's new outfits; she's also got a few new moves including crawl, monkey swing, and speed dash that help you get her out of trouble. *Tomb Raider III* costs around $40.

It amazes me how many software titles Expert Software can pump out. The company literally has something for everyone, and most titles cost only $14.99. I've been holding onto some Expert Software titles so I could lump them together this month, and there's quite a few of them. The titles can pretty much be broken up into three main categories: research/productivity, utility, and entertainment.

Research/productivity titles from Expert Software include *Easy Maps* (which helps you locate any street in the continental US), the *Windows 98 Personal Tutor*, and *Internet Tutorial*. *Great Guns* is the ultimate gun guide with information on guns, ammunition, accessories, and more. It covers the history of guns, too, with manufacturer's specifications, photographs, and so on. *Play Better Golf* provides expert advice on improving your game.

Utility titles from Expert range from *Tamper Proof PC*, which helps you set up a secure computer, to *3D Font Creator*, *Font Magician*, and *Print Center Deluxe*, which collectively let you design custom fonts and documents with tons of clip art. *5000 Sounds* features serious and wacky sounds for customizing your PC or for inclusion in multimedia presentations.

*(Continued on page 64)*

# NEW PRODUCTS

## SELF-POWERED LANTERN

Delivering three to six minutes of light for each 30 seconds of winding, the *Freeplay Self-Powered Lantern* is engineered to provide a virtually fail-safe light source without relying on disposable batteries or other outside power sources. You simply rotate the unit's winding handle to get immediate light.

The compact lantern (7 by 10 by 5½ inches) can be used anytime, anywhere. During prolonged power outages or when the lantern's being used in remote areas, users can simply generate and store extended power by successively performing 30-second winding sequences. By doing this, human-energy is converted and stored as electrical energy, ready for future use. The unit also accepts a normal electrical charge through a 12-volt AC/DC adapter or car adapter, providing up to two hours of continuous light, for immediate or later use.

In addition to instant light, the lantern can be used as a stand-alone generator. The unit features a three-volt output socket through which it can power a range of devices requiring the equivalent of two "AA" batteries.

The heart of the power source is the patented Freeplay Generator, a unique hand-wound spring mechanism that transforms human energy into electricity on demand. It is based on Personal Power Generation technology, in which a textured carbon steel spring is energized by winding it from one spool to the other. As the spring returns to its original position, it releases energy and applies a rotational torque into a transmission. The transmission consists of a gearbox that drives a DC generator to provide the energy for the lantern.

The Freeplay Self-Powered Lantern has a suggested retail price of $69.95. For more information, contact Freeplay Energy, 80 Amity Road, Warwick, NY 10990; Tel. 914-258-5660 or 800-WIND234; Fax: 914-258-3213; Web: *www.freeplay.net*.

**CIRCLE 80 ON FREE INFORMATION CARD**

## MICROWAVE ALARM

The size of a small pager (2.25 by 1.6 by .75 inches), the *MicroAlert Radio/Microwave Alarm* fits easily into your purse or pocket. Turn it on and select the sensitivity level you want. The minimum sensitivity is only .001 mW per cm. It is ideal for trying to find out what's emitting microwave or radio waves in hidden locations or in plain sight!

The switch on top lets you select standard selectivity, high selectivity, or off. A control on the side raises or lowers the sensitivity selected. The unit chirps once when it is turned on to indicate that the battery is good.

At the highest sensitivity, it will detect a typical cellular phone tower ½ mile away, a typical analog cell phone 40 feet away, and a digital phone 20 feet away. It can sense a microwave oven (in use) at a distance of 10–50 feet, usually with a less sensitive setting. The device is most sensitive from 100 MHz to 5 GHz, so ordinary cordless phones


do not cause much interference.

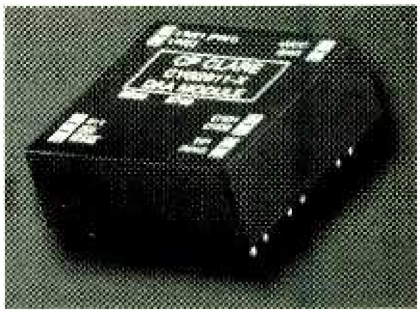
A clear loud beep indicates radio waves stronger than the level you select. If you move closer to the radio/microwave source, the beep sounds more frequently. It will ultimately become a solid tone if you move in even closer to the source. As you move away, the beeping stops.

Available in black, gray, and off-white, the unit comes with a 3-volt lithium coin battery, which has an average life of three years, and a pocket clip. The MicroAlert Radio/Microwave Alarm costs $81.50 plus shipping and handling. For more information, contact AlphaLab, Inc., Attn: David, 1280 South Third West, Salt Lake City, UT 84101-3049 (between 12:00 p.m. and 12:00 a.m. PST); Tel./Fax: 808-874-9126; Web: *www.rnaui.net/~emf.*

**CIRCLE 81 ON FREE INFORMATION CARD**

## TELEPHONE LINE-INTERFACE MODULE

The *CYG2911* provides a complete telephone line-interface, plus caller ID, and phone off-hook detection. The module is designed to be a simple "drop-in" solution for Data Access Arrangement (DAA) requirements in



various applications, including set-top boxes, bank terminals, plant monitoring equipment, home medical devices, security/alarm systems, utility meters, voice mail systems, vending machines, digital telephone answering machines, and modems. The FCC-compatible CYG2911 module is intended to free designers from the difficult task of designing their own DAA.

Offering complete PSTN (Public

*(Continued on page 65)*

# Net Watch

## Exploring Robotics Online

KONSTANTINOS KARAGIANNIS

Robotics is an area of electronics that has special appeal to most of us. How can you be involved in technology and not take an interest in the idea of interacting with an artificially intelligent machine? Whether you laughed at the antics of C-3PO and R2-D2, or thrilled at the advanced robot-filled society in many of the Isaac Asimov novels, the potential of robotics has likely captured some of your electronics-oriented imagination.

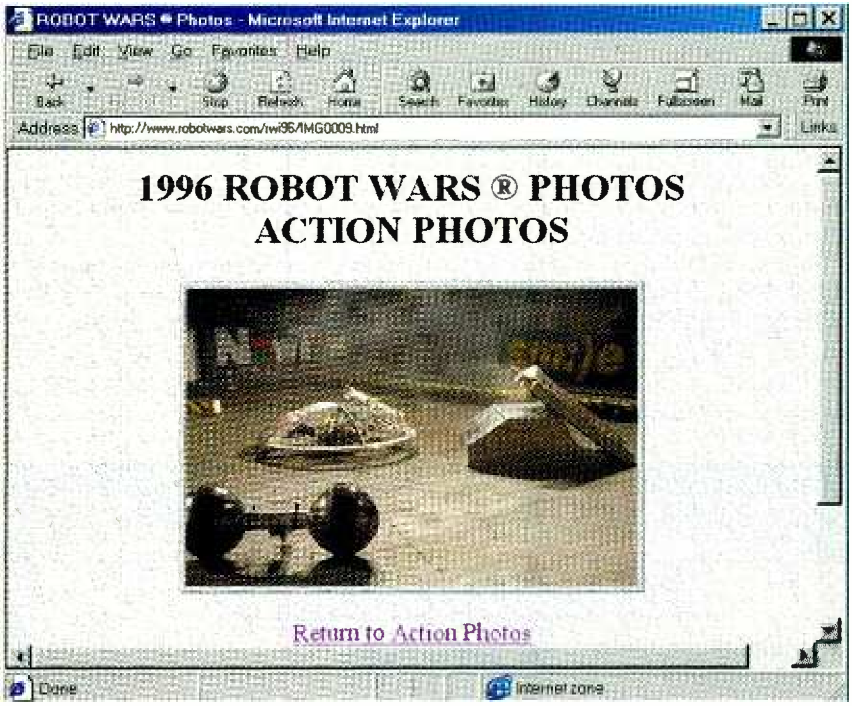
Electronics can sometimes be a lonely hobby. While others are hanging out at the local watering hole, hobbyists are likely to be working on a fascinating little gizmo, robot-related or not. Why not exploit the power of the Internet and take part in the growing online community of hobbyists out there? From what we've found, robot experimenters, in particular, are doing just that.

This month we're focusing on some robotics sites that might come in handy, whether you're shopping for an educational kit to build or looking to share tips and tricks with some other guys and gals working to create artificial life in various forms.

### A ROBOT STORE

One of the easiest ways to get started in robotics is to buy a kit and learn as you build. From all our hunting on the Web, we've found that Mondo-tronics is one of the best sources for beginners, as well as intermediate and advanced builders.

The heart of Mondo-tronics' product line is found in its Robot Kits section. Here you can choose from Listening, Touching, and Seeing Robots, as well as Robotic Arms, Legged Robots, Wheeled Platforms, Programmable Robots, Hackable Robot Kits, Fischertechnik Reconfigurable Robot Kits, Robotix Reconfigurable Robot Kits, Lego MindStorms Reconfigurable Robot Kits, and B.E.A.M. Solar Powered Robots. Prices range from under $20 to hundreds of bucks, depending on complexity.



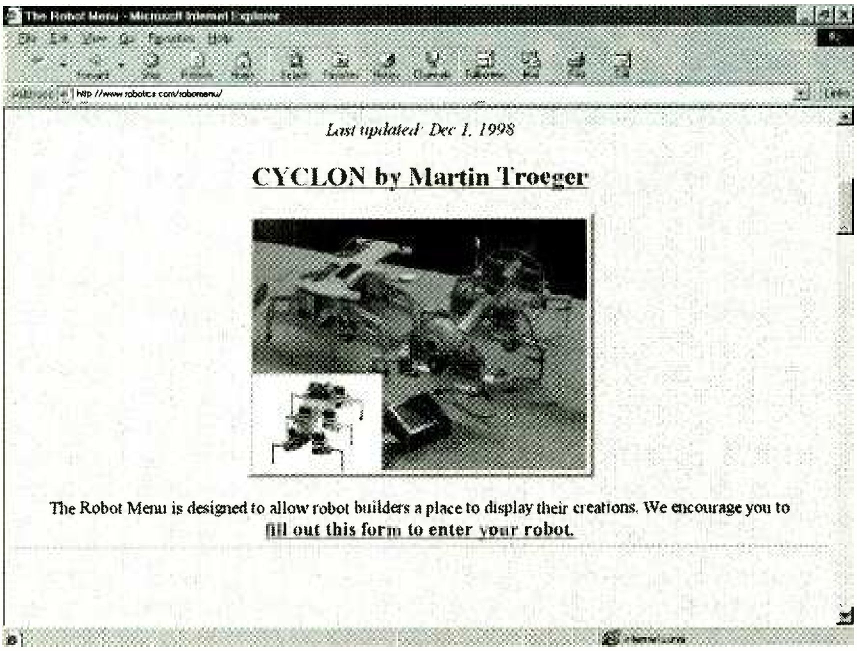

*To find images and details about some robots with real spunk, visit the Robot Wars Web site. Find out how to enter your machine in this mechanical battle to the "death."*

For those who like to experiment with their own designs, the site has a wealth of components worth checking out. Robot Brains & Controllers, Sensors (Inputs), Audio/Visual (Outputs), Motor Drivers/Servo Controllers, Motors/Servos, Communications, Radio Controlled (R/C) Electronics, PC Board Fabrication, and Rechargable Batteries and Charger all make up the basics of what you need. Of particular note are the Muscle Wire products.

Muscle Wire is a Shape Memory Alloy (SMA)—a composite material that undergoes a shape change when heated or cooled. Because of Muscle Wire's mechanical simplicity, high strength-to-weight ratio, silent operation, and precise control, it is a better actuator to use than a motor in certain applications. The lifetime of the wire can reach several million cycles and was considered dependable enough by NASA to go to Mars. The wire operated a dust-measuring device on the Sojourner Rover, and worked it without a hitch on the recent mission to the red planet. Learn more about this fascinating SMA material and order some through the Mondo-tronics site.

We've only touched the surface of what this site offers to the serious hobbyist. There are a great many other resources available from the company, including mechanical and software aids, as well as a plethora of books. But before we move on to another Web site, we should mention one more facet of Mondo-tronics.

Ever feel like splurging and just buying an assembled robot? Check out the few offered here. Prices range from a few hundred to over $10 million! That's right, if you're as financially endowed as Bill Gates, consider the 40-foot tall, 60,000-pound, fire-breathing Robosaurus. He's also available for daily rental of $25,000, if you just want to stomp on a few cars to pass the time.




*One of the nicest features of Robot Information Central is its RoboMenu, which allows experimenters and hobbyists to display their creations.*

## A NOTEWORTHY FAQ

Frequently Asked Questions (FAQ) files abound on the Net. These make it easy to find answers to common questions that more than a few people have asked about a subject in the past. Those new to robotics or just new to looking for such information on the Web will want to check out the Robotics FAQ.

Start with basics like the origin of the term *robot* (did you know that it was coined in 1921 by Czech playwright Karel Capek, who wrote R.U.R. or Rossum's Universal Robots?). Then learn Isaac Asimov's Laws of Robotics, which basically state that robots can't harm humanity as a whole or individuals, have to obey orders from humans, and must protect their own existence (unless it conflicts with an aforementioned law). Though used in science-fiction stories originally, these laws have become a kind of code of ethics that all robot-builders should seriously consider for their creations.

More advanced hobbyists will want to go straight to the FAQ sections that cover robotics-related organizations. Working on automatons doesn't have to be a solitary pursuit. The FAQ also lets you in on information about conferences, competitions, and even where you can get graduate and undergraduate degrees in robotics.

Yes, there's also hard-core techie data here. Find out more about sensors, actuators, microcontrollers, and remote control. Even download simulator programs that let you experience the act of controlling a robot, without putting in the construction time.

## PUSHING THE LIMITS OF ROBOT LAWS

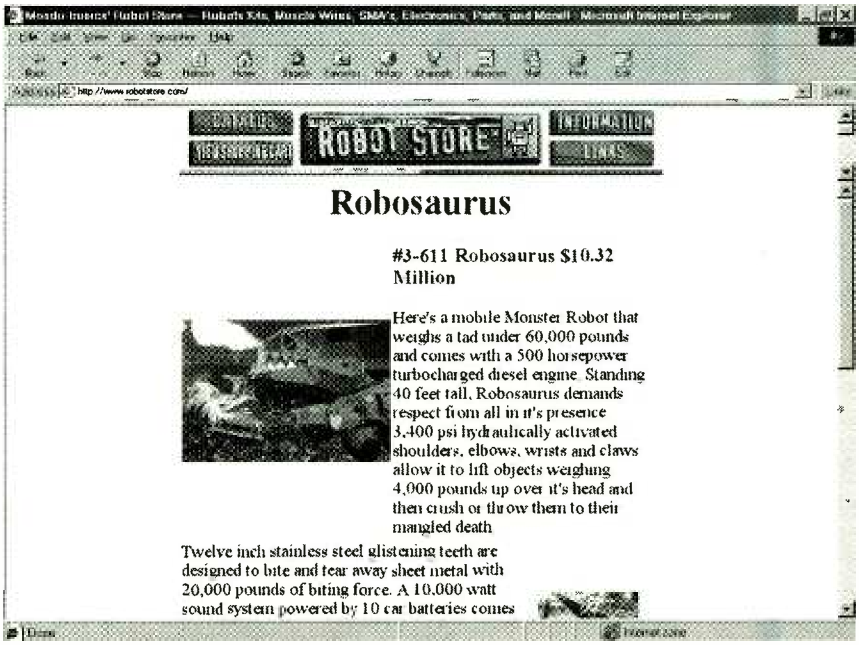
While Asimov's Laws of Robotics don't really address how these machines should interact with each other, you get the feeling that the writer thought that robots should be peaceful creatures. We wonder what he would think of the Annual Robot Wars if he were still alive.

Robot Wars is a death match unlike any other. In a specially designed 30- by 54-foot arena, radio-controlled and autonomous robots face each other (determined by weight class, up to 300 pounds) in one-on-one fights to the "death." Intricate lighting and techno music all add to the drama of the battle.

The robot that makes it to the final elimination match and wins gets a cash prize of $5000. Of course, if your creation loses, it could be costly. While no explosives are permitted, there are blades and saws of all kind used by the robots to rip into each other. You can imagine the irreparable damage that could occur.

The Robot Wars Web site is full of exciting photos from past events and links to descriptions of the types of warriors that have attacked in those matches. It's a great site to visit if you want to get a feel of one of the ultimate competitions that fellow hobbyists are taking part in.

Also, you may want to consider entering one of your own robots into the battle. If you register for the competition after visiting the site, feel free to send us a shot of your warrior. We'd like to take a look.




*For the person who has to have everything, Mondo-tronics' Robot Store sells a not-so-modestly priced, giant robot dinosaur. The site also features plenty of hobbyist projects that cost quite a bit less than $10.32 million.*

## INFORMATION CENTRAL

There's another spot on the Web where you can learn about what kinds of robots your peers are developing (most of them seem to be nonviolent, too). At Robot Information Central there's a great RoboMenu, where you'll find dozens and dozens of photos and descriptions of some really neat amateur, but not amateurish, automatons. Some of these listings are technical enough to give a good clue about how the inventor of each unit got the robot to work.

Information Central is also a terrific place to find direct links to all sorts of competitions, parts and kit suppliers, and even industrial robotics sites. There's even some information of interest to general electronics enthusiasts—for instance, software and FAQs devoted to making printed-circuit boards.

### HOT SITES

**Mondo-tronics' Robot Store**
*www.robotstore.com*

**The Robotics FAQ**
*www.frc.ri.cmu.edu/robotics-faq/*

**Robot Information Central**
*www.robotics.com/robots.html*

**Robot Wars**
*www.robotwars.com*

Another terrific resource to which this site gives you direct links is a list of robot-related Usenet newsgroups. The most notable of these is comp. robotics.misc, where all aspects of the hobby and science are discussed. You can also check out what's being said about artificial intelligence at comp.ai, as well as find out about specific robotics systems from newsgroups dealing with vision, speech, and other interfacing technologies. The great thing about Usenet newsgroups is that they're almost always frequently updated by contributors—join in.

And that's about all for this month. If you're interested in robotics and point-and-click your way through just a couple of the aforementioned sites, you'll end up greatly expanding your knowledge of the still-growing art.

As usual, you can send questions, suggestions, or comments via snail-mail to *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735, or e-mail to netwatch@gernsback.com. ■

# SCANNER SCENE

# Discussing a Discone

MARC SAXON

One of the peculiarities of scanner monitoring is that, if you intend to do it with all the stops pulled out, your scanner needs to inhale a wide swath of frequencies. A quality modern scanner is designed to be able to tune signals from as low as perhaps 29 MHz and up to 1300 MHz or even higher. A range of this magnitude requires certain wideband design compromises that are not needed in a scanner receiving only a limited frequency range, such as a single band. There are no free lunches in electronics, so the cost of wideband reception may include loss of maximum possible image rejection, selectivity, and other functions.

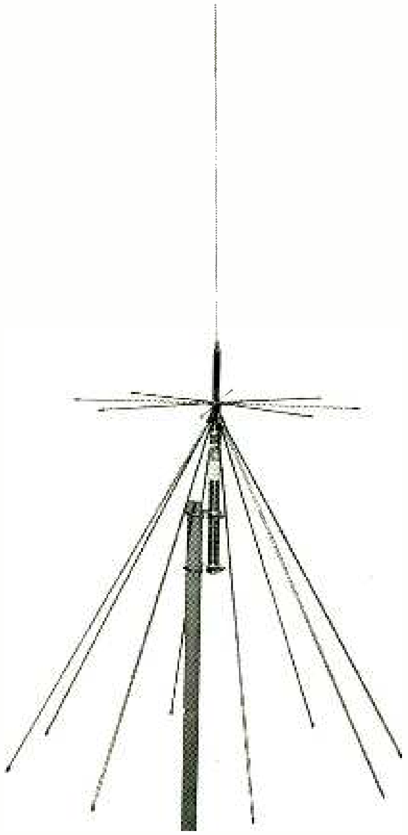
Likewise, antennas designed for single-band operation can be maximized for high gain (signal multiplication). Moreover, they are often intended for directional use.

But, for scanning you will be most interested in monitoring all of the frequency bands within the capabilities of your receiver. And you'll want to be able to pick up signals equally well from all directions around your station.

One excellent approach to doing this is the discone antenna. It is omnidirectional—receiving signals from all directions. The wideband compromise is that it offers no signal gain. If received signal amplification is needed, of course, you can use a 20-dB preamplifier such as the GRE SuperAmplifier. The RadioShack discone *20-243*, for instance, has an overall frequency coverage of 25–1300 MHz, and it can also be used for transmitting in the 50-, 144-, 220-, 440-, 900-, and 1296-MHz Ham bands. The RS 20-243 discone, which costs $59.99, is an easy-to-assemble antenna that weighs very little, stands less than 4 feet tall, and mounts on a standard size mast.

## DOUBLE YOUR PLEASURE

How do you connect two scanners to the same antenna? How do you combine two antennas to feed simultaneously into one scanner? These are commonly asked questions from hobbyists who have discovered that using T plugs and sockets offers disappointing results.



*The RadioShack discone 20-243 shown here has an overall frequency coverage of 25–1300 MHz, and can also transmit in the 50-, 144-, 220-, 440-, 900-, and 1296-MHz Ham bands.*

If you simply use a T connector to run two scanners from the same antenna, you find that the scanners interact with one another and the scanning keeps locking up. This can happen for several reasons, including one scanner picking up birdies (internal oscillator signals) from the other. Another possible problem comes from the tuned input filters, which are automatically tuned to the receiving frequency. If two scanners are connected in parallel, the scanner that is tuned to a UHF channel causes problems to the other scanner tuned to a VHF frequency.

Should you combine two antennas and feed them in parallel to the same scanner through a simple T connector, they "see" one another. That is to say, the signals picked up by one antenna are radiated by the other antenna.

To be sure, you can save space by running two scanners from the same antenna. And you can combine antennas without the need for switching by hand. Try combining an omnidirectional antenna with a beam (yagi), or combining a wideband antenna with one cut for a specific band. I have a discone combined with a MAX-46-CORD SuperSnooper antenna for 46-MHz monitoring.

Some people have attempted to use "TV splitters" for this. This is an inexpensive approach, costing about $5, but one that has produced little joy. Even forgetting the TV-type connectors and the impedance mismatch (they are for 75-ohm systems and a scanner system is 50 ohms), some TV splitters have minimal isolation and offer high signal loss, especially in the UHF spectrum.

You need to have at least 20 dB of isolation between two scanners to avoid interaction. Some TV splitters claim 22-dB isolation, but the best they do is 20 dB (that's well above 100 MHz).

What's actually called for is a signal splitter suited for scanners, specifically designed for 50-ohm communications systems and fitted with BNC connectors. It should be rated to specifically include frequencies at least between 30–1300 MHz. This should be no problem, as commercial models we have seen cover 10–2500 MHz. With such a device, you can readily operate two scanners from one antenna or feed two antennas into a single scanner. Remember "no free lunches," so expect to pay a lot more for such a device than for a TV splitter—I'm thinking in the $100 ballpark. Check communications catalogs.

More "no free lunches": When you connect one antenna to two scanners, the received signals will be shared

*(Continued on page 66)*

# Fujifilm MX-500 Digital Camera

*Forget about film—here's a high-quality megapixel camera at a consumer-friendly price.*

New technologies often take a little time to capture consumer interest, and digital imaging is no exception. While digital cameras have been out for a few years now, high prices and poor quality have kept most shoppers away from these little devices. As attractive as the idea of doing away with developing film was, the resolution of film just wasn't there. As appealing as the idea of snapping a shot and having it ready for use in, say, a small-business Web site or flyer was, realistic prices just weren't there.

Both problems (low resolution and high price) are finally being handled. You can get digital cameras now that, when connected to a photo-quality printer, will produce prints even a pro couldn't distinguish from film. These cost upwards of $20,000, though, and are used for professional work (*e.g.*, magazine cover photography). They do not really represent what uses the average consumer or small-business person has for a digital camera.

Since most people just want to be able to get a reasonably high-quality print into their computer without hassle, such non-professional photographers would do well to pick up the Fujifilm *MX-500*. Whether for the Web, brochures, or digital records of fun vacation spots, the MX-500 will capture all the crispness the average user needs, at a price that's not so hard to like.

**The Tech at the Core.** The lens in the MX-500 is a f3.2 Fujinon with shutter speeds ranging from 1/4 second up to a maximum 1/1000 second. What happens with this gathered light is totally different than the process found in old film types, however.

Digital cameras are based on a charge-coupled device or CCD, 

upon which gathered light falls. This type of device contains numerous sensors that each resolve light as a pixel, or single dot that can be electronically stored and viewed. The CCD in the MX-500 contains 1.5 million of these pixel-resolving sensors (1.5 megapixels). Thanks to its high-quality CCD, the MX-500 can capture images at a terrific 1280 × 1024 resolution, in full 24-bit color (16.7 million colors).

What the camera does with this raw data is also pretty impressive. The digital cameras of yesterday sometimes took 30 seconds to process data before you could take another picture. The MX-500 has circuitry that allows it to compress a captured image to standard JPEG format, enhance its quality with an RGB color filter, and store it to a SmartMedia removable storage card in about five seconds. This means you won't get stuck waiting to take that next shot as an event totally passes you by.

Hold it—SmartMedia? For those who might not have seen them, SmartMedia are thin cards about the size of a large, rectangular postage stamp. On one side they contain highly miniaturized memory, which looks like a gold foil. A SmartMedia reader, such as the one built into the camera, can access the memory for read/write operations. The MX-500 comes with a 4MB card; 8 and 16MB cards are available, should you want to buy extra "film" to have on hand.

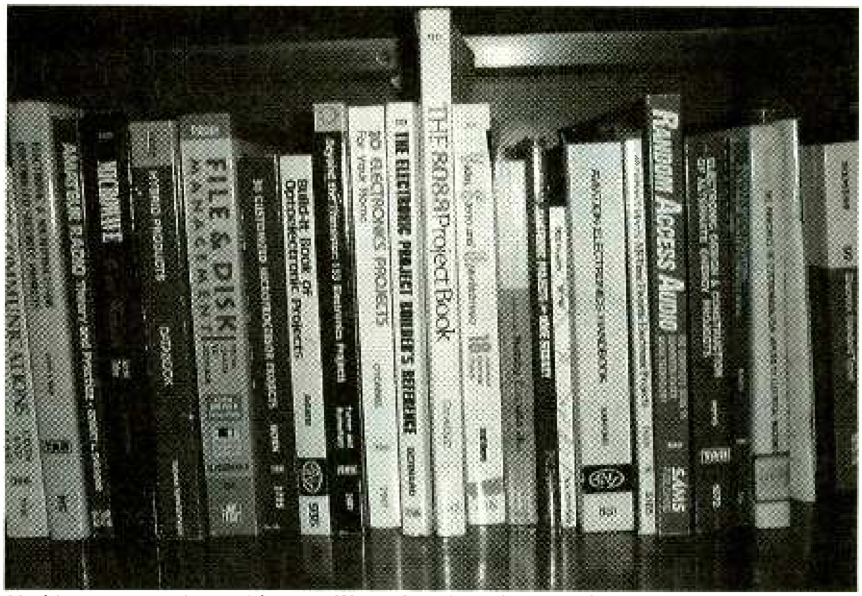
**A High-Quality Snap.** Using the MX-500 for the first time was a real pleasure. The manual is wonderfully complete, yet pleasantly short. With some quick scanning we had the basics down in a few minutes.

Everything you need to get started is in the box. We loaded the four AA batteries, inserted the 4MB SmartMedia card into the camera's side hinged compartment, and slid the spring POWER switch to turn the camera on. A button releases the lens cover (you have to manually pull it closed).

To use the camera, you have to set a dial in the rear, upper-right corner. This lets you choose from Setup, Self-Timer, Manual, Normal, Playback, Erase, Protect, or PC Modes. Setup Mode is a good place to start, as you can choose the flash setting (on, off, auto, or red-eye reduction), quality (normal, basic, or fine), file size (1280 × 1024 or 640 × 480), and sharpness (normal, soft, or hard).

It all sounds a lot more complicated than it really is. What it boils down to is that you have to choose how to manage your camera's memory. At the highest quality, size, and sharpness settings, you'll be able to fit five shots on the included 4MB card. Lowering the quality will help you get 22 basic shots.

You'll take most of your photos in the Normal or Auto Mode, and for space considerations this is the only photo-taking mode we will discuss here. To take a photo you can either use the viewfinder or the 1.8-inch color LCD screen on the back. If you use the latter (a tiny button turns it on or off), you'll be limiting




*Nothing tests resolution like text. We took a shot of a row of book spines from our electronic library, using the MX-500's Fine mode. This image has a 1280 × 1024 resolution, and we had to do no retouching.*

battery life to about 200 shots. Without the LCD, the camera's good for about 500 pictures.

To take a picture, you hold the button down halfway, letting the camera automatically adjust the focus and exposure. After it beeps, you press it fully, letting it take the shot. That's all there is to it. When the orange light in the viewfinder stops blinking and turns green, you're ready to shoot again.

Turn the dial to Playback, wait a second, and your first image will appear onscreen. You can use the four-way cursor-control pad to scroll through the shots you've taken. Don't like one? Turn the dial to ERASE, and hit the EXE button, as instructed onscreen, to delete the image. Protect Mode will ensure you don't delete a "keeper."

**Interfacing with the World.** So what do you do with your photos? First, you can display them on a television or video monitor using the included composite-video cable. Of course, there's not much you can do with photos on that type of screen.

That's why the MX-500 comes with cables that let you transfer the images to either your PC's serial port or a Mac's modem or printer port. Installing the included software will load a TWAIN (technology without an impressive name) driver in your computer that lets you control the camera from your keyboard. The *Picture Shuttle* software then lets you transfer images back and forth.

You have another option when it comes to getting data from the MX-500 to a PC. Available on the market is a SmartMedia Floppy Disk Adapter. This device looks like a metal floppy disk and has a slot in which you can insert a SmartMedia card. Then, you can slide the Adapter into your computer's floppy drive, and (assuming you installed the Adapter's driver software) you'll be able to access the images as if they were on a diskette.

Once on your computer's hard drive, images can be manipulated using the included Adobe *Photo Deluxe 2.0* software. While not as advanced as Adobe *Photoshop*, the program is full-featured enough for most consumer and small-business uses. And that's what we have to say about the entire package: full-featured enough. Digital photography is finally "getting there."

The Fujifilm MX-500 is available for $499 (manufacturer's suggested retail price). The optional SmartMedia Floppy Disk Adapter retails for $99. Contact Fuji Photo Film USA, Inc., 555 Taxter Rd., Elmsford, NY 10523; Tel. 800-800-FUJI; or circle 120 on the Free Information Card for additional details. Visit the Fujifilm Web site at *www.fujifilm.com.* ■

# JVC Digital Camcorder

STEPHEN A. BOOTH

This is the first Mini DV (digital video) camcorder we've tested, but judging by their increasing availability at ever-lower prices it won't be the last. Much of the newfound popularity for the format can be attributed to JVC, whose *GR-DVM5 CyberCam* hits the test bench here.

Against formidable rivals such as Canon, Panasonic, and Sony, JVC has led the charge to lower-priced Mini DV camcorders. When the company's first CyberCam hit the streets in May 1996, it carried a shocking $2500 sticker. Today, the much-improved GR-DVM5 sells for much less, with an MSRP of $1799, and a street price of about $1499. Meanwhile, entry-level JVC CyberCams can be had for under $800.

The latter pricing is likely an attempt by JVC to replace lost sales in the analog Compact VHS (VHS-C) market. That format is virtually dead in Japan, where 80 percent of new camcorders sold are digital. As there's little difference in price there between top-shelf analog Hi8 camcorders and entry-level digital ones, home moviemakers have been opting for the newer technology. Meanwhile, in other world markets, the Sony-championed 8mm and Hi8 formats now outsell VHS-C by about two to one. Reading the tea leaves, JVC made haste to focus its camcorder efforts on Mini DV so as to leapfrog the competition and establish a beachhead in next-generation video.

There is much to like about digital video and, as we found with the GR-DVM5, there is much to learn. Compared with analog video, your creative and technical options are much greater in the digital domain—maybe too great. The GR-DVM5 comes with one whopper of an owner's manual, which you should read diligently if you wish to fully exploit all of the camcorder's functions.

These include the ability to record digital stills that can be printed as snapshots or sent as e-mail through a PC. You also can perform sophisticated editing and other functions on a PC through the CyberCam's digital IEEE 1394 output (sometimes called iLink and FireWire, which are actually Sony and Apple names for the interface, respectively). Owing to such digital-to-digital transmission and manipulation, there's no generational loss as would be the case with analog dubbing. And even if you're copying to VHS, with its 240 lines of horizontal resolution, the digital source makes for one heck of a master. As digital television (DTV) rolls in and PCs take a more prominent role in casual home-video production, digital camcorders such as the GR-DVM5 will make even more sense as the point of origin for the raw footage.


## MINI DV EXPLAINED

You'll find brand-to-brand differences among digital camcorders, but unlike the total incompatibility between analog VHS and 8mm video, the fundamentals of digital operation have been agreed to by all manufacturers who standardized on the Mini DV format. It's called "Mini" to denote the matchbox-size videocassette (about 2 × 2.5 inches). This media has up to 60 minutes of standard-play capacity.

Spec-wise, Mini DV promises horizontal resolution "approaching 500 lines"—practically, though, the "ideal" is 480. Vertical resolution is another matter. It's important to remember that although the recording system is digital bits of zeros and ones, Mini DV's video format is NTSC—meaning the image is vertically scanned in the interlace fashion for TV display, rather than progressively in the manner of PC monitors (and the "Standard Definition" mode of DTV). Fact is, though, some Mini DV camcorders (although not the GR-DVM5) also offer the option of progressive scanning for users who intend to confine their editing and display to the PC world.

Mini DV's audio is digital too, but it comes in two flavors. The default is the CD-like two-channels with 16-bit linear quantization. Although the sampling frequency for recording here is 48 kHz, playback output is a CD-like 44.1 kHz. Mini DV also offers a four-channel option, enabling the main stereo soundtrack to be augmented with narration or background music in a more sophisticated four-track mixdown. Audio fidelity in this mode isn't quite CD level, although it's still digital—12-bit nonlinear quantization sampled at 32 kHz.

Since what gets recorded on tape is bits of data rather than an analog waveform, the Mini DV format also is capable of capturing digital stills on tape—some 5000 of them on a 60-minute cassette. Sure, you could pull a freeze frame from an analog camcorder to display a still or print a snapshot, but it can never be as sharp and rock-steady as a digital frame-grab. As you might suspect, the still output is even better from those Mini DVs that offer progressive scanning, as no interlaced line-structure will be evident in the onscreen or printed output (actually, though, some PC editing programs will interpolate adjacent NTSC scan lines for printout).

## A HANDS-ON LOOK

Ironically, executing the Snapshot mode of JVC's CyberCam was the most difficult operation we encountered in hands-on evaluation. That's the downside of miniaturization—the Snapshot button on this compact 1.25-pound moviemaker is necessarily small and shallow. You might train your left index finger to find it, but in cold weather or when wearing gloves, it's questionable as to whether you'll be able to feel it or receive any tactile response—your only confirmation of successful execution might come through the "Photo" message in the viewfinder. For the record, you can only take still photos when the lens is in the optical mode with maximum 10X magnification. The function isn't operable in the digitally extended zoom modes (up to 100X).

Positives? There are plenty. The slim, lightweight CyberCam fits easily and unobtrusively in the outer or inner pockets of a sports coat, and the polycrystalline silicon active-matrix LCD monitor is a joy to use. The swivel-mounted 2.5-inch display delivers 400 lines of resolution from its 180,000 pixels. Most important though is the brightness derived from the polycrystalline material. Unlike most LCDs used in circumstances of high ambient light (read outdoors and sunny or with high glare conditions), this one doesn't suffer washout. And because it has an active-matrix grid rather than the less expensive passive scan, the monitor is easily readable even at extreme angles of view (such as when you're using it as a waist-level viewfinder or holding the camcorder above your head to shoot over a crowd).

If you've had any experience with camcorders, you know that small and light units are easy for transporting, but difficult to keep steady when recording. JVC's CyberCams are no exception. It takes some work to learn how to shoot steadily from the eye through the eye-level viewfinder (ironically, it's easier to shoot from the hip using the LCD monitor!).

Any erratic camera movement owing to shaky operator hands ought to result in jittery movies. Fortunately, JVC provides Digital Image Stabilization (DIS) to smooth out those jitters. As always, though, the company candidly admits that although the image might remain steady, image quality does deteriorate in the digital-zoom modes. That's because digitized zooms merely enlarge a smaller portion of the optical image, and sharpness is sacrificed because fewer lines of resolution appear on your TV screen. At extreme magnifications, images bear the tell-tale pixelization of the CCD image sensor.

So much for the potential of the Mini DV format and the handling properties of the GR-DVM5. What follows is the tale of the tape in performance testing.

## LAB RESULTS

Here's how the GR-DVM5 fared when examined by the Advanced Product Evaluation Laboratory (APEL), an independent testing facility located in Bethel, Connecticut. When you read APEL's electrical measurements in the accompanying chart, keep the following in mind: Although JVC's CyberCam records images digitally and has an IEEE 1394-compliant digital output, it ships only with analog cables as standard, and that's the output APEL measured. JVC offers an IEEE 1394 cable only as an option, and for good reason. At this writing, there are precious few devices (*e.g.*, digital VCRs) with complementary digital inputs (mostly owing to copyright-protection concerns that have yet to be resolved). So, it makes little economic sense for manufacturers to burden consumers with a costly cable they can't likely use. And, since most people who buy the GR-DVM5 will be transferring images through the analog outputs, that's the performance we thought most meaningful to measure.

The minimum-illumination test rates

### TABLE 1
### PERFORMANCE MEASUREMENTS

The following test results were furnished by the Advanced Product Evaluation Laboratory, an independent testing facility located in Bethel, CT. Measurements were taken in the Standard Play mode, using JVC's DVM30 metal-evaporated formulation Mini DV cassette. Minimum illumination was measured using EIA Standard EIA-639, with the camcorder in automatic exposure mode.

| | |
|---|---|
| **Brand:** | JVC Company of America |
| **Model:** | GR-DVM5 CyberCam |
| **Price:** | $1799 (MSRP) |
| **VIDEO MEASUREMENTS** | |
| Minimum Illumination: | 11.5 lux |
| Resolution (Record/Play Video Out): | 410 lines |
| Camera Resolution: | 410 lines |
| Signal-to-Noise Ratio (Record/Play Video Out) | |
| Chroma AM (100 Hz-500 kHz): | 45.5 dB |
| Luminance (50 kHz, 4.2 MHz, SC Trap): | 44.4 dB |
| Signal-to-Noise Ratio (Camera) | |
| Chroma AM (100 Hz-500 kHz): | 45.8 dB |
| Luminance (50 kHz, 4.2 MHz, SC Trap): | 44.6 dB |
| Color Contamination: | 5.0 IRE |
| White Balance: | 5.0 IRE |
| Streaking/Lag, Image Retention: | Excellent |
| Color Quality (see Fig. 1 vectorscope photo) | |
| Phase Accuracy: | Excellent |
| Chroma Saturation: | Slight Oversaturation |
| **AUDIO MEASUREMENTS** | |
| Frequency Response | |
| 48-kHz Sampling (20 Hz to 20 kHz): | −11.8 dB to −1.3 dB |
| Signal-to-Noise Ratio: | 48.5 dB |
| Maximum Output (built-in stereo mic): | 0.4 volts |
| Input Sensitivity (external mic): | 2.7 millivolts |
| **ADDITIONAL DATA** | |
| Image Sensor: | 0.25-inch CCD |
| Minimum Focus Distance | |
| Normal: | 1.5 inches |
| Macro: | N/A |
| Power Requirements: | 10.5 watts |
| Battery: | Li-Ion (7.2V, 7200 mAh) |
| Weight (with battery and tape): | 1.25 pounds |
| Dimensions (HWD, inches): | 5 $\frac{5}{16}$ × 1 $\frac{7}{8}$ × 3 $\frac{1}{4}$ |

the camcorder's ability to record in low light and still capture a viewable image. It's measured in lux—the lower the number, the better. If the CyberCam's score of 11.5 lux seems unimpressive compared with others you've seen in the past, remember that APEL measures by the EIA-639 method. It's a new industry-standard that's designed to create a level playing field for all camcorders, compared with the ILS (If-Lightning-Strikes) snakepit of proprietary measurements that companies used in the past to put their goods in the best-possible light. APEL's honest-weight measurement here indicates that the GR-DVM5 handles low-light situations quite well.

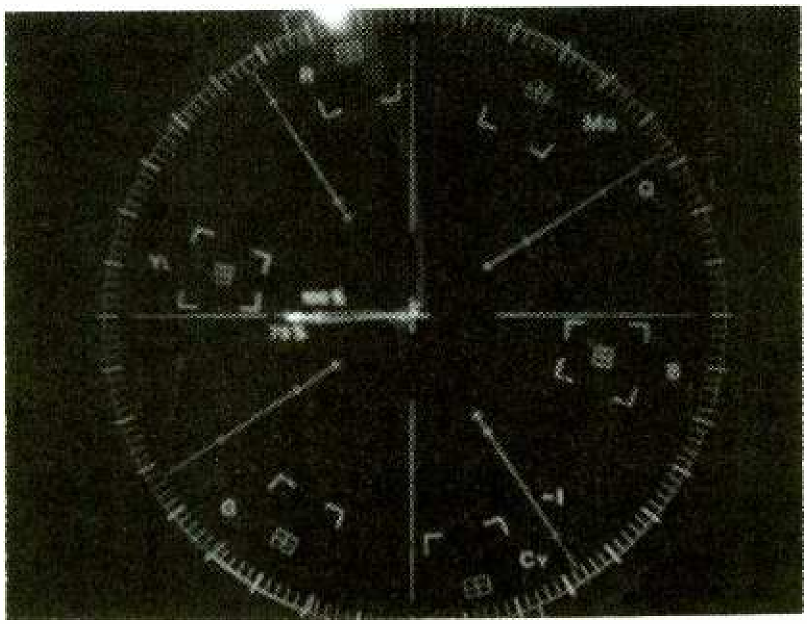


*Fig. 1. This vectorscope photo shows that phase accuracy is right on the mark. Although chroma saturation appears a bit oversaturated, showing up just high of the crosshairs, you could easily adjust it with the color controls of your TV or monitor.*

Resolution or sharpness is indicated by the number of image-making lines the camcorder records in picket-fence fashion across your TV screen. From its analog record/play outputs, the CyberCam resolved 410 lines—better than we've measured in high-band analog camcorders (S-VHS or Hi8, whose theoretical ceiling is 420 lines). By comparison, top resolution for standard VHS is 240 lines, and a live TV broadcast weighs in at 330. Theoretically, Mini DV is capable of nearly 500 lines from a digital output. Incidentally, the camera resolution is also 410 lines from the analog out. Camera performance is increasingly important as people input images directly to a PC, rather than recording to tape.

The signal-to-noise ratio from the GR-DVM5 averages a visible 3 dB better than the best analog camcorders we've seen; which is to say it's quite good. It's measured under optimal lighting conditions and reveals the amount of usable signal—color (chroma AM) and luminance (brightness—black-and-white)—above the threshold of electrical noise. By a rule-of-thumb, noise increases with resolution (of which the GR-DVM5 has plenty), as does color contamination. When testing for the latter, we found the presence of unwanted color specks in a black-and-white test pattern. The CyberCam's score isn't a perfect zero, but it isn't terrible. The distortion probably won't be visible in movies, but might be in a video still snapshot made in close-up mode.

Our white balance test reveals a camcorder's ability to adjust to different temperatures of light (say, sunshine or indoor fluorescence and incandescence) to reproduce pure whites and, therefore, correctly balanced colors. JVC's auto white-balance circuitry isn't perfect, but it can be manually adjusted if you're a perfectionist.

Color quality was determined by testing phase accuracy and chroma saturation; the color red is the test case because it's the most difficult for video to handle correctly. Phase accuracy tests look for deviation from true red, toward magenta or yellow. Chroma saturation testing gauges depth, or intensity of hue.

As the bouncing ball in APEL's vectorscope photo shows (see Fig. 1), phase accuracy is right on the mark. And although chroma saturation appears to be just high of the crosshairs—and therefore a bit oversaturated—you could always adjust it as you wish with the color controls of your TV or monitor.

The tests for streaking/lag and image retention look for flares or tails of light and color that trail behind the highlights of a moving subject. Look for this during action sports on TV, when light reflects off helmets or other shiny gear. Since the advent of CCD image pickups, it's been virtually banished from home camcorders, and is nonexistent here.

## CONCLUSION

Should you buy the GR-DVM5 or, for that matter, any other Mini DV camcorder? Certainly the price is right in terms of performance. And, the movies you make will be stored in digital format, ready for display on the digital TVs just beginning to arrive.

The camera has some great I/O jacks, too, ensuring you can do diverse things with the output. In addition to the IEEE 1394 input and output, there's an analog A/V output and S-Video output (on the charger station). You'll also like the infrared remote control.

What probably should determine your choice in the short term is the extent to which you think you'll use a digital camcorder for digital purposes, such as with a PC. Very capable Hi8 analog camcorders (there are no S-VHS camcorders) already are available at reasonable prices, so it might not make sense to buy digital capability that you won't use. But if the price spread between analog and digital isn't much, you might as well buy the digital capability for the future. Meanwhile, you'll be recording some very high-quality masters for analog display and dubbing.

For more information on the JVC GR-DVM5 CyberCam, contact JVC Company of America, 1700 Valley Rd., Wayne, NJ 07470; Tel. 800-252-5722; Web: *www.jvc.com*; or circle 50 on the Free Information Card. ■

# DX LISTENING

## International Smorgasbord

DON JENSEN

One of the interesting developments in international broadcasting in recent years is the "shortwave station without a shortwave station." By that I mean a broadcasting organization that targets overseas listeners without owning any SW transmitters of its own. Two examples are Ireland and Denmark, which operate modest SW broadcasting schedules from somebody else's transmitting facilities located outside their own national territory.

Beginning some 70 years ago, all SW broadcasters operated their own shortwave transmitters, doing their best to pump out strong, clear signals to distant listeners. As frequencies filled up with more and more stations, it took more and more powerful transmitters to outshout the pack. And that cost money!

As things evolved, by the 1960s, countries were finding it more economical and efficient to bolster their own SW signals by adding overseas relay transmitters located closer to intended target areas. And in time, rather than building their own relays, these broadcasters started swapping or leasing air time from other SW stations.

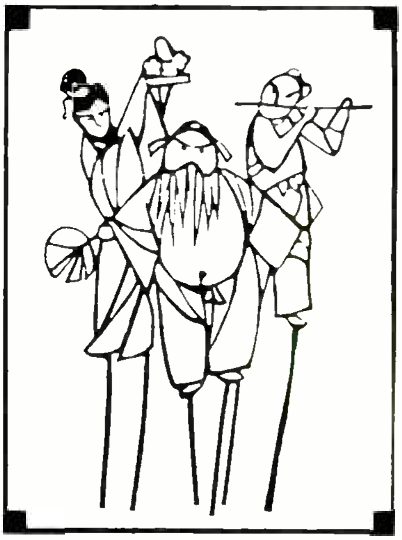
Today, world broadcasters from Spain to China augment programming from transmitters on their own soil with relays of the same broadcasts from SW relay facilities abroad.

But a few smaller countries have gone one step further, airing all their SW programs from other stations outside their own territory. They own no shortwave transmitters at all; no programs are actually aired from their own national territory. While sacrificing some control, they find it more cost effective to simply buy shortwave air-time somewhere else, where and when they need it.

(CREDITS: Bruce Barker, PA; John Boone, TX; David Clark, ONT; Peter Costello, NJ; Betsy Robinson, TN; David Ross, ONT; John Sgrulletta, NY; World DX Club, c/o Richard D'Angelo, 22 Burkey Drive, Wyomissing, PA 19610; North American SW Association, 45 Wildflower Road, Levittown, PA 19057).

Both Ireland and Denmark once had their own shortwave stations. The Irish outlet, a very low powered station at Athlone, ceased operations at least 40 years ago, a victim of equipment obsolescence. Radio Denmark's 50-kilowatt SW station once ranked right up there among the major international stations, but eventually its aging transmitter also could no longer keep up with the "big boys" and was phased out.

After decades with no shortwave broadcasting presence at all, Ireland's state broadcaster, Radio Telefis Eireann (RTE), in recent years, has taken more of an interest in reaching Irish expatriates. RTE has done this in several ways, including a satellite service and a presence on the Web (*www.rte.ie*). But the Irish broadcaster also buys broadcasting time on U.S. shortwave station WWCR, near Nashville, TN, and other for-hire facilities on Ascension Island in the South Atlantic and in Singapore in the Far East.



*These stylized characters, illustrating a Radio Taiwan International program schedule, suggest that good Chinese food and music go together, even on stilts!*

As of this writing, RTE's evening English language newscast is rebroadcast on shortwave 1930 UTC, Mondays through Fridays; and 2000 UTC, Saturday and Sundays; over WWCR's Stateside transmitter on 12,160 kHz. At 1000 UTC Mondays through Fridays, and 1100 UTC Saturdays and Sundays, RTE's programming, also via WWCR, goes out on 5,070 kHz. Reception reports may be sent to Radio Telefis Eireann, P.O. Box 4950, Dublin, 1, Ireland.

A few years ago, rather than invest in its own expensive high-powered SW equipment, Radio Denmark entered into an agreement with its Scandinavian neighbor, Radio Norway International, to share powerful new Norwegian transmitters. The 500-kilowatt transmitters are located at Kvitsoy, not far from Stavanger; and at Sveio, near Haugesund; both along the Norwegian western coast.

Radio Norway International uses those facilities for the first half of each hour. Radio Denmark's Danish language programming, with occasional English identifications, is heard from 30 to 55 minutes past the hour. Radio Denmark programs are aired to North America at 0030 UTC on 11,735 and 13,805 kHz; at 0130 UTC on 11,990 and 13,805 kHz; at 0230 UTC on 11,990 kHz; at 0330 UTC on 11,635 kHz; and at 0430 UTC on 7,485, 9,945, and 11,635 kHz.

Other times for North American services are at 1630 UTC on 13,800, 15,340, and 18,950 kHz; at 1730 UTC on 13,830, 15,220, and 15,705 kHz; at 1830 UTC on 7,485, 15,705, and 15,735 kHz; and at 2330 UTC on 11,640, 11,735, and 13,805 kHz. You can send reception reports to Radio Denmark, Rosenorns Alle 22, DK-1999, Frederiksberg C., Denmark.

### DO-WOK-A-DO

Like Chinese food? If you're like me, a wannabe chef, you may even try your hand in the kitchen now and again. If so, I guarantee you'll love a tiny gem of a program that I discovered, aired weekly on China Radio International (CRI) from Beijing.

It's called, simply enough, *The Cooking Show*, and is heard about 0325 UTC, and again an hour later, on Sundays (remember because of the UTC time differential, this is Saturday evening in the U.S. and Canada). I tune the brief—only five or six minutes—program during the latter time slot on 9,690 kHz, but you may find it on other CRI frequencies as well.

Host and resident chef is Stuart, a pleasant and witty fellow, who introduces us to culinary specialties from many regions of China. During one of his recent mini-cooking lessons, he observed that Chinese cooks often prepare purely vegetarian fare that tastes like meat or even fish. Stuart then "woks" us through the preparation of Stir Fried Vegetarian Crab, a non-seafood "taste-alike" made from potatoes, carrots, black mushrooms, eggs and bamboo shoots, spiced up with ginger and coriander.

But Stuart does more than read a recipe. He cooks before our very ears. We hear him mashing the boiled potatoes and stirring the ingredients. We hear him chop the green onions with his razor sharp cleaver. The peanut oil sizzles loudly in the pan. You almost smell the delicious aroma through your receiver's speaker!

I suggest you tape *The Cooking Show*, so you can play it back later to carefully copy down the ingredient list, although, as Chef Stuart explains, you can write to CRI for a printed copy of the recipe.

It's a great little program!

## AND MUSIC, TOO

And if you'd enjoy a little traditional Chinese music while you dine on Stir Fried Vegetarian Crab or one of Stuart's other Oriental delicacies, let me pass along a couple of suggestions from John Figliozzi's excellent "Easy Listening" column in *The Journal*, the monthly bulletin of the North American SW Association (NASWA).

Just a few minutes after *The Cooking Show* ends, China Radio International serves up an excellent programming segment called *Music from China*. More imaginatively named is *Jade Bells and Bamboo Pipes*, a half hour musical program from Taiwan's Radio Taipei International, Mondays at 0215 UTC, and again, Tuesdays at 0315 UTC, relayed by WYFR's Florida transmitters on 5,950 and 9,680 kHz.

If you want more program tips from John and his column contributors, you may want to join NASWA and receive *The Journal* monthly. For more information, send a request and a self-addressed stamped envelope to NASWA at the mailing address listed in this month's credits.

## RUSSIAN UPDATER

For those of us who recall vividly the shortwave omnipresence of Radio Moscow not so many years ago, it's little short of amazing to note the changes that have occurred to its post-Cold War successor, the Voice of Russia. While most government radio organizations have suffered budget cuts in recent years, the dismal state of the Russian economy has meant that the Voice of Russia has fared much worse than most.

At its zenith in the mid-1970s, Radio Moscow aired over 200 program hours of broadcasts every day in 65 languages and dialects. In 1988, Radio Moscow had a spectrum occupancy—the number of frequencies multiplied by hours used—of 28,981 hours. That was one and a half times the frequency usage of runner-up United States and 17 times that of Egypt's Radio Cairo.

Currently, the Voice of Russia has cut back to 77 hours of programming daily in just 32 languages. This puts Russia in 15th place among international broadcasters, behind even Egypt! For all that—and despite the layoff of 30 percent of its staff—the Voice of Russia still employs about 1000 people. And it still utilizes 80 shortwave transmitters, 50 of them on Russian territory, the rest in neighboring former Soviet Republics.

The Russian broadcaster changes frequencies too often to include a meaningful list here, but an up-to-date schedule can be found on its Web site: *www.vor.ru.*

### ABBREVIATIONS

**kHz** = kiloHertz, unit of frequency measurement, equals 1000 cycles per second; formerly referred to as kilocycles per second, or kc/s.

**SW** = shortwave.

**SWL** = shortwave listener.

**UTC** = Universal Coordinated Time, a standard used by most international shortwave stations; equal to the military's Zulu or Z-Time. If you live in the Eastern Time zone, add 5 hours in the winter, or 4 hours in summer, to get UTC. In the Central, Mountain and Pacific Time zones, add 6, 7, or 8 hours, respectively (add 5, 6, or 7 hours, respectively, during the summer daylight savings months.)

## DOWN THE DIAL

Looking for some interesting stations to tune? Try these:

**ABKHAZIA**—9,490 kHz, Republic of Abkhazia Radio is the SW voice of one of the regions of the former Soviet Union that has declared its independence from Russia. Its non-English programming has been noted here around 0330 UTC.

**ALASKA**—9,615 kHz, KNLS, at Anchor Point, Alaska, broadcasts mostly in Russian to listeners across the Pole. But look for some English language programming and music after 0800 UTC.

**AUSTRALIA**—21,725 kHz, Radio Australia has English at 0435 UTC and later, including news features, program notes and commentary.

**HUNGARY**—9,840 kHz, Radio Budapest's English language service is logged here and on parallel frequency, 11,910 kHz, about 0230 UTC.

**KENYA**—4,915 kHz, Kenya Broadcasting Corp., signs on just before 0300 UTC with the Kenyan national anthem, identification, and a talk, operating in parallel with 4,935 kHz.

**MEXICO**—4,800 kHz, XERTA, Radio Mexico, noted in the morning around 1000 UTC, and also about 0245 UTC in the evening with Latin American ballads and Spanish identifications.

**PARAGUAY**—9,735 kHz, Radio Nacional is heard here around 0130 UTC with romantic ballads, Spanish-language news, and a talk show.

**SEYCHELLES**—6,005 kHz, British Broadcasting Corp. airs English programming directed to Africa from this Indian Ocean island nation until sign off at 2200 UTC.

**TAHITI**—15,170 kHz, RFO Polynesie Francaise, back on the air after an absence, is noted with French and Tahitian language programming around 0300 UTC. Interference picks up after 0400 UTC. ■

# GIZMO®

## Bundled Up

Thinking about taking the MiniDisc plunge? Sony makes it easy with the *MD Bundle 5*, a one-box way to start recording digital music mixes at home and to listen to them on the road. The MD Bundle 5 packages a MiniDisc home-recording deck, a portable MD player, and two 60-minute recordable MiniDiscs, for a suggested list price of $350.

The *MDS-JE320* home-recording deck offers Wide Bit Stream technology said to accurately reproduce soft, low-level music and a 20-bit analog-to-digital converter for superior sound recording. The portable *MZ-E40* MD player weighs in at just 10.6 ounces (including headphones and batteries) and is small enough to fit in a pocket. It can play for up to four hours on two "AA" batteries. Its 10-second shock-resistant memory makes it virtually skip-proof.

## Memo Master

Sharp's pocket-sized *Memo Master Model EL-6690B* ($29.95) electronic organizer offers PC Link capability and enough memory to hold more than 1000 names, numbers, and addresses. With the optional PC Link software, you can easily connect it to a PC and back up and restore data by transferring it from the Memo Master to the computer or to one of Sharp's more advanced personal digital assistants, such as the Wizard or Zaurus. "Some consumers are still a little nervous about storing

information electronically," noted Glen Gillen, product marketing manager of Sharp's Mobile and Home Office Equipment Division. "We have helped ease this concern by offering a feature that allows information to be stored in two completely separate locations."

The Memo Master provides three separate telephone directories and a bookmark function for recalling frequently used phone numbers. It offers schedule, memo, search, calculator, clock, and alarm functions as well as a "secret" function that lets you safely store confidential information. A timer feature uses an audible alarm to remind you to retry a busy phone number or complete a task. The organizer has a QWERTY keyboard with separate numeric keys and a backlit LCD screen.

## Out of the Kitchen

TV/VCR combo sets are quite convenient. With no wires to connect, they're truly plug-and-play devices. They don't take up much space and are easy to carry from room to room. Originally introduced in small-screen sizes, they quickly found their niche in kitchens and kids' rooms.

Panasonic's *PV-M2768 TV/VCR* ($699.99) is ready to move into the family room or master bedroom. With its 27-inch screen and four-head, hi-fi stereo VCR, it can do justice to most TV and videotape viewing. Its PanaBlack Picture tube is said to provide improved contrast over conventional tubes. The built-in Spatializer Audio Processor provides viewers with spacious, 3D sound from the television's two speakers for a multichannel effect without any additional equipment.

The PV-M2768 also has a built-in FM radio that can serve as a clock radio. It offers Auto Clock Setting, which uses the Extended Data Service (EDS) signal carried by most PBS stations to automatically set the time, even adjusting for Daylight Savings Time.

## Getting the Big Picture

Conventional TV sets display only 88% of the image that is broadcast by TV stations and is available from videotapes and DVDs, putting the rest into the "overscan" area of the picture. Samsung's *Vision Plus* direct-view televisions are equipped with wider picture tubes that allow you to see up to 94% of the original video image. The Vision Plus line consists of three 28-inch models, all of which come with S-video input, MTS stereo with dbx noise reduction, and universal remote control. The flagship model *TXF2899* ($799), pictured here, includes two-tuner picture-in-picture, an Ultra Flat screen with INVAR Shadow Mask, and digital stereo surround sound. A three-way

# GIZMO®

"super horn" speaker system provides 25 watts of total sound output.

## Satellite Control

The SoleControl *SC-545* ($35), a five-device remote control with satellite-control capability, is compatible with virtually all DSS mini-dish brands and models. Its four-way cursor control matches that of remotes supplied with mini-dish satellite systems, simplifying the transition to a universal remote. It also facilitates navigation of satellite menus and allows users to operate picture-in-picture functions.

In addition to controlling DSS systems, the SC-545's 32-kilobyte memory includes preset codes for some 6000 other consumer-electronics components. A 25-minute memory backup gives you plenty of time to replace the unit's batteries.


The SC-545 is ergonomically designed and easy to use. Buttons for related functions are color-coded and clustered together, making the keypad readily understandable at a glance. Keys for selecting satellite, TV, and VCR components are lighted, as is the AUXILIARY key, which can be used to select a second satellite, TV, VCR, cable box, or a DVD player.

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## Priced-Right Digital Camera

Hewlett-Packard's *HP Photo-Smart C30* digital camera is the first one-megapixel camera with digital zoom available for less than $400. The camera also provides improved image quality thanks to a built-in primary color (RGB) filter for the CCD imager, and HP's image-processing enhancements. The RGB filter is said to reduce the chromatic noise level and capture images that are sharper and more


pleasing to the eye. The color sensor also enhances image sharpness and color fidelity. According to the company, the TWAIN-compatible camera, when used with the HP PhotoSmart photo printer and Photo-Smart photographic papers, allows users to produce digital 3.5 × 5-inch snapshots that look, feel, and last like conventional silver-halide photos.

The C30's 2X digital zoom lets users minimize file size and boost image size by cropping out unwanted portions of a photo. Users can take shots that are instantly ready to e-mail to friends. The built-in digital zoom makes it unnecessary for users to lug around heavy, breakable lenses.

A color LCD on the camera's rear panel allows users to preview photos they want to take, review and select the photos they want to upload to their PC, or delete unwanted photos on the spot to free up memory. The included 4MB removable CompactFlash memory card acts like reusable digital film. The PhotoSmart C30 works with all standard CompactFlash cards.

HP photo-finishing software is included. The software automatically downloads photos whenever the camera is connected to a PC, features index-page printing, and provides exclusive page-layout capabilities that allow the efficient use of paper. An integrated video connection makes it easy to view photos on a TV.

## Robo-LEGO

The best toys are not those that make the most noise, come in the fanciest packaging, require the most batteries, have the most frequent commercials, or cost the most. Those might be the ones kids beg for (it's hard to avoid or resist those Toys R Us commercials)—but, for all their flashy appeal, they're usually the first to find their way to the back of the closet. The toys that have true longevity—not only holding the attention of individual children but enthralling generations of kids—are those that stir a child's imagination and creativity. Building blocks, Lincoln Logs, and Tinker Toys come to mind, and, perhaps topping the list, LEGOs.

You might have played with LEGOs when you were a kid, especially if you're a Baby Boomer or younger. The classic plastic bricks—which can be snapped together in virtually limitless ways to form buildings, animals, entire cities, planes, trains, and automobiles—have been around since the 1950s.

The founder of The Lego Group created the name "LEGO" from a contraction of two Danish words meaning "play well." (Coincidentally, "LEGO" means "I put together" in Latin.) The LEGO System was designed from the start to appeal to children of all ages, to provide hours of quiet play all year, and to encourage imagination and creativity.

Over the past few decades, besides the familiar small, brightly colored, plastic LEGO bricks, the company has introduced oversized LEGO Systems for babies as young as three months old, theme playsets for toddlers and school-age children, and LEGO Technic systems that use gears and pulleys and can be motorized. And now LEGO has entered the computer age, with the *LEGO MindStorms Robotic Invention System* ($199), a building set with a brain. That "brain" is the RCX, a microcomputer that can be programmed using a home PC. The RCX accepts inputs from sensors, processes the data, and uses it to instruct various motors to turn on and off.

The MindStorms Robotics Invention System, which was created in close cooperation with the Massachusetts Institute of Technology, includes more than 700 LEGO pieces, the RCX, an infrared transmitter, light and touch sensors, motors, gears, wheels, the "Constructopedia" building guide, and software. The general idea is to build a robot using the LEGO pieces, write a program using RCX code, download the program to the RCX via the infrared transmitter, and then sit back and watch your robot do its stuff. And they call this playing!

The RCX itself is about the size of a pocket transistor radio. It has three sensor inputs and three motor outputs and a display to let you know which program is running. It runs on six "AA" alkaline batteries (not included). The little "tubes" protruding from the yellow top of the RCX and molded circles on the gray bottom allow standard LEGO bricks to be snapped onto the unit, so that the RCX actually becomes part of the robot's body, as well as its brain.

MindStorms is aimed at children aged 12 and older, but computer-savvy 9- or 10-year-olds should be able to get a handle on the system even without parental help. That's because the program walks you through the robot-building process at your own pace with a guided tour and personalized training.


The tour is a two-minute introduction to the product that familiarizes users with key MindStorms ideas, processes, and terminology. It is followed by a two-stage setup process and guided training to create a simple robot. The set-up process itself describes the RCX and how it works, from installing the batteries to adding sensors and running the unit's built-in programs. As you successfully complete each stage of the training, you're rewarded with praise ("So far, you're brilliant!").

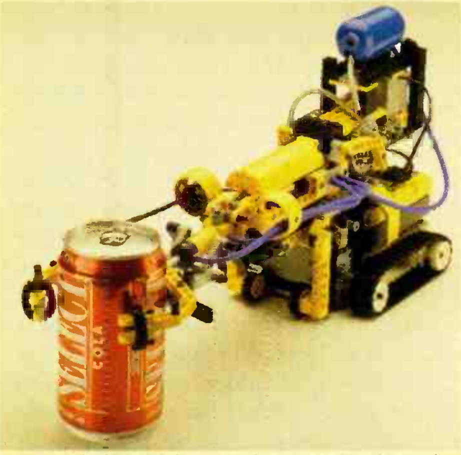
VCR-like buttons (PLAY, STOP, FAST FORWARD, REWIND) allow you to proceed at your own pace and to repeat any material you didn't fully understand. If you need extra time (for finding parts and pieces, *etc.*), you needn't worry about falling behind. If you pause for an extended period, the program goes into a screensaver mode, complete with cool, realistic thunderstorm sound effects that had fooled us the first time we heard them (on a rainy day, no less).

Next, you're talked through the connection of the infrared transmitter to the PC's communication port and the subsequent downloading of the system's firmware to the RCX. The program will recognize if you've connected it correctly; if you haven't, there's an extensive troubleshooting section to help you fix the problem.

The next stop is the Training Center where you learn about RCX code, an easy programming environment that uses graphics to build a program. To program the RCX to carry out an action, you click, grab, and link graphical blocks on the screen, stacking them like pieces in a puzzle to create a program. The first training classes guide you through creating a program, downloading it to the RCX, and saving it in the Program Vault.

As you progress through various Training Missions, building upon prior lessons, you eventually find yourself building and programming robots that really do act on your command. Although the on-screen training is thorough and encouraging, mastering even the basics takes time, patience, and concentration. All that hard work (er, play) has a big payoff, however—the satisfaction of learning and creating something new.

It was a lot of fun to build our first MindStorms robot, following the helpful tutorial's step-by-step directions. However, we should have read the "helpful hints" before setting the little guy loose. Then we'd have



*LEGO MindStorms lets you design and build a robot and then program it to perform simple tasks.*


*LEGO MindStorms combines the power of a computer with the popularity of LEGO building blocks to create programmable robots.*

known just how fast he moves and avoided the first fall off the desk! Luckily, LEGOs are built to take a lickin'. We just put him right back together again—for a while at least.

The MindStorms "Constructopedia" includes three types of robot challenges, which are defined as "intriguing invitations to create mechanical programmable robots and other exciting devices all capable of performing one or another specific tasks." According to the Constructopedia, "The challenges are open-ended and can be met in various ways, but each task is clearly described by measurable or observable outcomes."

Robo, Pathfinder, and Acrobat are the three main types of robots in the Robotics Invention System. The simplest, Robo 1 and Robo 2, each require one motor and move in one specific pattern. The Pathfinders use two motors and turn right and left, slowly or quickly. The Acrobots, which also require two motors, move quickly and perform cool moves such as flips and wheelies.

MindStorms is truly interactive on many levels. You and your computer and the LEGO building pieces interact to create a robotic device that responds to its environment while following your commands.

Once you've mastered the basics, your imagination is the only limit. Use pieces from other LEGO sets. Add gears, wheels, and "arms" to your creation. For more ideas, contact other MindStorms users on the Internet (*www.legomindstorms.com*). You can create your own home page where you can upload programs and display your creations, chat with other users, ask questions of LEGO experts, learn from online tutorials, and discover new challenges.

There are also three "challenge" kits that are sold separately. *RoboSports* is used to make robots that play games with balls or pucks: Dunkobots, Puckobots, and Grabobots—each with four levels. *Extreme Creatures* lets you create twelve different robots that resemble living things in three categories, called Helptiles, Mutimals, and Big Bugs. *Exploration Mars* lets you "explore" the red planet remotely via tele-operated landers and rovers. You can design planet surfaces and have your rovers operate on the surfaces using images from a camera.

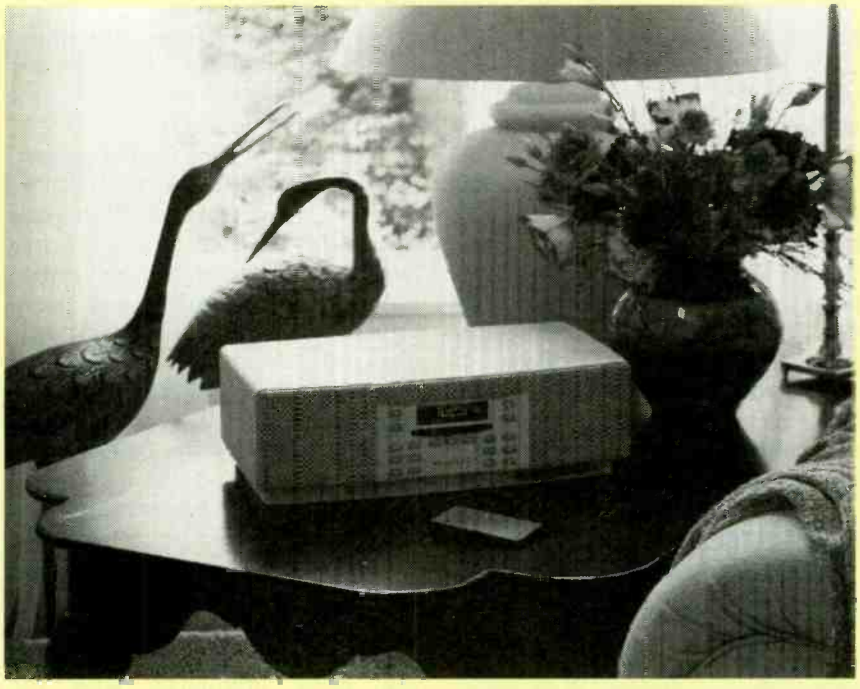
MindStorms, even without any additional challenges, is good for hours of intense, educational play. It presents plenty of opportunities for cooperation among siblings, especially if there's someone who's good at building things and someone else with computer skills. There's a good chance that parents will get drawn into the fun as well—in fact, one of the biggest "challenges" MindStorms presents to parents might be surrendering the mouse to their kids!

## Radio Days

It often seems that everything in our culture suffers from overkill. It's not enough for a TV to deliver video; today's sets must offer stereo and surround sound. A dozen or so channels won't do; we need cable or satellite systems capable of providing hundreds. All those extras can be nice, but mostly they're just not necessary. We don't need surround sound to watch the evening news, and we certainly don't need dozens of brain-draining programs beamed into our homes simultaneously, 24 hours a day, seven days a week (we don't even have the time to scroll through that huge onscreen guide!). All those bells and whistles jack up prices and make everything more complicated to use.

For instance, when was the last time you heard a stand-alone radio that sounded good and performed well? Not a high-priced component in a fancy stereo system, but a simple, easy-to-use, high-quality radio. We've found one: the *Model 88* stereo FM/AM table radio ($199.99) from Cambridge SoundWorks.

The Model 88 was conceived and designed by company co-founder Henry Kloss, whom you might remember as the creator of the renowned KLH and Advent radios of the 1960s and 1970s. In his own words, "The Model 88 is the culmination of my 45-year history of bringing music into people's homes in ways that both suit their lifestyles and provide truly long-term listening satisfaction." The Kloss reputation, not to mention the just-under-$200 price tag, was enough to pique our curiosity.



The Model 88, a plain, beige, shoebox-sized device, won't impress you with flashy good looks. It measures 14 inches wide by 4-¾ inches high by 8 inches deep. The top is flat and has no vents, making this table radio ideal for stacking desktop clutter on top without fear of overheating. Besides that advantage, the design offers the option of mounting the radio under a counter or even in the wall. The cooling vents are integrated into the front panel, which actually is an acoustically transparent metal grille.

The front-panel controls are simple. There's an LCD display flanked by VOLUME UP/DOWN buttons on the left and TUNING UP/DOWN buttons on the right. There are six station preset buttons (used to store six AM and six FM stations), four source buttons (FM, AM, CD, AUX); ON and OFF buttons; and ST, WIDE, and MN buttons used to select stereo, "wide," or mono listening mode. Only one button has more than one function; holding down the OFF button engages the sleep mode. The same controls are found on the credit-card-sized remote control.

As you might suspect from the paucity of buttons, the Model 88 is extremely easy to use. You don't need even the amount of explanation found on the one-page "manual."

The rear panel offers a jack for a 12-volt DC power supply, an "F" connector to allow hookup of a good FM antenna, RCA jacks for CD input, and a stereo mini-jack for the auxiliary input. There's also a rear-panel subwoofer control that allows you to set the level to your liking once and then forget it.

That built-in powered subwoofer accounts for two-thirds of the Model 88's inner workings. Housed in a separate, precisely designed subenclosure, the bass-reflex subwoofer frees the two main speakers to deliver sonically accurate mid- and high-frequency sound. With three individually tailored amplifier channels powering the two speakers and the subwoofer, the radio fills even a large room with distortion-free, natural sound. The Model 88 might not be much to look at, but it sure sounds great.

Of course, for a radio to sound good to your ears, it must be able to pull in the stations you want to hear. Instead of the usual off-the-shelf tuner IC, the Model 88 uses a unique, discrete-component FM tuner with high-Q coils and JFET mixer and RF stages. The Type F antenna jack allows the connection of a serious FM antenna.

We're part of that dwindling minority who really enjoy radio, but we lean toward the quirky, individual programming found on non-commercial and college stations. We're both blessed and cursed living in the New York metro region—blessed with scores of regional radio stations and cursed with high-powered superstations that block reception of smaller, more interesting, lower powered stations. A particular favorite, Fordham University's WFUV, broadcasts from up in the Bronx, and we often have trouble receiving it on the south shore of Long Island. The Model 88 did an admirable job of pulling it in, using only the antenna built into the power cord.

Selecting mono mode helps reduce background noise on distant FM stations. The other listening mode—"wide"—is said to "make some stereo programs expand beyond the width of the radio." Using the AUX input with a CD player, we found the wide mode did dramatically widen the soundstage. With most FM programming, the mono blend circuitry, while reducing FM noise, lessened the effectiveness of the mode.

AM listeners will be happy, but not ecstatic, with the Model 88's performance. Special circuitry rejects noise and weak signals, making the AM band very quiet—unsettlingly quiet for some—and making the reception of the weakest signals difficult.

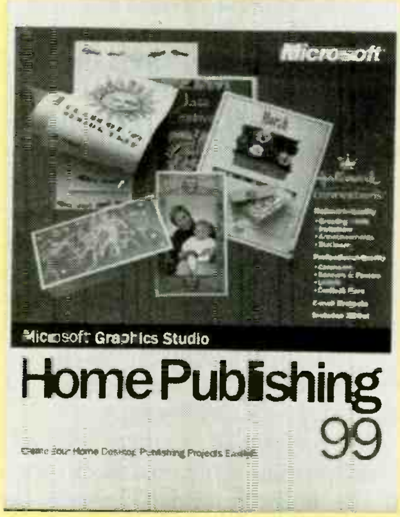
We thought it strange that the Model 88 didn't contain a clock. After all, its tabletop design appears to make it an ideal candidate for a bedside radio. Not so, according to Kloss. The radio is intended to be placed across the room from the listener, and that's where it sounds best.

Cambridge SoundWorks plans to market an alarm clock/remote control as an optional accessory for the Model 88. Priced between $30 and $40, it will turn the radio on at a user-selected time via an infrared transmitter.

Despite its nondescript appearance and small price tag, the Cambridge SoundWorks Model 88 produces accurate, natural, high-quality audio. It's as easy to use as it is delightful to hear. This is a radio that does just what it's supposed to do and does it well.

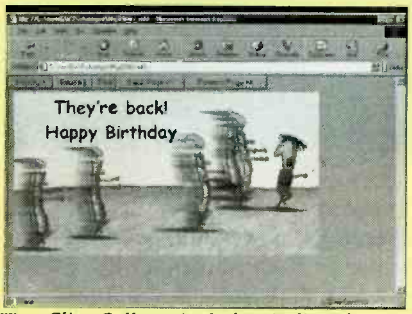
## Pretty Papers

How many greeting cards does your family send each year? Birthday cards to friends and relatives, anniversary and Valentine's Day cards to loved ones, Mother's Day and Father's Day (and maybe Grandparents' Day?), invitations and thank-you notes—and let's not forget the annual stack of Christmas cards. There are special occasion cards to be sent, and, if you've really fallen for those Hallmark commercials, you might even commemorate such holidays as St. Patrick's Day and Halloween with store-bought greetings. It all adds up.




What other type of printed materials does your family buy or create? Calendars, garage-sale posters, Happy Birthday banners, chore charts, newsletters for clubs? Well, if you've got a 90-MHz Pentium and a color printer, you can say good-bye to those card shops, sheets of oak tag, and permanent markers. With Microsoft's *Home Publishing 99* ($54.95), you can create all of those in the comfort of your home, usually for a fraction of the cost. What's more, it allows you to create personalized Web pages and multimedia e-mail projects complete with animation, sound effects, and music.

*Home Publishing* is designed with consumers in mind and requires no background in graphics or even any computer experience. The three-CD-ROM set comes with a companion book that shows all the graphics and fonts and describes the sound effects, that are available. But no written manual is included. There is onscreen help available, but, in general, anything that isn't completely self-explanatory has an onscreen pop-up box that guides the user. For the most part, those directions were sufficient to keep novices from feeling frustrated.




*The Clip Gallery includes Hallmark card designs for cards with personalized greetings but no home-made look.*

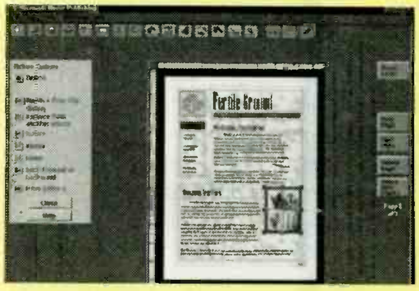
Just because the program is easy to use doesn't mean the finished products are simplistic. In fact, *Home Publishing 99* can be used to create quite professional-looking printed and on-line projects, with its 8000 some pre-designed project templates.

For instance, we recently volunteered to edit the bi-monthly newsletter for a club to which we belong. The first issue, we must admit, looked pretty awful. For all our years of writing and editing experience, we were new to desktop publishing and Microsoft *Word*'s columns feature gave us a lot of trouble. We'd add or delete a word in column one on page 2, and find that all the text on pages 2 through 8 had somehow shifted into the wrong places and wouldn't go back where it belonged no matter what we tried!

*Home Publishing 99* doesn't use columns in the standard sense. Instead, text goes into "text boxes," and you can have as many of those on a page as you choose. One in column A, one in column B? Fine. Want three columns on the top of a page, but just one on the bottom? No problem. Just use four separate text boxes.

To further spruce up the project, we were able to add icons and borders that complemented the articles (books for the book reviews, a bus next to the text describing an upcoming field trip), borders and backgrounds to visually differentiate articles on the same page, and we could even add digital photographs. The program supplies more than 70,000 graphics, 2500 photos, 2500 motion clips, and 1250 sound and music clips. All are easily accessed from the Clip Gallery. You can search for a specific graphic using a keyword, and then search for more like it.

Although *Home Publishing 99* doesn't require any computer expertise, some familiarity with the Windows environment comes in handy, particularly if you want to import files or text from outside the program itself. In our case, we wanted to copy some of the information from our first newsletter (a Word file) directly to the second. It was easy enough to do using the Windows "copy" and "paste" functions, but there weren't any instructions on how to do this. Within the program itself, however, it's easier to use the move function than to cut and paste. You can select an item, or even group of items, and move it to a different place on the page or to another page.



*The design screen shows your project on the left and design options on the right.*

*Home Publishing* offers a host of other tools and effects that make it easy for beginners to achieve professional results. Rulers span the top and left sides of the page, allowing you to

## MANUFACTURERS

**Cambridge SoundWorks**
311 Needham St., Suite 102
Newton, MA 02464
Tel. 800-367-4434
Web: *www.hifi.com*
**CIRCLE 100 ON FREE INFORMATION CARD**

**Hewlett-Packard Company**
3000 Hanover Street
Palo Alto, CA 94304-0890
Tel. 800-752-0900
Web: *www.photosmart.com*
**CIRCLE 101 ON FREE INFORMATION CARD**

**The Lego Group**
555 Taylor Road
Enfield, CT 06082
Tel. 800-510-5773
Web: *www.legomindstorms.com*
**CIRCLE 102 ON FREE INFORMATION CARD**

**Microsoft Corporation**
One Microsoft Way
Redmond, WA 98052-6399
Tel. 425-486-9258
Web: *www.home-publishing.com*
**CIRCLE 103 ON FREE INFORMATION CARD**

**Panasonic Consumer Electronics Company**
One Panasonic Way
Secaucus, NJ 07094
Tel. 800-211-PANA
Web: *www.panasonic.com*
**CIRCLE 104 ON FREE INFORMATION CARD**

**Samsung Electronics America, Inc.**
105 Challenger Road
Ridgefield Park, NJ 07660-0511
Tel. 800-SOSIMPLE
Fax: 201-229-4029
Web: *www.sosimple.com*
**CIRCLE 105 ON FREE INFORMATION CARD**

**Sharp Electronics Corp.**
Sharp Plaza
Mahwah, NJ 07430-2135
Tel. 800-BE-SHARP
Web: *www.sharp-usa.com*
**CIRCLE 106 ON FREE INFORMATION CARD**

**Sole Control**
(Division of RECOTON)
145 East 57th Street
10th Floor
New York, NY 10022
Tel. 800-742-3438
Web: *www.recoton.com*
**CIRCLE 107 ON FREE INFORMATION CARD**

**Sony Electronics, Inc.**
One Sony Drive
Park Ridge, NJ 07656-8002
Tel. 800-222-SONY
Web: *www.sony.com/MiniDisc*
**CIRCLE 108 ON FREE INFORMATION CARD**

align text and graphics precisely where you want them. Once you've added graphics and photos from the Clip Gallery, you can rotate, crop, or flip them to fit your project. If you decide to use your own digital photos, you can even use the included *Picture It! Express* to get rid of red-eye or fix other common photo problems. *Home Publishing* lets you get fancy with your text by opening a paragraph with an ornate first letter, adding outlines or shadows, giving it a shape like a circle or triangle, or making it wrap around a graphic. For two-sided projects, a "print wizard" guides you through each step, and animated instructions show you how to properly feed the paper into the printer.

When you're close to finishing, the multilevel zoom function allows you to view the entire page or zoom in at up to 400 percent. A built-in spell-checker gets rid of potentially embarrassing typos. Then you can print out the entire project or only the pages you specify. And should your project happen to be a Christmas card, party invitation, or any other mass-mailing item, *Home Publishing 99*'s mail merge/address book can make short work of addressing envelopes.

We had a good time using this family-oriented program. Besides creating a visually appealing newsletter, we made some calendars, a holiday party invitation, and a "Chores Chart" for our 3½-year-old (who now earns stars for picking up toys, having his hair washed, brushing his teeth, going to bed, *etc.*—without making a fuss).


*You can create eye-pleasing, professional newsletters for your club or business with* Home Publishing 99.

We do have a couple of caveats, however. First, as we've come to expect, the Microsoft software requires the latest and greatest hardware to run at peak performance. With enough available space on your hard drive, for instance, you can download the program's entire graphics library, saving time and eliminating the need to swap between the program's three CD-ROMs when searching for images. Anything less than the minimum specs (a multimedia PC with a Pentium 90; Windows 95, 98, or NT; 16 MB of RAM; 60 to 145 MB of available hard-drive space; a 4X CD-ROM drive; Super VGA; and a 256-color monitor), and you just might run into the same problems we did when we installed *Home Publisher* on our "writing" computer (which, we admit, is the electronic equivalent of an old black metal typewriter!). After an hour of fun and uneventful use, we received an error message about "irreparably corrupted data" on drive D:—which, for some reason known only to programmers, translates to "You don't have enough memory to handle this program." We deleted a bunch of files and managed all right for a little while, until we were confronted with a new message: "Your hard drive C: is out of memory." Fortunately, switching to a more powerful PC eliminated all those problems.

Our second concern is that the program does a disservice to novices by not using some established graphic-design tools (such as cut, copy, and paste), which are well worth knowing and understanding.

Assuming that you're not planning on a career in page layout, however, Microsoft *Home Publishing* is a good way to make your own professional-looking, colorful, and fun printed goods and to spruce up your e-mail.

# GIZMO NEWS

## AOL/Netscape Merger

America Online plans to purchase Netscape Communications Corporation in a $4-billion, all-stock transaction. The proposed deal also includes an alliance with Sun Microsystems Corporation, best known in the PC world for its Java technology. AOL currently distributes Microsoft Internet Explorer software to its subscribers; the merger would allow AOL to distribute Netscape's popular browser and to run Netscape's "Netcenter" Web site. It would also create a company strong enough to truly rival Microsoft, at least on the Internet front.

In fact, Microsoft greeted the news of the planned merger by asking the federal government to drop its antitrust lawsuit against them.

## Pocket Surfers?

What will America Online's merger with Netscape mean to you? According to AOL Chairman Steve Case, one of the company's primary goals is the creation of new gadgets to untether the net-surfer from his or her PC. Some of the ideas being tossed about are wireless handheld computers, smart phones with screens, and a flat-panel that sticks to a refrigerator door.

Yes, we know, we've heard it all before. But AOL's $4.2-billion takeover of Netscape and its alliance with Sun Microsystems might inject a healthy dose of reality into those plans—perhaps even enough to allow AOL to beat mega-competitor Microsoft to the marketplace with such devices. AOL plans to put Netscape's software programmers to work configuring new versions of the Navigator browser to work with different types of electronic equipment besides PCs.

One major hurdle facing the AOL/Netscape/Sun group, however, lies in convincing consumer-electronics manufacturers to begin producing equipment that can use AOL's content and Internet access, Netscape's Navigator browser technology, and Sun Microsystem's Java programming language. It will be interesting to see what they can come up with, and whether they can beat Microsoft to the punch.

## CEMA Approves DTV 1394 Interface Specs

The IEEE 1394 DTV interface specification, outlined in EIA-775, was officially approved by the Consumer Electronics Manufacturers Association (CEMA) back in November 1998. It will provide a simple way for consumers to connect digital cable set-top boxes to digital television receivers while providing the full resolution of the DTV program. It will also offer an interconnection that can carry audio, video, and associated control signals among DVD players, digital VHS players, Dolby Digital surround-sound processors/receivers, digital converter boxes, and other digital products.

CEMA approval does not, however, mean that everyone is in complete agreement over the digital interface. In fact, a battle over a copy-protected digital interface is in full swing among consumer-electronics manufacturers. Such an interface would prevent unauthorized copying of digital programming—there's no debate over its necessity. The argument is over whose copy-protection scheme to use.

On one side, we have the Sony team (dubbed "5C" for "Five Company"), which also includes Hitachi, Intel, Matsushita, and Toshiba. They have developed the Digital Transmission Content Protection (DTCP) method, which they call "the industry's first encryption-based IEEE 1394 link layer." On the other side, we have Zenith and Thomson with their Extended Conditional Access (XCA) smart-card based renewable encryption scheme.

DTCP was specifically designed for the IEEE 1394 with its inherent two-way communication capability and includes both encryption and authentication mechanisms in the digital interface. XCA is designed for both one- and two-way digital interfaces. Using a renewable security system based on smart cards, XCA could also be used with a one-way digital interface such as the EIA-762 RF remodulator standard.

Paul Snopko, director of electronic systems research and development at Zenith, admitted that the DTCP-enabled 1394 link "may be a good solution for an $8000 digital TV," but questioned its appropriateness for a kitchen TV set. The Thomson/Zenith camp calls their XCA "a simple, elegant, and cost-effective solution designed for a range of different digital consumer products."

The 5C proposal is said to have the approval of PC makers, consumer-electronics companies, and motion-picture studios. It was designed to meet the requirements of the Motion Picture Association of America. The DTCP chip will be commercially available this spring.

Snopko noted that while DTCP may appear to have "gone several steps ahead of our XCA proposal;" in reality, "no digital-consumer products [using either copy-protection scheme] exist on the market yet. In that sense, we are still at the same starting line." Meanwhile, the XCA group is actively trying to gain support for their proposal from the cable-TV industry.

The battle over the interface could translate into a slower resolution of the DTV-cable interface issue, which has been a problem for DTV promoters. The lack of an industry-standard encryption method could also slow the introduction of other digital consumer products.

# DTMF Computer Interface

BRIAN PLILER

*Decode DTMF signals picked up by your scanner and display that information on your computer screen or save it to memory with this simple scanner-to-computer interface circuit.*

If you have been looking for an inexpensive method of decoding DTMF digits and you already own a PC or compatible computer, then the *DTMF Computer Interface* described in this article might just be the monitoring accessory that you have been looking for.

The interface decodes DTMF tones that are received on any scanner, communications receiver, or other source (such as a tape recorder, *etc.*) and displays the resulting digits on the computer's monitor complete with the approximate time at which the digits were decoded. (The information is also stored automatically in a disk file for logging purposes.) The interface simply connects to the scanner or other receiver through the external speaker jack and to the PC through an ordinary parallel-printer port, such as LPT1.


**Circuit Description.** A schematic diagram of the DTMF Computer Interface is shown in Fig. 1. Note that relatively few parts are required for the interface. Scanner audio is fed to IC1 (an SSI-75202 DTMF receiver) through ceramic-disc capacitor C1. (Capacitor C1 must be a ceramic-disc unit, or digit decoding performance will be degraded—**Do not** substitute Mylar types for C1.) The DTMF receiver (IC1), with the aid of a single resistor (R1) and an inexpensive 3.58-MHz colorburst crystal (XTAL1), decodes the DTMF tones and outputs a 4-bit binary code, identifying each DTMF digit as it is decoded.

The DTMF digits along with their equivalent binary code as output from IC1 are given in Table 1. When IC1 decodes a DTMF digit, its Data Valid (DV) output at pin 14 goes high. The DV line goes high only while IC1 is decoding a DTMF Digit, signifying that binary-digit data is available from IC1. The binary-digit data that's output at pin 14 of IC1 is considered to be valid for the current digit only while the DV signal is present.

The 4-bit output (plus the DV signal) of IC1 is fed to IC2 (a 74LS04 low-power Schottky, hex inverting buffer). Note that only five of IC2's inverters are used as signal buffers. The data originally output by IC1 is coupled through a short length of cable to your PC.

Operating power for the circuit is provided by a 9-volt battery, whose terminal voltage is regulated to +5 volts by IC3 (an LM78L05 low-power, fixed, 5-volt regulator). Capacitors C2 and C3 filter against power transients, while switch S1 serves as the project's power switch.

**Interfacing to the Computer.** You are probably wondering how the interface can be connected to the computer's parallel printer port, since it is normally used to output data to a printer. The truth is that while the parallel port is usually considered strictly as an output port, it also has five TTL level input pins that are normally used to monitor status signals from the printer,

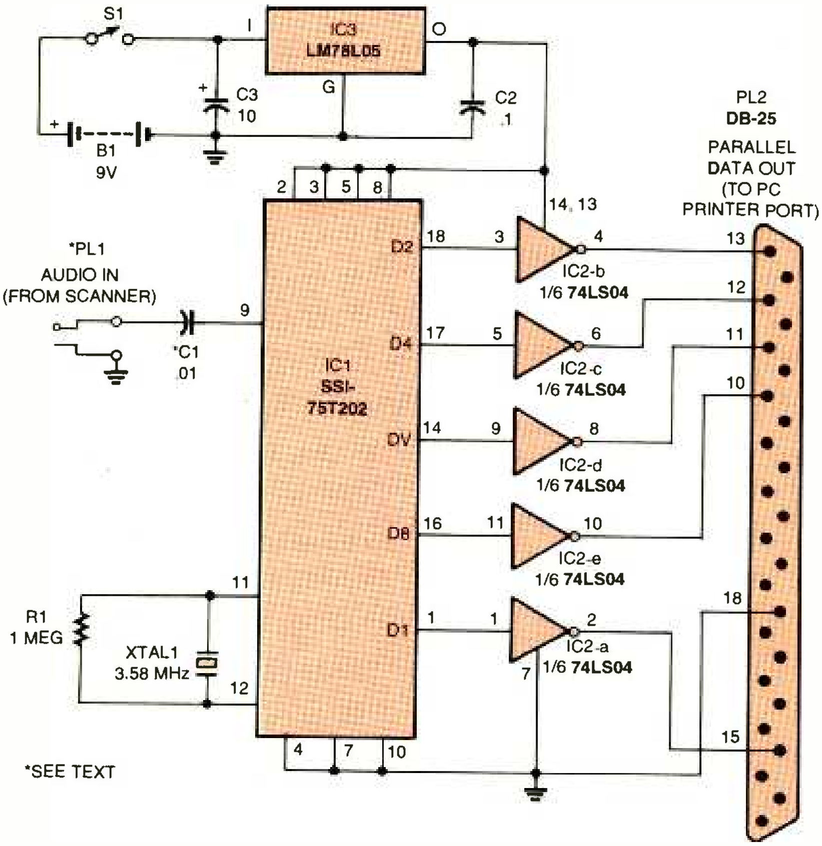



*Fig. 1. This schematic diagram of the DTMF Computer Interface reveals that the circuit is comprised of relatively few components. At the heart of the circuit is an SSI-75T202 DTMF receiver, which with the aid of a single resistor (R1) and an inexpensive 3.58-MHz colorburst crystal (XTAL1) decodes the DTMF digits and outputs a 4-bit binary code, identifying each DTMF digit as it is decoded.*

such as: error, paper out, *etc.* It is those five input pins that allow the DTMF interface to communicate with the PC.

A PC can actually have up to three parallel printer ports, normally referred to as LPT1, LPT2, and LPT3. If there is only one parallel printer port (most home systems), it is referred to as LPT1.

**Construction.** Construction is not critical, as the project can be assembled on a small section of perfboard or a printed-circuit board. For those readers who prefer to go the printed-circuit route, a template of the author's board layout is shown in Fig. 2. After etching your printed-circuit board, examine it carefully for shorted connections, *etc.*, and correct any defects before proceeding.

Using the parts-placement diagram shown in Fig. 3 as a guide, begin installing the parts onto the printed-circuit board. The use of sockets for IC1 and IC2 is strongly encouraged. After all of the appropriate parts have been soldered onto the circuit board, check the board for solder bridges and poor connections. (**Do not** insert IC1 and IC2 into their sockets at this time.)

Now temporarily apply power to the board, and check for the presence of +5 volts at the output of IC3 (the regulator). If that checks out, set the completed printed-circuit board aside for the time being.

Prepare the enclosure that's been chosen to house the project by simply drilling holes for the power switch, audio input wires, and the computer data cable. Note that almost any type of cable can be used to connect the interface to the computer as long as it contains six conductors (five signal lines and a ground), and its length doesn't exceed 3 to 4 feet.

Before you solder the audio input and computer data wires to the board, it is suggested that several inches of each be pulled into the enclosure. Then, strip and solder each wire to its respective pad (as shown in Fig. 3). After all of the wires have been attached to the printed-circuit board, mount the board into the enclosure, and carefully extract (pull out) any excess slack in the wires, being sure to fasten them securely into the enclosure so that they can't be pulled out again.

With that done, connect an audio plug (selected to mate with the external speaker or earphone jack on your scanner or other receiver) to the appropriate points on the printed-circuit board through audio-speaker cable. After that, connect a male DB-25 connector to the 6-conductor cable to the printed-circuit board as indicated in Fig. 3. IC1 and IC2 can now be installed into their respective sockets.

### TABLE 1—DTMF OUTPUT DATA

| KEY | OUTPUT |
|---|---|
| 1 | 0001 |
| 2 | 0010 |
| 3 | 0011 |
| 4 | 0100 |
| 5 | 0101 |
| 6 | 0110 |
| 7 | 0111 |
| 8 | 1000 |
| 9 | 1001 |
| 0 | 1010 |
| * | 1011 |
| # | 1100 |
| A | 1101 |
| B | 1110 |
| C | 1111 |
| D | 0000 |

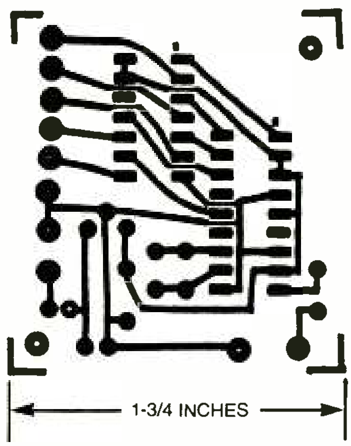



*Fig. 2. The project can be assembled on a small section of perfboard or a printed-circuit board. For those who prefer to go the printed-circuit route, a full-size template of the author's board layout is shown here.*

## PARTS LIST FOR THE DTMF DIGIT COMPUTER INTERFACE

**SEMICONDUCTORS**

IC1—SSI-75T202 or similar DTMF decoder, integrated circuit
IC2—74LS04 low-power Schottky, hex inverting buffer, integrated circuit
IC3—LM78L05 5-volt, 100-mA, fixed, low-power voltage regulator, integrated circuit

**CAPACITORS**

C1—0.01-µF, ceramic-disc (see text)
C2—0.1-µF, Mylar
C3—10-µF, 16-WVDC, electrolytic

**ADDITIONAL PARTS AND MATERIALS**

R1—1-megohm, ¼-watt, 5% resistor
B1—9-volt transistor-radio battery
XTAL1—3.58-MHz, colorburst crystal, HC-18/U case type
S1—SPST miniature toggle switch
PL1—Audio phone plug (see text)
PL2—Male DB-25 connector
Printed-circuit-board materials, enclosure, battery snap, IC sockets, DB-25 hood, wire, solder, hardware, *etc.*

**The Software.** The DTMF-digit decoding program (DTMF.BAS), which is written in QBASIC, is given in Listing 1.

Note that machines running Windows 95 and greater will not have QBASIC installed, you'll need to go to the "other" folder of your Win95 CD-ROM, click on "oldmsdos" and copy "QBASIC.EXE" and QBASIC.HLP to your hard drive. There are a few things about the program that should be pointed out. The first is that the program expects the interface to be connected to parallel port LPT1 at address &H379. If the interface is to be connected to LPT2 at address &H279 or LPT3 at address &H3BD, then the "INP (&H379)" statements appearing in lines 11 and 14 must be changed accordingly. For example, if LPT2 is to be used, change line 11 to read: "11 IF INP (&H279) <> 127 THEN 11", and change line 14 to read: "14 P = INP (&H279) : IF INKEY$ = CHR$(27) THEN 50."

**Note:** The program was originally written for a 386SX operating at 20 MHz, so the CT value in line 13 (currently 5000) may have to be changed, depending on the computer speed and user preferences.

The CT value is what determines how much time must pass after the last digit was decoded before the system time and date information is displayed. A 5- to 10-second time delay is usually desired by most users. Suitable CT values for various computer speeds are given in Table 2. Note that all of the data that is displayed on the monitor is also saved in a comma-delimited disk file named "DTMFDATA.TXT," which is placed in the current directory. That data can then be imported into a spreadsheet program for later analysis if desired.

The term "comma delimited" simply means that the different information fields are each separated by a comma. For instance, suppose that the telephone number 555-1234 was decoded at 7:25:00 p.m. on March 13th, 1998. That information would be saved in file "DTMFDATA.TXT" as: 5551234, 07:25:00.p, 03-13-1998 followed by a carriage return (CHR$(13)), which causes any new decoded information to be placed on a new and separate line.

To use the decoded data in a spreadsheet program, such as the one included with MSWORKS, first start Windows and start MSWORKS. Choose "Open File" and select file "DTMFDATA.TXT." A dialog box will appear stating that MSWORKS cannot open conversion files; click OK. In the next dialog box that appears, choose "open as spreadsheet." The spreadsheet program then appears with the data from file DTMFDATA.TXT placed in the first three data fields. Decoded DTMF-digit data appears in the "A" field, the time information appears in the "B" field, and the date information appears in the "C" field.

The data can now be sorted or printed as desired. Other spreadsheet programs should have similar features—refer to their instruction manuals. To enter the program DTMF.BAS, boot the PC into DOS or DOS mode. At the DOS prompt (C:>), start QBASIC by typing the word "QBASIC" and pressing <ENTER>. (QBASIC is included with DOS versions 5.0 and above. If you installed it yourself as described earlier, make sure you try to run it from the directory or folder you put it in.) Press the <ESC> key to clear

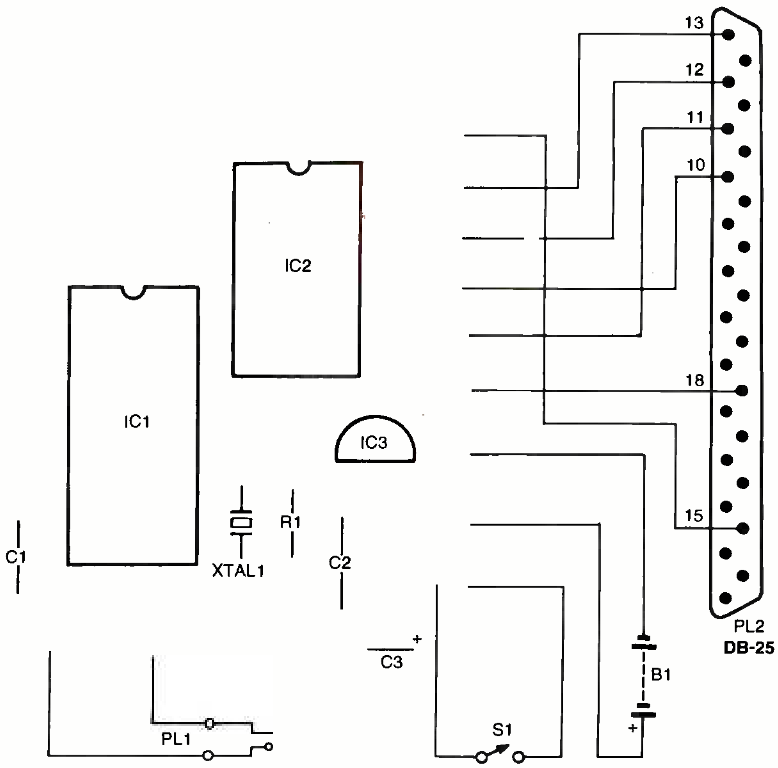



*Fig. 3. Assemble the project guided by this parts-placement diagram. **Note:** The use of sockets for IC1 and IC2 is strongly encouraged.*

## LISTING 1—DTMF BAS

```
1 REM DTMF Digit Decoder Program for PC/Compatibles
2 REM by Brian Pliler 8-96 DTMF.BAS
3 REM with Time/Date Stamp & Disk Logging
4 REM Interface Connects to Parallel Port
5 REM LPT1=&H379 LPT2=&H279 LPT3=&H3BD
6 REM Uses System Clock for Time/Date info.
7 CLS : LOCATE 1, 15: PRINT " DTMF Digit Decode Screen Press 'ESC' to End "
8 OPEN "DTMFDATA.TXT" FOR APPEND AS #1
9 CT = 1000000: GOTO 14
10 PRINT #1, CHR$(DIG); : PRINT CHR$(DIG);
11 IF INP(&H379) <> 127 THEN 11
12 CT = 0
13 CT = CT + 1: IF CT = 5000 THEN 45
14 P = INP(&H379): IF INKEY$ = CHR$(27) THEN 50
15 IF P = 127 THEN 13
16 IF P = 255 THEN DIG = 68: GOTO 10
17 IF P = 247 THEN DIG = 49: GOTO 10
18 IF P = 239 THEN DIG = 50: GOTO 10
19 IF P = 231 THEN DIG = 51: GOTO 10
20 IF P = 223 THEN DIG = 52: GOTO 10
21 IF P = 215 THEN DIG = 53: GOTO 10
22 IF P = 207 THEN DIG = 54: GOTO 10
23 IF P = 199 THEN DIG = 55: GOTO 10
24 IF P = 191 THEN DIG = 56: GOTO 10
25 IF P = 183 THEN DIG = 57: GOTO 10
26 IF P = 175 THEN DIG = 48: GOTO 10
27 IF P = 167 THEN DIG = 42: GOTO 10
28 IF P = 159 THEN DIG = 35: GOTO 10
29 IF P = 151 THEN DIG = 65: GOTO 10
30 IF P = 143 THEN DIG = 66: GOTO 10
31 IF P = 135 THEN DIG = 67: GOTO 10
45 PRINT CHR$(44); : PRINT #1, CHR$(44); : PRINT TIME$; : PRINT #1,
TIME$;
46 PRINT CHR$(44); : PRINT #1, CHR$(44); : PRINT DATE$; : PRINT #1,
DATE$;
47 PRINT CHR$(10); : PRINT #1, CHR$(13)
48 GOTO 14
50 CLOSE #1: CLS : END
```

the opening dialog box. Press <ALT>, then choose "F" for file, then "N" for new, and press <ENTER>. Now type in the program as it appears in Listing 1, making any needed changes to lines 11, 13, and 14.

After the program has been entered, press <ALT>, then press "F" for file, select "S" for save, and press <ENTER>. Type in the name DTMF.BAS and press <ENTER>.

To run the program (DTMF.BAS) that you just entered and saved, press <ALT>, then press "R" for run, then "S" for start, and press <ENTER>. The screen will clear, the program will start, and the words "DTMF Digit Decode Screen Press 'ESC' to End" will appear at the top of the monitor screen. Any DTMF digits decoded by the interface will appear on the monitor.

Approximately five seconds after the last digit is decoded, the system time and date information appears to the right of the previously decoded DTMF digits. The next DTMF digit decoded appears on a new line immediately below the first. Once the screen becomes full, the oldest line of information is scrolled upwards one line at a time, as a new line of information is displayed. But don't worry, because all displayed information is saved in disk file "DTMFDATA.TXT," located in the same directory as DTMF.BAS.

To stop the program—whether to make changes or to exit—simply press the <ESC> key. The words "Press any key to continue" will appear at the bottom of the screen. Pressing any keyboard button will return you to the QBASIC main screen. To exit the program and QBASIC, press <ALT>, then press "F" for file, and select Exit from the menu. You'll be returned to the DOS prompt.

**Use.** With your computer and the DTMF interface both turned off, carefully connect the interface to the appropriate parallel port on your computer and turn on your computer. Make sure that the computer is up and running before applying power to the interface. After the DTMF decode program is running, connect the audio cable on the interface to a scanner tuned to an active frequency with DTMF tones present, or other appropriate source of DTMF tones. (Perhaps a friendly ham-radio operator can help you with this.)

## TABLE 2—DELAY TIMES

| PC Type/Speed | CT Value (5-Sec. Delay) | CT Value (10-Sec. Delay) |
|---|---|---|
| 386SX/20 | CT = 5000 | CT = 10,000 |
| 386DX/33 | CT = 10,000 | CT = 20,000 |
| 486DX/2-66 | CT = 20,000 | CT = 40,000 |
| 586 DX4-133 | CT = 35,000 | CT = 70,000 |

### DTMF DECODER IC SOURCES

**B.G. Micro, Inc.**
PO Box 280298
Dallas, TX 75228
Tel. 800-276-2206

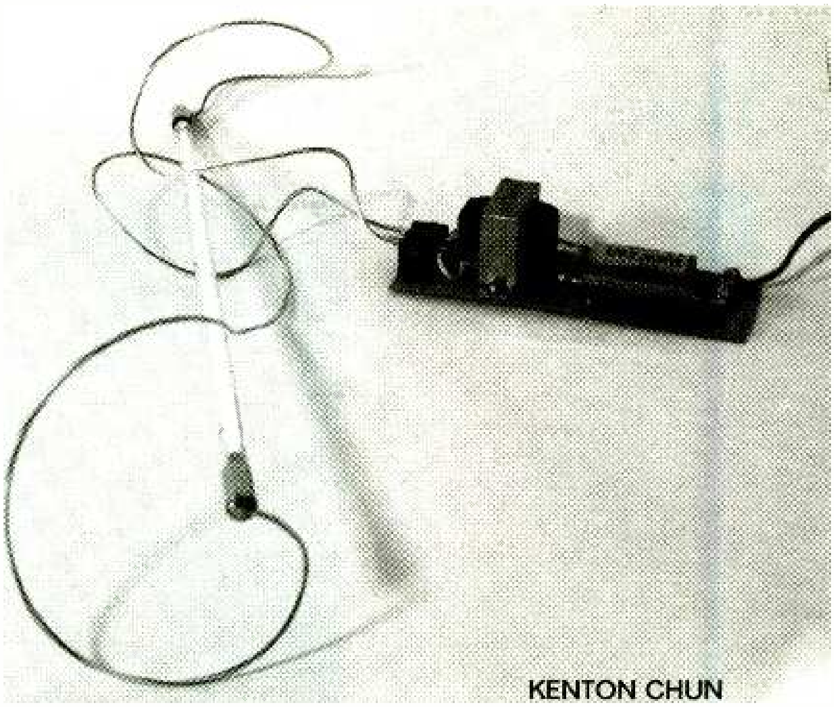
**Debco Electronics**
4025 Edwards Road
Cincinatti, OH 45209
Tel. 800-423-4499

**JDR Microdevices**
1850 South 10th Street
San Jose, CA 95112-4108
Tel. 800-538-5000

If you are unable to find a suitable source of DTMF tones to test the interface, an alternative would be to create a test tape using your answering machine. Simply ask a friend to call your answering machine, and instead of leaving a normal voice message on the machine, have the friend dial digits

*(Continued on page 66)*

# SUPER-SIMPLE HIGH-VOLTAGE CIRCUIT



KENTON CHUN

*Thanks to the development of the SIDAC, it is now easy to generate a high-voltage output capable of driving neon or laser tubes without resorting to the inefficient and complicated circuit configurations of the past.*

If you're a dedicated electronics hobbyist, you have probably needed a high-voltage power source at some time or another. Maybe you wanted to energize a neon tube or an old plasma-discharge laser. Or perhaps you were building an electric fence or trying to trigger a xenon strobe tube. No matter what you were trying to accomplish, you probably ran into the same problem every time—how to efficiently and economically generate a high voltage.

High-voltage technology has not changed much in the last century. Usually, we don't electrostatically generate high voltages, except for experimental or educational purposes, or by accident when we pet the cat. In most cases, we want to produce high voltages from relatively low DC voltages or ordinary 117-volt house current. In the case of a DC power supply, the typical solution is to create a DC-to-AC power inverter, and then step up the resulting AC through a transformer. That's often a very inefficient process.

Generating a high voltage from an AC power source is often even worse. In that case, alternating current must be stepped down to some low voltage, rectified (to provide DC),and then put through a DC to AC circuit. Talk about inefficient. Each conversion (or inversion) decreases efficiency.

The simplest way to generate a high voltage is to use AC voltage as the initial power source, which can be stepped up via transformer. The latter method is reliable and efficient, but requires enormous transformers (which strictly follow the power factor rules) for even modest voltage gains. Generally speaking, doubling the secondary output voltage requires twice the primary current. A typical neon transformer can supply 10–12 kV at 30 mA and draw almost 400 watts! The killer is that the transformer is likely to weigh about twenty pounds.

**Basic DC-to-AC Inverters.** Figure 1 illustrates the most basic form of DC-to-AC inverter. When momentary switch S1 is in its normally open position, no current flows in the circuit. Closing S1 causes current to flow from the battery into the primary winding of T1, generating a magnetic field. After a short time, the current reaches its maximum level and S1 is released. The magnetic field in T1 collapses, producing an extremely high-voltage pulse across T1's secondary winding.

While the circuit in Fig. 1 is fairly reliable, it requires a very large current source and a heavy-duty transformer when operated at lower frequencies. Large current demands result in high power factors and high losses. Its greatest drawback is that it requires a warm body to stand around and continually press the button. That type of circuit is also not very energy efficient.

By raising the operating frequency of the circuit, it is possible to use transformers with less iron for the same voltage increase. The reason that WWII avionics ran at 400 Hz was for exactly that reason—you could get away with much lighter transformers. Less weight in an airplane is always better.

**Semiconductor-Based Inverter Design.** The introduction of mod-

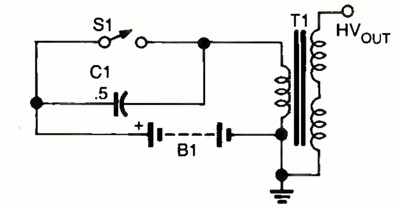



*Fig. 1. Shown here is the most basic form of DC-to-AC inverter. While the circuit is fairly reliable, it requires a very large current source and a heavy-duty transformer when operated at lower frequencies.*

ern semiconductors has made it possible to assemble a DC-to-AC inverter that operates very efficiently. The circuit in Fig. 2 is an example of a basic high-frequency DC-to-AC inverter. Many of the high-efficiency 12-volt DC to 117-volt AC power inverters and uninterruptible power supply (UPS) designs use a similar configuration as the heart of the circuit.

In the Fig. 2 circuit, an NE555 oscillator/timer (IC1) is set up as a pulse generator, the frequency of which can be set to almost any value. The output of IC1 is directed through a transformer and stepped up to the required level. The major limitation of the Fig. 2 circuit is its output power. The NE555 can directly source up to 200 mW through the transformer, but at the power-supply rail of 9 volts, that's barely enough power to light a tiny neon lamp. Only by adding output switches and a higher supply current can the circuit provide enough power to start a laser or a neon tube.

**An SCR-Based Inverter.** Another solution to the power problem is to use a high-current switch, such as an SCR to drive the primary winding of a large step-up transformer, as shown in Fig. 3. In the Fig. 3 circuit, the power comes from the utility, while the circuit's DC operating voltage is derived from a diode rectifier (comprised of D1 and D2) and a series capacitor (C1). Another capacitor (C2) charges to about 125 volts and supplies current through the Zener-diode regulator and potentiometer to the gate of a unijunction transistor (UJT), Q1. When Q1 discharges, a trigger voltage is applied to the gate of SCR1, causing it to turn on. With SCR1 turned on, capacitor C3 dumps its charge across the primary of T1, generating a high-voltage pulse in T1's secondary winding. The main drawback to the Fig. 3 circuit is the high parts count and complexity. So what's the alternative?

**Another Way.** In the world of high-voltage power applications, the tradeoff appears to be efficiency at the cost of size and/or complexity. Wouldn't it be nice to find a single semiconductor component capable of replacing the handful of resistors, capacitors, unijunction transistors, and SCRs, while having the capacity to efficiently switch several amps of power? Well, such a component—dubbed the SIDAC—already exists.

The SIDAC—which can be defined as a silicon, bilateral, voltage-triggered switch—has a high

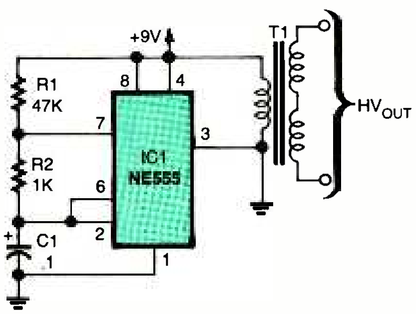



*Fig. 2. At the heart of this DC-to-AC inverter is an NE555 oscillator/timer (IC1) set up as a pulse generator. Many high-efficiency 12-volt DC to 117-volt AC power inverters and uninterruptible power supply (UPS) designs use similar configurations.*

"off" impedance at any voltage below its breakover voltage. When the voltage across the device reaches the breakover point, the SIDAC immediately goes into conduction in the same regenerative manner as a Triac or SCR: as the voltage across the device drops to a typical "on" value of a couple of volts or so. Because the SIDAC is bilateral, it behaves in the same manner regardless of voltage polarity. That makes it ideally suited to power switching in AC circuits.

SIDACs come in several styles. Motorola's MKP series is rated at 4 amps, while the MK series is rated at a whopping 20 amps. Typical SIDAC specifications are given in Table 1. The device's breakover voltage is indicated by the three-digit number at the end of the device code. Devices are available with breakover voltages of 120, 130, and 240–270 volts. Best of all, in quantities of less than 100, they are cheap—typically selling for about half a buck.

**SIDAC-Based HV Circuit.** Figure 4 shows a very efficient, but simple high-voltage circuit comprised of only five components, including the transformer and a fuse. For continuous duty, a thermal protector—a thermal link that opens up the circuit if it reaches 300–400°F—should be connected in series with resistor R1, giving the circuit a total parts count of six components.

The combination of R1 and C1 yields a time constant of about 2 milliseconds, which charges C1 to 117 volts at about the 90-degree point in the sinusoidal input-voltage waveform. It is at about that point that the SIDAC conducts and continues to do so for the duration of the first half cycle. The SIDAC then dissipates power as the input volt-

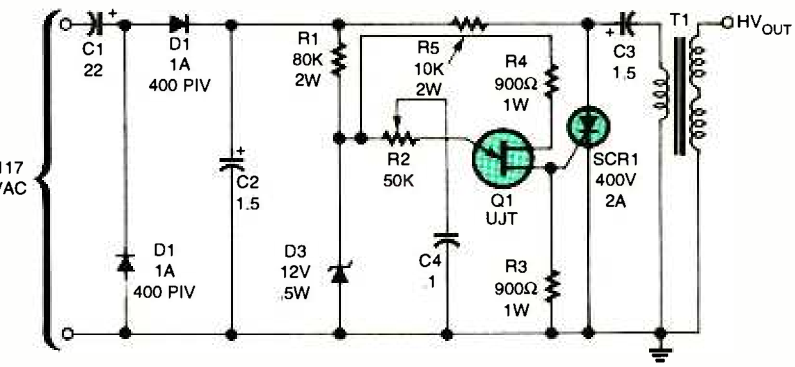



*Fig. 3. This high-voltage circuit uses an SCR to drive the primary winding of a large step-up transformer. The main drawback of this circuit is its high parts count and complexity.*

age declines toward the zero-crossing point. When the line voltage goes through zero crossing, the SIDAC turns off, waiting as C1 begins to charge to the opposite breakover-voltage point. When the opposite breakover point is reached, the SIDAC once again turns on.

During each half cycle, the circuit produces a high-voltage pulse at the output of transformer T1. That's a very efficient design from a transformer standpoint, since you are putting AC across its primary as opposed to the DC voltage used in the earlier circuits. The bottom line is that you can get away with less hardware, and transformer selection is not as critical as it is with other designs. Just about any transformer will work.

The author used a common 6-volt step-down AC power transformer; the transformer was turned around so that its secondary winding (which is normally used as the output) functioned as its primary. The SIDAC, driving the transformer's secondary winding, produced about a 1:20 step-up factor, or about a 2400-volt output. Not bad for three dollars worth of parts!

If a transformer with a very high turns ratio, such as a television flyback, is used in that setup, be careful! Even a small transformer can develop very nasty voltages at its output; at the power levels that the Fig. 4 circuit is capable of developing that can be "lethal." Be sure to observe all high-voltage safety precautions when working with the circuit.

**Important Note: Using an isolation transformer between the AC power source and the circuit would make the circuit a bit safer to operate.**

In the event that the SIDAC fails, which would be the worst case

*(Continued on page 66)*

### PARTS LIST FOR THE SUPER-SIMPLE HIGH-VOLTAGE CIRCUIT

D1—MK1V115–MK1V135 SIDAC bilateral trigger (see text)
R1—2000-ohm, 10-watt, power resistor
C1—1-µF, 200-WVDC, Mylar capacitor
F1—0.5-amp fuse
PL1—117-volt AC line cord with molded plug
T1—Step-up transformer (see text)
TH1—Thermal protector—optional (see text)
Perfboard material, 2-position barrier block, wire, solder, hardware, *etc.*
**Note:** Additional information about the SIDAC is available from Motorola's Web site at *http://sps.motorola.com.*

### TABLE 1—SIDAC MAXIMUM RATINGS

| Rating | Symbol | Min | Max | Units |
|---|---|---|---|---|
| **Repetitive Breakover Voltage** MK1V-115 / MK1V-125 / MK1V-135 | $V_{(BO)}$ | 104 / 110 / 120 | 115 / 125 / 135 | Volts |
| Off-State Repetitive Voltage | $V_{DRM}$ | – | ± 90 | Volts |
| On-State Current RMS (All Conduction Angles) | $I_{T(RMS)}$ | – | 1.0 | Amps |
| On-State Surge Current (Non-Repetitive) (60-Hz One Cycle Sine Wave Peak Value) | $I_{TSM}$ | – | 20 | Amps |
| Operating Junction Temperature | $T_J$ | −40 | +125 | °C |
| Storage Temperature Range | $T_{stg}$ | −40 | +150 | °C |
| Lead Solder Temperature | $T_L$ | – | +230 | °C |

**Electrical Characteristics ($T_J$ = 25°C unless otherwise noted)**

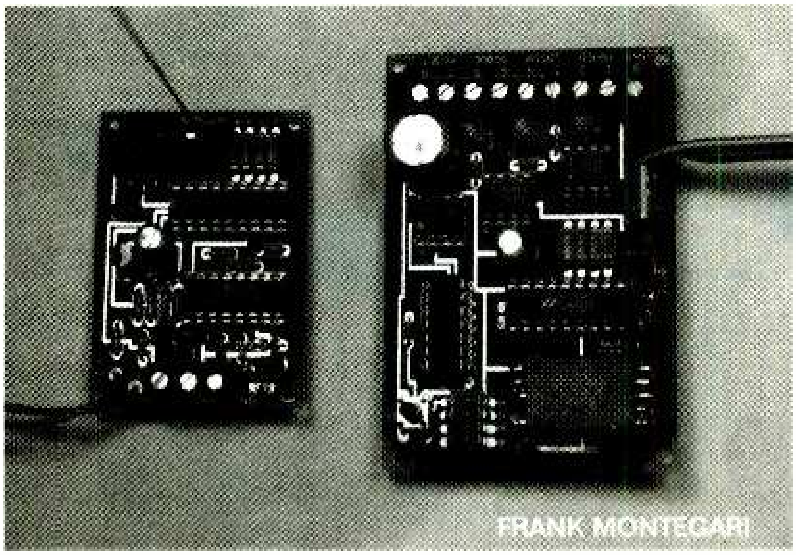
| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Breakover Current (60-Hz Sine Wave) | $I_{(BO)}$ | – | – | 200 | µA |
| Repetitive Peak Off-State Current (60-Hz Sine Wave, $V = V_{DRM}$) | $I_{DRM}$ | – | – | 10 | µA |
| Repetitive Peak On-State Current ($T_C$ = 25°C, Pulse Width = 10 µS, Repetition Frequency, $f$ = 1.0 kHz) | $I_{TRM}$ | – | 20 | – | Amps |
| Forward "On" Voltage ($I_{TM}$ = 1.0 A peak) | $V_{TM}$ | – | 1.1 | 1.5 | Volts |
| Dynamic Holding Current (60-Hz Sine Wave, $R_S$ = 0.1 kΩ) | $I_H$ | – | – | 100 | mA |
| Switching Resistance | $R_S$ | 0.1 | – | – | kΩ |
| Maximum Rate of Change of On-State Current | *di/dt* | – | 50 | – | A/µS |

# Wireless Control

*Build a remote-control transmitter/receiver pair that allows you to control almost any electronic device. Just connect the transmitter to a trigger source and the appropriate output of the receiver to the circuit to be controlled, and you're in business!*

Today remote wireless controls of one sort or another are used almost everywhere for almost everything. There are devices available that are designed to transmit audio and video signals or security and computer data from one point to another. They're also used to open garage doors and turn on lights—the applications for wireless controls are infinite.

However, for a specific control or pulse application not covered by one of the available devices, it's usually necessary to build your own. Unfortunately, in the past, building a simple and reliable RF transmitter and sensitive receiver was not an easy task. And even if the hobbyist were able to assemble such a system, the circuits required difficult measurements and complicated adjustments in order to set the system's operating frequency, minimize harmonic radiation, and maximize sensitivity. But now, thanks to new matched transmitter (TXM-418-LC) and receiver (RXM-418-LC) modules from Linx Technologies, those problems are things of the past. The modules—operating at 418 MHz, with a range of better than 300 feet—are based on surface acoustic wave (SAW) technology for accurate frequency control and have excellent stability and sensitivity.




Most wireless devices that are not dedicated to or a part of a video, audio, or computer system simply respond to the pressing of a pushbutton or closing of a switch. But the *Wireless Control* system outlined in this article, unlike other such systems, is designed so that the transmitter can accept inputs from mechanical and electronics switches; and other electronic devices—such as phototransistors, microprocessors, computers; as well as other sources.

The matching receiver features three sets of complementary outputs—momentary, latched, and sequential—giving it the versatility to handle almost any application.

**The Transmitter.** A schematic diagram of the Wireless Control's transmitter circuit is shown in Fig. 1. The circuit is comprised of three integrated circuits, several diodes, the transmit module, and a few additional support components. The signal applied to the transmitter is fed to the circuit through SO1 (a 3-position screw-type terminal block). From there, it travels across C1 and through R3 to the non-inverting input of IC1-a.

The output of IC1-a divides along three paths. In the first path, the output of IC1-a is applied to the inverting input of IC1-b, which then outputs the complement to the input signal. That complementary signal is fed to the inverting input of IC1-c through C3 and D2. In the second path, the non-inverted output of IC1-a is fed to the inverting input of IC1-c through another capacitor/diode combination (C2/D1), making both phases of the input signal available to IC1-c. The output of IC1-c is fed to the inverting input of IC1-d, producing an output signal that is applied to pin 6 of IC2 (a HT680 3[12] address encoder). That causes IC2 to generate three groups of bits containing data and address information, which is serially transferred to MOD1 (the transmitter module).

While that's going on, the two phases of the input signal (picked up from the outputs of IC1-a and IC1-b) are also fed to IC2 at pins 3 and 4, causing it to generate unique codes for positive and negative transitions at the input. MOD1 then produces an RF signal that is transmitted through ANT1.

Encoder IC2 can be programmed via S1 (a 4-position DIP switch) for 16 different addresses so that more than one pair of transmitters and receivers can be used in close proximity without interfering with each other. Resistor R1 (a 100k unit), which is connected between

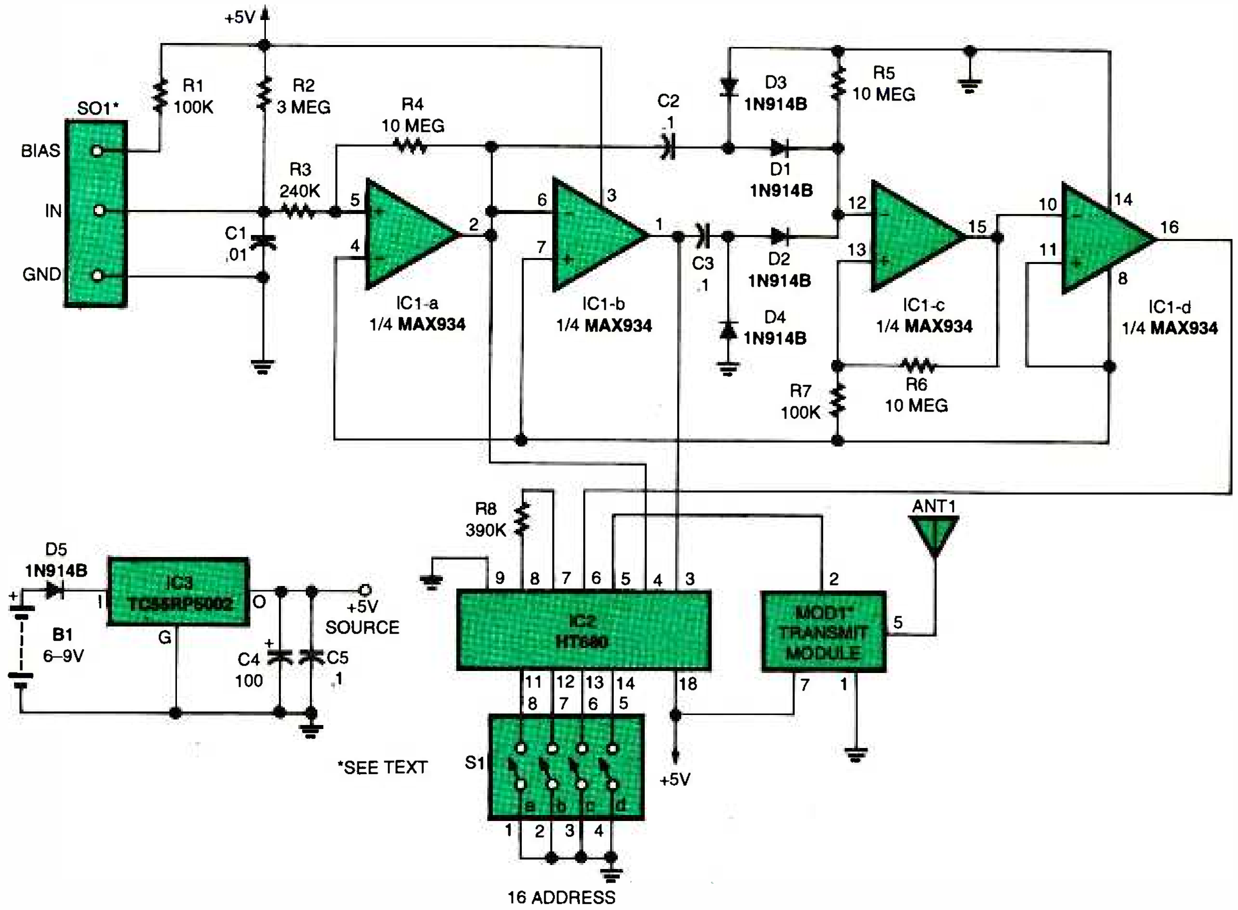



*Fig. 1. The Wireless Control's transmitter is comprised of three integrated circuits (IC1–IC3), a proprietary transmit module (MOD1), and a handful of support components.*

the +5-volt source and the bias terminal of SO1, allows an external potentiometer or resistor added to the circuit to provide sensitivity and threshold adjustment. The maximum current available from the bias terminal is 50 µA. Component R2 serves as a pull-up resistor, while R4 (a feedback resistor) provides hysteresis for switch debouncing and noise immunity.

The transmitter circuit is powered from a 9-volt transistor radio battery (B1), whose output is regulated to 5 volts by IC3 (a TC55RP5002EZB low-dropout, micropower regulator). Diode D5 is connected at the input of IC3 to provide reverse-polarity protection. Transmitter standby current is less than 10 µA, and the average transmit current is about 2 mA.

**The Receiver.** The RF signal output by the transmitter is picked up by ANT2 of the receiver circuit—a schematic diagram of which is shown in Fig. 2. The signal picked up by ANT2 is applied to MOD2 (the receiver module), which extracts the original data and address information from the RF signal and outputs same as a sequential data stream. That information is fed to IC4 (an HT692 $3^{10}$ address decoder), where it is stored and compared with previously programmed data. If a match is detected, one of IC4's data outputs (pins 3 and 4) goes high and remains there as long as a valid data stream is being received. That coding technique ensures that only valid data gets through and random noise pulses are rejected. The decoder can be programmed via S2 (a 4-posiition DIP switch) for 16 different addresses to match the output of the transmitter.

The decoded data outputs of IC4 at pins 3 and 4 are fed along several paths. In one path, the two outputs are fed to IC5—one of three TC4427 dual, level-translating power drivers, which are used to provide complementary 12-volt outputs that can source or sink 200 mA. The three power drivers accept 0- to 5-volt levels and output 0- to 12-volt, push-pull signal levels that can be used to drive external loads. The driver outputs are also applied to three bi-color LEDs, which are used to denote that data is being received; green indicates a low-to-high transition at the transmitter input, and red a high-to-low transition. Any driver output that is not high can sink up to 200 mA. The two IC5 power drivers (IC5-a and IC5-b) supply momentary pulses that can be used to trigger whatever load is connected to its output terminals.

In a second path, the two data outputs of IC4 are applied to IC6-a (half of a CD4013 dual D-type flip-flop) through S3 (a 4-position DIP switch). Switch S3 can be used to program IC6-a to be both set and reset by IC4's outputs or to be set by one of the outputs and reset by

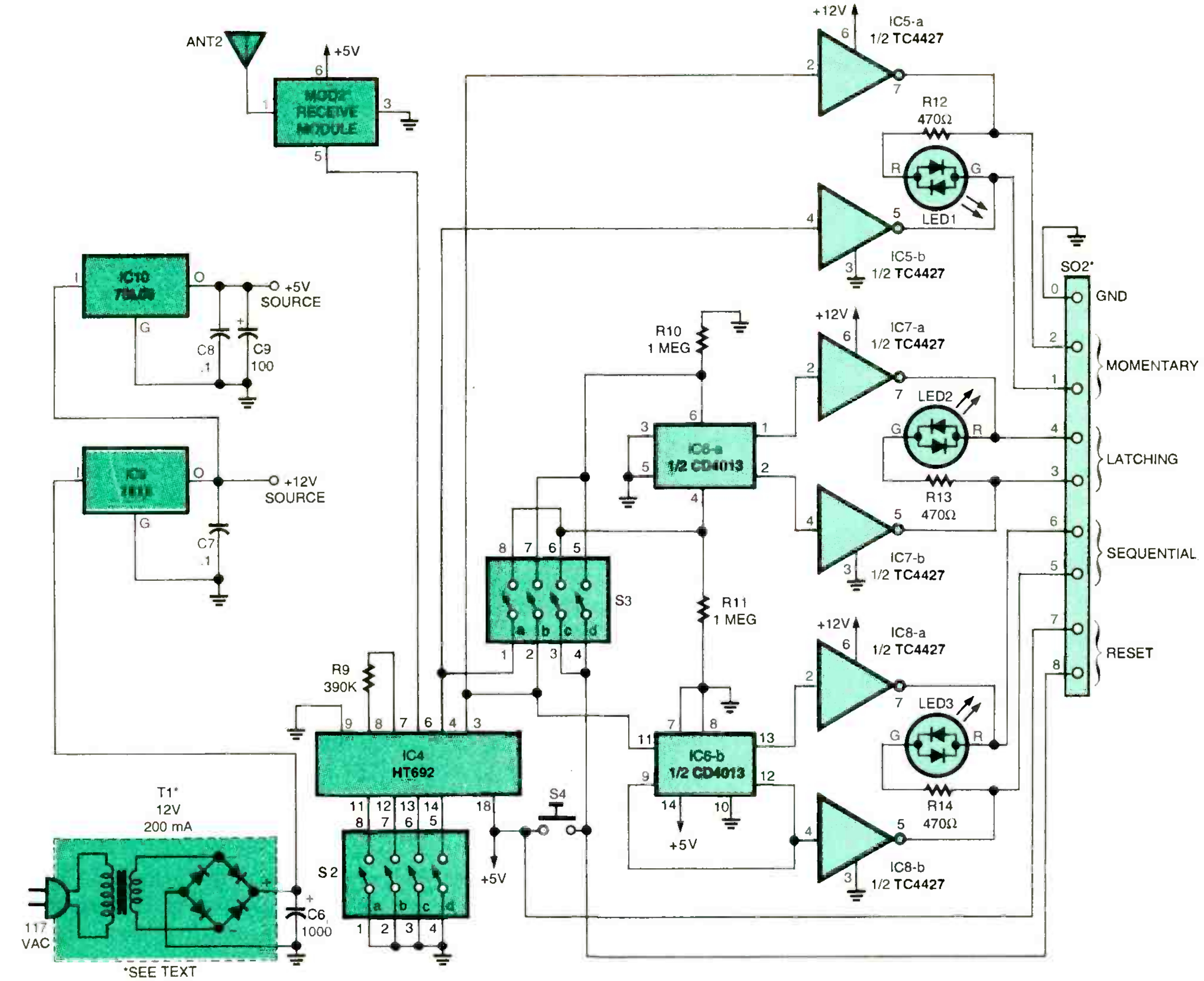



*Fig. 2. The Wireless Control's receiver circuit is composed of seven ICs (IC4 through IC10), a proprietary receive module (MOD1), three bi-color light-emitting diodes (LED1–LED3), and several support components.*

pushbutton switch S4. It can also be reset by one of the outputs and set by S4. The latched outputs of IC6-a are fed to IC7-a and IC7-b, whose outputs are used to drive LED2 (another bi-color LED that indicates IC6-a's output state).

The pin 3 output of IC4, following a third path, is also fed directly to IC6-b at pin 11 (its clock input), causing the flip-flop's outputs (pins 12 and 13) to alternately trigger high or low. The latched outputs of IC6-b are fed to IC8-a and IC8-b, which, like the other power drivers, provides complementary source/sink outputs. LED3 indicates the output state of IC6-b.

The six power driver outputs are fed to SO2 (a 9-position screw-type terminal block), through which the circuit is connected to the chosen load. The momentary outputs of IC5 at terminals 1 and 2 of SO2 can be used to drive a buzzer. It can indicate a transmitter input closing or opening, or can indicate both if two buzzers are used with different tones.

The outputs of IC7 at SO2 terminals 3 and 4 can be programmed via S4 to latch in different states and thus exactly correspond to an input closing and opening, or they can be programmed to latch on closing only or opening only and be manually set or reset by S4. Doing so is useful to store the results of temporary events, such as when a mailbox is opened by the postman.

The outputs of IC8 at terminals 5 and 6 can be used to sequentially turn a lamp on and off through a relay each time a contact is closed at the transmitter. Since the power drivers supply 12 volts and can source or sink 200 mA continuous and more than 1 amp peak, all sorts of load devices can be driven either directly or through mechanical or solid-state relays.

Power for the circuit is provided by T1 (a 12-volt, 200-mA DC wall transformer), plus a pair of fixed-voltage regulators (IC9 and IC10), along with assorted filter capacitors. Power for MOD2, IC4, and IC6 is provided through IC10 (a 78L05 5-volt, 100-mA fixed voltage regulator), while power for IC5, IC7, and IC8 is provided through IC9 (a 7812 12-volt, 1-amp, fixed-voltage regulator).

**Construction.** The transmitter and

receiver circuits were assembled on a pair of double-sided printed-circuit boards. A set of templates (measuring $2^5/_{16}$ by $1^5/_8$ inches) for the transmitter board is shown in Fig. 3, while a pair of templates (measuring $3^3/_{16}$ by $2^3/_{16}$ inches) for the receiver board is shown in Fig. 4. The double-sided boards provide a good ground plane for the transmit and receive modules.

**Note:** The transmit and receive modules are surface-mount units that are supplied already mounted to their respective double-sided PC boards. Due to a prior agreement with Linx, the manufacturer of these modules, and their minimum order policy, the supplier listed in the Parts List can not offer the modules separate from the board. However, those who wish can purchase the modules directly from the manufacturer in large quantities. Contact Linx Technologies, Inc. (575 S. E. Ashley Place, Grants Pass, OR 97526; Tel. 800-736-6677; Fax: 541-471-6251; Web: *linxtechnologies.com*) for details.

In addition, the modules are not certified by the Federal Communi-cations Commission (assembled kits cannot be sold as a product without being FCC certified). The kits are for personal or experimental use *only*.

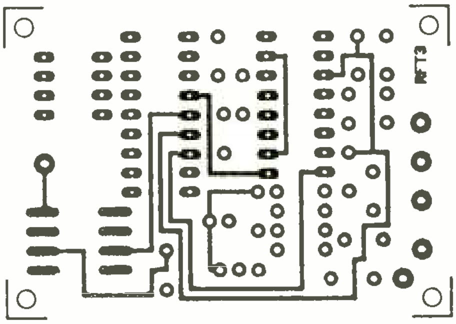
Once you've obtained all of the components listed in the Parts Lists, construction can begin. Parts-placement diagrams of the transmitter and receiver boards are shown in Fig. 5 and Fig. 6, respectively. Begin assembly by installing the resistors and capacitors, followed by the non-socketed semiconductor components. The bi-color LEDs (on the receiver board) should be mounted with the long lead connected to point R and the short lead to G on the circuit board.

Next, install appropriate DIP sockets wherever DIP ICs are indicated; **DO NOT** insert the ICs into their respective sockets at this time. Install the terminal blocks, DIP switches, and antennas on both boards. For antennas (ANT1 and ANT2 on the transmitter and receiver boards, respectively), the author used 6.7-inch lengths of stiff wire.

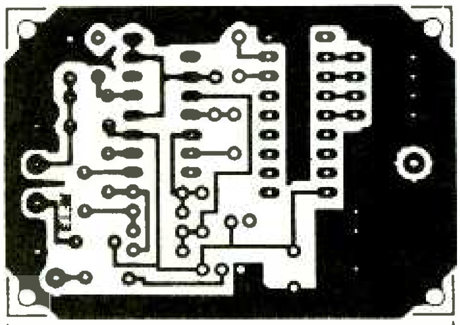
Then connect a 9-volt battery connector to the transmitter board as indicated in Fig. 5. Connect T1 (the wall transformer) to the receiver board, as indicated in Fig. 6.

**Note:** S4 and the LEDs of the receiver board should be connected to the receiver board through short lengths of wire so that they can be mounted in a convenient location on the unit's enclosure.

Check the construction workmanship of each board very carefully, looking for cold solder joints, solder bridges, or misoriented or mistakenly placed components; and cor-




A



2-5/16 INCHES

B

*Fig. 3. The transmitter circuit was assembled on a double-sided printed-circuit board. A set of templates (measuring $2^5/_{16}$ by $1^5/_8$ inches) for the transmitter board is shown here.*

## PARTS LIST FOR THE WIRELESS-CONTROL TRANSMITTER

### SEMICONDUCTORS

IC1—MAX934 (Maxim) quad ultra-low, single-supply comparator, integrated circuit (Digi-Key MAX934CPE)
IC2—HT680 (Holtek) $3^{12}$ address encoder, integrated circuit (Digi-Key HT-680)
IC3—TC55RP5002EZB (Telcom) +5-volt, fixed-voltage regulator, integrated circuit (Digi-Key 10001)
MOD1—TXM-418-LC transmitter module (see text)
D1–D5—1N914B general-purpose, small-signal, silicon switching diode

### RESISTORS

(All resistors are /-watt, 5% units.)
R1, R7—100,000-ohm
R2—3-megohm
R3—240,000-ohm
R4–R6—10-megohm
R8—390,000-ohm

### CAPACITORS

C1—0.01-µF, 50-WVDC, metalized-film
C2, C3, C5—0.1-µF, 50-WVDC, metalized-film
C4—100-µF, 10-WVDC, low-leakage, electrolytic

### ADDITIONAL PARTS AND MATERIALS

S1—4-position DIP switch
ANT1—6.7-inch antenna wire
SO1—3-position terminal block (see text)
B1—9-volt transistor-radio battery
Printed-circuit board, IC sockets, 9-volt battery connector, wire, solder, hardware, *etc.*

**TABLE 1—S3 SWITCH SETTINGS**

| XMIT | SETTINGS | | | | TERMINAL BLOCK NUMBERS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| INPUT | S3-a | S3-b | S3-c | S3-d | 1 * | 2 * | 3 | 4 | 5 | 6 |
| CLOSED | ON | ON | OFF | OFF | | R | | R | TOG | TOG |
| OPEN | ON | ON | OFF | OFF | G | | G | | NC | NC |
| CLOSED | OFF | ON | ON | OFF | | R | | R** | TOG | TOG |
| OPEN | OFF | ON | ON | OFF | G | | NC | NC | NC | NC |
| CLOSED | ON | OFF | OFF | ON | | R | NC | NC | TOG | TOG |
| OPEN | ON | OFF | OFF | ON | G | | G** | | NC | NC |

CLOSED = Transmitter input at a down level
OPEN = Transmitter input at an up level
R, G = Red or Green LED indicates a terminal at an up level
* = Momentary - terminal at up level for two seconds
** = Can be reset to opposite color by pressing SD
TOG = Toggles to opposite color
NC = No change

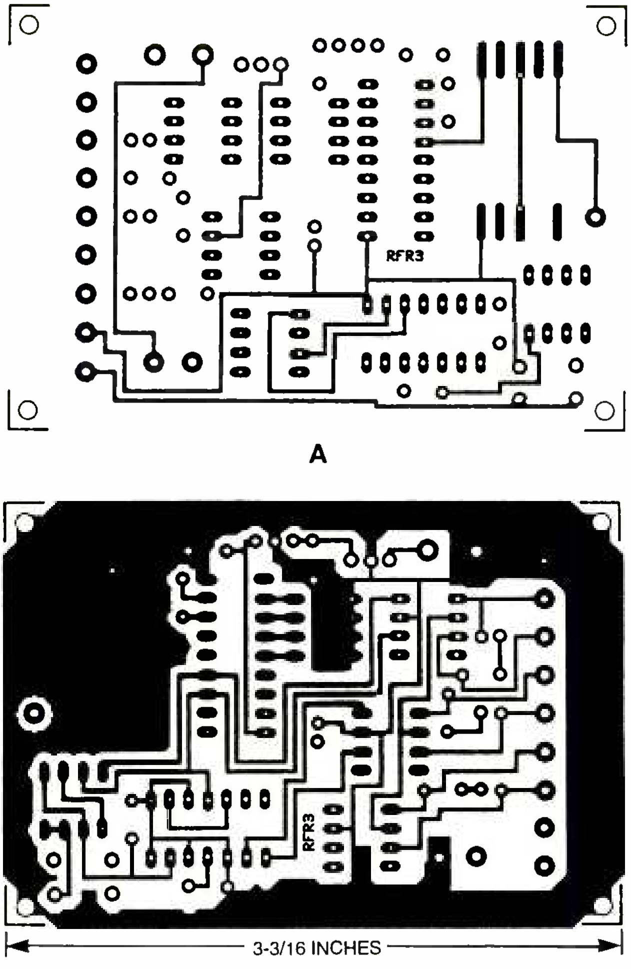



*Fig. 4. Like the transmitter, the receiver was assembled on a double-sided printed-circuit board (this one measuring 3³/₁₆ by 2³/₁₆ inches). Both foil patterns are shown here.*

rect any deficiencies before proceeding. Finally, install the ICs in their respective sockets on the transmitter and receiver boards.

**Testing.** Connect a 9-volt battery to the connector on the transmitter board. Plug the receiver's wall transformer into a receptacle. Set all the individual switches of S1 (on the transmitter board) and S2 (on the receiver board) off, on, or anywhere in between. Just make sure that, however you set the switches, the setting of S1 matches that of S2. Temporarily connect a SPST switch between the input and ground terminals of SO1 on the transmitter board. Next turn your attention to S3 on the receiver board. Set S3-a and S3-b to the "on" position, and S3-c and S3-d to the "off" position. LED1 should be extinguished, while LED2 and LED3 should light either red or green.

Close the test switch connected to SO1 of the transmitter board; LED1 on the receiver board should momentarily light red (blink) for two seconds and then turn off, LED2 should light red and remain lit, and LED3 should change color. Open the input switch, and LED1 should blink green, LED2 should light green and remain lit, and LED3 should remain as it was.

If the two circuits perform as expected, set S3-a and S3-d to the "off" position, and S3-b and S3-c to the "on" position. Press S4 to change LED2 to green (assuming that it is not already green). Close the test switch connected to SO1 of the transmitter board; LED1 of the receiver board should blink red, LED2 should light red and remain lit, and LED3 should change color. Open the input switch; LED1 should blink green, LED2 should remain red, and LED3 should not change. Press S4, and LED2 should change to green.

Set S3-a and S3-d to the "on" position, and S3-b and S3-c to the "off" position. Press S4 to change LED2 to red, assuming that it is not already red. Close the test switch connected to SO1, and LED1 should blink red, LED2 should remain red, and LED3 should change color. Open the test switch; and LED1 should blink green, LED2 should change to green, and LED3 should remain unchanged. Press S4, and LED2 should change to red.

Repeat each of the above tests a few times after changing the S3 switch settings, as some toggling of the latch may occur during the setting of the switches. Table 1 illustrates the functions.

**Applications.** The transmitter sends a unique digital code when the input toggles from low to high, likewise when it goes from high to low. A low is defined as any voltage below a threshold of +1.2 volts (extending down to −50 volts). A high is defined as any voltage greater than +1.2 volts (up to +50 volts).

The transmitter inputs can be driven from TTL or CMOS devices and circuits, or from a computer, micro-

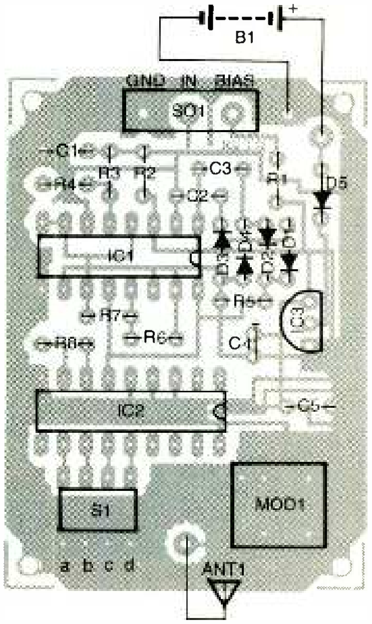



*Fig. 5. Use this parts-placement diagram as a guide when assembling the transmitter board.*

## PARTS LIST FOR THE WIRELESS-CONTROL RECEIVER

**SEMICONDUCTORS**

IC4—HT692 (Holtek) $3^{10}$ address decoder, integrated circuit (Digi-Key HT-692)
IC5, IC7, IC8—TC4427 (Telcom) dual 1.5-amp peak, inverting, FET power-driver, integrated circuit (Digi-Key TC4427CPA)
IC6—CD4013 dual D-type, flip-flop, integrated circuit
IC9—7812T 12-volt, 1-amp, fixed-voltage regulator, integrated circuit
IC10—78L05 5-volt, 100-mA, low-power, fixed-voltage regulator, integrated circuit
LED1–LED3—Bi-color light-emitting diode (Mouser 604-L937EGW)
MOD2—RXM-418-LC receiver module (see text)

**RESISTORS**

(All resistors are 1/8-watt, 5% units.)
R9—390,000-ohm
R10, R11—1-megohm
R12–R14—470-ohm

**CAPACITORS**

C6—1000-µF, 25-WVDC, electrolytic
C7, C8—0.1-µF, 50-WVDC, metalized-film
C9—100-µF, 10-WVDC, electrolytic

**ADDITIONAL PARTS AND MATERIALS**

S2, S3—4-position DIP switch (Jameco 139002)
S4—SPST momentary contact, push-button switch (Mouser 101-0461)
T1—12-volt, 200-mA DC, wall transformer (Jameco 114825)
ANT2—6.7-inch antenna wire (American Electromechanical ANT6.7)
SO2—9-position terminal block (see text)
Printed-circuit board, IC sockets, LED standoffs (Mouser 593-STD280), wire, solder, hardware, *etc.*

**Note:** The following items for the Wireless Control are available from Glolab Corp., 134 Van Voorhis, Wappingers Falls, NY 12590; e-mail: kits@glolab.com; Web: *http://www.glolab.com*: A complete kit of parts for the transmitter—containing an etched, screened, and drilled double-sided printed-circuit board with mounted transmitter module and all resistors, capacitors, ICs, *etc.*; instructions and schematic—for $39 (specify part KT418S2): a complete kit of parts for the receiver—which includes an etched, screened, and drilled double-sided printed-circuit board with mounted receiver module and all resistors, capacitors, ICs, *etc.*; instructions and schematic—for $58 (specify part KR418S2): an etched, screened and drilled double-sided transmitter PC board only with transmitter module mounted, instructions and schematic—for $26 (specify part BT418S2): an etched, screened, and drilled double-sided receiver PC board only with receiver module mounted, instructions and schematic—$35 (specify part BR418S2). Add $5 shipping for all orders. New York State residents, please add appropriate sales tax. Please allow 6 to 8 weeks for delivery.

processor, or other logic circuit. In fact, the input device can be something as simple as a pushbutton switch connected between the "IN" and "GND" terminals of SO1. In such an arrangement, when the switch is open, the input is pulled high through R2. Closing the switch grounds the input (pulls it low).

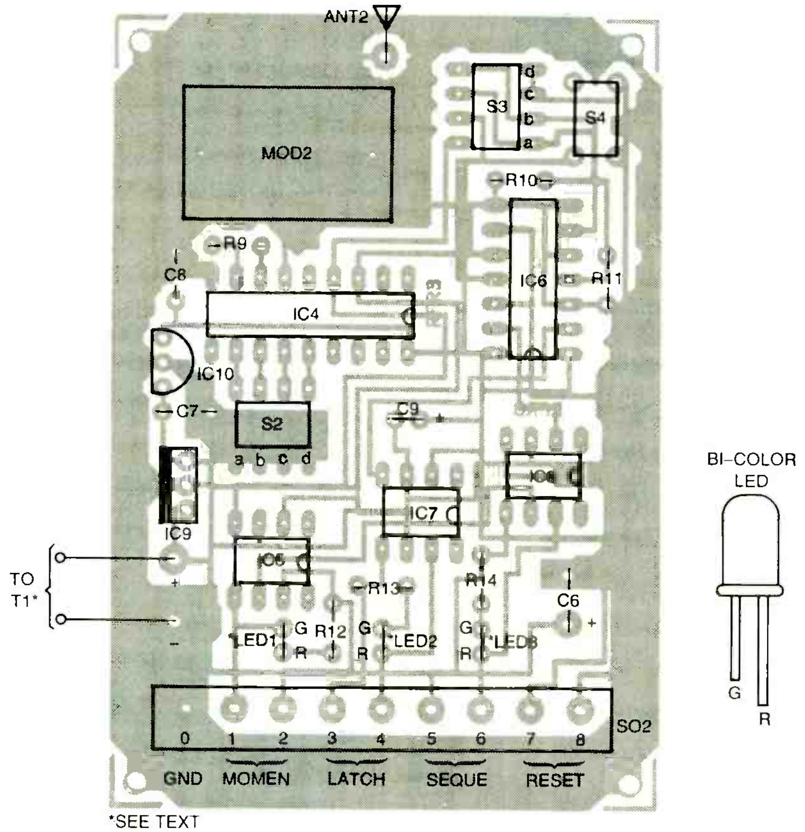



*Fig. 6. Guided by this parts-placement diagram, assemble the receiver board, making sure that all components are installed in the proper locations and that the polarized components are properly oriented.*

Although a pushbutton switch is used as an example, most any type of switch—magnetic reed, thermostat, a pair of metal probes (in a moisture-detector arrangement), interlaced printed-circuit traces (a homebrew touch-switch arrangement), light-dependent resistor, transistor, *etc.*, to name a few—can be used as the trigger device. In the case of the homebrew touch-switch and other arrangements wherein a bias voltage may be required, a potentiometer can be connected from the "BIAS" terminal to the signal IN terminal of SO1, allowing you to set the transmitter's input trigger level.

The output of the receiver can be used to drive any number of devices. For example, an LED or buzzer and an appropriate current-limiting resistor can be tied between any output and ground to indicate the occurrence of some event detected by the Wireless Control transmitter.

Alternatively, an optoisolator/coupler (with transistor, digital logic, or SCR output) or a relay could be connected to any output along with a current-limiting resistor and used to trigger some other circuit. The possible applications for the Wireless Control's are immense. ■

# TAPPER

JOHN F. MASTROMORO


*Try this updated electronic version of the old key-chain style tip-and-tap games of the past.*

Having idle time on your hands can sometimes be frustrating. Coffee breaks and work breaks can usually be accounted for, but I'm referring to those times we just sit around doing no-brainers.

At one time, those small key-chain ball-in-hole games were quite popular. The idea behind those games was to maneuver any number of balls to fill an equal number of holes on a cardboard base. The games, as simple as they were, were convenient and challenging enough to provide a few minutes of fun. Every once in a while, I see someone juggle two or three metal balls in a hand and wonder if that's the modern day equivalent!

*Tapper*, the game presented in this article, is designed around those ball-in-hole games. Although Tapper takes a slightly different approach, the object of the game is essentially the same. Briefly, Tapper contains three small ball bearings confined within a ridged and covered area festooned with pairs of metal contacts (target pins) that must be shorted together (bridged) in a given time frame and in a particular order.

Play is initiated by manipulating the ball bearings—tapping and tipping the unit—so that one or more bridge a pair of "start" target pins. After these pins have been bridged, an indicator lights, pointing to the next set of target pins to be bridged. The player must successfully bridge each set of target pins within the stipulated time in order to win. If the player fails to do so, Tapper shuts down and can only be re-initiated by again bridging the two "start" target pins. Each time a pair of target pins is successfully bridged, a hit is registered, causing a short tone to sound.

**A Look at the Circuit.** A schematic diagram of the circuit is shown in Fig. 1. The circuit is comprised of little more than a 4093 CMOS quad NAND Schmitt trigger (IC1); a 4017 CMOS decade counter/divider (IC2) with ten decoded outputs (only one of which can be high at any given time); ten 1N914 general-purpose, small-signal switching diodes (D1–D10); eight light-emitting diodes (LED1–LED8); a piezoelectric buzzer (BZ1); nine target pins (HS and H1–H8—which are actually multiple sets of bridgeable-metal contacts); and a handful of support components.

At the heart of the circuit is counter/divider IC2, whose ten decoded outputs (Q0 through Q9) sequentially go from low to high. Nine of IC2's ten available outputs, Q0–Q8, are tied to target pins HS and H1–H8, while the Q9 output is applied to pin 13 of IC1-d through a 1k resistor (R5). Play is initiated by momentarily bridging the start (HS) target pins with a small metal ball. Prior to the start of play (before the start pins have been bridged), the circuit remains in its default (or standby) mode. In the standby mode, the Q0 output of IC2 is high, while all other outputs are low.

Since the HS target pins haven't been bridged, no trigger pulse is applied to the input of IC1-a. Under that condition, the input to IC1-a—which is configured as an inverter—is pulled low through R1 (a 10-megohm resistor), causing its output to go high.

The high output of IC1-a divides along two paths. In one path, that signal is applied to the positive clock input of IC2 at pin 14. In the other path, the high output of IC1-a is fed to IC1-b (also configured as an inverter), causing its output to go low. That low travels along two paths; in the first path, the output of IC1-b is fed to the pin 13 input of

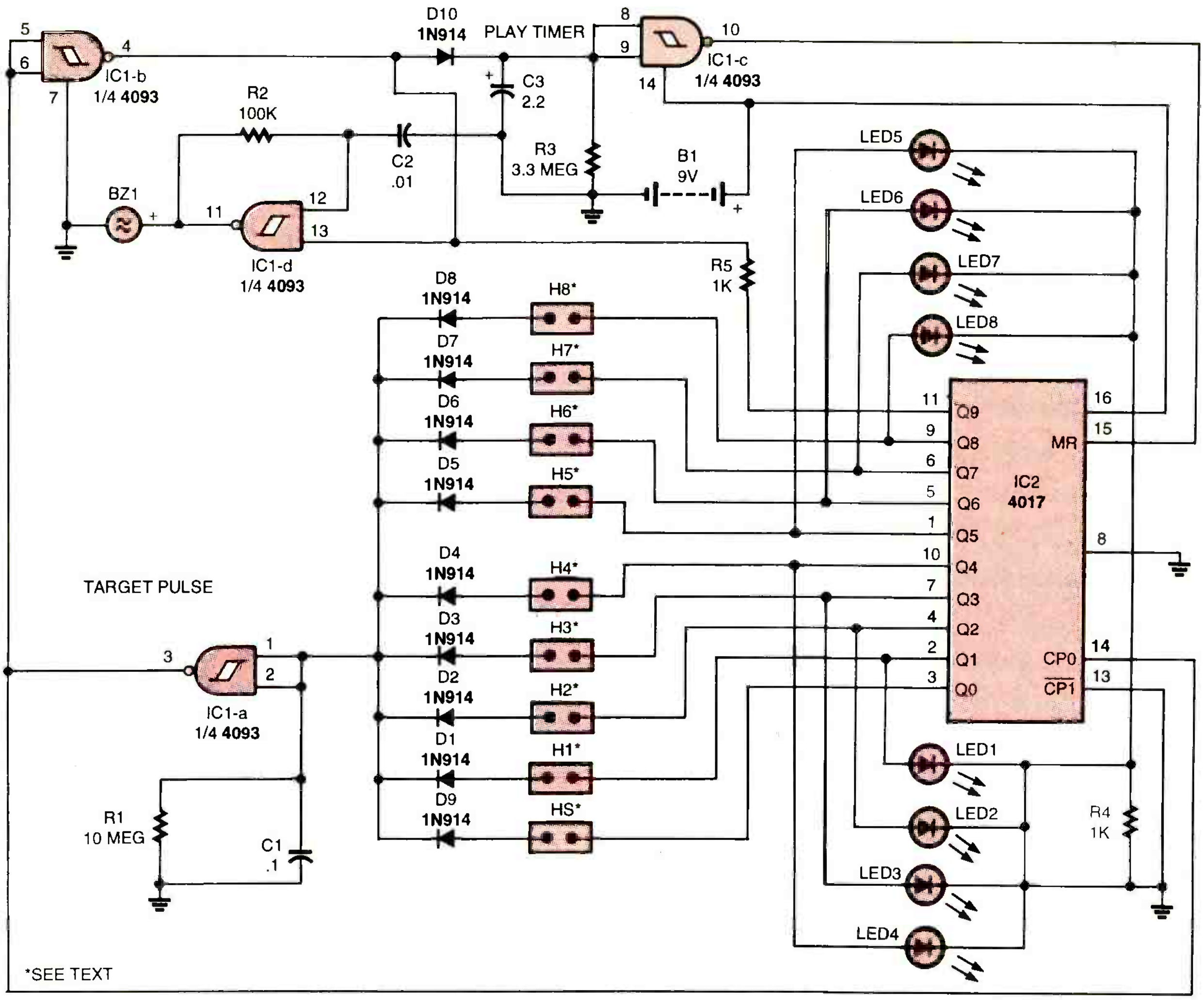



*Fig. 1. Tapper is comprised of little more than a 4093 CMOS quad NAND Schmitt trigger (IC1); a 4017 CMOS decade counter/divider (IC2); ten 1N914 general-purpose, small-signal switching diodes (D1–D10); eight light-emitting diodes (LED1–LED8); a piezoelectric buzzer (BZ1); nine pairs of target pins (H1–H8 and HS); and a handful of support components.*

IC1-d. In the other path, the low output of IC1-b is fed to the inputs of IC1-c (which like IC1-a and IC1-b is configured for inverter operation), forcing its output high. That high is applied to the master reset (MR) input of IC2 (causing it to maintain its default or reset condition).

When play is initiated, a positive pulse is fed through D9 to the inputs of IC1-a, causing its output to go low for a time determined by the R1/C1 time constant. With the values expressed for R1 and C1, the time delay is approximately 1 second—sufficient time to keep the ball from causing erratic inputs to IC1-a. The combination of R1 and C1 debounce IC1-a. (**Note**: The cathodes of D1–D9 are wired to the inputs of IC1-a and are included in the circuit to prevent shorting between the active and inactive outputs of IC2.) Once the delay has timed out, pin 3 of IC1-a returns to its normal positive state. During that time, IC2 increments to the next sequential output (target).

The low output of IC1-a is fed to both the positive clock input of IC2 at pin 12 and to IC1-b. The signal causes the output of IC1-b to go high. The high output of IC1-b at pin 4 divides along two paths. In one path, the output of IC1-b is fed through D10 to a third NAND Schmitt trigger, IC1-c, at pins 8 and 9. Note that pins 8 and 9 of IC1-c are tied to a time-delay network (the play timer) comprised of R3 and C3. The R3/C3 time constant sets the period of the play timer to approximately six seconds. The high output of IC1-b causes C3 to begin charging. The charge on C3 is then discharged through R3.

Each positive output pulse produced by IC1-b replenishes the charge on C3, resetting the play timer to six seconds. As long as the charge on C3 remains above half the supply voltage, the output of IC1-c at pin 10 remains low, allowing play to continue. If, on the other hand, C3 completely discharges during play, the inputs to IC1-c are pulled low, causing its output to go high, resetting IC2 and causing any lit LED to extinguish. At that point, the game must be restarted.

The high output of IC1-b applied to IC1-c forces its output low. That low is applied to the master reset (MR) terminal (pin 15) of IC2, disabling the chip's master reset and allowing the counter/divider to count up sequentially whenever a low-to-high transition is registered at its clock input (pin 14).

In the other path, the output of IC1-b is fed to pin 13 of IC1-d, which is configured as an oscillator and is used to drive the piezoelectric buzzer (BZ1). When the output of IC1-b at pin 4 goes high, the oscillator is enabled, causing it to output a frequency that's determined by a timing network comprised of R2 and C2. Once triggered, the piezoelectric buzzer sounds for approximately 1 second. At the end of that timing period, pin 4 of IC1-d returns to its low state. Resistor R5 is included in the circuit to prevent shorting between pin 13 of IC1-d and the Q9 output (pin 11) of IC2.

After scoring on target pins H8, pin 11 (Q9) of IC2 goes high, enabling IC1-d and causing BZ1 to sound for as long as the play timer is active. When the play timer deactivates, the game automatically shuts off. A new game is initiated by bridging the HS contacts.

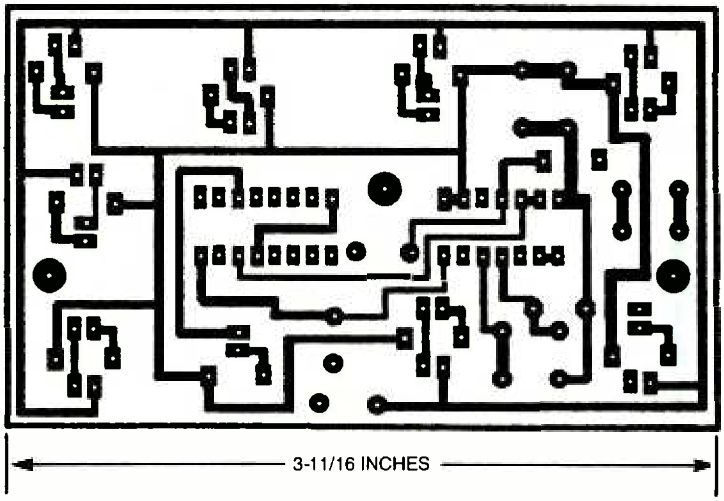



*Fig. 2. The author's prototype was assembled on a small double-sided printed-circuit board, measuring 3 $^{11}/_{16}$ by 2 $^{3}/_{16}$ inches. A full-scale template of the foil (non-component) side of the board is shown here.*

**Construction.** The author's prototype was assembled on a small double-sided printed-circuit board, measuring 3$^{11}/_{16}$ by 2$^{3}/_{16}$ inches. A full-scale template of the foil (non-component) side of the board is shown in Fig. 2, while the component side is shown in Fig. 3—for the do-it-yourselfer. For those not etching their own double-sided board, the board can be purchased from the supplier listed in the Parts List.

Instead of beginning construction by stuffing the circuit board, the reader must use the board to prepare the enclosure that'll house the unit. Begin enclosure preparation by centering the board (with the component side facing you) to the inside (sunk-in) bottom of the lid. The sunk-in bottom side of the lid will later serve as the playing area. It's important to center the board and then tape it securely in place!

Using a sharp-pointed object (or a mechanical pencil with a 0.5- or 0.7-mm lead), mark the lid through all pads where LEDs, target pins, and mounting hardware are indicated. Press *only* hard enough to make the indentations, or pencil marks, noticeable for later drilling. When finished, remove the tape and circuit board from the lid.

Drill holes through the lid for the target pins and mounting hardware *only*. The holes for the target pins were drilled with a #75 (0.021) drill bit, while those for the mounting hardware (three screws) were handled with a $^{1}/_{8}$-inch bit. Prior to and while drilling the holes, be careful not to make any unnecessary marks on the playing area. (Even seemingly minor surface blemishes in the play area can dramatically increase the difficulty of play.) It's very important that all holes be drilled perpendicular to the surface of the play area. Using a drill press is highly recommended.

Locate the pads for the LEDs. With a $^{1}/_{8}$-inch bit, drill through the lid at the points marked for the LEDs.

A parts-placement diagram for Tapper's printed-circuit board is shown in Fig. 4. With the component side of the circuit board facing you, install the ten diodes on the board and trim any excess leads. After that, place the ICs flat to the board

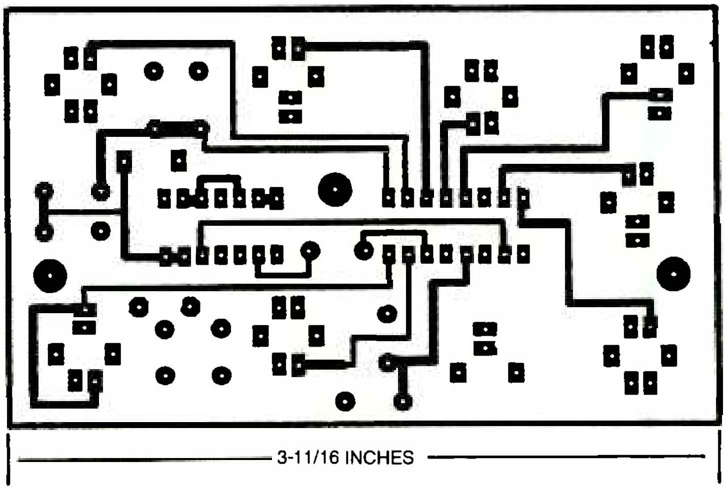



*Fig. 3. A full-scale template of the component side of Tapper's printed-circuit board is shown here. If you plan to etch your own printed-circuit board, be sure that the two foil patterns line up. If they don't, you'll either have great difficulty in getting the circuit to work or it won't work at all, depending on how far off the mark the registrations are.*

with the proper orientation and solder them in place on both sides of the board to ensure good connections. Try not to use excessive solder. Follow the ICs with the resistors and capacitors (in that order). Before soldering the capacitors in place, leave about ¼-inch lead on them so that you can bend them each over horizontal to the board. Be sure that C3 (a polarized, electrolytic capacitor) is properly oriented!

When that is complete, check the assembly for the usual construction errors—cold solder joints, misoriented or incorrectly placed, components, *etc.* When satisfied that all is well, move on to the next step.

From the component side of the board insert the eight LEDs, making sure that they are properly oriented. **Do not** solder them in position at this point! Instead, push the mounting hardware (three screws) through the lid holes from the top sunk-in side and place screw-on spacers on the screws. Attach them tightly. Hold and adjust the circuit board so that it can be screwed down to the spacers from the foil side of the board (*i.e.*, with the component side facing the flat top-side of the lid). Be sure the board is even and tightly secured.

Place the lid (sunk-in side up), with the circuit board attached, on the enclosure. Make sure that the lid-mounted, circuit-board assembly fits easily into its housing and that the lid lays evenly on the bottom half of the enclosure with no obstructions. When satisfied, remove the lid assembly from the bottom portion of the enclosure and flip it over so that the circuit board's foil side faces up.

Adjust the eight LEDs, one at a time, pushing them into their respective holes in the lid so that they protrude evenly. Solder each LED in place (from the foil side *only*) as you go along. When finished, trim any excess lead length and remove the three mounting screws holding the circuit board to the spacers. Place the circuit board on the table, foil-side down. Do not disturb the leads of the LEDs.

Solder the leads of a 9-volt battery connector to the circuit board, red wire to the positive (+) and black to the negative (–) pad. On

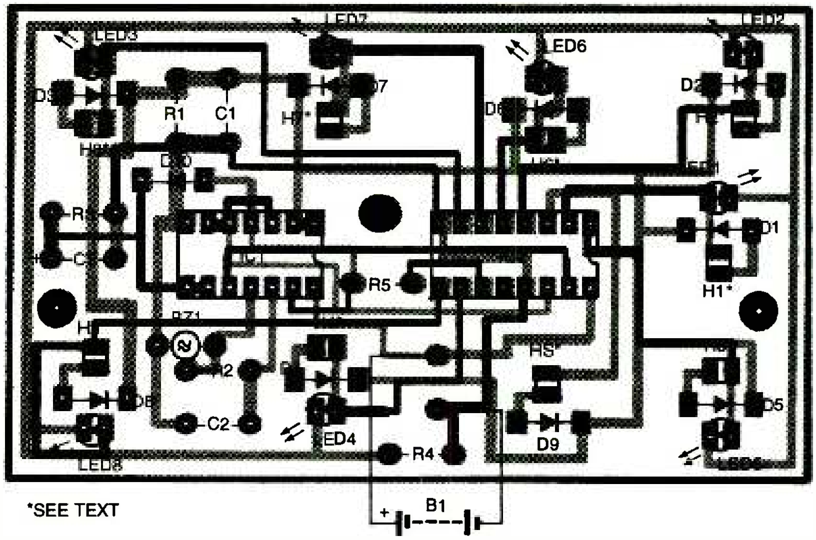



*Fig. 4. Assemble Tapper's printed-circuit board guided by this parts-placement diagram. But before starting down that "road," it is necessary to prepare the enclosure that'll house the unit. (See text for details.)*

the foil side of the board, solder short lengths (approximately 1-inch) of bare wire to each of the BZ1 pads, touch-solder the piezoelectric buzzer to the bare wires, and place a piece of tape between the body of the buzzer and the circuit board.

**Circuit Pre-test.** Check all solder connections and make sure that all components are properly oriented. If that checks out, connect a 9-volt battery to the battery connector and, using a small flat-head screwdriver, lightly press the tip to short the HS target pads. You should hear a short tone and LED1 should light. Within 12 seconds, short the screwdriver across the H1 target pads; again the buzzer should sound.

Again bridge the HS target pads; LED1 should light. Do nothing at this point but count the seconds until LED1 extinguishes. That is the play timer test. Temporarily remove the piezo element from the two wires for the final step.

**Target Pins.** Securing the target pins to the circuit board is the final step in assembling the project. Before beginning that process, remove the battery from the battery connector. Re-attach the circuit board tightly and evenly to the spacers, making sure that all the LEDs are placed into their respective holes in the lid with no obstructions. Check the sunk-in playing area to see if all the LEDs are evenly displayed—this is your last opportunity to make easy adjustments. When you're satisfied, place and solder the target pins to the board. The target pins (common straight pins) can be purchased through any craft or department store. The circuit should be working properly; if not, do not continue!

With a fine abrasive cleaning strip, completely rub the shine from all of the pins and the ball bearings. Rub the ball bearings on a strong magnet a few times. From the sunk-in side of the lid, insert all of the target pins into their respective holes, while holding the board and enclosure *sideways* on a flat table top. Make sure each pin goes straight through the hole in the lid and its associated circuit-board pad. Watch out for the pin tips when performing this operation. Place a stiff piece of thin cardboard over the pin heads that are protruding through the sunk-in side of the lid, flip the entire assembly over onto a flat table top, and slide out the cardboard. The pin heads should all drop down even with the top of the sunk-in lid top.

Press down with a flat screwdriver tip and solder each of the pins from the foil side of the board. When that's done, check your work

## PARTS LIST FOR THE TAPPER

**SEMICONDUCTORS**

IC1—4093 CMOS quad 2-input NAND Schmitt trigger, integrated circuit
IC2—4017 CMOS decade counter/divider, integrated circuit
D1–D10—1N914 or equivalent, general-purpose, small-signal diode
LED1–LED8—Red T1-size, light-emitting diode (Jameco #114673)

**RESISTORS**

(All resistors are ¼-watt, 5% units.)
R1—10-megohm
R2—100,000-ohm
R3—3.3 megohm
R4, R5—1000-ohm

**CAPACITORS**

C1—0.1-µF, ceramic-disc
C2—0.01-µF, ceramic-disc
C3—2.2-µF, 16-WVDC, electrolytic (see text)

**ADDITIONAL PARTS AND MATERIALS**

BZ1—Piezoelectric buzzer (Jameco #138763 or RS#273-073)
B1—9-volt transistor radio battery
H1–H8, HS—1-1/16-inch steel pins (Singer Item #00236)
Printed-circuit materials, battery connector, plastic enclosure, 1/16-inch thick clear plastic sheet, ½-inch hex female threaded aluminum spacers (Jameco #133639), ball bearings, wire, solder, hardware, *etc.*

**Note:** The following items are available from JFM Compositions, 9 Mechanic St., St. Johnsville, NY 13452; A pre-drilled double-sided printed-circuit board and three ball bearings for $10 (check or money order only). Price includes shipping and handling. Please allow 4 to 6 weeks for delivery.
Jameco parts can be ordered from Jameco Electronic Components/Computer Products, 1355 Shoreway Road, Belmont, CA 94002-4100; Tel. 650-592-8097; Fax: 800-237-6948 (domestic), 650-592-2503 (international); Web: www.jameco.com.

to make sure that all pin heads are even. If not, make any necessary adjustments. When satisfied, point the board away from you and trim the pins from the foil side of the board.

When finished, trim the bare wires on the circuit board that were used for the piezoelectric buzzer to about ¼ inch and re-solder the piezo element to them. Connect the battery. Lightly wet your finger and press it across the HS target pins. A tone should sound and LED1 should light, indicating that its target pins are active. Continue on in that manner until all target pins have been tested. Remember the timing between scoring!

Lay the battery flat on its side on the inside bottom surface of the enclosure and tape it down. Make sure that the battery is secured to the end of the enclosure opposite the buzzer. Place a thin piece of cardboard or tape over the battery to prevent it from shorting against the circuit board. Place the lid assembly onto the enclosure.

If you intend to apply decals to the enclosure, do so now. When this step is completed, cut a piece of 1/16-inch clear plastic to fit neatly across the top of the entire playing area. The mounting screws for the circuit board are used as bumpers in the game; decals (dots) can be placed over them if you like.

Drill holes in the clear plastic to accommodate the lid mounting screws. Put the ball bearings into the sunk-in playing area. Place washer(s) between the enclosure lid and the clear plastic cover, and insert screws to secure the lid assembly and plastic cover to the enclosure bottom. Tighten the screws enough to keep the ball bearings from escaping their confinement without restricting their free movement.

**Playing Tapper.** Once the HS target pins are bridged (transferring a voltage from one target pin to the other), two things happen. First, the play timer is automatically set to approximately 12 seconds. Second, LED1 lights, and its target pins go active and must be bridged via a ball bearing within the remaining play time or the game automatically shuts down. One playing option is slightly magnetizing the ball bearings; magnetizing the ball bearings causes them to attach to each other and/or the target pins when they come in contact. A slight tap then causes the balls to rotate around the pins, completing the electrical circuit and scoring. After playing the game a few times, you will see that the magnetic properties of the balls can either be an advantage or disadvantage.

Let's assume the player has successfully bridged the HS target pins. That produces a short tone and causes LED1 to light, indicating that the HS target pins are active. The player then tries to maneuver the ball(s) to bridge the H1 target pins within the 12-second play time. If the player succeeds in bridging the H1 target pins within the specified time frame, LED2 lights, indicating that its target pins are now active and that the player now has another 12 seconds in which to bridge the H2 target pins. The player continues in that manner until all eight target pins have been bridged, making the player a winner.

**Note:** The play time depends on the values of R3 and C3. With the values shown in the schematic diagram, play time is a minimum of approximately six seconds (a real challenge). Increasing or decreasing either R3 and/or C3 proportionally adjusts play time to your satisfaction. The easy way to change the play time without removing the circuit board from the lid is to touch-solder another capacitor in parallel with C3; that can be done on the foil side of the board. Using a 3.3-µF capacitor gives about 12 seconds of play time.

**Playing Hints.** Because of the strategy behind the game, Tapper seemed an appropriate name. Due to the light weight of the ball bearings, the player quickly realizes that tapping and tipping the enclosure is the only way to maneuver the balls around the playing area. Now the skill comes in appropriately doing this so that the balls hit and bridge the target pins with enough momentum to make a good electrical contact!

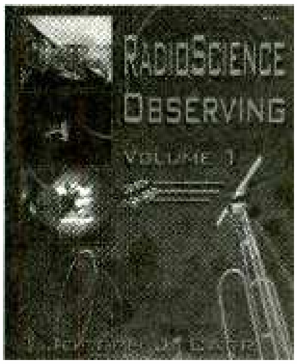
There will be times when it will appear that you've successfully bridged a set of target pins, but the circuit doesn't respond as expected—that's normal during play and is not a flaw in the game. You'll get a feel for how to tap and tip the game to score.

If the balls are magnetized, slightly tapping the enclosure causes the ball(s) to rotate around the pins, eventually bridging them and thereby scoring. ■

# Electronics Library

## RADIOSCIENCE OBSERVING, VOLUME 1
*by Joseph J. Carr*

Among the hottest radio topics right now are those related to radio astronomy, propagation studies, whistler and spheric hunting, searching for solar flares using very low frequency radio, and related subjects. In this volume, readers will find chapters on all these topics and more. RadioScience, the term that covers this field, was coined by the author, a columnist for this magazine.




Aimed at amateur scientists and radio hobbyists, this book provides an introduction to the field, with more in-depth studies to follow in future volumes. The last chapter, contributed by Dr. H. Paul Shuch, discusses SETI, the search for extraterrestrial intelligence.

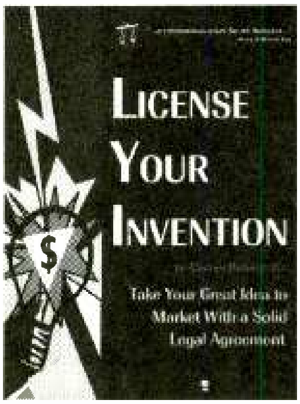
The included CD-ROM contains numerous examples of radio frequencies to help you learn how to identify them. It also contains information on celestial bodies, providing information about the natural radio signal generators of our solar system and beyond.

*RadioScience Observing, Volume 1 costs $29.95 and is published by Prompt Publications, Howard W. Sams & Company, 2647 Waterfront Parkway, East Drive, Suite 300, Indianapolis, IN 46314-2041; Tel. 800-428-7267; Web: www.hwsams.com.*

**CIRCLE 90 ON FREE INFORMATION CARD**

## LICENSE YOUR INVENTION
*by Richard Stim*

An attorney and intellectual property expert, the author tells inventors




everything they need to know to be able to enter into a solid licensing agreement. In addition, the book explains how to show the invention to others without getting ripped off.

There are detailed instructions on working with manufacturers, marketers, and distributors who handle the details of merchandising an invention. Inventors are shown how to draft a license that will be fair to all parties. Sample tear-out agreements for patenting an invention in the U.S. are provided, and all the necessary licensing forms are on the included disk.

*License Your Invention costs $39.95, and is published by Nolo Press, 950 Parker Street, Berkeley, CA 94710; Tel. 510-549-1976; Fax: 510-548-5902; Web: www.nolo.com.*

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## THE ARRL HANDBOOK CD, VERSION 3.0: 1999 EDITION
*edited by R. Dean Straw, N6BV*

Several generations of hams, students, engineers, and technicians have found *The ARRL Handbook* to be the best all-around electronics reference. Available in a convenient, easy-to-use CD-ROM format, the 76th edition contains new projects, such as a 13.8 V/40 A switching power supply.

In addition to the complete text and illustrations from the paper edition (which costs $32), this CD-ROM includes a powerful search engine and tools to create bookmarks for easy return to often-used topics. Text and illustrations can be printed or pasted into the other Windows applications.

All of the "template packages" from


the Handbook are found on the CD. Also included is utility software for filter design, transmission analysis, and more. Minimum requirements are a 386 PC, 4MB of RAM, 6MB of available hard disk space, Windows 3.x, VGA graphics, and a sound card.

*The ARRL Handbook CD, Version 3.0: 1999 Edition costs $49.95 and is published by American Radio Relay League, 225 Main Street, Newington, CT 06111-1494; Tel. 800-243-7767; Fax: 860-594-0303; Web: www.arrl. org.*

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## POLICE CALL: 1999 EDITION
*edited by Richard Barnett*

Considered "the scanner users' bible," the 1999 edition is the largest ever. There are nine regional volumes, containing over 350,000 frequencies. Volume 1 covers New England.

In addition to emergency agencies such as Police and Fire, the books list two-way radio frequencies for 18 additional categories including aircraft, federal government, transportation, sports, entertainment, and more.

*Police Call: 1999 Edition costs $12.99 per volume, plus $3.95 S&H, and is published by Hollins Radio Data, P.O. Box 35002, Los Angeles, CA 9003; e-mail: scangene@aol.com; Web: www.policecall.com.* ■

**CIRCLE 93 ON FREE INFORMATION CARD**

# Think Tank

## The Bipolar Transistor and Some New Designs

ALEX BIE

In this month's "What is a ...?" series, we review a semiconductor device that dates back to the discovery of the transistor. The bipolar junction transistor is used today in vast quantities, both as a discrete component and inside integrated circuits. It is a versatile device found in many applications and circuits, and it can be used over a wide range of frequencies.

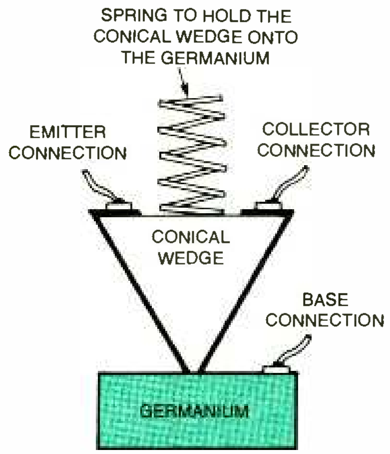



*Fig. 1. The original point-contact transistor—dating back to 1947.*

The bipolar transistor is over 50 years old. Three scientists—Bardeen, Brattain, and Shockley—working at Bell Laboratories in the 1940s discovered the device. The scientific trio had been researching an idea for a field-effect device, but they had been unable to make it work. And as they had not been able to discover why the device did not function, they decided to follow some other lines of research. In doing this, they came across the idea for the bipolar transistor, shown in Fig. 1, and in late 1947 they succeeded in making this device work.

Only a week after its initial discovery, the team demonstrated its results in front of a group of executives at Bell Laboratories. The device they showed was called a "point-contact transistor," because it consisted of two metal contacts placed close to one another on a piece of N-type germanium.

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

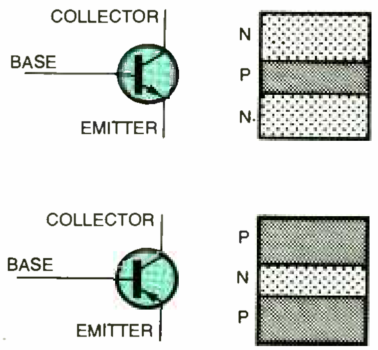



*Fig. 2. Transistor symbols and structure diagrams.*

During the 1950s other types of transistors based on the same principle were developed. These included the junction transistor, which is "grown" from two junctions fabricated on the same substrate.

It took some while for transistors to become generally accepted. Initially they were very expensive and their performance was poor. However, at the beginning of the 1960s, transistor prices began to fall and their use rose dramatically. Now the world would not be the same without them.

### The Structure

In practice, the internal structure of the transistor can be made either in a PNP composition, where an N-type region is sandwiched between two P-type regions, or an NPN structure, where the center section is of P-type material (see Fig. 2).

The center region is called the base. It derives its name from the first point-contact transistors where the center connection also formed the mechanical base for the structure. It is essential that the base region be as thin as possible if high levels of current gain are to be achieved. Often it may only be about 1 µm (one millionth of a meter) across.

A variety of different structures are used to make transistors today. The diagram in Fig. 3 illustrates two of them.

### How They Work

So, let's now look at how the bipolar transistor works. Simply speaking, the transistor can be considered as two PN junctions that are placed back to back. In operation, for an NPN device, the base-emitter junction is forward biased and the base-collector

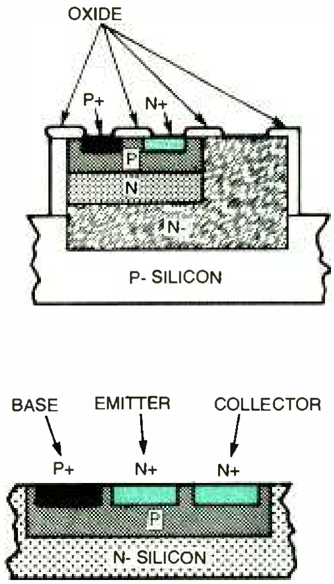



*Fig. 3. Some transistor structures in use in today's electronics.*

junction is reverse biased, as shown in Fig. 4. When a current flows through the base-emitter junction, a corresponding larger current is seen to flow in the collector circuit.

The same is true for a PNP transistor except that holes are the majority carriers instead of electrons, and the bias voltages are reversed.

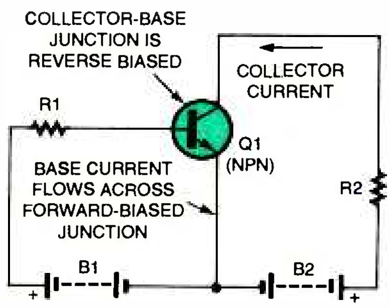



*Fig. 4. Transistor operation (NPN device shown). Forward bias the base-emitter junction and reverse bias the base-collector junction to allow current flow.*

### Collector-Base Junction

Take a look at Fig. 4. This base-collector junction is reverse biased, and remember that the majority carriers in the N-type region are electrons, and in the P-type region they are holes (this effect was described in the April 1997 *Think Tank*). In an N-type region there are free electrons that are able to move around the lattice structure of the semiconductor. Similarly, in a P-type region, there are free holes.

When this base-collector junction is reverse biased (*i.e.*, NPN device), the electrons move from the N-type region towards the P-type region and the holes move towards the N-type region. Finally when they reach each other they combine, enabling a current to flow across the junction. Should this junction be forward biased, the holes and electrons move away from one another resulting in a depletion region between the two areas, and no current flows.

In the case of the transistor, the second junction, between the base and emitter, plays a vital role. In operation, when a current flows between the base and emitter, electrons leave the emitter and flow into the base. Normally the electrons would combine when they reach this area; however, the doping level in this region is very low, and the base is also very thin. This means that most of the electrons are able to travel across this region without recombining with the holes. As a result, the electrons migrate towards the collector, because they are attracted by the positive potential. In this way, they are able to flow across a reverse-biased junction effectively, and current flows in the collector circuit.

The collector current is significantly higher than the base current. The ratio of the collector to base current is given the Greek beta symbol "β" (small-signal forward-current transfer ratio). Typically the ratio β may be between 50 and 500 for a small-signal transistor. This means that the current in the collector will be between 50 and 500 times that which is flowing in the base. For high-power transistors, the value of β is likely to be smaller, with figures around 20 being not unusual.

### Current Amplification

The transistor is a current-amplifying device, unlike the vacuum tube and the field-effect transistor (FET), both of which depend upon voltage changes to operate. It is the amount of current flowing in the base circuit that controls the amount of current flowing in the collector circuit. And although it is a current-operated device, the bipolar transistor can be used in just as many applications as FETs, proving to be more suitable in many applications.

In next month's column, we will look at the photo diode—an unusual semiconductor that is used in various commercial applications ranging from commonplace CD players to sophisticated wide-bandwidth optical telecommunications systems.

In this month's reader contributions, we have two designs by Craig Kendrick Sellen of Waymart, PA—nice going!

## TONE-RINGING GENERATOR

The circuit in Fig. 5 is a simple tone-ringing generator or ringing oscillator that has many applications. For instance, it can be used as an alarm for electronic devices or toys and other input-voltage-level-sensing circuits.

The 741 op-amp is wired as a bandpass filter, but when a pulse of at least 5-volts peak shocks its input, the bandpass filter becomes a ringing oscillator. Capacitors C2 and C3 and resistor R2 determine the fixed frequency and duration of the ringing signal. The 1500-ohm potentiometer, R3, can be used to vary the period of the ringing frequency. Transistors Q1 and Q2 are added to increase the power output of the op-amp to drive an 8-ohm speaker. With the values shown, the selectivity, or Q, of the filter is about 10 at a nominal frequency of 100 Hz.

*Nice simple design, Craig, I am sure hobbyists can find many uses for this type of circuit.*

## OSCILLOSCOPE-AMPLIFIER LINEARITY TESTER

The circuit, shown in Fig. 6, was designed to test any oscilloscope to see if its amplifiers are linear in operation. This is accomplished by producing an ever-expanding circle on the scope's screen.

In the design, the 2N2646 unijunction transistor, Q1, serves as a sawtooth or ramp generator. Resistors R3–R5 and capacitor C3 develop the ramp voltage. This sawtooth voltage is applied to IC1 through resistor R8. The CA3080E integrated circuit, IC1, serves as a voltage-controlled amplifier that slowly ramps up the sinewave applied to the integrated circuit through capacitor C4. The level of the

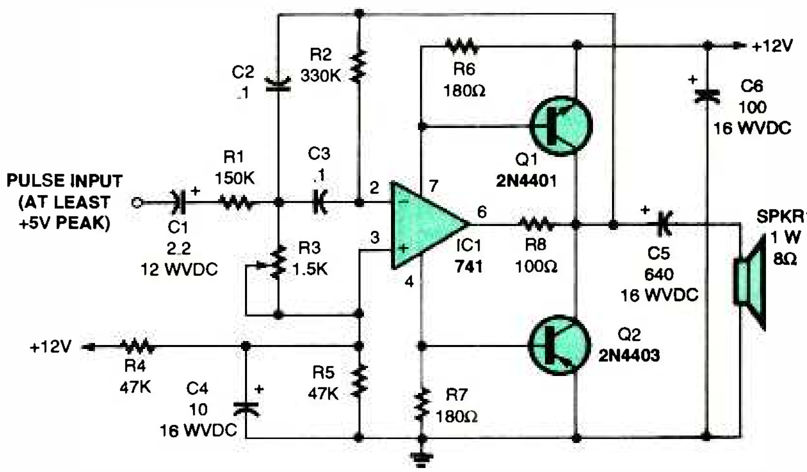



*Fig. 5. This simple tone-ringing generator circuit can be used in many applications requiring a voltage level-sensing alarm indication. The 741 single op-amp can be replaced with an NTE 941M or a Thomson SK3514 op-amp.*

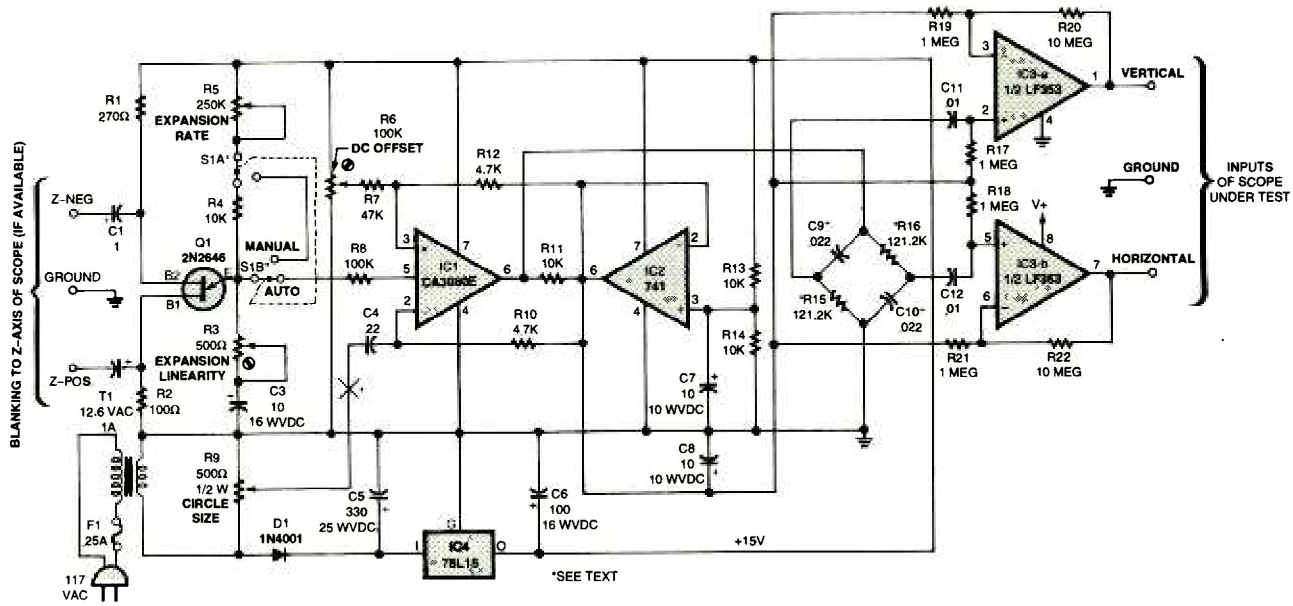



*Fig. 6. This circuit is used to check out the linearity of any oscilloscope. If the scope's amplifiers are truly linear, you should see ever-expanding circles developing on the screen.*

sinewave voltage, or circle size, is controlled by potentiometer R9. The output of IC1 is applied to the resistor and capacitor bridge network made up of R15, R16, C9, and C10. This phase-shift network shifts apart the output phase by 90º. This 90º phase shift is buffered by the LF353 dual op-amps, IC3-a and IC3-b, and is applied to the vertical and horizontal inputs of the oscilloscope under test.

If the amplifiers of the scope under test are working properly, and they are linear, a circle will appear on the screen—starting small and expanding ever larger to the outermost edges of the screen. "Expansion Rate Control" R5 governs this action, while "Expanding Linearity Control" R3 smoothes out the charging rate of capacitor C3 to produce a smooth linear expansion of the circle. Blanking to the Z-axis of the scope is applied through capacitor C1 or C2, which cuts off the beam on retrace before the start of the next circle. The 741 single op-amplifier, IC2, functions as a voltage-source reference for IC1 and IC3.

There is one adjustment to be made on the tester. DPDT switch S1 serves as a way to switch from automatic sweeping to manual sweeping, if calibration is needed for the scope. For calibration, toggle S1 to the manual position and set control R5 at midpoint. Place a voltmeter across resistor R11 and temporarily disconnect capacitor C4 from resistor R9 (this connection point is shown as an "X" in the schematic). Now adjust potentiometer R6 (the "DC Offset Control") so there is 0 volts DC across resistor R11 on the voltmeter. Now reconnect C4 to R9 and place S1 back in the automatic position. You should get a sinewave voltage across R11 in proportion to the setting of R5.

*Very practical circuit, Craig. This application could go along very well with the many oscilloscope circuits we have featured in this column. I am sure those who build this tester will contact us with additional applications. Craig also notes that for the bridge network to work properly it is important to match capacitors C9 and C10 and resistor R15 with R16 (the value of 121.2K ohms needed can be obtained by series connecting precision 120K- and 1.2K-ohm resistors together). Also capacitors C11 and C12 should be good Mylar or polystyrene-type capacitors.*

## MAILBAG

*This letter describes a handy circuit application. It is written in response to the "untapped voltage source" comment by J.C (*Letters, *December 1998) concerning the uses of old Polaroid film-pack batteries. These batteries produce about 6 volts for the flash and motor drives in the cameras.*

I have taken these old Polaroid batteries (flat devices, about 3 × 3 inches with two circular contacts on one side) from the film for over 12 years. Some household items for which I have used this source of "free energy" follow:

I have a cooking scale that uses a commercially available 6-volt battery that I have changed over to use the film-pack battery. The battery also works with a similar IR pyrometer requiring the same commercial battery. I used one battery for a rocket launcher—which worked beautifully.

With these Polaroid batteries you can run most items that require 6 volts, up to four C-cells in size, depending upon current drain. I replaced a corroded battery holder with my homemade Polaroid battery holder, to power an old Zenith AM/FM transistor radio, which runs on 6 volts. It looks tacky, but works very well! I used an old battery pack and some 10-gauge solid copper wire to make a Polaroid battery holder that lets me slip out the batteries and slip in new ones.

*—Jim Hathaway III, via e-mail*

Keep those circuits and ideas coming. For each of your circuits that appear, you'll 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. Write to *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

# ANTIQUE RADIO

## Scaling Down for the Depression

MARC ELLIS

Let's think back to the year 1929, just before the stock market crash that led to the Great Depression. It was an era of comfortable affluence. Radio broadcasting was entering its golden age, and many middle-class American living rooms were dominated by large and powerful electric console receivers.

The cabinets of table models were apt to be crafted of fine wood or elaborately decorated heavy-gauge metal. Transformers, sockets, capacitors, and other parts had beautiful individual finishes or were enclosed in decorative metal cases. The design of these early table models clearly revealed their evolution from battery receivers.

Most had tubes arranged in the straight-line "stage after stage" design typical of the earlier battery sets. And it was usual to have a separate power pack connected to the radio proper via a fat multi-lead cable—much as the battery packs of the 1920s were connected to the sets they powered. A separately purchased external speaker was also generally required, just as with the battery sets of old.

As the depression deepened, many families lost their discretionary income. Food and shelter had to be the major priorities. Little could be spared for entertainment. Yet radio could provide enjoyment, cheer, and temporary escape from care.

### DOWNPRICING BY DOWNSIZING

Radio manufacturers who wanted to tap into the potential mass market of entertainment-hungry families had to take a hard look at making their wares affordable. Fortunately, advances in radio technology were making it possible for ingenious designers to create low-cost receivers. Of course the fact that radio stations were becoming more numerous and more powerful was another factor in obtaining satisfactory reception from a minimal radio.

The 4-tube TRF set produced by the Charles A. Hoodwin Co. of Chicago is an excellent example of what might be called the first generation of minimal depression radios. It appears in a 1932 *Radio News* ad stating that the set was equal in performance to "last year's" 5-tube pentode sets (see Fig. 1). The Hoodwin schematic for the set, shown in Fig. 2, didn't include tube type numbers. However, they were all pentode (5-element) tubes. The pentode was a newly introduced type that was providing unprecedented sensitivity and power with little or no increase in a radio's parts count.

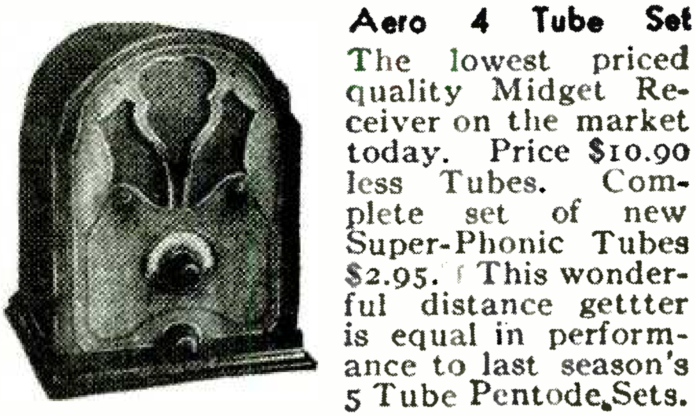



*Fig. 1. The Aero 4-tuber was one of the early "midget" cathedrals, and cost $10. A set of tubes was an extra $2.95.*

In addition to the set's overall simplicity, note another significant aspect of its design: The field coil of the Aero 4's dynamic speaker receives its energizing voltage by serving as the radio's filter choke. Thus, the manufacturer could eliminate the expensive and bulky choke, reducing the radio's size and cost still further. This design wrinkle became standard until dynamic speakers were replaced by permanent magnet types, which required no field coil.

Another design feature typified by the Aero is the integration of the speaker into the radio circuitry and the housing of the unit within the radio cabinet. As already mentioned, the table models of a previous generation required a separate speaker that had to be purchased as an accessory.

The incorporation of an internal speaker had an interesting effect on the design of radio cabinetry. As shown in Fig. 1, cabinet tops were often rounded off to follow the contours of the speakers they enclosed.

This rounded profile, combined with the elaborately cut patterns of the typical speaker grill—which resembled a stained-glass window—made some sets look like miniature churches. Today, such radios are universally called "cathedral" sets. Similar radios with squared-off tops carry the grim nickname of "tombstones."

The little 4-tube Aero sold for $10 (tubes were $2.95 extra), which may have been a lot of cash to a family on a depression budget. However, it was a sum that even a family with a limited income might hope to raise by hoarding pennies, nickels, and dimes.

### DISPENSING WITH THE TRANSFORMER

The International Kadette Universal is another interesting example of a "minimal" depression radio. Take a look at the schematic shown in Fig. 3 and you'll see that, like the little Aero, it is a 4-tube TRF receiver making use of pentode tubes. The types 39, 36, and 38 used in the RF stage, detector, and AF amplifier, respectively, are 6.3-volt types originally developed for use in auto radios. I don't have data handy on the K31 rectifier, but it is apparently a gaseous type—probably a forerun-

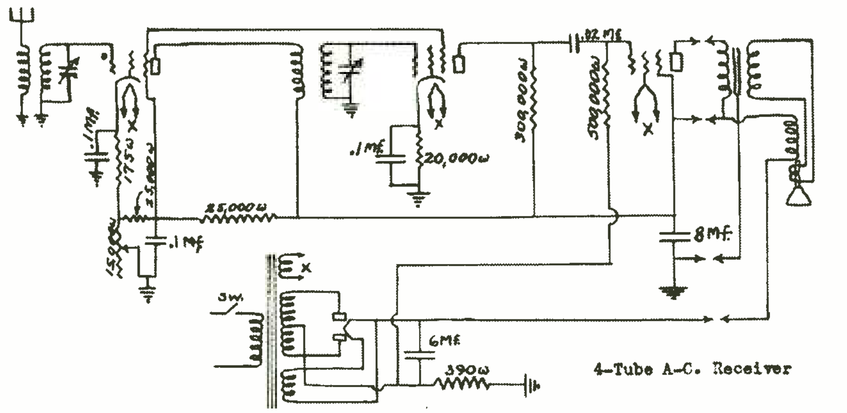


*Fig. 2. This original schematic of the Aero 4 shows its extreme simplicity. Note that speaker field doubles as a power-supply filter choke.*

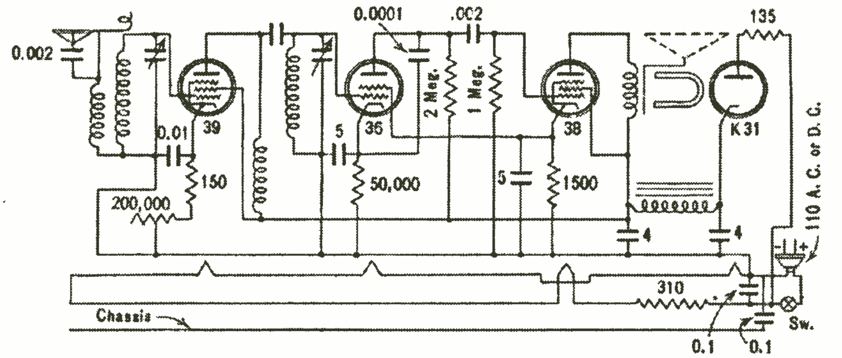


*Fig. 3. As this early schematic shows, the International Kadette Universal pioneered the transformerless AC/DC design.*

ner of the 0Z4 that for years was standard in auto radio power supplies.

The Kadette didn't use the speaker field-coil trick because its speaker didn't have a field coil. It was a magnetic type—essentially a scaled-down version of the horn speakers used in early battery sets. This short-lived design was used in some of the earlier depression radios. One advantage was that it was a high-impedance device and didn't require an output transformer to match the audio output tube. (Compare the Kadette output stage with that of the Aero.)

One very important economy measure that was pioneered in the Kadette was the elimination of the power transformer. That chunk of iron was even more costly than the filter choke, so dispensing with it really took a bite out of manufacturing costs. Eliminating the power transformer required replacing its two functions: (1) providing a source of high voltage for the tube plates and screen grids and (2) providing a source of low voltage to light the tube filaments.

Thanks to the high performance of the pentode tubes, standard line voltage did not have to be stepped up by a transformer for use on the plates and grids. It could be rectified and used directly. As for the filaments, the three of them were connected in series like an old-fashioned set of Christmas tree lamps. Also in the series circuit was a 310-ohm power resistor. The resistor dropped the line potential by about 93 volts, leaving about 19 volts for the three 6.3-volt filaments.

The elimination of the power transformer had a side effect that became a useful selling feature. Without the

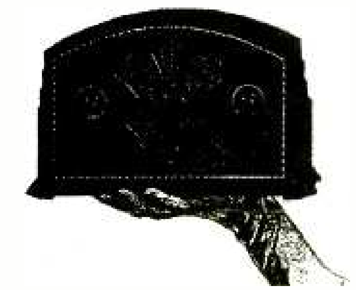


*Fig. 4. Emerson's Universal Compact, an electrical copy of the International Kadette Universal, is shown here nestled comfortably on an outstretched hand.*

transformer, the radio could be operated on DC just as well as on AC. The downtown sections of many large cities still had DC mains, a holdover from the service provided by the original Edison Illuminating Company.

The DC market wasn't really big. But the AC/DC, or "universal" feature of the Kadette was a boon to folks who still had DC services. These unfortunates had to purchase rotary converters to operate any straight AC appliances (which of course were much more common than DC ones) that they wanted to use.

## MIDGET ENCLOSURES

The Kadette was not housed in a vertically oriented "cathedral" or "tombstone" cabinet. Its really small chassis (made possible, in part, by the elimination of the transformer) allowed the use of a small, oblong enclosure. I don't have any size documentation on this set. However, I do have an ad for the Emerson "Universal Compact" radio (see Fig. 4), which is an almost exact electrical copy of the Kadette, giving the dimensions of the former as 10 by 6 ½ by 4 ½ inches (WHD). The Kadette was probably the first "midget" radio, a term later applied to its many similar competitors and successors.

Another trend that made it possible to achieve such dramatic radio downsizing was the "minimizing" of many radio parts. Tuning capacitors became closer-spaced so they could achieve the needed capacitance in a smaller format. The "potting" of components into decorative housings was eliminated, with coils and transformers mounted individually as "naked" units.

In addition, stages were grouped so that they could be interconnected with the shortest possible leads rather than hooked up in a straight line, beginning with the first RF amplifier and ending with the audio output. The home radio no longer looked as if it had been built from individual parts in an electronics lab. Rather, it was now a home appliance of integrated design.

Personally, I enjoy the little thirties midgets at least as much, if not more, than the more sophisticated looking and expensively built radios of earlier (and later) times. Only rarely was the appearance of these sets influenced by industrial designers. As a result, many have an ingenuous appearance that I find quite charming. ■

# CIRCUIT CIRCUS

# Hall Effect Sensors

CHARLES D. RAKES

Get ready for a magnetic adventure, circuiteers, because this visit we're going to look at some CMOS Hall Effect sensors and see what we can do with them. A German company, MICRONAS INTERMETALL, produces a relatively new line of inexpensive CMOS Hall Effect sensors, which fall into four categories: bipolar, unipolar, latching, and differential. Our first adventure begins with the HAL 115UA-C bipolar sensor that sells for less than a buck in single quantity (Digi-Key sells it as part number HAL115UA-C-ND; Tel. 800-344-4539).

## INSIDE THE 115UA-C

The 115UA-C can operate with a 4.5- to 24-volt supply and output 10 mA to a load. The junction-temperature operating range for this device is 0° to 100° C. Figure 1 shows the plastic transistor-outline package (TO-92UA). Note the branded side of this chip (*i.e.*, the side that shows the sensor's ID numbers), as this is the side that actually contains the Hall Effect sensor (more on this in a moment).

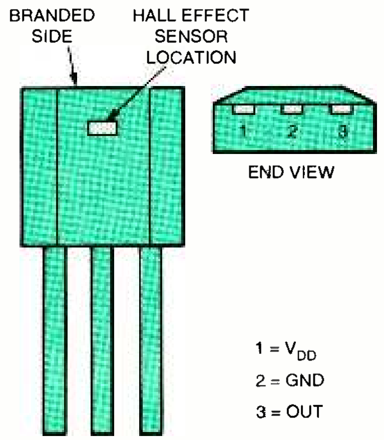



*Fig. 1. Here are two views of the HAL 115 UA-C that will make it easier to orient the IC in the circuits that follow.*

Before we proceed, a word of warning is in order. These are very small devices, measuring only 4 × 3 × 1.5 mm, which can easily get lost on a busy workbench. Murphy has a rule for this size device: If you drop it you lose it.

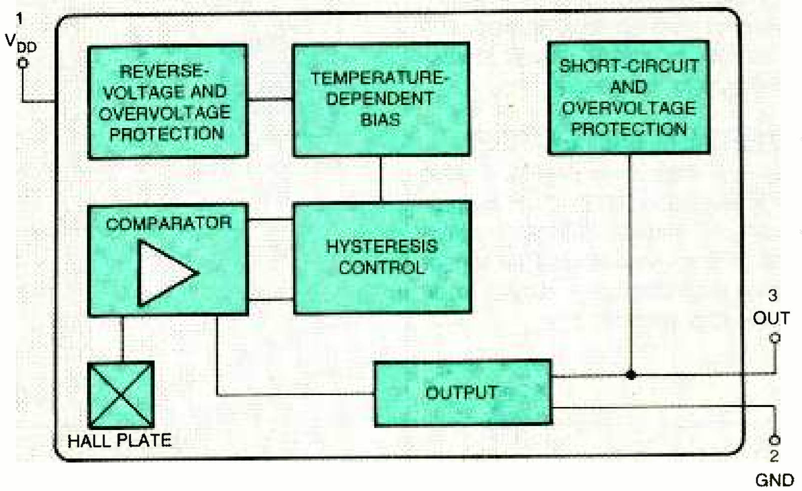



*Fig. 2. This block diagram of the HAL 115UA-C shows how the Hall Effect plate-sensor signal is processed and made available at pin 3. Note the hysteresis control, which eliminates oscillation and allows for clean switching.*

Let's take a brief look at what goes on inside this mini-three-legged magnetic sensitive device. A block diagram of the chip is shown in Fig. 2. Deep inside the tiny package is a monolithic integrated Hall plate or Hall Effect sensor, which responds to a magnetic field. When a magnet is placed close to the plate, with the proper pole parallel to either side (more on polarity later) of the flat area on the IC, the output at pin 3 changes states.

A temperature-dependent bias circuit keeps the Hall Effect sensor stable for any temperature changes within its rated operating range. An over-voltage protection circuit keeps tabs on the input supply voltage, and the output is short-circuit protected. Last but not least in importance is the circuit's built-in hysteresis feature, which eliminates oscillation and allows for a clean switching on/off output.

## SIMPLE MAGNET DETECTOR

Our first application, shown in Fig. 3, contains the HAL 115 in its simplest circuit form. The output, at pin 3, is normally low without a magnetic field present, causing LED1 to light. However, if the north pole of a magnet is placed near IC1's branded side, the LED will turn off. The same results will occur when the south pole of a magnet is positioned near IC1's opposite, unbranded side. Removing the magnet turns the LED back on. A typical, small donut-shaped magnet, like the ones sold in most hardware stores, will activate the sensor at a distance of about ¾- to 1-inch.

Here's how to check out the IC's hysteresis characteristics: Start with a

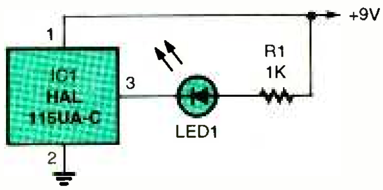



*Fig. 3. In this simple circuit, LED1 will turn off when a magnet is brought close to IC1 (see text).*

### PARTS LIST FOR THE SIMPLE MAGNET DETECTOR (FIG. 3)

IC1—HAL 115UA-C Hall Effect sensor, integrated circuit
LED1—Light-emitting diode, any color
R1—1000-ohm, ¼-watt, 5% resistor

magnet placed about 3 inches away from the sensor and slowly move its north pole toward the branded side of the chip. Stop at the point where the circuit turns the LED off. Now slowly move the magnet away from the sensor and stop where the LED turns back on. The distance between the turn-on and the turn-off point is the sensor's dead zone. This zone keeps the sensor's output from flip-flopping back and forth as the magnet is moved toward and away from the sensor.

## REVERSED DETECTOR

Our next entry, shown in Fig. 4, adds an NPN transistor, Q1, to invert the previous circuit's output function. In this circuit the LED remains off until the sensor detects a magnetic field— a more traditional detector scheme.

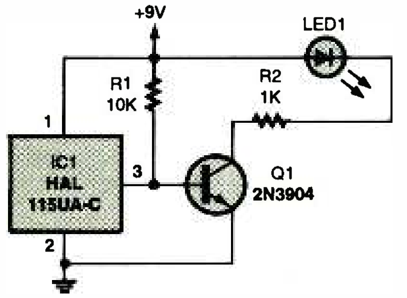



*Fig. 4. By adding an NPN transistor to the circuit in Fig. 3, we get a detector whose LED*

**PARTS LIST FOR THE REVERSED DETECTOR (FIG. 4)**

**SEMICONDUCTORS**
- IC1—HAL 115UA-C Hall Effect sensor, integrated circuit
- Q1—2N3904 general-purpose NPN transistor
- LED1—Light-emitting diode, any color

**ADDITIONAL PARTS AND MATERIALS**
- R1—10,000-ohm, ¼-watt, 5% resistor
- R2—1000-ohm, ¼-watt, 5% resistor

This circuit may be modified for many different circuit applications. As an example, an optoisolator may be used in place of the LED; and the circuit can be used to turn on an AC-operated device, such as a motor, lamp, relay, or solenoid. If the normally "on" output condition is desired, the previous circuit can be used in the same way by replacing the circuit's LED with an optoisolator.

Both this circuit and the one in Fig. 3 can operate off a 5-volt power supply and interface with TTL logic IC circuitry. Also Hall Effect ICs will interface with most CMOS logic IC families.

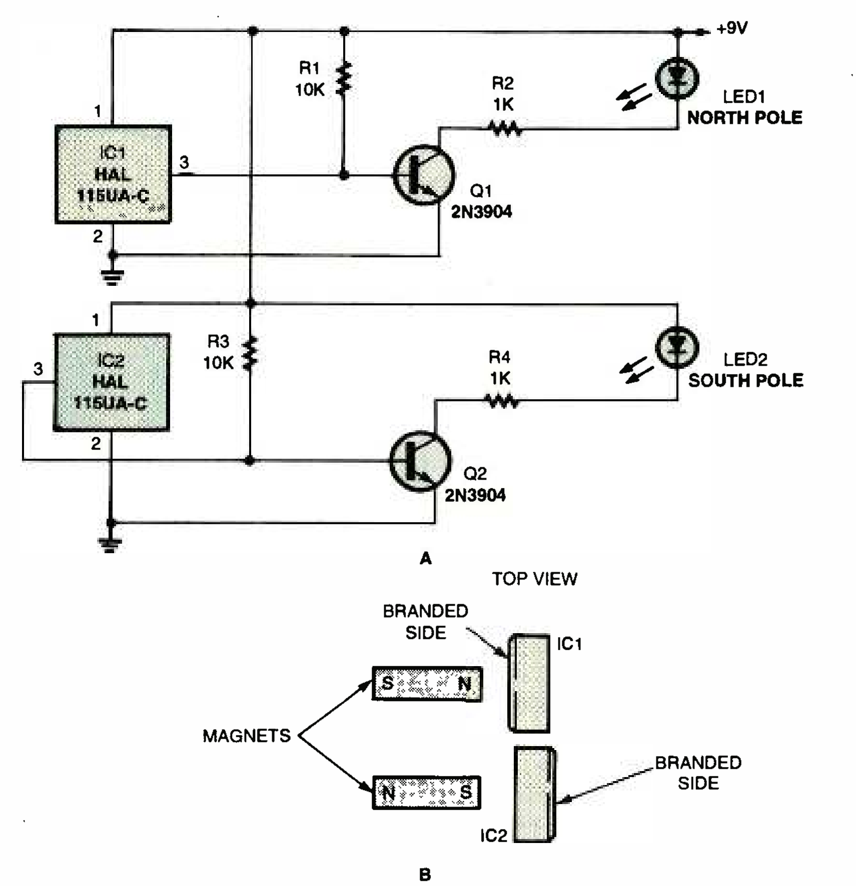



*Fig. 5. The circuit in A will let you detect the polarity of a magnet. The two ICs are aligned as shown in B.*

## MAGNET-POLE IDENTIFIER

Our next entry (see Fig. 5A) uses two HAL 115 sensors in a magnet-pole identification circuit. IC1 is positioned with its branded side facing out; and IC2 is positioned with its branded side facing in, as shown in the mounting scheme in Fig. 5B.

If the north pole of a magnet is aimed at the two sensors, LED1 will light, indicating a north pole; and if the south pole is aimed at the two sensors, LED2 will light, indicating a south pole. The circuit can also be used to match magnets as to their polarity and relative field strength. If two similar shaped magnets turn on either of the LEDs at the same distance, then you can deduce that their fields are similar in strength.

**PARTS LIST FOR THE MAGNET-POLE IDENTIFIER (FIG. 5)**

**SEMICONDUCTORS**
- IC1, IC2—HAL 115UA-C Hall Effect sensor, integrated circuit
- Q1, Q2—2N3904 general-purpose NPN transistor
- LED1, LED2—Light-emitting diode, any color

**ADDITIONAL PARTS AND MATERIALS**
- R1, R3—10,000-ohm, ¼-watt, 5% resistor
- R2, R4—1000-ohm, ¼-watt, 5% resistor

## HIGH-SENSITIVITY DETECTOR

Our next circuit, shown in Fig. 6A, increases the HAL 115's sensitivity range by a factor of forty. This magnetic regenerative circuit can detect a magnet passing within 30 to 40 inches of the sensor.

The sensor's magnetic regeneration circuit is not that different in operation or in principle from the regenerative receiver circuits used in the early days of radio. In a regenerative receiver circuit, a portion of the amplified RF signal is fed back into the input in a controlled manner at a level just below the point of circuit oscillation. Even today a good performing regenerative receiver can rival many of the low-end radios in its ability to receive a weak signal.

Here's how our regenerative circuit operates. Coil L1 (read on for winding details) is positioned, as shown in Fig. 6B, snugly against the non-branded side of the IC. If L1 is temporarily disconnected from Q1's collector, the sensor's output at pin 3 will be low. At this point, the circuit operates in the same way as our first circuit in Fig. 3. By re-connecting L1 to the collector of Q1, the circuit is now operating in a feedback mode. With the sensor's output low, Q1 is biased on sending current into L1, which produces a south pole magnetic field at the non-branded side of the sensor. The sensor detects the south pole's field and tries to turn off; but when the sensor's output starts to go high, Q1 begins to reduce the current flow into L1, reducing its field strength—at this point the circuit goes into oscillation.

The frequency of oscillation is determined by the feedback current through L1 and the coil's inductance. Potentiometer R4 sets the regeneration feedback current level. For the circuit to operate in the traditional manner, R4 is adjusted to the point where the oscillation just ceases. Now if the north pole of a magnet is moved toward the branded end of the sensors, it detects the change in the magnetic field and produces a high output at pin 3. Transistor Q1 then turns off, removing the magnetic field produced by L1; and the sensor's output goes low, turning Q1 back on to start the circuit oscillating. The frequency of oscillation is determined by the strength of the magnetic field produced by the magnet on the branded side of the sensor.

The circuit's most sensitive mode of operation is with the regeneration control set to the point where the circuit oscillates at its lowest frequency. In fact, at this setting it will sound like the background count of an old Geiger counter or even an early beat-frequency metal locator. For those of you who are not familiar with either of these elderly gadgets, the sound is something like a putt-putt, at a one-second or lower repetition rate. When a magnet is brought into the sensor's detection range, the frequency of oscillation will either increase or decrease depending on the polarity of the magnetic field facing the branded side of the sensor. Transistor Q2 amplifies the audio signal and sends it to the 32-ohm speaker, SPKR1.

The circuit should be built in a non-metallic enclosure, with the speaker mounted perpendicular to the IC and as far away from the chip as possible. Coil L1 can be just about any relay coil with a DC resistance of 100 to 200 ohms, or a hand-wound coil can be built by winding about a thousand feet of 30-gauge enamel-covered copper wire on a soft iron core. A soft iron bolt with a diameter of ¼ to ½ inch and a length of 2 inches will do. I tried several old relay coils with the circuit and they all worked.

If you love experimenting, this is a must-build circuit. I'm sure that some of you will come up with some interesting applications for this unusual magnetic detector circuit. Stay tuned because next month we'll continue with more Hall Effect circuits. ■

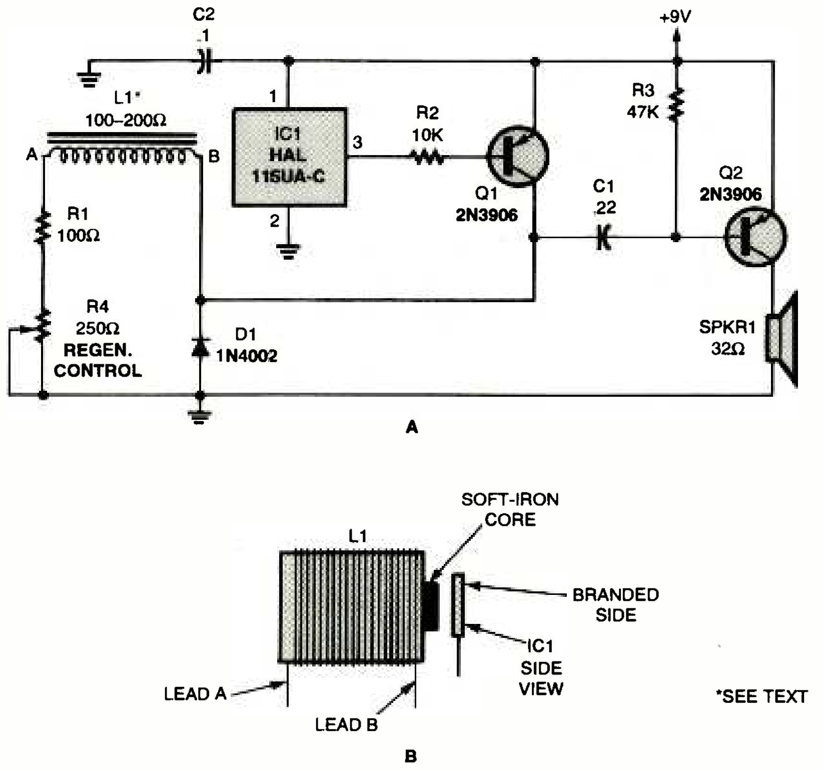



*Fig. 6. Using a coil (L1) to increase sensitivity, the circuit in A can detect a magnet up to 40 inches away. Align the coil as shown in B.*

## PARTS LIST FOR THE HIGH-SENSITIVITY DETECTOR (FIG. 6)

**SEMICONDUCTORS**

IC1—HAL 115UA-C Hall Effect sensor, integrated circuit
Q1, Q2—2N3906 general-purpose PNP transistor
D1—1N4002, 1-amp, 100-PIV silicon rectifier diode

**RESISTORS**

R1—100-ohm, ¼-watt, 5% resistor
R2—10,000-ohm, ¼-watt, 5% resistor
R3—47,000-ohm, ¼-watt, 5% resistor
R4—250-ohm potentiometer

**ADDITIONAL PARTS AND MATERIALS**

C1—0.22-µF, ceramic-disc capacitor
C2—0.1-µF, ceramic-disc capacitor
L1—100- to 200-ohm iron-core coil, see text
SPKR1—32-ohm speaker
Plastic enclosure, *etc.*

# HAM RADIO

# A Neat Little WWV/WWVH Receiver

JOSEPH J. CARR, K4IPV

From time to time I like to review various products that are of interest to hams, as well as to others. This time I am going to look at a neat little high-performance WWV/WWVH receiver. You can build it yourself or buy it wired and tested.

But first, some background "for those who came in late."

## WWV BASICS

The National Institute of Standards and Technology (NIST), successor to the old National Bureau of Standards, operates several time and frequency standards stations. There are two HF shortwave stations (WWV at Fort Collins, Colorado, and WWVH at Maui, Hawaii), and one 60-kHz VLF station (WWVB, Fort Collins). Both HF stations operate on 2.5, 5, 10, and 15 MHz (WWV also transmits on 20 MHz). You can tell the difference between them by the announcer: WWV uses a male voice and WWVH uses a female voice. On occasion, you can hear both at the same time, but for the most part only one will be audible at any one listening site.

These stations offer a number of different services. The NIST WWV Web site is *www.boulder.nist.gov/timefreq/wwv*. The site has a couple of QuickTime video movies that explain what the organization does for the public. In brief, the services include: time announcements, standard time intervals, standard frequencies, UT1 time corrections, and BCD time code (which can be used for WWV-controlled time clocks).

Further, NIST broadcasts geophysical alerts, prepared by the Space Environment Services Center of NOAA. These are aired on the 18th minute of the hour to give information on solar activity, geomagnetic fields, solar flares and other geophysical statistics. More Earth-based alerts are given by NIST, too, such as marine storm warnings (prepared by the National Weather Service).

OMEGA Navigation (10–14 kHz) System status reports are also handled, as well as Global Positioning System (GPS) status reports (prepared by the U.S. Coast Guard to give current status information to mariners on the GPS navigation satellites).

The WWV and WWVH output frequencies are useful for secondary frequency measurements and calibration in your ham shack. For example, hams often calibrate 100- and 1000-kHz crystal-marker oscillators to either WWV or WWVH. The time announcements and BCD code are related to the NIST atomic time scales in Boulder, Colorado.

The frequencies as transmitted are accurate to about one part in 100 billion for frequency and about 0.01 ms for timing. Day-to-day deviations are normally less than one part in 1000 billion. The actual received accuracy is far less due to various propagation effects, but is usually about one part in ten million for frequency and about 1 ms for timing.

WWV and WWVH radiate 10 kW on 5, 10, and 15 MHz. WWV radiates 2.5 kW on 2.5 and 20 MHz, while WWVH radiates 5 kW on 2.5 MHz and does not broadcast at all on 20 MHz.

*This tiny little Hamtronics RWWV receiver is very selective and sensitive, yet doesn't carry a very hefty price in kit form. The company even offers an inexpensive alignment tool.*

The NIST site describes antenna and modulation characteristics: "The WWV antennas are half-wave dipoles that radiate omnidirectional patterns. The 2.5-MHz antenna at WWVH is also of this type. The other antennas at WWVH are phased vertical half-wave dipole arrays. They radiate a cardioid pattern with maximum gain pointed toward the west. Both stations use double sideband amplitude modulation. The modulation level is 50 percent for the steady tones, 25 percent for the BCD time code, 100 percent for the seconds pulses and the minute and hour markers, and 75 percent for the voice announcements."

## WWV RECEIVER

Hamtronics, Inc. (65 Moul Rd., Hilton, NY 14468-9535; Tel. 716-392-9430; Fax: 716-392-9420; e-mail: jv@hamtronics.com; Web: *www.hamtronics.com*) offers a neat little WWV receiver. The Hamtronics model RWWV is a very sensitive and selective AM superhet receiver, crystal controlled on 10.000 MHz.

The RWWV can operate on either a 12-volt DC power supply or a 9-volt DC battery (neither supplied). It is available either in kit form for builders or already assembled. If you purchase the unit with the metal cabinet, a 115-volt AC power adapter is provided so you can simply plug it in the wall. The cabinet has a built-in speaker, but you can also use an external speaker. The receiver even has a squelch circuit that can be used to mute the audio if the signal fades into the noise.

and I got good reception with just a 10-foot length of 22-gauge insulated hook-up wire stretched up to the ceiling (a convenient planter hanger has made a "skyhook" for many an impromptu living-room antenna at my house). You can also use a small telescoping whip antenna of the sort found on FM and shortwave portable radios; a simple, random-length, outdoor wire antenna; or a 10-MHz dipole (46.8 feet overall, 23.4 feet each leg).

Some more specifications of the receiver: Sensitivity is 0.2 $\mu$V for 10 dB s/n, selectivity is $\pm$3 kHz at $-3$ dB and $\pm$10 kHz at $-50$ dB, image rejection is 43 dB, and audio output is 1 watt.

Prices for the RWWV receiver in its many forms are: PCB-only kit—$59; RWWV Receiver kit with cabinet and speaker and 12-volt DC Adapter—$89; RWWV Receiver assembled and tested with cabinet, speaker, and 115-volt AC Adapter—$129. There are also some accessories you can get: the A2 Tuning Tool is $2.50 (and highly recommended if you buy the kit form, and at least mildly recommended if you buy the built version), and the mating plug for the receiver (#A74 BNC twist-on plug for RG-58/u cable) is $1.75.

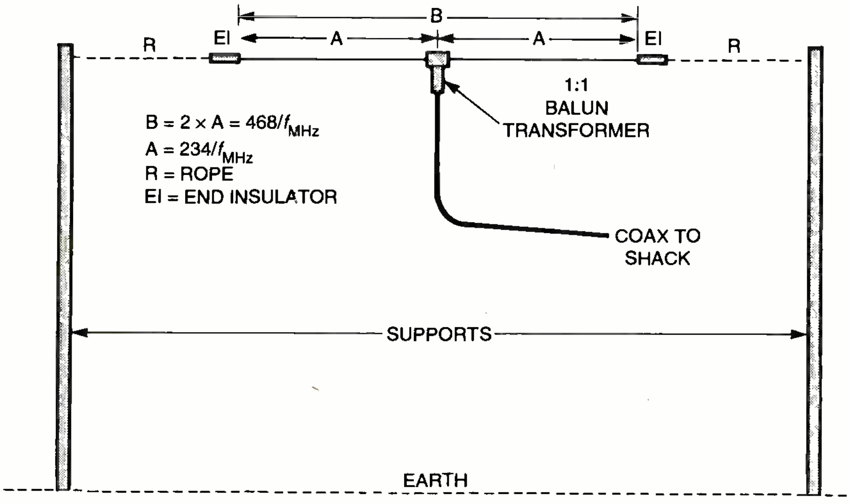



*Fig. 1. Here's an easy-to-build dipole antenna that will help you get terrific results with the RWWV receiver. The supports at the ends do not need to be masts—you can use any combination of trees, buildings, and poles to get the antenna in the air.*

The RWWV is set for 10 MHz—the WWV signal can be heard for a large part of the day throughout the country on this frequency, while frequencies above and below 10 MHz will fade either day or night depending on propagation conditions. A 10-MHz frequency is the best compromise for a single-channel receiver and permits you to get time and frequency calibration almost anytime.

The RWWV has a 50-ohm input so you can connect it to any type of HF antenna. It is pretty sensitive, however,

Unlike some companies who supply the ham and hobbyist market, Hamtronics provides lifetime technical support for anyone needing help before or after equipment purchase.

One of the things that bothers a lot of neophyte builders who attempt receiver projects is the matter of alignment. However, the RWWV is easy to align, especially with the $2.50 Hamtronics alignment tool. Turn on the newly completed receiver and hook it to a good indoor or outdoor antenna. If you hear the WWV or WWVH signal, then you already have your "signal generator" courtesy of NIST! Otherwise, you can use any service grade or homebrew signal generator that will tune to 10 MHz to "rough it in," and then use the actual WWV/WWVH signal to complete the alignment process.

Don't let fear of building get in the way of actually trying the kit. Of course, if your only goal is to obtain a WWV receiver, then buy it built. But if you are "on a budget" or want the experience of building a radio receiver, then try the kit approach. I've built two Hamtronics kits, and the instructions are uncommonly good.

## AN ANTENNA TO BUILD

The RWWV is a single-channel shortwave radio receiver, so it will work best if connected to a good antenna. The standard half-wavelength horizontal dipole antenna is one of the easiest antennas to build, yet works very well. One does not need a 100-foot tower with a Yagi beam to do pretty well operating on the ham bands (many DXCC and WAC awards were won by people using 100 watts or less into a dipole, so don't sneer at this handy antenna).

Figure 1 shows the basic construction of a dipole. The supports are shown here as masts, but they can be any combination of things that gives the needed height: trees, buildings, masts (commercial and homemade). The antenna is connected to the masts through ropes. I've found over the years that nylon rope works best (nylon parachute cord is easily available). The ropes are tied to end insulators, either ceramic, glass, or nylon.

The wire segments (A) are each a quarter-wavelength long, and the overall (B) is 2A. The general case is that B = $468/f_{MHz}$ and A = $234/f_{MHz}$. The "468" constant is an approximation of the foreshortening from the "real" half wavelength ($492/f_{MHz}$) caused by capacitive end effects and wire velocity factor.

The correct lengths for a 10-MHz frequency are 23.4 feet or 7.15 meters for A, and 46.8 feet or 14.3 meters for B. For a 10.075-MHz frequency, use

23.25 feet or 7.1 meters for A and 46.45 feet or 14.2 meters for B.

OK, so why did I include 10.075-MHz specs for a 10-MHz receiver? The reason is simple: we're hams, aren't we? The 30-meter ham band is right above the 10-MHz WWV/WWVH frequency covered by the Hamtronics RWWV receiver, so we can use a single antenna on both frequencies. The VSWR-versus-frequency curve for the typical dipole is relatively broad, so the antenna can be used over about a 200-kHz portion of a band. The antenna design frequency, 10.075 MHz, is the mid-point between the 10-MHz WWV and the upper end of the 30-meter amateur band. If you want to try QRP operating (covered here last year), then a simple shielded SPDT toggle switch can be used to provide antenna access for both the QRP station and the RWWV.

## OTHER USES

Long-time readers of this column know that I am fond of observing natural radio phenomena such as whistlers, spherics, propagation anomalies, and others (a phrase I coined, *radioscience observing*, covers all of them—see my book *RadioScience Observing Volume 1*, Howard W. Sams/PROMPT Publishing). One of the needs of radioscience observers is to record time marks. The usual procedure is to record WWV signals on one track of a stereo cassette tape recorder, and the natural radio signals on the other. That procedure allows radioscience observers to accurately time events. The RWWV can be easily modified to output a signal to the recorder. Tap the audio signal at the top of the volume control and feed it to the recorder.

## HAMS IN EMERGENCIES

According to a W1AW bulletin transmitted from ARRL headquarters (225 Main St., Newington, CT 06111; e-mail: hq@arrl.org; Web: *www.arrl.org*), the FCC ordered hams not to use 14.275 MHz (±3 kHz) until "further notice," unless the hams are involved in handling emergency message traffic for the Honduran emergency following Hurricane Mitch. Recall from news stories last fall that more than 10,000 people were killed by the storm, and more than 1,000,000 were made homeless. Two former U.S. presidents, Carter and Bush, went to Honduras and were utterly appalled by the extent of the damage. Tipper Gore, wife of Vice President Al Gore, called the damage "... of Biblical proportions."

We keep hearing that hams are no longer relevant for emergency communications because of the explosion of commercial telecommunications. Who needs hams when there are cellular telephones? The answer is simple: everyone. Hams can get back on the air much more rapidly than most commercial sites. A few yards of wire to replace a destroyed antenna and a charged car battery will get many of us back on the air in about twenty minutes time. And give us a couple hours and a light generator and we're first class. Even when commercial and military facilities come on air, they will be overwhelmed with priority official traffic and have little time for "health and welfare" messages to family and friends. That's a role hams do real well. A simple "We survived and are well" can be sent as a book message to dozens of recipients at a time.

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

## MULTIMEDIA WATCH

*(continued from page 7)*

Expert's entertainment titles are varied, but they include all the basic card games in multimedia form such as *Bicycle Solitaire, Bicycle Blackjack, Bicycle Poker, Bicycle Euchre, Bicycle Rummy*, and *Bicycle Bridge. Safari Hunter* delivers the thrill of the hunt without needless gore, while *Deep Sea Challenge* takes you on a virtual fishing expedition. *Titanic* puts you in charge of an expedition to find the wreck all over again, and you can look for your own clues as to why it sank once you discover the wreck.

Expert Software even publishes famous Sega game titles on CD-ROM for the PC. These include *Sega Virtua Squad*, which turns you into a super cop in an urban zone that has been overrun by criminals, and *Sega Rally Championship*, which brings off-road racing to the PC with dirt, mud, jumps and more. *Sega Worldwide Soccer* puts all the action of the real game on your PC for you to enjoy at home.

And now for a software vendor that's completely different. *Sentinel Returns*, from Psygnosis, is based on the 1980s strategy game, so it contains similar gameplay, but with modern enhancements such as a score written by John Carpenter. The haunting game also features stunning 3D graphics with advanced texturing and lighting. This title costs $49.95.

Hasbro Interactive has released a wonderful *Star Wars Millennium Falcon* CD-ROM playset. It comes with a plastic cockpit (complete with Han Solo action figure) that mounts on top of your keyboard and acts as a game control. The software transports you into the *Star Wars* universe, where you'll trade blaster fire with enemies from the Dark Side in locations like Dagobah and Tatooine. The playset, for ages five and up, costs $49.95.

Also from Hasbro Interactive are two other great titles. *Tonka Workshop* is another ingenious computer playset for kids. This is basically workshop software that lets kids build everything from vehicles to furniture, letting users shape and assemble the materials and even paint the finished product. The ingenious part is a workshop of real tools—real enough, anyway—that straps onto the keyboard providing kids with working sanders, drills, wrenches, and more to interact with in the game. My four-year old thinks he's really building an airplane, especially when he prints a color picture of it on the inkjet. *Hedz* turns head hunting into sport, with 20 levels played across four asteroids. As you work your way through the tournament, you collect new heads by shooting other headhunters until their heads pop off—different heads provide different powers. *Tonka Workshop* and *Hedz* each cost about $40.

Access Software has upped the PC golfing ante once again with *Links LS 1999 Edition. Links LS 1999 Edition* features the St. Andrews Links Old Course plus more than 25 new features. Arnold Palmer takes part, along with two new golfers and several new courses. St. Andrews, the most popular course in the world, and Arnold Palmer's Bay Hill, are both included in the new course lineup. Of course, the more than 25 already available add-on courses are still compatible with the Links LS 1999 Edition. This title costs about $50. There's an upgrade version for previous Links customers that costs less. ■

## NEW PRODUCTS

*(continued from page 8)*

Switched Telephone Network) interface circuitry, including ring detection, hookswitch function, gyrator/transformer function, surge protection, and transient protection, the unit provides galvanic isolation and is packaged in a single 1.07 × 1.07 × 0.4-inch plastic module. An innovative electronic gyrator circuit is used to minimize DC resistance and maximize AC impedance seen by the telephone line with the hookswitch closed. Transformer coupling is used for the signal path. The integrated module features 0.01% THD, 1500V peak isolation, and 300V surge protection, and accepts ring voltages up to 150V rms. The module is rated over a temperature range of 0º C to 70º C.

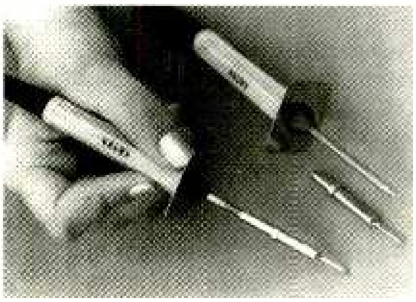
The CYG2911 is priced at $12.90 in quantities of 5000. For more information, contact CP Clare Corp., 78 Cherry Hill Drive, Beverly, MA 01915-1048; Tel. 978-524-6700 or 800-CPCLARE; Fax: 978-524-4900; Web: *www.cpclare.com*.

**CIRCLE 82 ON FREE INFORMATION CARD**

### MINIATURE SOLDERING IRON

Built for comfort and efficiency, this precision miniature soldering iron is ideally suited for electronic assembly work. The heating element of the *Antex Model G/3U Precision Miniature Soldering Iron* is located directly under the tip for optimum thermal efficiency, while the handle remains cool—and it recovers instantly after soldering each joint. Constructed with a plastic handle and a metal heat shield, this positively grounded industrial-grade soldering iron is only 7½ inches long and 3/8 inches wide.

Providing power and performance comparable to a conventional 30-watt soldering iron, this lightweight miniature 18-watt soldering iron reaches 750°F in only 45 seconds. Over 40 different shapes and sizes of slide-on tips including spades, chisels, pyramids, and needles are available for virtually all soldering tasks.



The Antex Model G/3U Precision Miniature Soldering Iron is priced at $23.32 and tips are priced from $1.99 each, depending upon shape, size, material, and quantity. For more information, contact M.M. Newman Corp., 24 Tioga Way/P.O. Box 615, Marblehead, MA 01945; Tel. 781-631-7100; Fax: 781-631-8887; Web: *www.mmnewman.com*.

**CIRCLE 83 ON FREE INFORMATION CARD**

### FIELD-STRENGTH ANALYZER

With the battery-operated *Protek 3201* in hand, engineers can make quick, accurate RF field measurements of any communications installation or equipment, from 100 kHz to 2060 MHz. Its phase-lock-loop circuitry provides precise tuning and frequency stability with 3 PPM accuracy. This 24-oz. handheld 2-GHz instrument automatically scans 160 channels in selectable steps and offers the convenience of manual, memory, and search scans.

A built-in frequency counter provides 50 PPM with 120-mV input sensitivity. The large, easy-to-read, back-lit LCD display panel features a variety of display formats including bargraphs and a spectrum display with 192 ×192 pixel resolution. In addition, there is an audio output stage with built-in speaker and a volume control for monitoring signals.

Operationally, the 3201 can be used to test, measure, install, and maintain RF equipment, including wideband FM and narrowband FM transmitters; single sideband and AM systems; cable television; TV and radio broadcast equipment; PCs and paging systems; antenna sites; cellular, cordless, and mobile telecorn communications systems; marine radio and navigation systems; and to do EMC compliance testing. Test setups and measurements can be stored in the internal memory, and the user can select all the functions from the menu or from the RF-232C user interface, which has a 4-baud rate and a parallel-port connector.

Printouts are also possible via a printer port connection. There is a Copy Set Mode to permit DMA of channel setup and data values. This portable instrument can also make measurements on 75-ohm systems via software calibration. RF field-level measurements are from -70 dBm volts to -20 dBm volts (N-FM mode).

The Protek 3201 costs $2100. For more information, contact HC Protek, 154 Veterans Drive, Northvale, NJ 07647; Tel. 201-767-7242; Web: *www.hcprotek.com*.

**CIRCLE 84 ON FREE INFORMATION CARD**

### AM INDOOR ANTENNA

Intended to receive AM frequencies from 530 kHz to 1700 kHz, for local and distant AM reception, the adjustable *AM Advantage* permits ease of tuning and superior reception. Using TERK's Pin Dot Pre-Tuning, the antenna electrically adjusts to the AM station the user is trying to receive. This function allows the user to fine tune the antenna to match the frequency on the tuner or receiver, while minimizing noise and interference caused by unwanted signals.

AM broadcasts are captured clearly on this passive indoor radio antenna with less noise and static distortion than if using an ordinary AM loop antenna. The antenna's tuning dial enables users to receive AM stations with greater efficiency.

This antenna has a sleek styling that helped it win CEMA's Innovations Award for 1998. The Advantage is a sculpted two-tone black and gray loop that rests on an arched base with a soft lavender dial in the center.

The AM Advantage costs $49.95. For more information, contact Terk Technologies, 63 Mall Drive, Commack, NY 11725; Tel. 516-543-1900 or 800-942-8375; Web: *www.terk.com*. ■

**CIRCLE 85 ON FREE INFORMATION CARD**

## DTMF INTERFACE

*(continued from page 34)*

0-9, *, # several times, and then hang up the phone.

Once the answering machine resets, simply remove the tape and play it back using a cassette recorder with an earphone jack. After cueing up the tape to the portion containing the DTMF tones, connect the interface to the recorder's earphone jack, and play back your test tape. DTMF digits should now begin appearing on your monitor. If no digits appear, try raising or lowering the tape recorder's (or scanner's) volume-control setting and try again. However, normal volume should suffice.

If incorrect digits appear on the monitor (for example, the digit received was known to be a DTMF "1," but a "4" was displayed), then re-check the wiring of the DB-25 connector and try again. After everything is working properly, install the cover onto the enclosure, and show your friends that useful monitoring accessories don't have to be expensive. ■

## HIGH-VOLTAGE CIRCUIT

*(continued from page 40)*

condition, R1 would take the full 117-volt line, dissipating approximately 7.2 watts. At the maximum line-voltage tolerance of 117 volts AC + 10%, or about 129 volts AC, the resistor would have to dissipate about 8.3 watts. If a 10- or 20-watt resistor were used, you'll probably never have a problem. But if you are concerned, the optional thermal cut-out protector mentioned earlier can be attached to R1 to provide added protection for the circuit in the event of a catastrophic failure.

**Construction.** The author's prototype unit was assembled on a small section of perforated construction board measuring approximately 6 by $2\frac{7}{16}$ inches (which is about the width the transformer's base). Assemble the circuit, using Fig. 4 (the circuit's schematic diagram) as a guide. Start by temporarily mounting the components to the perfboard section. When mounting power resistor R1, be sure that it is mounted away from anything flammable and that sufficient space is provided between the power resistor and any other components to allow good air flow around the resistor. **Note:** Although the author specifies a 10-watt power resistor in the Parts List, the unit used in the prototype is a 50-watt, metal-enclosed unit. Using a resistor of sufficient power-handling capacity helps to guard against possible mishap.

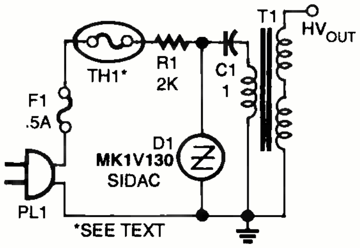



*Fig. 4. This circuit featuring a SIDAC (which can be defined as a silicon, bilateral, voltage-triggered switch) reduces the cost and complexity of assembling high-voltage circuits, while retaining the capacity to efficiently switch several amps of power.*

Depending on the line voltage in your area and the SIDAC you use, it may be necessary to adjust the value of R1 in order to get the circuit to switch at or before 90 degrees. Doing so reduces the amount of power R1 is required to dissipate, while allowing sufficient margin to enable the SIDAC to fire slightly after 90 degrees in the event that the line voltage goes low.

A two-position barrier block was tied to the transformer output and used to connect the circuit's high-voltage source to an 18-inch long, small-diameter neon tube.

**Use.** With its 2400-volt output, the circuit can be used to fire neon tubes. The author used the circuit to repair an ancient "weed-burner" fence charger by replacing the burned-out mechanical vibrator with this SIDAC-based circuit. With high-voltage rectification, the circuit can be used as a plasma neon laser supply or an air ionizer. Use your imagination—the possibilities are limitless! ■

## SCANNER SCENE

*(continued from page 12)*

between them. Split your 16 oz. can of Pepsi with a pal and what's left for you? Just enough to fill an 8 oz. glass! Split the antenna's received energy, and it's divided in half to each scanner. Not to worry. Although each set will notice a minimal 3-dB signal loss, in most instances this should be imperceptible to you. weak signals can be rejuvenated with a SuperAmplifier.

## MONITORING THE FEDS

Barry, of Charleston, SC, reports monitoring unidentified communications on 140.075 MHz, and he asks for more information. We looked it up, and it's the Channel 1 repeater of the U.S. Naval Investigative Service! This agency uses the same eight channels, nationwide.

Interest in monitoring federal agencies continues to tantalize scanner owners. An excellent guide for Barry and everyone else who's interested is the huge 308-page *Federal Government Frequency Assignments, 6th Edition.* Here's the all-in-one resource for the latest known VHF/UHF frequencies used by the U.S. military services; the Secret Service, ATF, CIA, DEA, FBI, Border Patrol, and Immigration; IRS, Customs Service, and Postal Inspectors; EPA, FAA, FCC, NASA, and NSA; and by the National Park Service, Dept. of Agriculture, and so on. CTCSS tone information is provided.

Plenty of additional information reveals military satellite communications channels, White House code names, USAF aircraft IDs, *etc.* Frequencies are listed by agencies, and they are also cross-indexed. Special lists show all (1500+) assignable federal frequencies from 29–420 MHz.

This great reference is $24.95, plus $5 shipping/handling ($7 to Canada) from CRB Research Books, Inc., P.O. Box 56, Commack, NY 11725; Tel. 516-543-9169; Web (fully secure site): *www.crbbooks.com.* Residents of NY state, please include $2.47 tax. MC/VISA are OK.

We invite your questions, comments, and frequencies. Our direct e-mail address is Sigintt@juno.com. Send snail mail to *Scanner Scene*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

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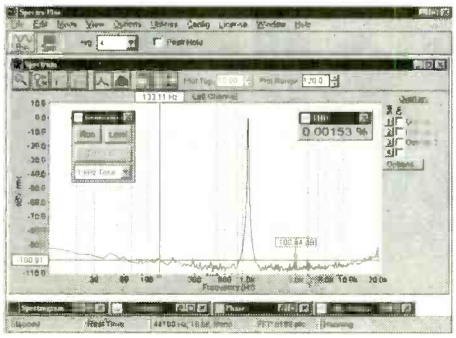





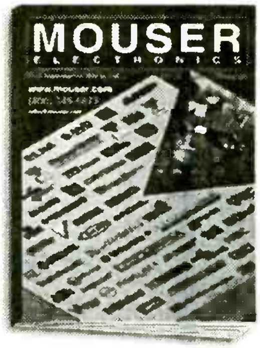

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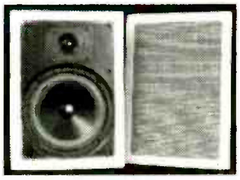

This is our most popular in-wall. You won't believe how good these really sound. Big enough to produce great home theatre sound and still fit everyone's budget. Put a pair in every room of your house. Great for front or rear speakers in your surround system. The 6-1/2" polypropylene woofer and 1" textile dome tweeter were specially designed with home theatre in mind. The crossover network utilizes a mylar capacitor for crisp clean highs. 3 piece design make installation in new or existing walls a snap. **Specifications:** ◆6-1/2" polypropylene cone woofer with poly foam surround ◆1" textile dome tweeter/ midrange ◆8 ohm impedance ◆3 component L/C crossover network ◆Frequency response: 50-20,000 Hz ◆Power handling capability: 60 watts RMS/85 watts max ◆Sensitivity: 89 dB 1W/1m ◆Overall dimensions: 8-1/2" W x 12" L x 3-1/2" D ◆Hole size: 7-1/4" x 10-3/4" ◆Fits into standard 2" x 4" wall ◆Net weight: 12 lbs. per pair.

**#300-036** .......... **$89.90**(1-3 PRS) **$79.50**(4 PRS-UP)

## Satellite Speaker Stands

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| 180-121 | 12 ft. | 8.95 | 7.95 |
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Designed for the home and office, these 6-1/2" round in-walls are ideal for ceiling installations, or for use as rear channel surround speakers. Adding music to the kitchen, den, bath, or patio has never been easier! System features a weather resistant 6-1/2" treated paper cone with poly foam surround, coaxially mounted 1/2" polymer dome tweeter, and built-in crossover with a mylar capacitor in the tweeter feed. Retrofit design allows installation in both new and existing construction in just minutes. System includes removable steel mesh grills, built-in mounting bracket, hardware, and installation instructions. **Specifications:** ◆Impedance: 8 ohms ◆Frequency response: 60-20,000 Hz ◆Power handling capability: 30 watts RMS/45 watts max. ◆Sensitivity: 89 dB 1W/1m ◆Dimensions: 9" round x 2-7/8" deep. ◆Net weight: 5 lbs. per pair.

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In addition to functions found in regular DMM's, this meter can also measure inductance in 5 ranges (4mH, 40mH, 400mH, 4H, 40H), capacitance in 5 ranges (4nF, 40nF, 400nF, 4uF, 400uF), frequency in 4 ranges (4KHz, 40KHz, 400KHz, 4MHz), TTL logic test, diode test and transistor hFE test. 5 AC/DC ranges up to 1000V (AC750V), 3 AC/DC current ranges up to 20A and 7 resistance ranges up to 4000 M ohms. Includes test leads, battery, spare fuse, and manual. Net weight: 1 lb.

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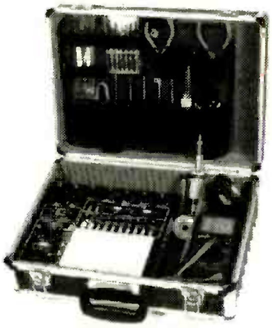

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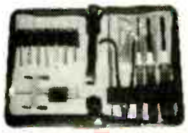

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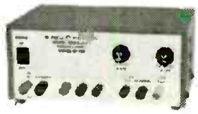

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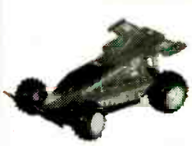

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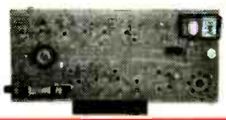

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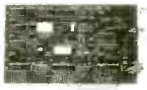

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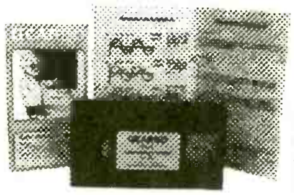

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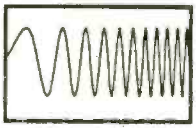

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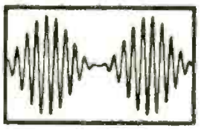

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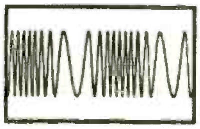

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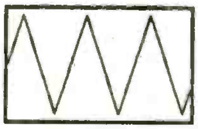

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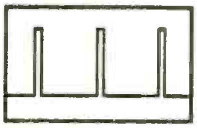

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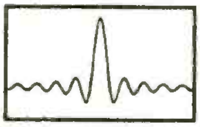

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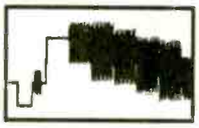

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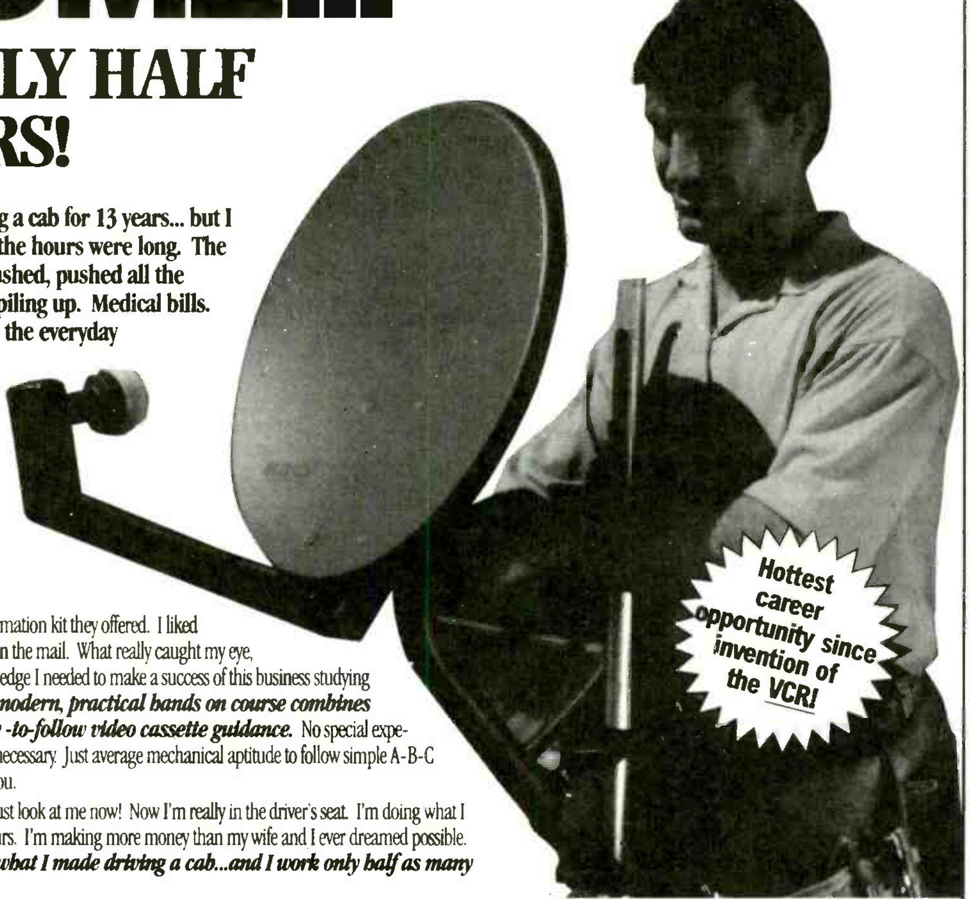


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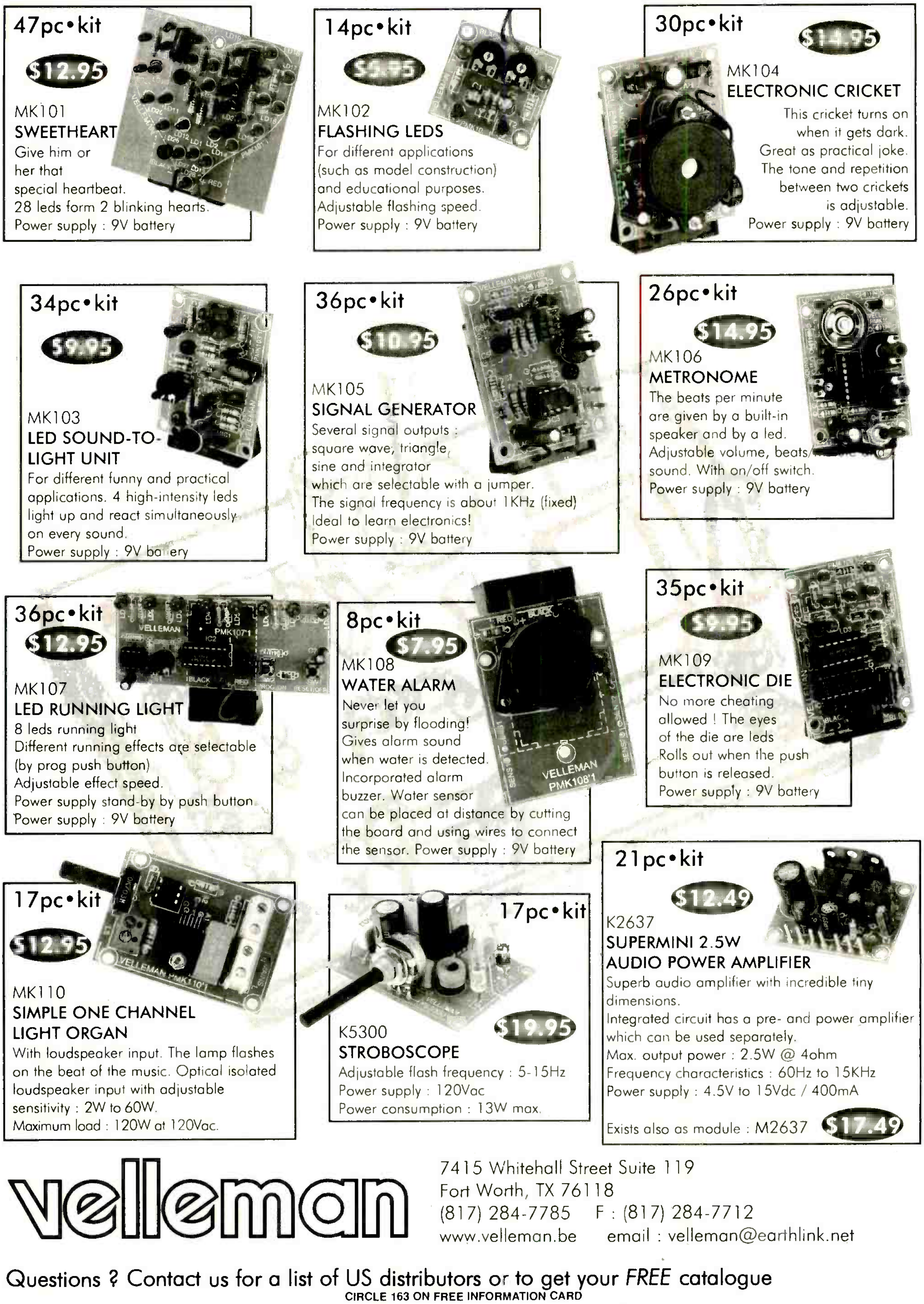
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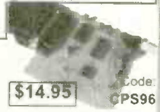

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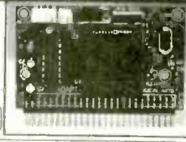

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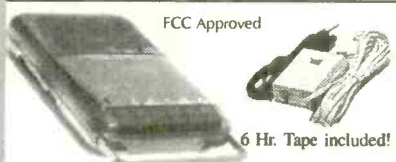

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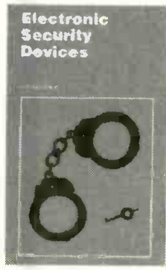


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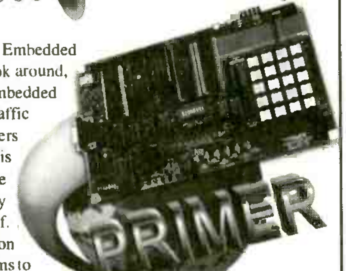


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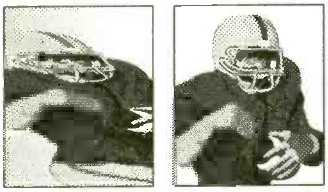

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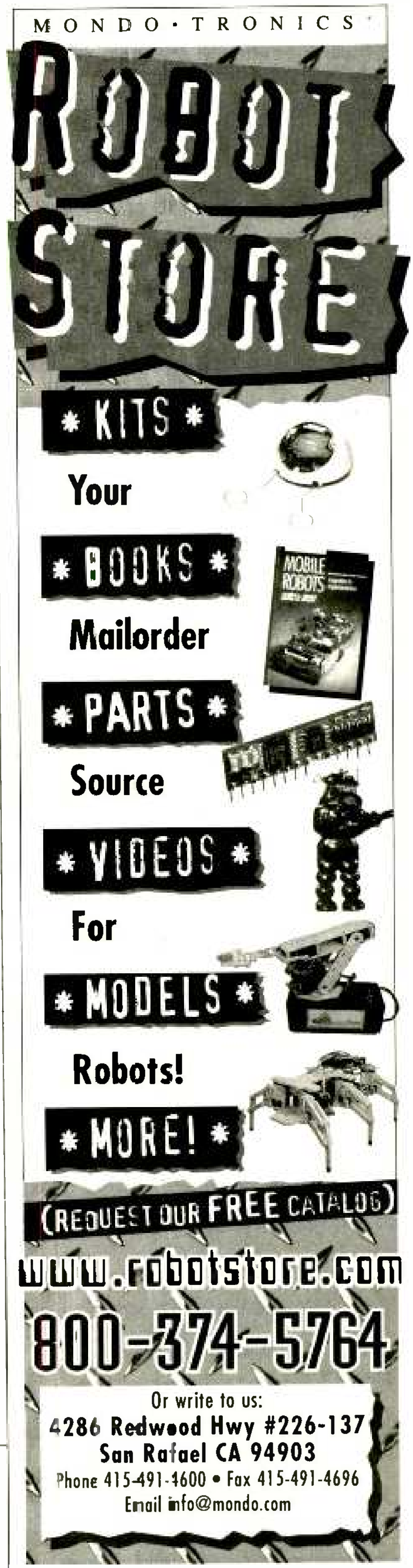

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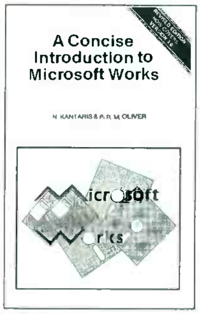


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