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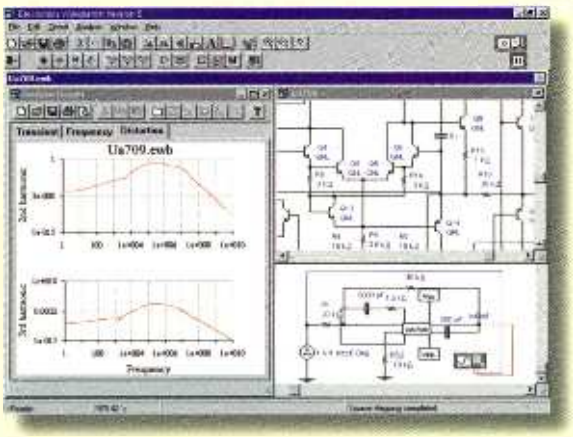

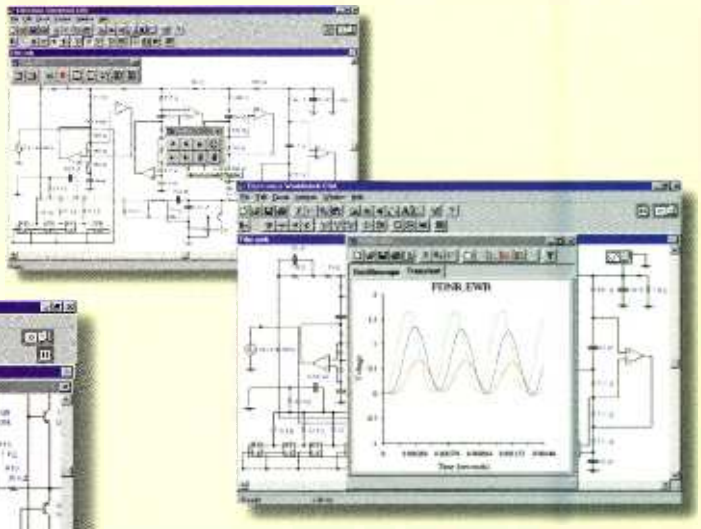

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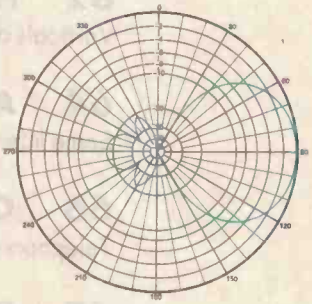

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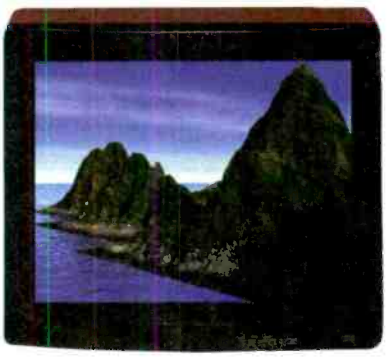
ABC AUDITED

TECHNOLOGY UPDATE

"My TV reception is so clear, you'd think I had a 50-foot antenna on my roof!"

Emerson's ingenious new antennas are hard to spot, easy to install and provide clear, powerful reception of broadcast signals...without rabbit ears.



Replace your unsightly "rabbit ears" today!

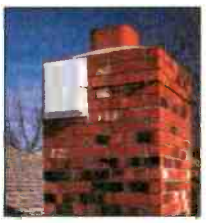
I'm amazed at the way technology has improved television. Developments in electronic circuitry have resulted in TV sets that have sharper pictures, brilliant colors and clearer sound. From the smallest portables to wide-screen home theater systems, televisions continue to work better and better as optical innovations are introduced. Unfortunately, a television's picture is only as good as the broadcast it's receiving, and even the world's best televisions cannot make up for a weak or distorted signal. Antenna technology has not kept pace with television design, and the rabbit ears from the 1950's are not far removed from what's available today. Well, there's finally been a quantum leap in the design of antennas, and it's the result of two patented components developed by scientists. These improvements are the secret behind Emerson's revolutionary new antennas.

Picture imperfect. Cable subscription solves the problem of getting the signal to your television, but storms and other factors can result in cable outages. If you prefer not to pay the rising monthly fees for cable or live in an area where it's not available, your picture is likely to be weak, undefined and distorted.

One way to improve your reception would be to mount a large antenna on your roof. Unfortunately, most roof antennas are not particularly pleasing to the eye and may even be prohibited in the area where you live. Rabbit ear antennas don't improve your picture to any great degree and make your room look like something from an earlier decade. Most antennas need to be aimed at the source of the broadcast and require turning mechanisms to pick up the signal clearly.

Whether you live miles out in the country or in a concrete building next door to a broadcast tower, bad reception can rob you of the definition and color you were intended to see. The Optima antenna gives you the signal-grabbing power of a large antenna in an inconspicuous, low-profile size.

Stealth antenna. In the past, creating an antenna with optimal reception meant making it big, with a large amount of surface area. This resulted in products that were large and unsightly or small and ineffective. Either way, the aesthetic look of your room or house suffered. Research and development tended to focus on the television, not on signal reception...until now.



Your neighbors won't know it's there unless you tell them.

Recently, a brilliant scientist in Colorado developed an antenna that would maximize reception without being overly conspicuous. Emerson, a leader in electronic technology, has now made this innovation available to the public.

At a lab in Colorado, they developed two patented design improvements that made the Optima antenna possible. First, they created a flexible circuit board with a serpentine antenna, resulting in a large surface area confined to a small space. Second, they developed a technique that converts the copper shielding on the attached cable to an additional signal receiver that results in an antenna almost 10 feet long. This greatly enhances the antenna's reception power and allows you to tune the antenna by simply moving the cable! The handmade assembly is encased in aircraft-grade plastic and high-density foam. The weather-resistant cover is a neutral white and can be painted to match the color of the house or room. Plus, the omnidirectional design allows you to mount the unit anywhere you please. The Optima's universal design makes it adaptable to any component, and installation is a snap. Simply mount the antenna on a wall inside or outside the house, connect the cable and fasten it in place. Then sit back, relax and enjoy the clearest picture you can get from your television.

Attention mini-dish owners. If you own a mini-dish satellite system, you are aware of the off-air issue and are probably wondering how you can pick up local broadcasts. After all, what good are hundreds of channels if you can't find out who won the local city council race? The Dishmate™ harnesses the same technological innovations as the Optima TV antenna to give you a powerful omnidirectional antenna that is virtually invisible. It is compatible with a variety of systems and is easy to install.

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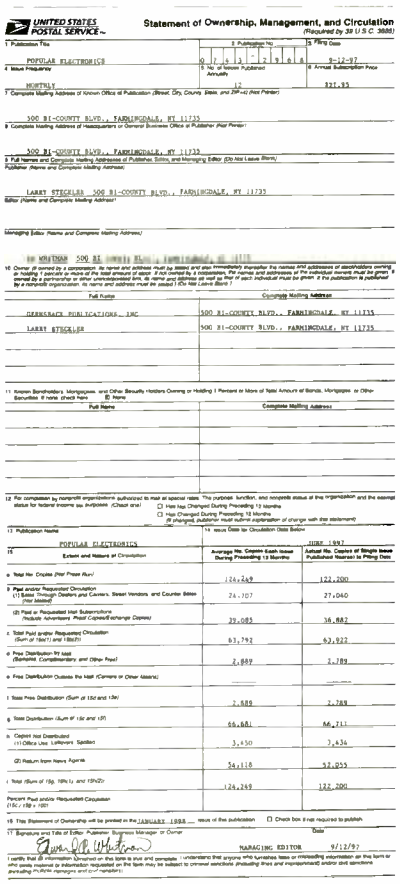

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Editorial

K.I.S.S. Please

No, I am not getting fresh nor am I talking about the rock group. The acronym KISS is a common term found in the ham radio packet world, and signifies a capability found in the terminal network controller unit, commonly referred to as a TNC—the heart of every packet station. You can also find the acronym used in other fields, such as in software development. But what does KISS mean?—it stands for Keep It Simple, Stupid.

This term should also be applied to a lot of the electronics on the market today. I think back to my early *Heathkit* ham equipment (the SB301 receiver and SB401 transmitter for those *Heathkit* buffs), which was about as simple to operate as an advanced crystal set. Even my present *Ten-Tec* Omni-V transceiver is ergonomically designed with a minimum of front panel operator controls. In contrast, I look at some of the other equipment out there, and am amazed that the average ham (that is, one who was not trained on an F-16 simulator) could operate these complicated rigs (especially if you have fat fingers!). Are all those front panel controls and adjustments *really* necessary?

How about the average non-technical consumer and his dilemma using a newly-purchased TV, VCR, or even a home theater console? Maybe these units don't have all the user controls found in ham equipment, but what about ease of operational capability? How many people can comfortably figure out the steps necessary to program their VCR to record different channels, at different days, at different times? Some of these issues are addressed in this month's *Gizmo* column. Even more basic, how many times have you gone into someone's house and seen their digital VCR clock display blinking because no one in the family can figure out how to set the time? Perhaps the manufacturers should keep in mind the KISS philosophy—after all, many of the novel features in their product are wasted if the consumer cannot figure out how to use these capabilities easily.

I have a friend who is still so confused on how to set his digital watch that he keeps two of them running—one is set at standard time and the other for daylight time (I hope his batteries never run out!). Sound familiar? Manufacturers—KISS!

Ed Whitman
Managing Editor

LETTERS

CORRECTIONS

Oooops. The November editorial mentioned that the online publication of **Poptronix** *was owned by Gernsback Publications. In actuality* **Poptronix** *is an independent stand-alone online electronics magazine. Some of the best of our older material, especially construction articles, will be made available at this Web site*—http://www.poptronix.com. *Electronics articles from other sources will also be found here, along with new products, book reviews, and a host of other features for electronics activists. At the present time, you might have to wear your hard hats when you enter this site—a lot of construction is underway!—Editor*

In the Parts List on page 56 for "The Electronic Garage Door Opener" (September 1997), the power rating for the resistors was omitted. They are all fixed resistors, ¼-watt, 5% units, unless otherwise noted.—Editor

MULTIPLE TV/VCR HOOKUP

In the September "Letters," a question was raised on how to hook up two TVs and four VCRs to one master TV antenna, so that two VCRs can be connected to each TV, and they can work at the same time without interfering with each other. I decided to put together a workable scheme. The figure shown details how to connect one master cable to feed four VCRs and have those four VCRs feed two TVs. Please do your readers a great service by publishing this diagram.

K.S.
Auburn, WA

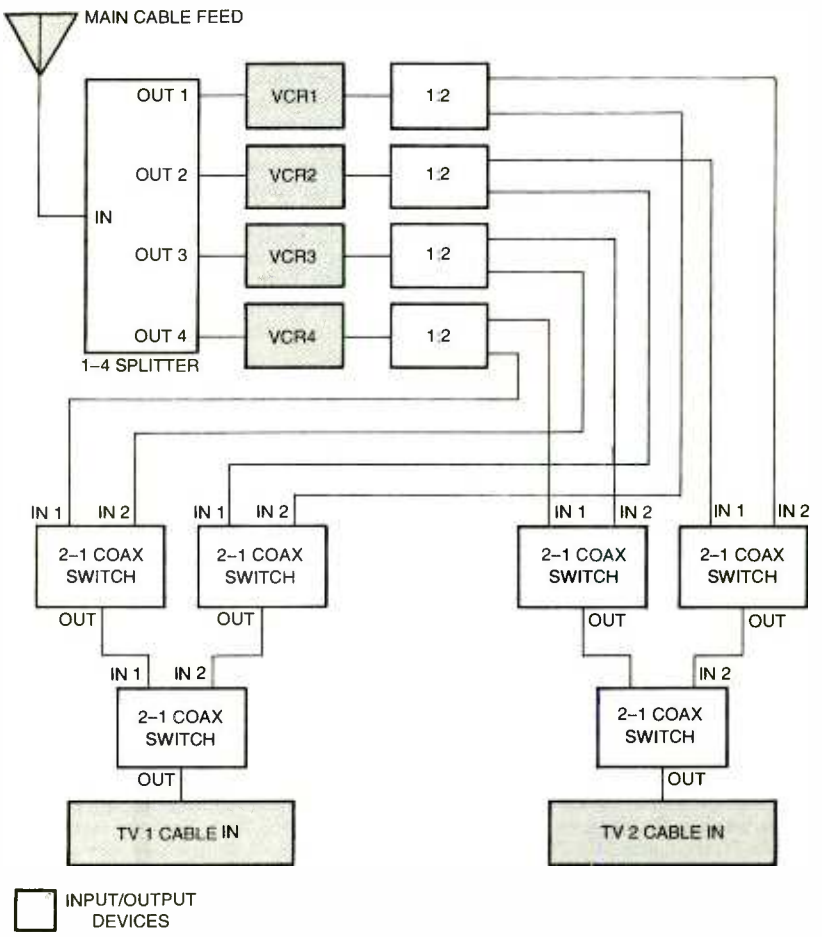
Thanks for the feedback and block diagram—also all parts can readily be obtained at RadioShack. If you don't want to "roll your own," you might look into purchasing the RadioShack Amplified Video Selector (part 15-2100). This unit provides manual switching between five input signal sources and three output jacks. Three built-in amplifiers also eliminate signal loss caused by the switching and splitting and provide isolation between output signals.—Editor

AUTO A/C GRAVITY SWITCH

Here is an idea for any driveway mechanic or enterprising entrepreneur. The idea came to me as I was driving one hot July day in my V8 Pontiac. While driving up one of the many hills on my route, I turned the air conditioner off. The 250 hp engine accelerated due to the elimination of the 5 hp A/C load. The interior of the car stayed cool until I reached the summit, whereupon I switched the air back on. On level ground, I could feel the added load on the engine. Going downhill, it helped the braking. You can easily check out what I found. I thought it would be nice if this switching could be done automatically.

It can, and it's easy to do. A simple gravity-sensing switch in the A/C line should do the job. Constructed with a pool of mercury, such as is used in light switches, this device could handle the power and be placed anywhere between the car's interior and the hood. It would do the same thing that I did manually—automatically saving fuel and wear on the engine. Around town, the switch would give extra benefits, like shutting off the A/C when accelerating after a stop light, or when braking—and then turning the A/C back on when driving on level terrain. To a mercury switch, gravity and acceleration are the same thing—Newton said it! For turning, an extra set of contacts positioned front and back and connected in series would augment fore and aft switches. This control would be a savings on the open road and around town, and could result in reduced pollution due to the reduced fuel usage.

D.C.
Frederick, MD



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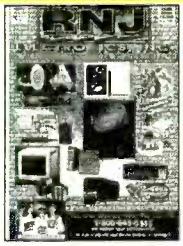

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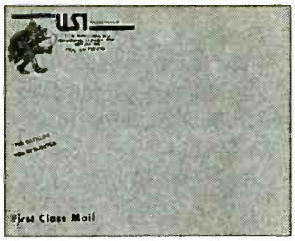

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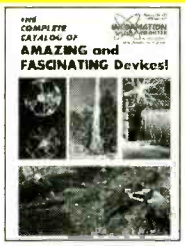

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Diode Laser Projects and Applications

World Star Technologies' Laser Diode Application Note describes laser diode structure, principles of the variety of instruments based on laser diodes. Some examples of instruments based on laser diode were discussed in some detail. Laser diode security systems, laser light show, laser alignment, laser-communication link, laser distance and height measurement, and measurement of particle size and concentration of chemical species were explained briefly. Specifications of variety of laser diodemodules suitable for the described projects are given in detail. ***$2.00***

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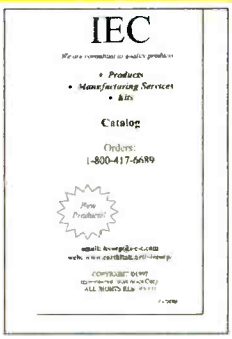

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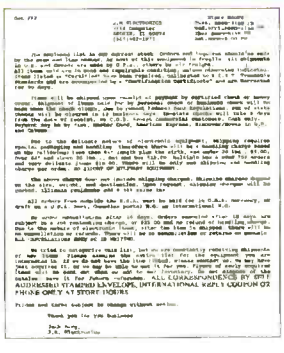

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Void after March 31, 1998

That idea surely seems interesting. New car designers might well consider this feature worthwhile as a means of helping the mileage fleet ratings as well as satisfying EPA standards—Editor

YEAR 2000—NOT A HOAX!

In your October editorial, you made an enormous mistake by stating that the 'Year 2000 Problem' is a hoax. It is NOT. Many systems are incapable of handling the transition (in 2-digit years) from '99' back to '00', and have severe problems. While I enjoy your electronic content, you are clearly NOT qualified to discuss application programming issues, especially those involving older 'legacy' systems mainframe computer systems. If you have tried four systems and they appear to work past the year 2000, do you extrapolate that the millions of other computers and application programs will also work? In fact, many older PC BIOSs have reported having problems with the year 2000, which makes this not just an applications issue, but also a systems issue as well.
T.P.
via e-mail

Your October editorial shows a lack of understanding of the Year 2000 problem. A number of readers in my hometown discovered this at the beginning of this year. Their newly issued renewed credit cards with a 01/00 expiration date were not useable in a local supermarket because the verification system thought that the cards had expired. This happens when the card's expiration year of '00' is compared to the current year, '97'. Since zero is less than '97', the card expired. This has also appeared in another state's motor vehicle bureau, where almost one-fourth of the licenses that expired in the year '00' turned up as being expired. Program fixes and a rerun were made before the report was released.

As you mentioned, your local banker has mortgage repayment schedules running well into the 21st century. If you use his recommended PC accounting software and try to produce a depreciation schedule with a 40-year depreciation period for a house that was purchased in 1959, the program would assume the building was purchased in 2059 and will depreciate until 2069, then switch to run from 1970 to 1999.

Your bank spent a lot of money to fix this problem in the mid-1960s. Today all of the businesses that didn't want to spend the money years ago are being forced to deal with the consequences of their prior decisions.
P.S.
via e-mail

Wow, I guess that my experiences so far have been very lucky. With the clock ticking away we will find out all too soon if there is indeed a problem. Perhaps we could postpone things a bit, by turning the clocks ***back a year****, instead of an hour, when we return to Standard Time in the Fall of 1999. Anyway once we get all the software bugs out of these systems, we won't have to worry about this for another millennium!—Editor*

HAVES & NEEDS

I am looking for a service manual for a Gertsch 60 KHz Comparator, model RLF-1, made by the Singer Co., Metrics Division. It's about 20 years old, and I think the company is no longer in business. I appreciate any information.
Kenneth Hogg
417 W. Kiowa Street
Colorado Springs, CO 80905-1415

I'm interested in purchasing a fully-assembled Heathkit IM-5217 solid utility voltmeter at a reasonable cost. You've helped me before, so I thought you might be able to do so again. I enjoy the magazine. Thanks for your help.
Larry Cook
362 East South Street
Richland Center, WI 53581-2971

Recently I picked up a mobile Lafayette Dyna-Com12 (LRE) handheld radio. It contains transmit and receive crystals for three channels: 3, 10, and 11 (CB I believe). For adding other channels—there are nine more pairs of sockets—how do I figure out the crystal frequency and how to send and receive? I know only a little about CB frequency. If anyone could help, I'd be grateful.
Michael E. Keller
322 South West End Avenue
Lancaster, PA 17603

I have two questions regarding my RadioShack AM/Shortwave Receiver, model DX200, which is no longer being supported by RadioShack. First of all, do you know who the original manufacturer of this receiver is? The second question is more important—where can I obtain the main variable tuning capacitor. The RadioShack part number is C-4704, and the manufacturer's number is GA-79D-0558. The shaft on this tuning capacitor is broken, and I am looking for a replacement part. Any help in my quest will be greatly appreciated.
Nelson Pickett
5526 Monaco Street
Commerce City, CO 80022 ■

Multimedia Watch

Murphy, Computers, and Some New Software

MARC SPIWAK
ASSOCIATE TECHNICAL EDITOR
COMPUTER RESELLER NEWS

It's funny how I can never plan ahead properly when it comes to working on my computers at home—Murphy must hang out in my den. I work for Computer Reseller News in the Test Center with dozens of computers and hundreds of spare parts to play with, and we always have the very latest in hardware and software to work with. Aside from all the equipment, I can also get help from extremely skilled coworkers, many of them with much more knowledge about computers than myself. Very few problems can stop me dead in my tracks when I'm at work.

At home it's another story. Even though my corner of the den is bursting at the seams with computer hardware and software, my resources are relatively limited. I have only two desktop systems to work with at home and pretty much one of everything else. Anything I want to do at home requires careful planning so that I bring home the right stuff from work—even if it's something as simple as having the right SCSI cable. But usually it's something more complicated, like having a program that doesn't like the "B" version of Windows 95.

In my October 1997 column, I reported on a video-capture card called *Broadway 2.0*. I had installed Broadway in a 266 MHz Pentium II system that I use as a test bed. I had made an MPEG movie that was stuck on my hard drive in two large files—around 450 megabytes apiece. I wanted to be able to watch the movie on other PCs and delete the two large files from the hard drive. But my only CD-R (recordable CD) drive was installed in my other computer—the one that I use to write this column.

There are many ways to move large files between computers, and the fastest method would be to temporarily install the hard drive containing the files into the CD-R-equipped system. But I didn't want to mess with the hard drives on the system that I use to write with. That system is fussy when it comes to getting two hard drives to work off the same IDE controller, and I didn't want to fix something that wasn't broken. I could have used a portable SCSI hard drive to transfer the large files, but the 266 MHz system didn't have a SCSI card installed.

Fig. 1. Monster Sound from Diamond Multimedia produces three-dimensional sound that comes from behind you, around you, and above you. The technology was initially developed for NASA's virtual-reality simulators.

One weekend I installed a network card in each system, but couldn't get the computers to talk to one another. It might have been Murphy looking over my shoulder, but networking is not my specialty. And because I don't like to use up resources with hardware that is not absolutely necessary, I pulled the network cards and let the movie files sit for several weeks.

On the last day of work before my summer vacation, I brought home a hot new Hewlett Packard external CD-R drive and, stupidly, an all-too-old Adaptec ISA SCSI card, in case I could find nothing better at home. But Murphy must have taken the same week off that I had. On my first Sunday morning off, I rummaged through my supply boxes but found nothing better than the old SCSI card I brought from work. Windows 95 recognized the card immediately but couldn't free up enough resources. And neither could I—the only resources it could use were tied up by hardware that could not give them up. Perhaps I could have gotten everything to work properly with extended finagling, but I decided to pull the card out instead. I didn't want to screw up any of my other goodies.

In addition to Broadway, I recently installed a DVD-ROM drive in the 266 MHz system. Marketed by Hi-Val, Inc., the $799 DVD package includes a Toshiba DVD-ROM drive—a DVD drive and 8× CD-ROM (CD-player) drive all in one IDE unit—and an AC-3/MPEG2/MPEG1 PCI audio decoder card that works in conjunction with an existing sound card. The DVD-ROM drive can play DVD movies, DVD games, music CDs, and CD-ROMs. It just can't read CD-R discs as I found out that Sunday morning. I haven't played any DVD games yet, but I've watched *The Exorcist* and *Eraser* with Laserdisc quality on my PC and on my TV. The Hi-Val bundle includes a microwave transmitter that beams the movie to a cable, composite, or S-Video input with no signal degradation. The movie discs have the wide-screen version on one side and the panned-and-scanned version on the other. I'm sold on DVD. To make installing the DVD drive as easy as possible, I disconnected the original CD-ROM drive, but the DVD drive is also 8× CD-ROM drive, so I didn't think it was a big deal.

Getting back to my original story, I had just pulled the old ISA SCSI card. I decided to try something as simple yet slow as a parallel-port data-transfer program, but the only version I could find was for Windows 3.1. I installed it in both systems anyway, but then the system I write with wouldn't reboot. I had to start Windows in safe mode and uninstall the program before the computer would boot properly. Don't you see why I do not like to experiment with the system that I write with? Then I remembered that I had a newer version of the program on a CD-R disc in my briefcase. Of course the DVD-ROM drive didn't like the CD-R disc. It's been a long time since a new

CD-ROM drive would not read CD-R discs, but apparently DVD-ROM drives cannot!

Murphy must have left the room because then I remembered that my portable SCSI hard drive came with a SCSI card. Luck was finally with me—it was a plug-and-play Adaptec PCI model, dated 1997. The card installed properly and liked the Hewlett Packard CD-R drive. I felt the momentum build. In minutes I had CD-R mastering software installed and was burning my first disc. Now the SCSI card, good for countless high-speed peripherals, plus Broadway and DVD are all happy. And the external CD-R drive can read CD-R discs at 6× speed. Now I wonder what else I can install?

MONSTER SOUND

I recently checked out a new sound card from Diamond Multimedia. Not just another new sound card, *Monster Sound* is a totally new concept in computer sound. It produces three-dimensional sound that comes from behind you, around you, and above you. The technology was initially developed for NASA's virtual-reality simulators. *Monster Sound* accelerates DirectSound and Direct Sound 3D in Windows 95 and has 32-voice hardware wavetable synthesis.

Monster Sound supports up to four speakers and provides joystick acceleration which processes all game port signals relieving your PC from having to do so. It has a greater than 80 dB signal-to-noise ratio. Installation is easy with Windows 95 plug-and-play operation. Plenty of games already support the card and many more will in time. *Monster Sound* can't handle DOS games, but it's the only sound card you need for Windows 95. It can work alongside an existing sound card that can handle older DOS games. *Monster Sound* has a suggested retail price of $199.95.

BEST BUY IN SPEAKERS

If you've been stuck for a long time with the cheesy speakers that came with your PC because you didn't have a lot of money to shell out for something better, then I have the answer for you. New from GNT Electronics, the *GNT-5000* is a 32-watt satellite/subwoofer speaker system that sells for the incredibly low price of $54.95. The magnetically-shielded speaker system has dual internal amplifiers—19 watts for the subwoofer and 13 watts for the satellite speakers.

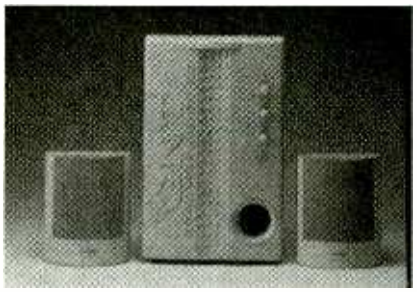

Fig. 2. The GNT-5000 is a 32-watt satellite/subwoofer speaker system that sells for the incredibly low price of $54.95.

The subwoofer's frequency response is from 35 Hz to 250 Hz and the satellite's frequency response is from 250 Hz to 20 kHz. The subwoofer unit contains a single 5.5-inch woofer and measures about 7 inches wide by 9.25 inches deep by 11 inches high. It features separate volume, bass, and treble controls and a power on/off LED indicator. The space-saving satellites each contain a 3.5-inch full-range driver and measure about 4.25 inches wide by 6 inches deep by 5.25 inches high. While the *GNT-5000* won't blow you out of your seat, it's the best speaker system you can get for the money.

NEW SOFTWARE

This month I've got three games from Psygnosis. The action adventure game, *Ecstatica II* is now available at retail outlets for $54.95. *Ecstatica II* has the same look and feel as the original title, with its ellipsoid technology. Traditional 3D games are built from polygons, which create stiff-looking characters and objects. Ellipsoid technology achieves an organic, fluid look. In *Ecstatica II* the hero returns to his castle with his rescued damsel-in-distress, only to discover that it has been over run by enemies. A spell has shattered the holy seal that guards the secret of existence, and the pieces have been scattered throughout the land. You must collect the pieces and reassemble the broken seal while fending off demons. *Ecstatica II* features larger fighting arenas for more freedom of movement in the confrontations with the demons and gargoyles. You have to let loose with roundhouse kicks, backwards rolls, evasive actions, and combination moves. You can also build up an arsenal of weapons and armor as well as potions and other items.

Psygnosis' *Formula 1* also has a suggested retail price of $54.95. The game takes advantage of Microsoft's Direct 3D technology; every driver, track, and option have been optimized to provide the most realistic racing experience outside the real track. Formula 1 literally races on Diamond Monster 3D and Orchid Righteous 3D accelerators and also runs with 3D Labs' Permedia and the Matrox Mystique via Direct 3D. Other cards are supported as well. A rock soundtrack features musical legends Joe Satriani and Steve Vai. Formula 1 includes all 13 Constructor teams and all 35 drivers from the 1995 racing season. Tracks vary dramatically and races are run in both wet and dry conditions. Other game options include steering and braking assistance, manual or automatic transmission, random and statistically correct weather conditions, multiple viewpoints and a comprehensive replay feature.

For more futuristic racing, try Psygnosis' *Wipeout XL*. This anti-grav-

(Continued on page 13)

WHERE TO GET IT

Diamond Multimedia Systems, Inc.
2880 Junction Avenue
San Jose, CA 95134
408-325-7000
http://www.diamondmm.com
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☐ **BP415–Using Net-scape on the Internet $7.95.** Get with the Internet and with surfing, or browsing, the World Wide Web, and with the Netscape Navigator in particular. The book explains: The Internet and how the World Wide Web fits into the general scenario; how do you go about getting an Internet connection of your own; how to download and install the various versions of Netscape browsing software that are available; and how to use Netscape Navigator to surf the Web, and to find and maintain lists of usful sites. There's a heck of a lot more, too!

BRAND NEW

☐ **BP325–A Concise User's Guide to Windows 3.1 $7.95.** Now you can manage Microsoft's Windows with confidence. Understand what hardware specification you need to run Windows 3.1 successfully, and how to install, customize, fine-tune and optimize your system. Then you'll get into understanding the Program Manager, File Manager and Print Manager. Next follows tips on the word processor, plus how to use Paintbrush. There's more on the Cardfile database with its auto-dial feature, Windows Calendar, Terminal, Notepad, etc.

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BRAND NEW

☐ **BP377—Practical Electronic Control Projects $6.95.** Electronic control theory is presented in simple, non-mathematical terms and is illustrated by many practical projects suitable for the student or hobbyist to build. Discover how to use sensors as an input to the control system, and how to provide output to lamps, heaters, solenoids, relays and motors. Also the text reveals how to use control circuits to link input to output including signal processing, control loops, and feedback. Computer-based control is explained by practical examples.

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☐ **ETT1—Wireless & Electrical Cyclopedia $5.75.** Step back to the 1920's with this reprinted catalog from the Electro Importing Company. Antiquity displayed on every page with items priced as low as 3 cents. Product descriptions include: Radio components, kits, motors and dynamos, Leyden jars, hot-wire meters, carbon mikes and more. The perfect gift for a radio antique collector.

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PRODUCT TEST REPORT

Alkaline Batteries

STEPHEN A. BOOTH

The year-end and year-beginning holidays represent the heaviest purchasing-time for all sorts of commodities—but that portable power-source, the cell or battery, is often overlooked. Indeed, that gift-wrapped packet of power is the welcome stocking-stuffer that brings instant gratification to the recipient of a brand-new electrical toy.

With this in mind, ***Popular Electronics*** decided to bench test a bunch of batteries to see if there is any significant difference in performance among brands, as their advertising hype would claim. As you will see in this report and the accompanying charts, there are differences—often quite significant ones.

Here we've tested single-use batteries—by far more popular than rechargeable types. Americans buy nearly 4 billion disposables a year, and 3 billion of these are the alkaline type. *Duracell*, which claims to have about half the U.S. market to itself, estimates that alkaline cells power 80% of the portable devices in U.S. homes. Among its attributes, the alkaline boasts a run-time six to eight times longer than general-purpose ("carbon") batteries, at just double to triple the price—but you seldom have much choice as most equipment manufacturers specify their products for use with alkalines. The AA-size cell is the most popular, so that's what we put on the test bench. We won't bother listing prices or manufacturer addresses here, as price varies by store and the batteries are widely available.

LAB RESULTS

Life-testing on six brands of AA cells was performed by the Advanced Product Evaluation Laboratory (APEL), an independent test facility in Bethel, CT (coincidentally, just down the road from Duracell's headquarters!). APEL bought these broadly-distributed brands of batteries at retail—just as you would—in each case, selecting packages with the latest expiration date. The only exception to retail shopping was *Sony's* new *Stamina* battery. It was supplied by the company, as distribution

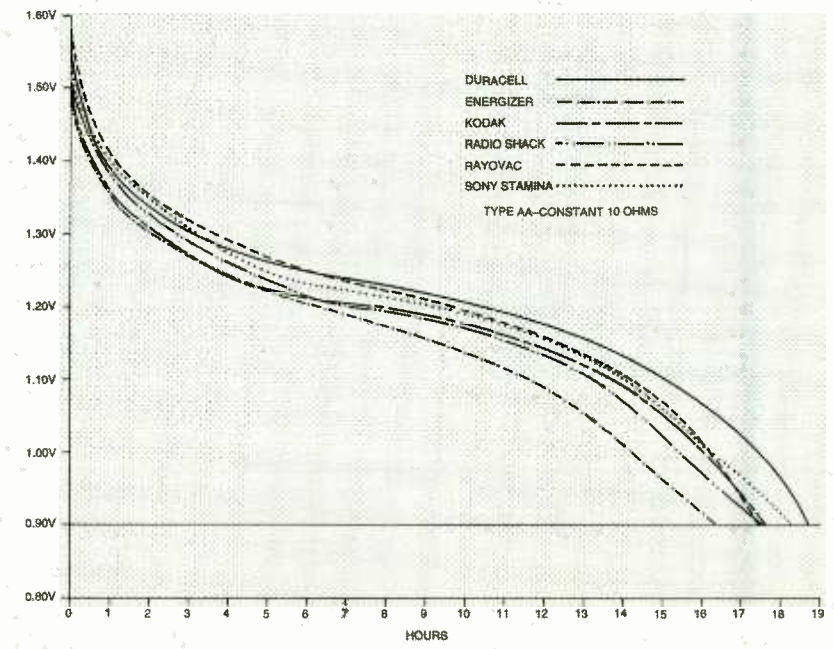
was limited to the Midwest (and Japan) at the time of our testing—it should be available nationally by the time you read this report.

Regarding expiration dates, APEL does not believe them to be a factor in the test results as alkalines are alleged to have a stable shelf life as long as five years. The tests seem to bear this out—compare the performance of the two brands with identical January 2001 expiration dates.

APEL performed two different sets of life-tests on the cells to simulate performance with different types of products. The tests are virtually industry standards, used by engineers at major battery companies.

The "Continuous Test" measures how many hours the cell will run under a constant, 10-ohm load. This is the typical application and load for batteries used in devices such as portable audio equipment and some kinds of toys which require constant power. For this test, APEL took voltage readings every 10 minutes until a fully-charged cell (1.5 volts) dropped to 0.9 volts—a typical cutoff point for most equipment.

The "Pulse Test" gives an insight to the cell's performance with very high-drain products, including some (like flash cameras and some kids' toys) that demand intermittent power and, often, fast recycling times. For this test, the 1.8-ohm load was applied for 15 seconds, and then removed for 45 seconds, continuously, with voltage levels recorded each time down to the 0.9-volt finish line. For the record, both tests were performed at a constant 72-degrees Fahrenheit—about the midpoint of the alkaline formulation's operating range.



Battery output voltage versus time under constant 10-ohm load.

PERFORMANCE MEASUREMENTS

All electrical measurements were conducted by the Advanced Product Evaluation Laboratory using industry-standard performance tests at 72 degrees Fahrenheit. Brands are listed in order of performance.

CONTINUOUS TEST

(Longevity—under constant 10-ohm load before reaching 0.9-volt cutoff point)

Brand	Time (hours)
Duracell	18.8
Sony Stamina	18.3
Kodak Supralife	17.7
RadioShack Super	17.7
Rayovac High Tech	17.5
Eveready Energizer	16.5

PULSE TEST

(On-Off cycles—using pulsed 1.8-ohm load before reaching 0.9-volt cutoff point)

Brand	Pulses (15 sec ON; 45 sec OFF)
Duracell	773
RadioShack Super	711
Sony Stamina	702
Kodak Supralife	675
Eveready Energizer	660
Rayovac High Tech	651

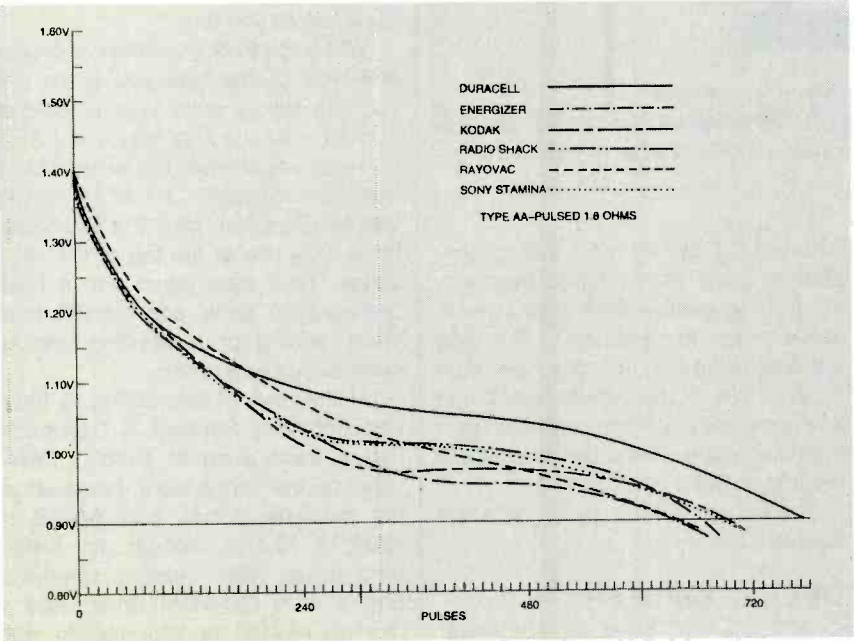
FEATURES CHART

Brand*	Expiration	Origin	Notes
Duracell	Jan 2001	USA	1, 4
Eveready	Jan 2001	USA	1, 4
Kodak	Jan 2002	USA	1, 2
RadioShack	Mar 2001	USA	3
Rayovac	Jul 2001	USA	1
Sony	Jan 2002	Japan	1

*All cell's formulation is virtually mercury-free.

Notes:

1. Guarantee—At manufacturer's option, repair or replacement of any device damaged by cells.
2. Guarantee—Replace battery if it fails to perform satisfactorily.
3. No guarantees stated.
4. Cell tester on packaging.



Battery output voltage versus pulsed 1.8-ohm load.

RESULTS

You'll find the brand-to-brand performance displayed in two forms. The Table ranks the cells in order—longevity in hours of operation, and in number of pulses sustained. Figures 1 and 2 illustrate loaded battery voltage-level by time and by pulses, respectively.

Unquestioned champ in both tests is the *Duracell*. It ran half an hour longer and produced about 10% more pulses than the next-closest brands (*RadioShack, Sony, and Kodak*). The difference between the *Duracell* and the lowest performers is more pronounced—2 hours 18 minutes longer under constant load than *Eveready's Energizer*, and 122 more pulses than *Rayovac's High Tech*.

CONCLUSION

It's pretty clear—the single brand that performs best under either kind of power application is the *Duracell*. We won't rank the others for dual-purpose use, but you can conclude from both sets of numbers that the *RadioShack, Kodak Supralife* and the *Sony Stamina* are close enough in each test for a photo finish. The latter stands up well to the manufacturer's claim as being optimized for use with constant-load products—such as the Walkman and Discman audio gear *Sony* makes and markets.

As for *Eveready's Energizer*, you might conclude from its cellar- and less-than-stellar finishes that some of that TV advertising money ought to get recycled into the product, at least until there's really something to bang a drum about. ■

MULTIMEDIA WATCH

(continued from page 10)

ity racing title also has a suggested retail price of $54.95. *Wipeout XL* is optimized for a variety of 3D accelerator cards. Players choose from four racing classes. Difficulty curves are included for novice drivers and a super-fast hidden Phantom class will give WipeOut veterans a run for their money. The game features 15 anti-gravity ships, 11 powerful weapons, checkpoints and pit-stops that help players optimize their performance as the tracks get tougher. Ships can be destroyed after too much collision damage although pit-stop energy blocks give players a fighting chance of staying in the race. ■

NET WATCH

Buying a Computer Direct

KONSTANTINOS KARAGIANNIS

Before we get to the point of this month's column, you regular readers might have noticed that there's a different first name on the byline at the top of this page. No, your regular writer's brother hasn't taken over this column. It's still me, "Dan," it's just that I've decided to switch over to using my real first name. I know, it's long, but I've been using it more and more lately, so I figured it was time to make it official with **Popular Electronics** as well.

Number one in the direct computer market, Dell has made a solid presence on the Web with its successful online "Configure, Price, and Buy" site.

Now, on to Net business. Everyone knows that a primary ingredient in any Internet connection is a computer with a modem. Some of you reading this have such a setup, some of you have a setup you're not happy with, and some of you don't have a computer at all. If you fall into one of the two latter groups, it's time to buy.

What's the most efficient way to get a new PC on your desk? Well, if you want fresh technology as it's made available, and don't feel like paying a middleman, the answer is to buy direct. Instead of walking into a store and picking up some system that's been sitting on the shelf for a few months, get one that will be put together the day after you order it. Forget about buying and immediately upgrading a PC—order your computer with exactly the configuration and hardware you want.

Two of the most successful direct computer marketers in the world, *Dell Computer Corporation* and *Gateway 2000*, have decided to increase their accessibility by not only letting consumers order from toll-free numbers, but from innovative Web sites as well. Dell's sales, for example, have long surpassed the million-a-day mark from its Web site alone, which hasn't hurt this company's number-one position in the direct market. And Gateway is fast nipping at Dell's heels.

So without further delay, let's get right to the sites.

DELL COMPUTER

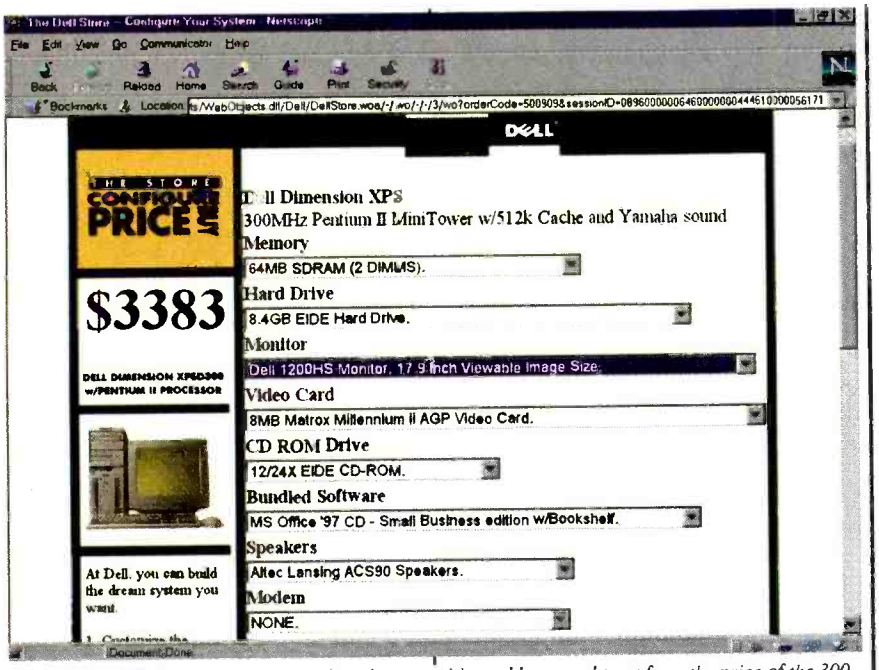
At the '97 PC Expo, an interviewer asked Michael Dell how his company became number one in the direct computer market. Mr. Dell's answer was, "Do you have a credit card, I'll show you." While it got more than a few chuckles from the crowd, and made the interviewer frown in a most interesting way, Michael Dell's statement was actually quite to the point. Dell has made buying a PC as easy as ordering flowers to be delivered.

Expanding on the success of its toll-free order lines, Dell has put together a truly groundbreaking Web site, which more than a few companies are imitating. When you first log on to the site with its easy-to-remember URL, you're presented with several choices that really break down to two different types of links—Information and Ordering.

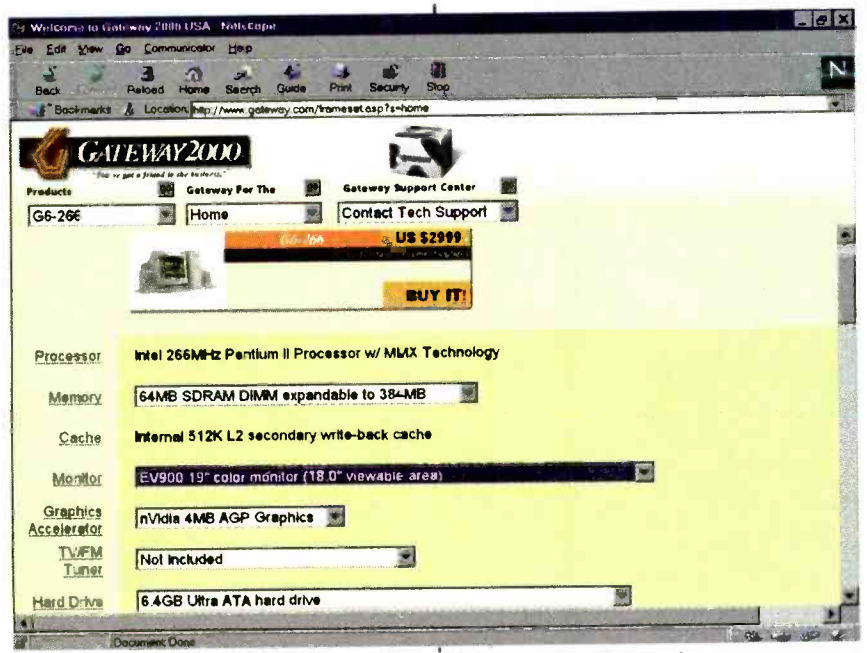
If you opt to learn more about Dell's various desktop and laptop computers, simply click your way to the appropriate link. Select from the award-winning Dimension line of powerful PCs, OptiPlex Desktops designed for business, Workstations for advanced users, Notebooks that break all speed records for portables, and Dellware software and peripherals. Each of these links will give you all the information you need to know before you buy.

When you think you know what general type of machine you want, and you're ready to send your credit-card number over the Net (which is SAFE! with a secure browser like version 3.0 of Netscape Navigator 3.0 or Microsoft's Internet Explorer), click the Configure, Price, Buy box at the top of the site's pages. You'll then begin with a base configuration price and take it from there, adding or subtracting components to suit your needs.

At the time of this writing, a high-end 300-MHz Pentium II Dimension had a base price of $3383. "Base" might be the wrong word, however, as the machine comes with 64-MB of RAM, a 19-inch monitor, an 8.4GB hard drive, Altec Lansing speakers, and a 24× CD-ROM drive. Add a modem, replace the large monitor with a 17-inch unit—your configurations will



Each of the pull-down menus you see here lets you either add to or subtract from the price of the 300-MHz Pentium II Dimension. Don't worry, the numbers you see should be even lower by the time this hits print.



Similar to Dell's site, Gateway 2000 lets you use pulldown menus to select what features you want your next PC to have.

affect the price. Before you give too much thought to the price, though, keep in mind that by the time you read this, this super system could be in the upper $2000 range!

On the low end, you can begin with a 200-MHz Pentium with MMX for around $1746 and add or subtract items to your heart's content. With PC technology changing as fast as it does, my best advice is to get the best processor you can to start. Pentium II is the next platform, and Intel will be doing away with standard Pentium chips before you know it. If you can't afford the 300-MHz chip, try for a 266- or 233-MHz one. But as I mentioned, that's part of the beauty of buying direct; you can choose from technology that will still be here tomorrow.

Once your system's configured, you can send your credit-card number and await your big cardboard boxes. Dell has excellent service and support policies as well, so you won't feel alone after you open those taped-up packages.

GATEWAY 2000

When Ted Waitt started Gateway 2000 in the middle of farm country in South Dakota and took the cow as his mascot, he probably didn't know what would come of his venture. I'm sure he dreamed of doing well, but he couldn't possibly have imagined how far the comfortable-feeling advertising and warm person-to-person approach of Gateway 2000 would take the company. Everyone in the computer world knows what's inside a cow-spotted box, and many, many consumers feel comfortable going with Gateway.

HOT SITES

Dell Computer Corporation
http://www.dell.com

Gateway 2000
http://www.gateway.com

I asked Mr. Waitt recently at a press conference if he thought the company would now shift its focus on pushing individual product lines by name. What he told me sums up the experience you'll find at the Gateway 2000 Web site. He said, "We'll continue to keep our focus on the fact that Gateway has a blanket of products, with a computer that's right for everyone."

When you first access the site, you're given a view of a cow, of course, and either a selection of items based on your needs—Home, Enthusiast, Small Business, Education, or Government—or, if you're familiar with the company's line, an option to go straight to a product by model.

The Web site has a much friendlier feel than Dell's, with many of the screens making you feel as if you really are in Sioux Falls strolling through the grass and trying to decide what computer to buy. The information in both companies' sites is equally clear; however, Gateway's looks less "stuffy," I suppose.

Pricewise, the two are in close competition, though it's hard to compare accurately, as each company uses different hardware add-ons. At press

(Continued on page 18)

A Hands-on Electronics REPORT

Kenwood FreeTalk Two-Way Radio

Designed for the FCC's Family Radio Service, this pocket walkie-talkie brings the family together when they are apart!

For active families and friends that want to stay in touch during outdoor excursions, or even trips to the mall, they can use Kenwood's *FreeTalk* two-way radio, model UBZ-LZ14, a lightweight, palm- size, personal two-way radio. The portable radio's fourteen channels, thirty-eight talk groups and scramble mode help maintain privacy and avoid interruption from other radio conversations.

Unlike cellular phones, which incur toll costs when making or receiving calls, Kenwood's *FreeTalk* radios' only operating expense is three AA batteries used to power the unit. The radio spectrum designated as Family Radio Service (FRS) by the Federal Communications Commission is free to all who want to use it.

Designed for all weather use (just don't submerge it), the *FreeTalk* radio allows friends or family members to stay in close contact when hiking, biking, fishing, boating, snowmobiling, skiing, shopping or caravaning in cars or on motorcycles. The radio has up to a two-mile range and can be kept on standby for 120 hours.

Slightly larger than a deck of cards and weighing only 6.3 ounces with batteries, *FreeTalk* features a LCD display, and comes equipped with a unique flip-down antenna and swivel belt clip. Other features include auto power off and auto channel select, which finds a free channel and automatically opens it for communication.

Ringing It Out. Field tests back up the claim of the unit's versatility. The maximum range between the two radios tested was a 2.1-miles track through a golf course, small inlet, and heavy trees, where both units were not in sight because of sloping ground rises. The signal was loud and clean. *The FreeTalk's* characteristics for getting the signal out was slightly better than can be obtained from a 1-watt CB hand-held unit.

Air-conditioned commercial buildings pose a transmission problem due to their aluminum-lined insulation. However, the *FreeTalk* functioned exceedingly well at the building's windows with only slight range loss when compared to outside range measurements. Within a two-level mall of mammoth size, the *FreeTalks* we tested batted a 1000 no matter what nook or corner contacts were tried. Voice quality was good compared to a telephone, but don't expect hi-fi sound. The units' FM signals were exceedingly clear and free of static even in high-density fluorescent light locations. The screw-on belt clip came in handy, and the unit does fit nicely in a breast shirt pocket.

About the FRS. The Federal Communications Commission (FCC) authorized *Family Radio Service (FRS)* in 1996 as a short-distance,

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PLUS...Gizmo, our honest and straight-shooting review of the latest consumer-electronics gear...Market Center, featuring mail-order merchants that are ready to help you in all your hobby activities...articles and columns covering every aspect of the electronics hobby — including antique radio, shortwave listening, ham radio, computers, scanners, circuit design, and more!

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Send no money, unless you prefer. We'll be glad to bill you in January, 1998. Just take a brief moment to go over your gift list and make sure you haven't forgotten anyone who might appreciate the many benefits of Popular Electronics. Then write the names on the attached Gift Certificate and mail it back in the postage-paid reply envelope . . . we'll take it from there!

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unlicensed, two-way, voice, radio service for general purpose use. Family Radio Service is meant to be used for direct, personal voice communications among two or more people. *FRS* radios are personal two-way (send/receive) radios which conform to the FCC FRS specifications. In brief, they're an inexpensive and easy way to communicate with family and friends over short distances. FRS radios can be used by groups engaged in activities that take people out of sight or earshot of each other. The radios are small, rugged and easy to use, so they can be used by children as well as adults.

FRS radios offer 14 separate communications channels, and each channel can handle up to 38 separate conversations or talk groups (actually sub-channels). This means that FRS radios provide 1038 (14 x 38) separate pathways for conversations to take place at any time. Conversations or talk groups can include two or more people, as long as everyone in the conversation has an FRS radio tuned to the same channel and talk group.

Channel and talk groups are shared by FRS radio users on a *take turn* basis, and they cannot be assigned exclusively to any specific individual or organization. Because FRS radios conform to FCC specifications, units manufactured by any one manufacturer can communicate with people using FRS radios from other manufacturers. However, Kenwood is currently the only company to equip its FRS radios with a *privacy* feature which, when in use, prevents owners of other makers' radios from listening in or speaking in *private* conversations. This will be an important feature once many people own FRS units. And, if you want to really be secretive, a scrambling feature is included.

Unlike ham radios or cell phones, FRS radios do not require users to have a license or third-party authorization. FRS radios are not connected to the public telephone network, so they cannot be used to make phone calls. However, unlike cellular phones, they incur no air time charges for either speaking or listening.

You can use a FreeTalk radio in the United States and anywhere else regulated by the FCC. There are a few restrictions on its use in connection with emergency overrides and other federal regulations, but these are typical of any radio communications equipment. FRS radios are specified to transmit signals at $^1/_2$-watt power output; utilize a three-kHz signal bandwidth, which is adequate for clear voice communications; and provide automatic squelch control to reduce static and other unwanted RF noise. FRS radios transmit FM signals around 460 MHz, which is in the Ultra High Frequency (UHF) portion of the radio spectrum.

The *FreeTalk* comes in two colors, black and yellow, and has a suggested retail price of $159.00 per radio. Available accessories include a voice-activated headset for hands-free use, a speaker-microphone similar to those used by police, and a clip microphone. *FreeTalk* radios can be used out of the box, without licenses or registration. Further information can be obtained by contacting Kenwood Communications at PO Box 22745, Long Beach, CA 90801; Tel: 800-KEN-WOOD; Web: *http://www.kenwoodusa.com*. ■

NET WATCH

(continued from page 15)

time, a G6-266 machine with a 266-MHz Pentium II, 19-inch monitor, 6.4GB hard drive, Bose speakers, x2 56-Kbps modem, and a 24× CD-ROM drive was $2999. The same add/subtract rules apply as with Dell's machines—pulldown menus facilitate your choices. It's interesting to note that the green-pasture color scheme disappears from the pages as you approach buying time. I guess when it comes time to pay, you're thinking about green enough as it is!

Gateway 2000 makes ordering by credit card easy and secure just as Dell does. If you still think this isn't a safe way to go, and feel more comfortable giving your number over a cordless phone that anyone can intercept, you can call each company's toll-free number and read your specs to a sales rep. Either way, these Web sites will make it easy to see where each dollar is going.

I guess that's all the space we've got for this month. Until next time, I hope you find just the right piece of computer hardware to help you enjoy your online experience. If you'd like, drop me an e-mail at netwatch@comports.com, or a snail-mail to *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

"She works on Motherboards"

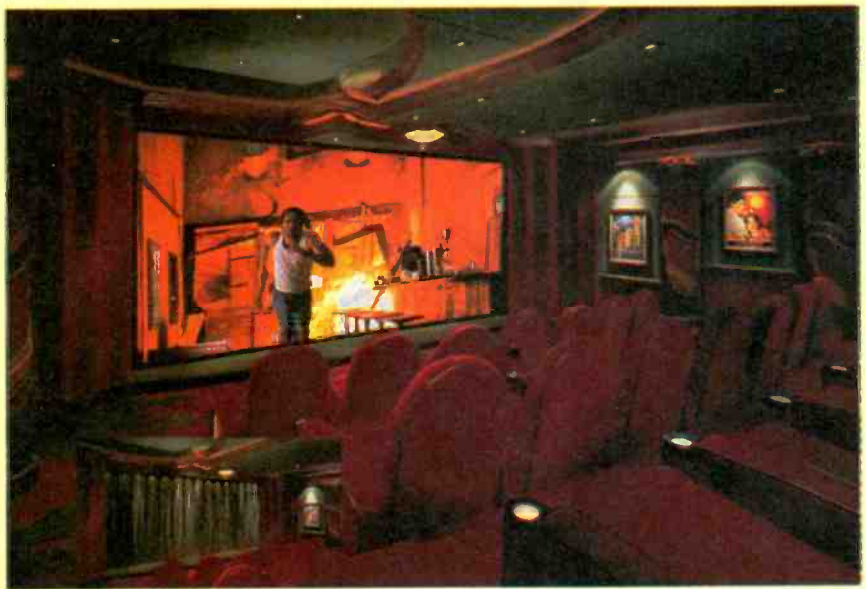
GIZMO®

Shake, Rattle, and Roll!

How to create a home theater that looks, sounds, and feels like the real thing!

Home theater is not just a trend. In fact, it's fast becoming a way of life. Americans watch 15 hours of TV a week—why waste even a minute of it on dull programming or poor quality video and audio? Make your time in front of the tube count with a home-theater setup that takes you out of your easy chair and into the action!

When you think of home theater, what picture pops into your head? If you've bought into all the hype, you probably visualize a custom, built-in installation that cost more than your car (perhaps even more than your house), complete with huge screen, ground-shaking sound, and plush seating for a crowd. That type of home theater does exist outside the glossy pages of magazines—it's more common than you'd think.



Who would guess that this theater is in a home? At the extreme top end of home theaters, this was designed and installed by First Impressions Design & Management (North Miami, FL) for a movie-industry client who shows previews of first-run films on a regular basis. *Jurassic Park* was seen on this $100,000-plus home-theater before it was released in theaters nationwide!

But creating a home theater does not have to be a huge, complex, expensive proposition. Chances are, you already own some, or most, of the necessary components. In its most basic configuration, a home theater is simply a large-screen television, a surround-sound receiver, and five speakers.

That's a bit like saying a car is just a chassis, an engine, and four wheels. Of course, your viewing (or driving) experience is going to depend on a lot of other factors—the quality and power of the basic components, and what extras you opt to add. And, in home electronics as well as in automotives you tend to get what you pay for. But it isn't any more necessary to break the bank when creating a good home-theater system than it is when buying a reliable car. Driving a Ferrari might be a thrilling experience, but for everyday driving, a Taurus, Saturn, or minivan will fit the bill admirably—and if your family's lifestyle includes hauling kids to soccer games, pets to the vet, and groceries home from

This attractive, streamlined home theater was designed and installed by Tom Doherty Architectural Audio & Video of Indianapolis. Its extensive use of built-ins keeps clutter to a minimum.

the market, the Ferrari probably won't do at all.

The same goes for home theater: A $25,000 preamp, a $15,000 powered subwoofer, and a 100-inch screen would be overkill in most homes—not to mention most savings accounts. Don't despair: You can feel as if you're in that alien ship in *Independence Day* even using home-theater components with down-to-earth price tags.

To buy a car, you read through the literature, visit some showrooms, select the make and model, choose the options you want to add, pick a color, and then begin haggling over the price. Shopping for a home theater, however, is usually more difficult. While there are some all-in-one, out-of-the-box home-theater setups, it's much more common to buy separate components, adding them to the gear you already own. There are dozens of models of each component, each with different features and covering a wide range of prices. As with car buying, you'll start out with a basic budget—the difference is that you'll have to decide how to allocate the available funds between the various pieces you need (or want).

In this issue of *Gizmo* and the next, we cover home theater from A to Z. This month, we examine what goes into home theaters—both basic and sophisticated ones. We look at each of the different components, and explain what features are most important and how to match various brands and models. We show you the most popular technologies and features available today—and we'll reveal the new technologies that will be considered all-important in tomorrow's systems. We explain how to arrange your speakers and furniture to get the most from your setup. Finally, we'll take a close-up look at a home-theater-ready mini-system. Next month we'll set up and review a couple of home-theater configurations, complete with hands-on reviews of televisions, VCRs, DVD players, A/V receivers, speakers systems, and some exciting accessories.

PIECE BY PIECE

Home theater is the merging of home video and audio systems. It is not a new phenomenon; in fact, the home theater has become the driving force behind audio and video retail sales over the past decade. In 1996, almost half of the direct-view televisions sold were 25 inches and larger, and hi-fi stereo VCRs accounted for 46% of total VCR sales. Sales of audio home theater equipment are expected to increase by 8% each year to the end of this century, by which time sales of digital video products should reach $5 billion.

Manufacturers are well aware of those figures, which are strongly reflected in their product offerings. Most stereo receivers sold these days include the circuitry needed to decode Dolby Pro Logic movie soundtracks. And you'll be hard pressed to find a large-screen (27-inch-plus) TV that doesn't offer stereo sound.

The video portion of a home theater consists of a television or monitor and source components. With a TV and a good antenna, you might be able to pull in as many as a dozen stations of standard network fare—which was once considered a broad viewing selection. These days, you'd be hard pressed to find a home that did not contain at least one source component—most likely, a VCR. Cable TV and, more recently, direct broadcast satellite (DBS) have provided TV watchers with easy access to dozens of channels of movies, sporting events, and mainstream and alternative programming.

Today's must-have video source components include not only the ubiquitous VCR but also a cable box or a satellite system (in some cases, both). Many videophiles also opt for a laserdisc (LD) or digital videodisc (DVD) player.

A stereo system usually doubles as the audio section of the home-theater setup. As with traditional music systems, several options are available. You can take the easy road with a rack system from a single manufacturer; purchase speakers, receiver, and source components separately; or go one step further and replace the receiver with individual tuner, amplifier, and preamplifier. In a home-theater audio system, you'll need an audio/video (AV) receiver, which means one equipped for decoding surround sound and driving five speakers instead of the two needed for stereo listening. (Because our focus is home theater, we won't get into audio source components—CD player, cassette deck, turntable, MiniDisc—in any detail in these articles, except to note that a good A/V receiver will have sufficient inputs for all of your gear.)

That might all seem pretty simple and straightforward. Well... it isn't. Take the TV, for instance. All you have to do is decide which size will fit in your entertainment center and how much you want to spend, right? Nope. There are direct-view sets, front- or rear-projection televisions, wide-screen jobs for viewing films in different aspect ratios, and "data-ready" units for the convergence of PCs and TVs. Do you need digital inputs or picture in picture? Every piece of your potential home-theater system has a similar set of options designed to increase your viewing and listening pleasure—and drive you crazy as you shop.

Let's take a look at each of those components and the most common options that they offer. You'll still have to make the ultimate decisions, but at least you'll have something to work with other than the salesman's spiel!

VIEWING VIDEO

The television is the most obvious piece of home-theater equipment—and often the focal point of your family room, as well. The first decision you'll need to make is the size of the screen. Anything less than 27-inches (measured diagonally) is considered rather small for a home-theater setup. We're tempted to say: "Buy a set that's at least as large as your best friend's" simply because, after watching a few movies on his 35-incher, your 32-

inch set will seem a bit, well, petite.

In reality, the size of the set depends mainly upon the size of the room in which it will be watched, and also upon the placement of the furniture in that room. A 27-inch set will be lost in a large room. Conversely, you'll be able to see every pixel that makes up a 100-inch projected image if you're sitting practically on top of the screen.

From a practical point of view, some of those rear-projection sets are quite bulky and difficult to fit in a small room.

A rear-projection set, like this 62-inch model from Pioneer, is a popular choice for home-theater viewing.

(If your wife hates those large floor-standing speakers, she's not likely to take to a monster television either.) Remember, the room you're using will also have to hold a couch and some chairs. And, unless you have a dedicated home-theater room, when the television's not on, other activities such as homework and hobbies (and associated paraphernalia), will probably have to be accommodated as well.

As a general rule of thumb, the viewing distance should be at least twice the picture height. The height of a 40-inch screen, for instance, is 24 inches. So your sofa would have to be at least four feet away from it for comfortable viewing.

Know the dimensions of your family room, and the probable placement of TV and furniture, before you begin shopping. Then watch the floor samples from approximately the same distance and viewing angle as if you were on that sofa or easy chair. The image should be large enough to hold your attention, without being overpowering. You shouldn't feel as if you're sitting in the front row of a theater. (If you find yourself absorbed in the pores on the star's nose or the texture of the leading lady's stockings, the picture is too large.) Will some of your furniture be arranged off to the sides of the set? Then make sure that the image doesn't degrade significantly as the viewing angle moves off center.

Ambiance Unlimited (Clifton Park, NY) won CEDIA's 1997 Electronic Lifestyles Award in the under-$25,000 category for the design and installation of this home theater. With projector and all the other components (along with adequate media storage) built into the wall behind the couch, viewers can focus on the huge screen with no distractions.

Once you've determined what sizes would be suitable, buy the largest one that you can afford. Don't scrimp on screen size—you don't want to have to squint to see if that rhythmic thumping sound booming from your surround speakers is a helicopter or a jackhammer.

To a large extent, the size of the screen will determine the type of television you'll end up with. The familiar cathode-ray-tube sets, commonly called direct-view TVs, are limited in size because it's simply too expensive to produce really big picture tubes—not that you'd be able to fit them through your door, anyway. The largest direct-view sets now measure 40-inches diagonally; more common (and more affordable) "large-screen" sizes are 27, 31, 32, 35, and 36 inches. What they "lack" in size (a 36-incher should suffice in an average-sized living room) CRT sets make up in clarity and brightness. You get a better picture from a direct-view TV than from front- or rear-projection sets, and the angle of view has little effect on the quality. That gives you a bit more leeway in arranging furniture. Direct-view sets produce pictures bright enough to watch in a well-lit room, so if your family likes to do other things (play games, work on jigsaw puzzles, do crafts projects) in front of the TV, go for a CRT set.

For larger images, a front- or rear-projection television is required. A front-projection unit provides the largest images, and offers the added bonus of portability. The setup includes a projector that beams images across a room onto a separate screen. The picture size is adjustable from about 40 inches to more than 100 inches. Both front- and rear-projection sets perform much better in darkened rooms, and require viewers to sit as close as possible to "center stage."

With a bit of installation ingenuity, front-projection sets can be made to vanish when not in use. Projectors can be mounted inside a coffee table or suspended from the ceiling, and screens hidden behind a valance and retracted to reveal a picture window—or even a standard-sized TV set for everyday watching.

Rear-projection sets, on the other hand, are generally one-piece units offering screen sizes ranging from 40 to 80 inches (measured diagonally). Their biggest drawback is the sheer size of the sets themselves; rear-projection sets take up quite a bit of floor space.

Within most front- and rear-projection televisions are found red, green, and blue picture tubes that emit light beams that must be converged—merged accurately—to create a clear image with true color reproduction. Rear projectors are factory converged, and because the distance between projector and screen never changes, they rarely require any adjustments. Front-projection systems, however, require reconvergence every time the screen or the projector is relocated—which tends to hinder their portability.

A different type of front-projection set eschews tubes altogether in favor of a liquid-crystal display panel. A full-color image is created by passing white light through colored filters and LCD panels. Convergence is not required; simple focusing does the trick. So far, however, LCD projectors have not delivered the picture resolution or brightness offered by tube-based projectors.

Once you've decided upon the size

and type of television, there are a few other features you might want to look for. Just about all 27-inch and larger sets offer multichannel TV sound (MTS) for decoding and reproducing stereo broadcasts. Many also offer built-in speakers of varying degrees of quality. (You're not likely to rely on the TV speakers' sound, however, if you intend to set up a complete home theater.) Every set comes with a remote control, but some are better designed than others. Look for frequently-used buttons that stand out from the rest for easy access. Many remote controls can be programmed to operate other components, which can greatly reduce coffee-table clutter. Picture-in-picture is a popular option. Keep in mind, however, that unless two tuners are included in the set's circuitry, a second source will be required for the feature to work. Some of the newest sets even offer on-screen program guides, such as *TV Guide Plus*, which displays about two day's worth of programming. Finally, if you already own an entertainment center that you intend to keep, measure the TV compartment to be sure the set you select will fit!

What about digital TV (DTV) and high-definition TV (HDTV)? Should you put off buying a TV altogether until digital sets are available? It will take another year, at least, until DTV sets go on sale in the U.S., and longer still for a significant amount of programming to be broadcast in the new format. And, just as black-and-white sets remained in use for years after color sets were introduced, you can expect NTSC TVs to stick around well into the new century. If you're thinking of buying a new TV now, by all means, go out and do so. Enjoy it for the next few years and just about the time you're thinking of trading it in for a bigger and better model, HDTV sets might be reaching affordable price levels. Also, you can be sure that when digital broadcasts begin, converters will be available to allow your current NTSC set to receive digital programming, though not necessarily in their wide-screen or high-definition splendor.

As of this writing, however, it's decidedly uncertain just how much high-definition programming will be available from broadcasters. Thanks to the flexibility of digital encoding, broadcasters have a choice of using their DTV channel to deliver a single high-definition signal or multiple standard-definition signals. Many broadcasters have indicated that they don't plan to offer high-definition signals. Why should they when there aren't many sets to receive them — especially when they can earn additional revenue from commercials on multiple channels?

With all the programming choices available today, an on-screen listing such as this one from StarSight makes it easier to select the shows you want to watch and to record those you want to save. Many VCRs, and some TVs, offer such programming aids.

FROM THE SOURCE

The VCR has been, and will continue to be in the foreseeable future, by far the most popular source component. VCRs currently are found in 98% of American households, and second decks are not uncommon. While their recording capabilities are impressive, they are most often used for watching prerecorded videos. There are thousands of titles available on VHS video, and rental shops can be found in just about every town in this country. VCRs are familiar, inexpensive, and easy to use—they won't be put out to pasture any time soon. They survived (with flying colors) the laserdisc, and they are likely to hold their own against DVD for years to come (with the same type of staying power as analog cassette decks have exhibited since the introduction of the compact disc player).

When they were first introduced, VCRs had a deservedly bad reputation as being impossible to program. That's no longer the case, but some units are easier to program than others. A good proportion of today's VCRs offer the VCR Plus programming aid. Instead of inputting stop and start times and the channel, the user simply punches in a numeric code that's printed along with the show description in many newspaper TV timetables as well as in *TV Guide*. The VCR Plus circuitry recognizes the code, and sets the VCR to tape the show to which it corresponds. StarSight is a subscription-based programming aid that displays a week's worth of listings. Pressing a few buttons on the remote control "selects" the shows to be recorded, and sets the process in motion at the correct time. But even a VCR with no add-on programming help should be easy to use, thanks to improved on-screen menus that walk the user through the process.

There are a few convenience features worth looking for when buying a VCR. Auto clock set, for instance, uses information in the broadcast signal to properly set the VCR's clock—and reset it in the event of a power interruption. Bye-bye flashing "12:00"! Some VCRs offer an index search function that allows you to place electronic "bookmarks" on the

tape every time you begin recording. The VCR can then locate those bookmarks, making it easier to find the beginning of taped programs. A few units now offer circuitry designed to automatically fast-forward through the commercials in the tapes you've recorded; others will zip through the ads and previews found at the beginning of most prerecorded videos. Somewhat more common is a "skip" button that fast-forwards the tape in 30- or 60-second increments. With a bit of practice, you can become proficient at skipping through those commercial breaks without missing any of the programming. Parents will appreciate a lockable cassette door (ever tried to remove a peanut-butter-and-jelly sandwich or a handful of paper clips from the tape transport?).

Laserdisc players represent a small part of the audio/video market. Pioneer is one of the only manufacturers still standing behind the format.

Home videographers should look for front-panel inputs that make it easy to hook up a camcorder for playback and editing. Special VCR editing features include audio dub for adding narration or music, a jog-shuttle dial for two-way control of tape speed, a flying erase head for easy insertion of video segments, and a title generator.

When buying a VCR for use in a home-theater, the most important thing to look for is hi-fi stereo capability. A four-head unit provides a more stable image than a two-head VCR; models with six or more heads are available but not common. They won't give you a better picture in play mode, but will produce better special effects.

The big drawback to VCRs—technically and artistically speaking, that is; mainstream consumers don't seem to mind much—is picture quality. Especially when viewed on a large screen, VHS tapes leave much to be desired.

LASER LAGS

Why, then, didn't the much improved picture image—not to mention the CD-quality sound—offered by laserdisc players lead to the demise of the VCR? It wasn't the VCR's recordability that kept it going strong. As we mentioned earlier, most people don't even learn how to time shift a program with their VCRs. To some extent, the laserdisc player's higher price tag kept customers away. The fact that it took quite a while before there was a large library of movies available on laserdisc (and longer still before stores and catalogs offered them to folks living in the boonies) played a far greater role. Quantity won out over quality: Most people just didn't seem to mind the inferior resolution of the VHS format, as long as they had plenty of movies to watch.

Despite the indifference of John Q. Public, laserdisc has enjoyed a firm standing in its own little (2% of American households) niche market. Its position, more than that of the VCR, now is being seriously threatened by the rise of DVD.

HERE COMES DVD

DVD officially stands for ... nothing. It is sometimes called Digital Versatile Disc, with a nod toward its other persona as a computer storage medium, sometimes Digital Video Disc. We'll just stick with DVD.

DVDs look just like CDs, but the five-inch discs can hold an incredible amount of data compared to a CD's 650 megabytes. DVDs use a unique layered configuration. The 1.2mm-thick digital video disc actually consists of two 0.6mm discs that are bonded together back to back. It's possible for each side of the disc to have two layers, each with a 4.7-gigabyte capacity, for a grand total of 17 gigabytes on a dual-layer, double-sided disc. Each layer can store a movie that's up to 133 minutes in length. Longer films can "run on" to the second layer on the same side. Although no such discs have been produced yet, the transition from the top to bottom layer is supposed to be transparent and automatic—presumably, there will be no need to get up and physically flip the disc, and no "skip" in the film action.

What to do with all that extra disc space? That's up to the software producers. A tiny portion is used for a table of contents that allows viewers to easily access particular scenes in a movie, and for versions of a film in different aspect ratios. It's also possible to add audio

DVD players are expected to become the source component of choice.

tracks and subtitles in several different languages, to include multiple camera angles, and to offer "bios" of the actors and other relevant information.

Those factors are convenient and/or "cool," but the best thing about DVD is the high-quality video and audio that it offers: 720 pixels per horizontal line and 500 lines of horizontal resolution. Compare that to VHS (240 lines), S-VHS (400 lines), laserdisc (425 lines), and even direct broadcast satellite systems (450 lines). The DVD picture is noticeably clearer, brighter, and free of artifacts. And, as part of the DVD standard, all DVD movies released in this country will include Dolby Digital surround sound soundtracks.

Dolby Digital (formerly known as AC-3) has been used since 1992 to provide multichannel digital surround sound in select movie theaters. The system offers five full-range channels in a "3/2" configuration consisting of three front and two surround channels. The sixth channel is not full range. Used solely for bass-effects, it's called the low-frequency effects or LFE channel and handles only those frequencies below 200 MHz—which is why Dolby Digital has been dubbed a 5.1-channel system.

Unlike Dolby Pro Logic systems, in which a single, monaural, band-limited surround channel is played (usually over two speakers), Dolby Digital (DD) features two completely independent surround channels, each with the same full-range fidelity as the three front channels. Dolby Digital's true stereo surround effects create an expanded sense of depth, localization, and realism—and, as a bonus, the complete separation of the audio channels makes DD just as well suited for listening to music.

You won't get Dolby Digital surround sound just by hooking up a DVD player, however, unless that player is equipped with an on-board decoder (and your receiver is "DD-ready"). That feature is offered in only a few top-of-the-

line models. We'll have more on Dolby Digital in the sections on receivers and speakers.

The DVD format has been firmly embraced by almost all of the major consumer-electronic manufacturers and is gaining in acceptance by the big players in the motion-picture industry, who originally voiced strong reservations about the format because of its potential for piracy. Last September, Disney announced that it would back the DVD format, joining the ranks of Columbia Tri/Star, MGM/UA, and Warner. DVD stood poised on the brink of success, even before its first birthday rolled around.

Ah, but in the world of consumer electronics new technologies rarely reach maturity without suffering some growing pains—which often stem from consumer confusion. For a product to be successful, people must feel that they need it and want it, and before that can happen, they have to understand what it is and what it can do for them. One of the worst scenarios is for another as-yet-untried rival to be thrown into the arena.

Despite delays as the computer, consumer-electronics, and the motion-picture industries hammered out their differences, DVD's introduction was relatively straightforward. No compatibility issues, no serious competition from other formats, all the major players presenting a united front as the product was launched.

Within a week of Disney's DVD endorsement, however, that studio, along with Paramount, Universal, and DreamWorks, and manufacturers including Panasonic, RCA, and Zenith, joined retail giant Circuit City as it announced plans to market yet another digital video technology in the summer of 1998. Not officially a rival to DVD, Divx is not fully compatible with it either. Divx players will be able to play DVD discs, but today's DVD players cannot play Divx discs. It will be possible, however, to buy DVD players that include the circuitry necessary for viewing Divx discs. Zenith, for instance, plans to market a Divx DVD player this spring.

Confused yet? You will be.

PAY-PER-VIEWING PERIOD

Created by Digital Video Express (a partnership in which Circuit City holds the majority position), the system relies upon 5-inch discs that will cost $5 or less. For that nominal fee, you can "own" a digital video movie that's yours to watch as often as you like—for two days, and only on one Divx player. The viewing period is activated not when you buy the disc, but when you put the disc into a Divx player and press PLAY. The player counts down the time, and when it runs out, the specially encrypted disc can no longer be watched.

If you really like a movie, you can place a phone call, pay an additional fee, and have it reactivated for another two-day viewing period. With some titles, you'll be able to pay a one-time fee to convert them to unlimited viewing. Other titles will be made available at the original purchase time as "unlimited viewing discs." No prices have been announced for those options.

What makes Divx so appealing to the movie studios is that it offers several layers of piracy prevention, including individual serialization of players and discs, triple DES encryption, watermarking, and analog copy protection. Disney's Buena Vista Home Entertainment, Paramount, Universal, and Dreamworks showed their approval by committing to make all new titles, and close to 1000 catalog titles, available for release on Divx discs. Upwards of 100 titles should be available when Divx is launched this summer, with close to 500 in stores by the end of the first year.

In effect, Divx will give you digital-video-on-demand. Stop by Circuit City any weekday to pick out your weekend viewing ("Divx plans to make ample supply available to immediately and fully meet demand when videos are released to the rental market," claims the company.) You needn't worry about returning it or accruing late fees.

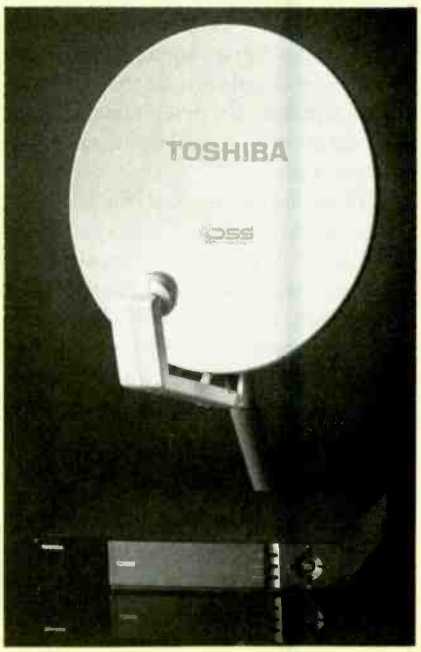
Its backers, such as Zenith Sales Company president William J. Simms, believe that Divx "will help move DVD technology into America's family rooms." Could be. But from now until next summer, it's sure to slow sales of conventional, non-Divx DVD players—and to create a lot of confusion.

SPACE JAM

While you're waiting for all that DVD/Divx dust to settle, you can always sit back and enjoy digital movies, and a wealth of other digital programming, via satellite. Today's direct-to-home (DTH), or direct broadcast satellite (DBS), systems don't require those unsightly 12-foot dishes. They rely instead on compact (18- to 39-inch) dishes to pull in hundreds of channels of digital and audio programming. The quality is not quite up to par with DVD, but is dramatically superior to what most of us are used to seeing on cable and broadcast television and on VHS tapes.

There are several options in DBS systems. Each consists of a small dish antenna, an integrated receiver/decoder, and a remote control. Each offers a wealth of programming options and digital signals. Dish sizes vary, however, as do the programming packages offered. Most DBS systems require an initial equipment investment, although one company leases its gear to its subscribers. Increased competition has created a price war that has brought the buyers initial outlay way down—as little as $99, in some promotions, when you purchase a year's worth of programming.

Introduced in 1994 by Thomson Consumer Electronics, DSS was the first high-power digital DBS service available in the U.S. It became an overnight success and remains the best-seller today, with systems available from several manufacturers. DSS, which uses an 18-inch dish, relies on two program providers: DirecTV provides 45 basic channels and 30 music channels, while USSB offers premium channels, sports packages, and 55 pay-per-view channels. Its on-screen program grid lets you see listings up to



DSS, first introduced by Thomson, is now being offered by several manufacturers, including Toshiba.

three days in advance and provides program descriptions. DSS is the most expensive DBS service as far as programming goes. A true TV junkie can spend as much as $90 a month on DSS programming.

The programming from EchoStar/Dish Network won't set you back more than $60 a month. Its starter package of 40 TV-, 30 music-, and six pay-per-view channels costs only $20 a month. EchoStar's RF remote allows you to control the receiver from another room in which a secondary set is located (a feature not offered on every brand of DSS). Like DSS, EchoStar uses an 18-inch dish.

Primestar leases its 39-inch elliptical dish, receiver, and remote control, so there is no initial outlay for equipment (although in these days of low-cost promotions, that factor is not as important as it once was). The cost of the lease is rolled into the monthly programming fee, which ranges from $33 to $55 a month.

How do you decide which system—and, within each system, which particular setup—is right for you? There are several factors to be considered. First, although the small dishes are touted as able to be mounted anywhere, that's not quite true. Like any satellite system, the antenna requires a clear line of sight to the satellite that's beaming down the signal. Each system's satellites travel in a different orbital position; some might not be "visible" from your site. A satellite-TV installer will be able to tell you if that's the case for one or more of the DBS systems.

Second, while all of the systems offer the same high-quality digital audio and video, there are big differences in the programming choices and pricing and convenience features, as outlined above. We don't have the space here in which to detail each system's program offerings—you'll have to compare them on your own.

If you want to be able to simultaneously watch two different channels on two separate TVs, you'll need to buy a system with a dual LNB (low-noise block downconverter). That ups the cost of the system by at least $50, perhaps as much as $200—which might seem like a lot when the basic system is practically being given away. A dual LNB also allows you to use your VCR to tape one show while watching another. To watch separate channels, however, you'll also need a second receiver, which can cost about $300, and you'll probably have to pay a small additional programming fee.

The one major drawback of these satellite systems is that they don't provide local TV programming. You can get ABC, but not necessarily from your area—possibly not even your time zone. To receive local broadcasts, you'll have to turn to your cable company, or hook up that old standby—a rooftop antenna. (Feel as if we've now come full circle?)

LISTEN UP!

Home-theater audio should wrap the viewers in sound—transport them out of their living rooms and into a pilot's seat, a war zone, the path of a tornado, or an island full of dinosaurs. Today's audio gear is designed to do just that. Here's how to make it work in your home theater.

At the heart of the home-theater audio system is the audio/video receiver. This one unit contains an AM/FM tuner, a preamplifier that provides controls including volume and also handles source switching, and an amplifier to boost the signal and direct it to the speakers. The main differences between a standard receiver and an A/V receiver lie in the number of channels (two for stereo listening vs. multi-channel for home-theater), the presence of a surround-sound decoder, switching capabilities for the video as well as the audio components, and the extra amps required to power the center-channel and surround speakers. All of the seemingly disparate pieces of your home theater get hooked up to the A/V receiver's connectors. The result will be an integrated home-theater.

One way to make sure that all your home-theater audio components work well together is to buy a boxed set, such as these from Pioneer. Home-theater-in-a-box packages are available at every price level, from several manufacturers.

It is possible to buy three separate components instead of a single integrated receiver. Audiophiles often prefer to mix and match their preamps, amps, and tuners to meet their own specific audio tastes and power requirements. Most of us, however, prefer the higher level of convenience—not to mention the lower price tag—afforded by the integrated receiver, so that's the option that we'll explore here.

The first decision you'll have to make when buying a receiver is how much power you'll need. It isn't a case of "the bigger the better." Just as the size of your TV depends on the size of the room, power requirements are affected by both size and acoustics. Carpets, draperies, and upholstery "absorb" sound, driving up power requirements, whereas bare floors and windows reflect sound. Other factors include your listening habits—both the type of music and the listening circumstances. Do you tend to play soft background music or do you throw dance parties every weekend? Loud music, heavy on the bass, requires more power than softly played background music. (On the other hand, an underpowered receiver won't be able to play music at low volume without distortion.) And the receiver's power rating should match the speaker's requirements, which we'll cover in our speaker discussion.

With so many variables, there are no cut-and-dry formulas to help you choose an A/V receiver. However, here are some (very) general guidelines. If you do casual listening in an average-sized living room, a receiver that delivers at least 50 watts per channel should be sufficient. If you want to rock down the house, or have a large room, go for 100 watts or more. In a small space, such as a dorm room or a bedroom, you could get away with as little as 35 watts per channel.

For true surround sound, make sure that power is evenly distributed across the three front channels. If the left and right channels are more powerful than the center channel, you'll lose much of the dialog. The amplifiers for the surround channels don't have to have as much power—if your home theater is based on Dolby Pro Logic, that is. Dolby Digital requires equal power to all five channels.

That's your second major decision. There's nothing inherently wrong with Dolby Pro Logic—in fact, it can sound terrific. It's just that Dolby Digital sounds even better. With CD-quality sound from five discrete channels, it's the best you can get for your money. And that will probably be the deciding factor. Dolby Digital is here to stay—it's being used on some laserdiscs and all

DVDs, and will be used on all DTV broadcasts (AC-3 encoding is part of the DTV standard). It's also found on some music-only recordings.

The decision isn't a matter of either/or—Dolby Digital receivers also contain the circuitry needed to decode Dolby Pro Logic surround sound. It's up to you and your wallet whether or not to spring for the extra few hundred dollars required to buy a Dolby Digital receiver. (For now, the lowest manufacturer's suggested price for a Dolby Digital-equipped receiver is about $700. Sales flyers included in last week's Sunday papers here in New York showed Dolby Pro Logic receivers priced as low as $299—with a "three-pack" of speakers included!)

There's yet another option: You can buy a Dolby-Digital-ready receiver now, and, when your budget allows, add a stand-alone decoder unit or one of those DD decoder-equipped DVD players. You'll pay more in the long run, but your receiver will have more "staying power." If you currently own a decent Dolby Pro Logic receiver, you might want to hold off on an upgrade until the prices begin to drop on the Dolby Digital units.

Every single component of your home theater will be routed through the receiver. A good receiver will turn all those bits and pieces into a single, smoothly operating system. Choose wisely. First, make sure the receiver has the necessary connections for all of your components—and some extras for those you'll add in the future. Second, make sure it does its job well. A poorly conceived receiver can severely detract from your viewing and listening pleasure by complicating setup and operating procedures. Switching sources, adjusting brightness or volume, and even turning on the various components will be as easy or as difficult as your receiver makes it.

If possible, try it out in the store, preferably connected to a television. Many receivers offer on-screen menus to guide you through setup and everyday audio and video adjustments. Most, but not all, menus simplify those processes; some just add to the confusion. Whether or not onscreen menus are provided, the receiver's front-panel display should be large enough to read and should clearly indicate the current source, mode, and function.

Also examine the remote control. It should not present you with an overwhelming crowd of tiny buttons. The most frequently-used buttons should be larger and set apart; the rest should be logically arranged. That's particularly important with a universal remote, which will operate most if not all of the components in your system—a major convenience. A backlighted remote comes in handy if you do your movie watching in the dark.

SPEAKING OF SPEAKERS

Buying speakers can be tricky—requiring subjective choices as well as objective decision-making. We can talk your ears off about power ratings and crossover networks, but, in the long run, the best speakers for you are the ones that sound best to you. That means that you have to listen to them twice, first in the showroom, and then at home. The size, layout, and acoustics of your living room will dramatically affect the way your speakers sound. Don't buy speakers unless you can return them if they don't sound as good in your home as they do in the controlled environment of the store.

Large, floor-standing speakers are not needed for large, floor-shaking sound. Bose makes several home-theater speaker systems noted for their big sound and small packages.

Now, about those power ratings and crossovers... here's a bit of technical background. Inside the speaker enclosures are drivers that are designed to reproduce a certain frequency range. Two-way speakers usually have a small dome tweeter that reproduces the high frequencies and a large cone woofer for the bass and middle frequencies. A three-way speaker adds a midrange driver for the middle frequencies (the vocal region). The crossover network separates the signal and routes the frequency to the proper driver. The enclosure itself plays an important role. A ported speaker (which might also be called vented, ducted, or bass-reflex) extends the low-frequency output by allowing the speaker's rear sound wave to escape from the cabinet and reinforce the front wave. Acoustic-suspension speakers come in less efficient, tightly sealed enclosures, but can often reproduce lower bass.

Tower speakers used to be necessary for a truly good audio system. Not any longer. Today, thanks to advances in speaker technology and materials, good things do come in small packages. Inexpensive bookshelf speakers sound quite good—except for bass response, which requires a large driver. That's where a subwoofer comes in.

Many manufacturers now offer satellite/subwoofer systems. Two small speakers, called satellites, are paired with a larger subwoofer module. Our ears can't tell where bass frequencies are coming from, so the subwoofer can be placed anywhere in the room. (The same cannot be said for the other speakers in a home-theater system; see the box on page 28 for pointers on speaker placement.)

Don't be confused by speaker specifications. Its sensitivity, which doesn't affect its sound quality, tells you how much acoustic energy (in decibels) it can produce with a given input (power in watts) at a specific distance (usually one meter). The higher the sensitivity, the higher the efficiency—which means less power is required from the receiver. Impedance is a measure of the speaker's current draw: low-impedance speakers (those rated at less than 6 ohms) draw more current, which causes the amplifier to heat up more. The power-handling specs let you know how many watts the speaker can handle at both peak (the maximum it can take for just a few seconds) and average (continuous) play. This is where "matching" your receiver to your speakers comes into play—mismatches can damage or destroy a speaker or amplifier.

When setting up a home theater, the speakers must also match each other. Ideally, all of the speakers should have the same tonal balance, or be "timbre-matched." It's vital that the three front speakers (left, right, and center) have the same sound and are matched in power. It helps to buy all the speakers from the same manufacturer. You can also use a matched (pre-packaged) set of front and center speakers, and then use a satellite/subwoofer set for the surround speakers. For booming sounds from action movies, go for a powered sub-

woofer, with its own amplifier and crossover network built in. The same set of speakers will work equally well for Dolby Digital as for Dolby Pro Logic systems.

There are a couple of ways to reduce the headaches of shopping for a home-theater system. One is to hire a professional installer to advise you on components and set up the whole thing for you. The other is to buy a pre-packaged audio system—just add a TV and a source component and... instant home theater. Read on for a review of one such system. And then tune in next month as we assemble and test a complete home theater component system.

MINI-CINEMA

Home theater sounds like a great idea. It sure *looks* terrific in all the glossy magazines—big screen TV; dozens of audio and video components; big speakers; and huge libraries of videotapes, CDs, laserdiscs, and DVDs.

But what if you don't live in a huge house or have a large bank balance? What if your "home" is a room in a dorm? A studio apartment? Or a room in your parents' house? Does that mean you simply can't have a home theater?

Not at all! Sure, you'll have to think small scale, but you *can* put together a perfectly good home theater in a small space. You'll need a TV. You'll need an A/V receiver with a built-in surround-sound decoder. And you'll need five speakers.

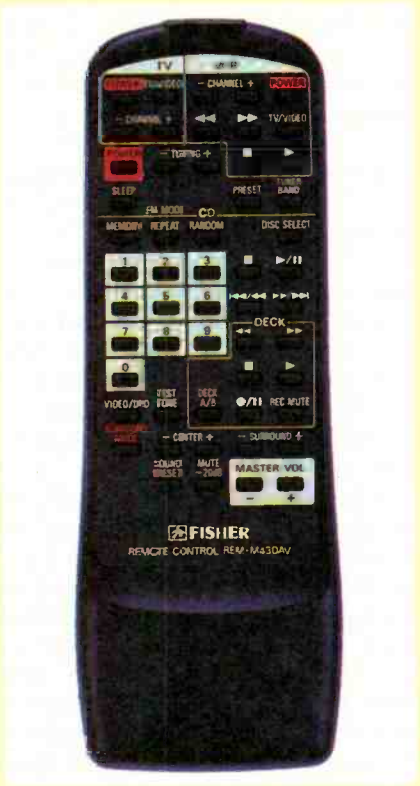
Chances are you already have a TV that will do. After all, it doesn't have to be very large if your space is tiny. (And these days you can pick up a 27-inch set for less than $350.)

For the audio portion, why not go with a boxed set? You can buy a bookshelf-sized audio mini-system with a Dolby Pro Logic receiver and five speakers. It's a cost-effective, convenient solution for small-space home theater. And you get an audio system to boot.

This afternoon, we set up one such systems—the *Fisher DCS-M430AV Home Theater Mini Shelf System*—in our home office. The DCS-M430AV includes a 40-watt by 4 RMS Dolby Pro Logic receiver, a three-disc CD changer, a dual-well cassette deck, and five full-range speakers. Both the center speaker and the two front-channel speakers are magnetically shielded so as not to cause interference with the television. That's a smart move, because in a tight space, the front-channel speakers could end up placed very close to the TV. The two front-channel units are three-way bass-reflex speakers with 5.1-inch woofers. Two surround speakers round out the set.

The mini shelf system joined our existing TV—a relatively tiny 19-inch set, which seemed adequate for the small amount of viewing we do when we're supposed to be working. We also added *Hitachi's VT-UX625A VCR*, which will be reviewed in detail next month (among other features, it offers "Movie-Advance," which automatically skips through all those previews and ads that precede the main feature on rental tapes).

Setup took less than a half hour—and a good portion of that time was spent trying to clear enough counter space in our cluttered office. One of the best features of a boxed set is the easy "installation." Plug in the speakers, hook up the VCR (an A/V cord is *not* included), put batteries (also not included) into the remote control, plug in the power cord, and it's done. The receiver, CD player, and cassette deck are "stacked" in one compact unit.



The remote control can operate a TV and VCR—but only if they are made by Fisher

Which brings us to another big advantage of the DCS-M430AV: It takes up very little space. The all-in-one receiver section, which comes in basic black with silver trim, measures approximately 11×12×12-½ inches. The center speaker is intended to sit right on top of the TV. The two front speakers each measure 9×9×13 inches—they just squeaked in to our wall shelves, with no headroom to spare. The surround speakers are a compact 5×6×8-½ inches, and can be wall-mounted to save shelf space.

The CD changer is centered at the top of the main unit. The main power button is at its right; at its left are PLAY/PAUSE, STOP, and OPEN/CLOSE buttons. At the bottom of the stack is the dual-well cassette deck, with its controls arrayed directly above the cassette wells. With silver bands at each side, and two large silver dials, the amplifier/tuner

DCS-M430AV HOME THEATER MINI SHELF SYSTEM. From Fisher, 21605 Plummer Street, Chatsworth, CA 91311; Tel. 818-998-7322.

section stands out. It is home to most of the front-panel controls, including a jog dial that serves as CD track selector, tuning, and time-setting control; timer- and clock-set buttons; controls for setting preset sound modes, dynamic bass, surround modes, and center mode; and function selector/indicators.

A press of the POWER button immediately brightens the front panel. The function- and disc-select buttons, arrayed down each silver side panel, light up to glow green (red when that function is selected), and the display features bright blue indicators and equalizer, with a few splashes of red.

The remote control contains dozens of buttons, mostly grouped into sections by function. We were pleased to see basic controls for a TV and VCR arrayed at the top of the remote, but those turned out to work only with Fisher-brand video gear. The POWER button is found just below the TV/VCR section. Although it rests on a red square, the power button is no larger than any of the others; neither are the VOLUME or MUTE controls, found at the bottom right. It's not an easy remote control to use in the dark. In fact, we found ourselves searching for the buttons we needed just about every time we picked it up.

On the plus side, you don't really need to use the POWER button. The DCS-M430AV features "Smart Start," which lets you press TUNER/BAND on either the remote or the front panel to automatically power up the unit and tune the radio to the last selected station. Similarly, you can press the PLAY/PAUSE, OPEN/CLOSE, or SELECT DISC 1, 2, or 3 in the CD section of the remote to activate the CD player; or press TAPE A/B, PLAY, or DECK A/B (found in the "deck" section of the remote) to hear a tape.

The mini-system offers a variety of preset sound EQ modes, including pop, rock, jazz, and classical. It also offers several surround modes. When listening to Dolby Pro Logic-encoded sources, you can opt for normal (five-speaker) mode, phantom mode (when no front-channel speaker is in use), or three-channel logic (no rear speakers). Of course, with five speakers included in the system, you'd be unlikely to use the phantom or three-channel modes. For music listening, you can select live or hall DSP modes. You can also listen to your music in straight stereo by choosing "off."

The DCS-M430AV offers the audio functions you'd expect to find on any mini-system. The CD player, which allows you to change two discs while the third is playing, can be controlled using the jog dial or the front-panel or remote-control buttons. It provides repeat play of one or all songs, random play, and programmed play of up to 32 selections.

The tape deck allows recording on deck B only. "Endless" tapes cannot be used, but relay playback allows you to listen to the tape in deck A automatically followed by the tape in deck B. "CD computer recording" lets you record a CD onto a tape with the press of one button, at either normal speed or high speed. A manual recording mode is offered as well.

A timer turns the mini-system into an alarm-less clock—it will wake you up with music instead of an alarm. The timer permits unattended recording, allowing you to time-shift your favorite radio programs (just as you would with a TV and VCR). The sleep timer automatically shuts off the system after a preset length of time.

The tuner stores up to 36 FM and 12 AM station presets. It also offers an automatic preset (APT) mode that detects strong signals and stores them into memory. All it takes is a three-second press of the MEMORY button to set the process in motion. Warning: When APT mode is selected, all previously programmed stations are deleted from memory.

The major advantage of this boxed system—its price tag. With a suggested retail price of less than $400, the DCS-M430AV isn't going to break the bank, even if you're a student or just starting in a career. It's a decent audio system that provides the bonus of Dolby Pro Logic surround sound for TV viewing, in a compact, convenient package. And once you've graduated—from school, to your own place, to a larger home—the DCS-M430AV can be moved to a bedroom or home office to serve as a second audio/video system. ■

SPEAKER PLACEMENT

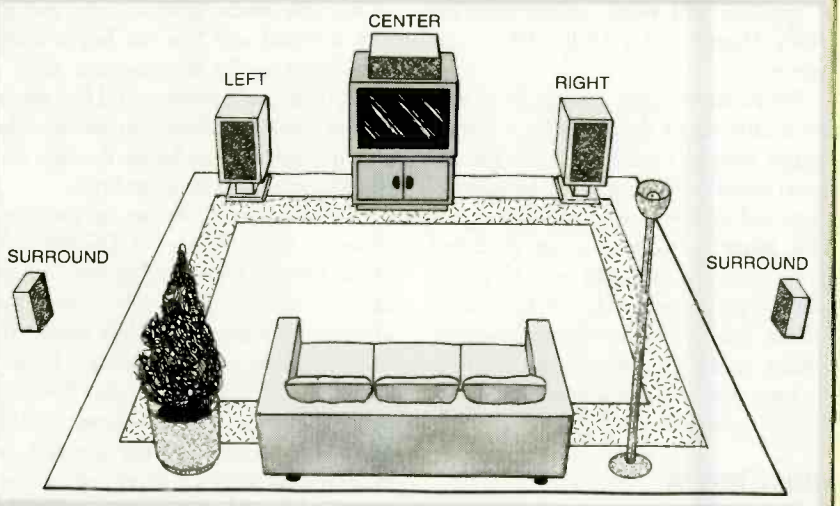


FIG. 1. This speaker/furniture arrangement is recommended by Dolby for home-theater setups using Dolby Pro Logic and/or Dolby Digital surround-sound systems.

For music listening, speaker placement is a relatively simple affair: You want to create a triangle between the two speakers and the listener. This is where your listening habits and your speaker system's "sweet spot" come into play.

That same triangular plan will work for the front speakers in your home-theater setup, provided they are set far enough to the right and left of the television to create a stereo effect. The center-channel speaker sits as close as possible to the TV to create realistic dialog and center-stage sound. The rear speakers should be placed behind your viewing seat (to the rear of the room), if possible, mounted on the wall above your head (when seated). Pointing them away from the listener will enhance the surround effect by increasing reflected sound. The subwoofer can be placed anywhere in the room.

ELECTRONIC CLIMATE CONTROLLER

Popular Electronics
January 1998

If you are an apartment dweller like myself, chances are that your air conditioning system consists of a fan blowing hot or cold air drawn from a central unit, with no thermostatic temperature control. Or, perhaps, there is a temperature control of a sort—a "High / Medium/Low" switch that controls the fan's motor speed. That simple arrangement works just fine, provided that you are *in* the apartment and *awake* to manually turn the fan on or off. If not, you either come home to an uncomfortably hot or cold apartment, or wake up in the middle of the night in a sweat or with a chill.

If your situation corresponds to the above scenario, then the *Electronic Climate Controller* (ECC) is for you. The ECC, which is user preset to the desired temperature, is designed to keep your apartment warmed in winter and cooled in summer. And the circuit is built around common components that are readily available from electronics parts suppliers and your local RadioShack store.

SANDEEP BAGCHI

If you are tired of antiquated, indoor, thermal controllers that require near constant human intervention to maintain your house or apartment at comfortable temperature levels all year round, then perhaps the project presented here is just what you need.

Circuit Description. A schematic diagram of ECC is shown in Fig. 1. Power for the circuit is derived from a rather conventional power supply, comprised of a 12-volt, 300-mA transformer (T1), a 1-amp, 50-PIV (peak-inverse voltage), fullwave bridge rectifier (BR1), a 1000-µF filter capacitor (C1), and a positive 5-volt, 1-amp voltage regulator (IC1). The regulated 5-volt output of the supply is used to power the entire circuit, except for the relay (RY1), which is powered from the unregulated 12-volt DC output of the bridge rectifier. Integrated circuit IC2 (an LM3914 dot/bar display driver) is used to drive LED1 trough LED10.

In this application, IC2 is configured for the bargraph mode. That mode is selected by connecting pin 9 to the +5-volt supply rail. The bargraph driver functions as both temperature and set-point indicator, depending on whether switch S1 is in the RUN or the SET position. There is a highly stable internal reference voltage generated at pin 7, the magnitude of which is set by R1, R2, R10, and R11. That voltage is directly connected to the upper end of IC2's internal voltage-divider chain at pin 6. Pin 4 is the lower end of the voltage-divider chain, which is connected to the wiper of preset R10. The voltage difference between pins 6 and 4 determines the "span" of the display.

Potentiometer R12 is connected across pins 6 and 4 of IC2, and thus provides a precise voltage at its wiper. Pin 5 (the signal input of IC2) is connected either to the wiper of R12 or to the temperature sensor (IC4), depending on the setting, S2. The ten comparators inside IC2 compare the voltage at pin 5 with the voltage span across pins 6 and 4, and incrementally turn on LED1 through LED10 at every tenth of the span. Hence LED1 turns on at

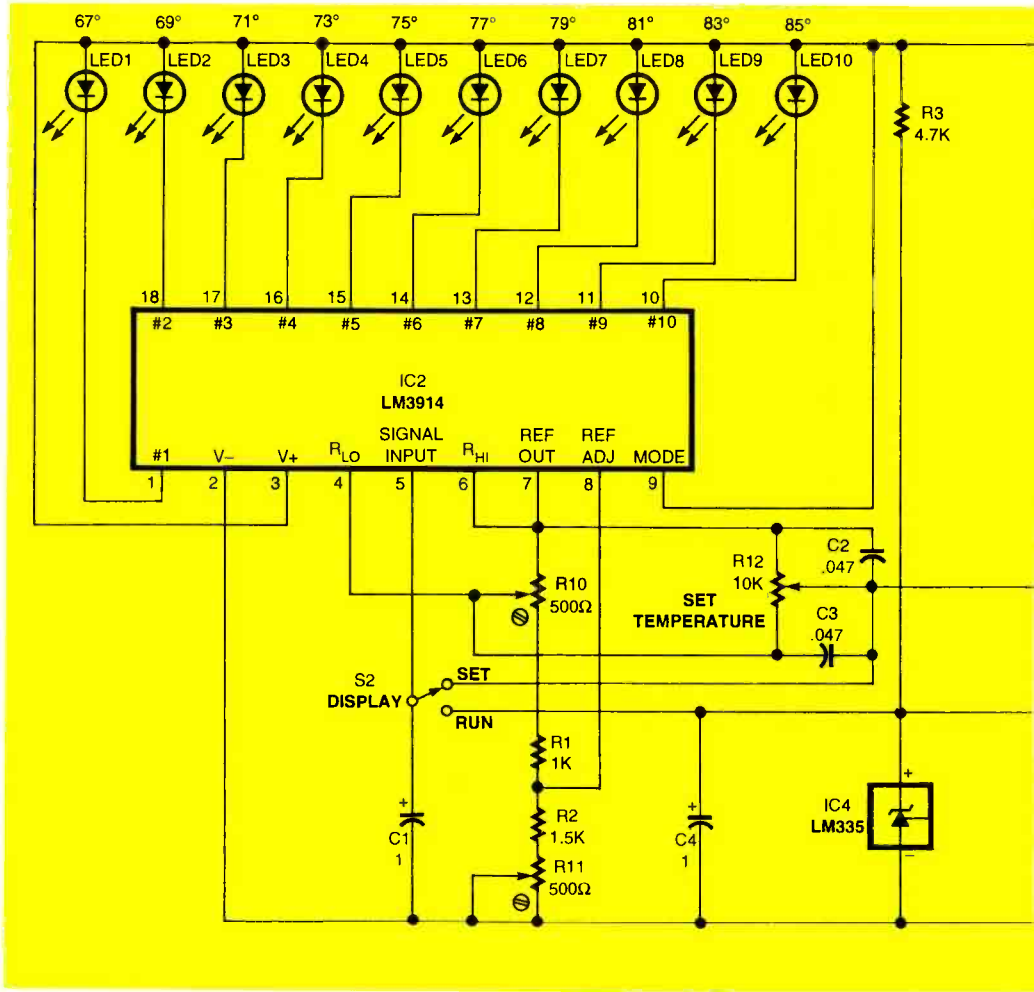


Fig. 1. The Electronic Climate Control is comprised of four integrated circuits—IC1, a 5-volt, 1-amp voltage regulator; IC2, an LM3914 dot/bar display driver; IC3, an LM339 quad comparator; and IC4, an LM335 precision temperature sensor—a bridge rectifier (BR1), a 2N3904 NPN transistor (Q1), and a few additional support components.

$V_{pin4}+(V_{pin6}-V_{pin4})/10$, and each subsequent LED is lighted at increments of $(V_{pin6}-V_{pin4})/10$.

Note: There is a constant-current driver at each output of IC2; as a result, no current-limiting resistors are required for the LEDs. If the set or run temperature is, say, 75°, LEDs 1–5 will light; or if the temperature is 69°, only LEDs 1 and 2 will light. The highest LED (in our examples, LED 5 and LED 2, respectively) represents the set/run temperature.

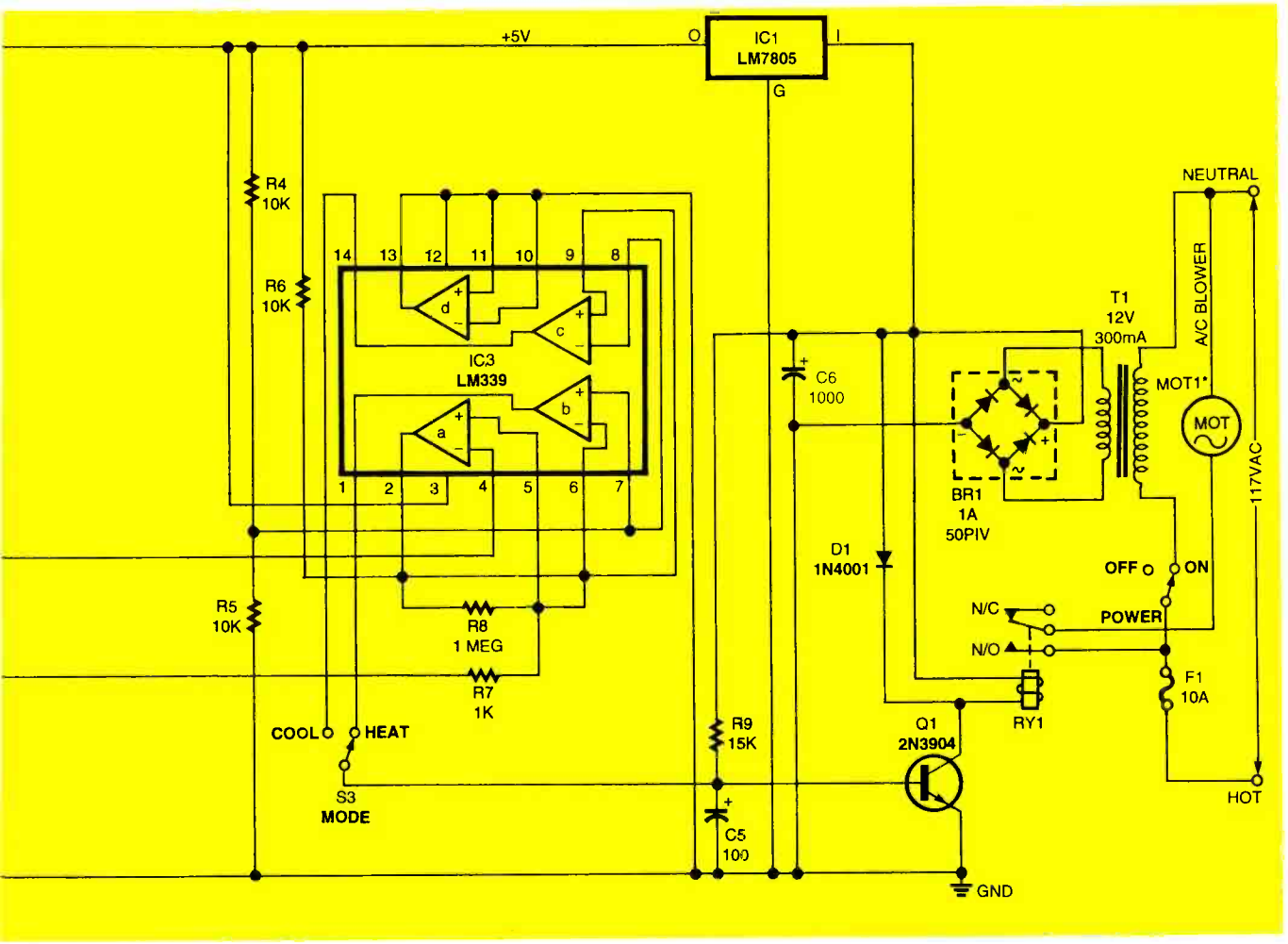
The temperature-control function of the circuit is performed by IC3 (an LM339 quad comparator with open-collector outputs). Of the four comparators contained within the chip, only three (a, b, and c) are used. One comparator, IC3-a, is wired as a non-inverting comparator with hysteresis. Resistor R6 is used as a pull-up for IC3-a, while resistors R7 and R8 provide a hysteresis voltage of about 5 mV. The inverting input of IC3-a at pin 4 is connected to the variable-voltage reference available at the wiper of R12. The non-inverting input of IC3-a is connected to the positive terminal of IC4 (an LM335 precision temperature sensor). The output of IC3-a at pin 2 goes high when $V_{pin5}>V_{pin4}$. Comparators IC3-b and IC3-c act as inverting- and non-inverting buffers. Their other inputs are biased at $V_{CC}/2$ by a voltage-divider network comprised of R4 and R5.

The MODE switch, S3 (a SPDT unit), is used to select between the outputs of IC3-b and IC3-c (pins 1 and 14, respectively). The pole of S3 connects to the base of transistor (Q1). The base of Q1 is biased into saturation via resistor R9, which is connected to the unregulated DC output of BR1. Relay RY1 is connected in the collector circuit of Q1, so that Q1 acts as an on/off switch for the relay. A diode (D1), connected in parallel with the coil of RY1, is used to protect Q1 from reverse voltage spikes. Capacitor C5, which is connected in shunt across the base of Q1, is used to eliminate any relay chatter. The normally-open contacts of RY1 are connected in series with the 117-volt A/C fan motor. The relay is used to switch the fan motor on and off.

The temperature sensor, IC4 (an LM335), which acts like a Zener diode with a temperature coefficient of reverse breakdown voltage equal to +10 mV/°K, is extrapolated to 0 mV at 0°K. Thus, at room temperature (298.2°K), the voltage across IC4 should be 298.2 mV × 10 mV/°K = 2.982 V. In practice, however, there are errors, because the temperature coefficient is not exactly 10 mV/°K due to the self-heating effect. Those errors are eliminated during the calibration procedure.

Resistor R3 limits the current through IC4 to a nominal value of 0.425 mA (at room temperature), close to the minimum current suggested by the manufacturer for its proper operation. That's done to minimize the self-heating effect caused by power dissipation across IC4, which may degrade the accuracy of the sensor. Any external noise voltage across the sensor is bypassed by capacitor C4.

Construction. The prototype of the ECC was assembled on a pair of printed-circuit boards (designated board 1 and board 2). Handling things that way allows the entire circuit to be housed in a compact enclosure. The first printed-circuit board (board 1) was mounted to the lid of the enclosure, while the second one, board 2, was mounted



to the inside bottom of the enclosure.

A template of the foil pattern for board 1 is shown in Fig. 2A, while its parts-placement diagram appears in Fig. 2B. Board 2's printed-circuit template is shown in Fig. 3A, and its parts-placement diagram is shown in Fig. 3B. Once you have obtained all of the parts listed in the Parts List, construction can begin. It is recommended that IC sockets be provided for IC2 and IC3.

Starting with board 1, install 18-pin and 14-pin sockets, where indicated, for IC2 and IC3, respectively. As usual, be careful that the polarized components are installed with the proper orientation. Note: All the components shown in the schematic diagram (Fig. 1) mount to one of the two printed-circuit boards, except S1–S3, R12, C2, C3, and IC4. Capacitors C2 and C3 are directly soldered onto the terminals of R12 (the SET TEMPERATURE control). You'll also notice a callout labeled "*to ext sensor.*" In the author's prototype, those connection points, which are in parallel with the IC4 (sensor) position, are brought out to a $^1/_8$-inch phone jack that is used to connect an external sensor to the circuit through a mating $^1/_8$-inch phone plug.

Mounting IC4 directly on the printed-circuit board is not recommended. That's because the heat dissipated by the other components can introduce large errors in temperature measurement. Externally mounting IC4 also allows remote sensing of temperature, if required. A shielded wire should be used to connect IC4 to the circuit board. If a jack is used, shielded wire should also be used between the jack and the printed-circuit board, with the shielding braid connected to circuit ground.

Once all of the on-board components have been installed, solder wires to the board at the appropriate points, and begin to wire the off-board components to the circuit. Note that the pole terminal of S3 connects to a point specified on board 2. Also note that a pair of wires is used to connect the +5-volt and ground points on board 1 to appropriate points on board 2.

For the other externally-mounted components, wire length is not critical, but it's a good idea to keep the wire lengths as short as possible. Assemble board 2 and make the appropriate inter-board connections, guided by Figs. 2 and 3. When connecting the mains and the motor to board 2, heavy-gauge wire rated to carry at least 15 amps must be used.

Now let's turn our attention to the circuit's plastic enclosure, which measures approximately 5-$^{11}/_{16}$ (L) × 3-$^1/_{16}$ (W) × 1-$^{11}/_{16}$ (D) inches. The front panel of the ECC's enclosure holds the POWER switch (S1), the DISPLAY select switch (S2), the MODE switch (S3), the SET TEMPERATURE control (R12), and LED1 through LED10. The LEDs are used to indicate either the set point temperature (when S2 is in the SET position), or the actual room temperature (when S2 is in the RUN

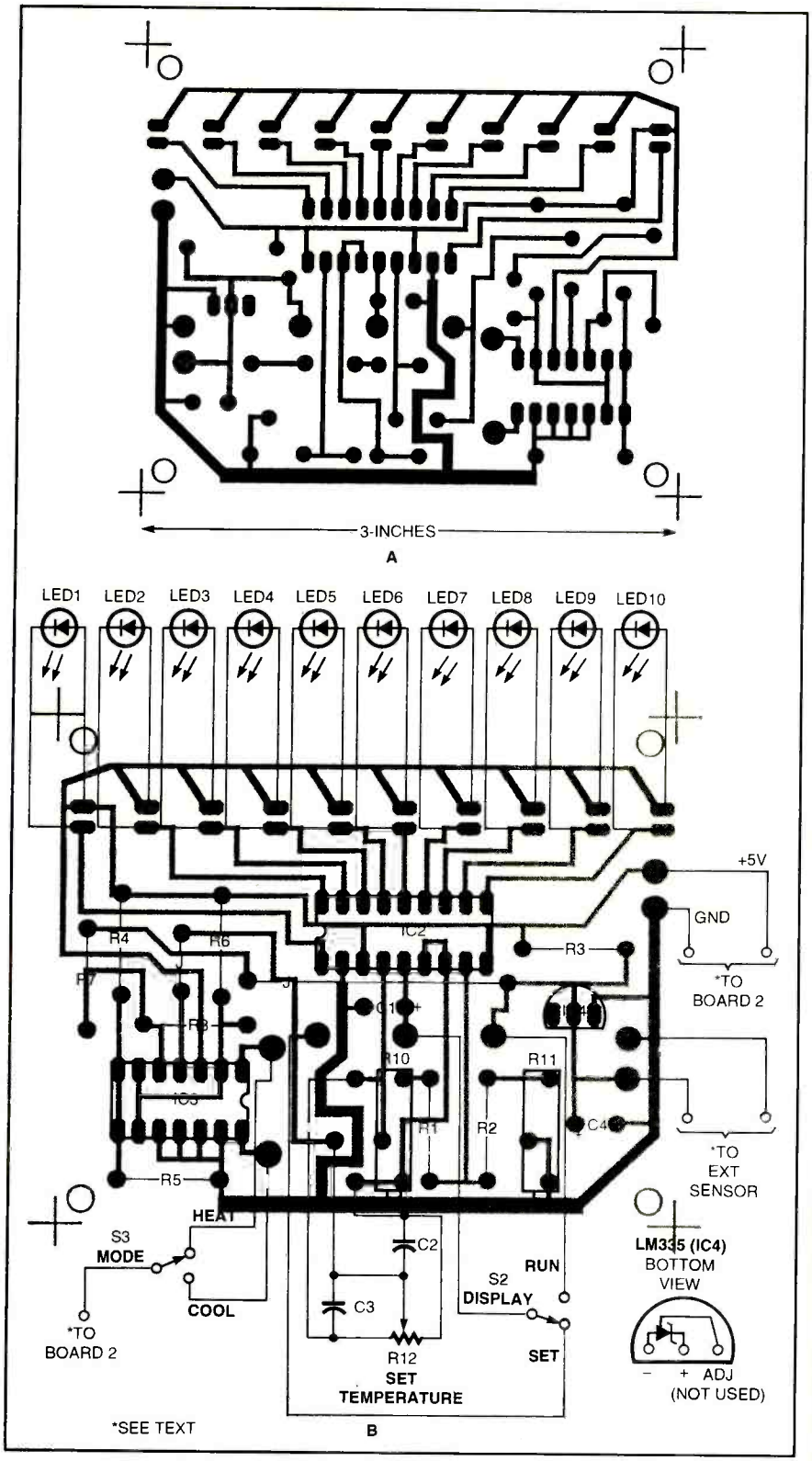


Fig. 2. The prototype of the ECC was assembled on a pair of printed-circuit boards (designated board 1 and board 2). A template for board 1 is shown in A, while its parts-placement diagram is shown in B. It is recommended that IC sockets be provided for IC2 and IC3.

PARTS LIST FOR THE ELECTRONIC CLIMATE CONTROLLER

SEMICONDUCTORS

IC1—LM7805 positive 5-volt, 1-amp voltage regulator, integrated circuit
IC2—LM3914 dot/bar display driver, integrated circuit
IC3—LM339 quad comparator, integrated circuit
IC4—LM335 precision temperature sensor, integrated circuit
Q1—2N3904, general-purpose NPN small signal transistor
LED1–LED10—Light-emitting diode, Red, T-1-3/4 (5mm)
D1—1N4001 1-amp, 50-PIV silicon diode
BR1—1-amp, 50-PIV, fullwave bridge rectifier (DIP)

RESISTORS

(All fixed resistors are 1/4-watt, 5% units.)
R1, R7—1000-ohm
R2—1500-ohm
R3—4700-ohm
R4, R5, R6—10,000-ohm
R8—1-megohm
R9—15,000-ohm
R10, R11—500-ohm, 15-turn trimmer potentiometer
R12—10,000-ohm, linear potentiometer

CAPACITORS

C1, C4—1-µF, 16-WVDC, radial-lead, electrolytic
C2, C3—0.047-µF, ceramic disc
C5—100-µF, 16-WVDC, radial-lead, electrolytic
C6—1000-µF, 25V electrolytic, radial

ADDITIONAL PARTS AND MATERIALS

T1—12-volt, 300-mA, PC-mount, step-down power transformer (RadioShack # 273-1385)
RY1—SPDT 12-volt, 30-mA DC coil; 10-amp, 120-volt AC contact miniature PC-mount relay (RadioShack #275-248)
S1–S3—SPDT micro toggle switch
F1—10-amp, 250-volt, 3AG, glass-cartridge fuse
Printed-circuit board materials, IC sockets, plastic enclosure (RadioShack #270-233), PC-mount fuse, knob, TO-220 heat sink, 1/2- and 1/4-inch nylon spacers, shielded wire, 15-amp AC-rated wire, barrier connector, solder, wire, hardware. *etc.*

position).

Figure 4A shows the placement and dimensions of holes to be drilled in the lid for mounting board 1, while Fig. 4B shows the mounting location of board 2 in the bottom of the enclosure. Board 1 is mounted to the lid of the enclosure with the component side facing the lid on 1/2-inch spacers, so that the LED lenses protrude through the appropriate holes in the lid.

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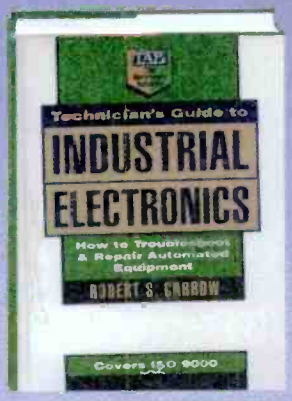

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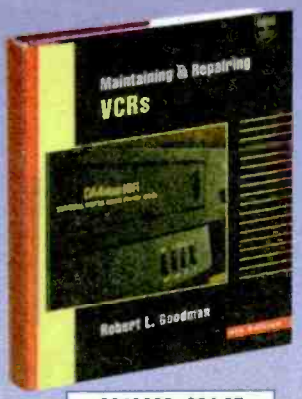

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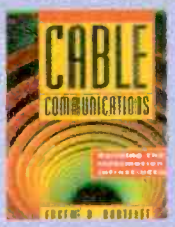

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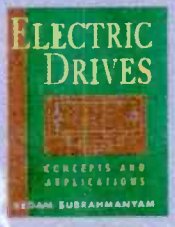

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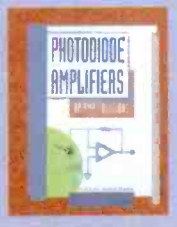

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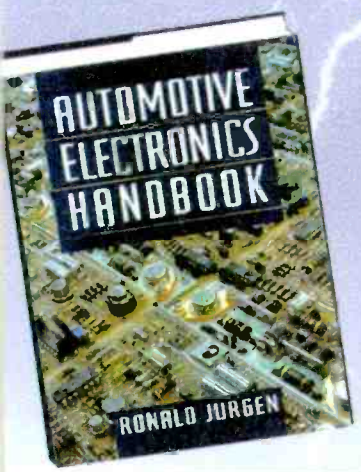

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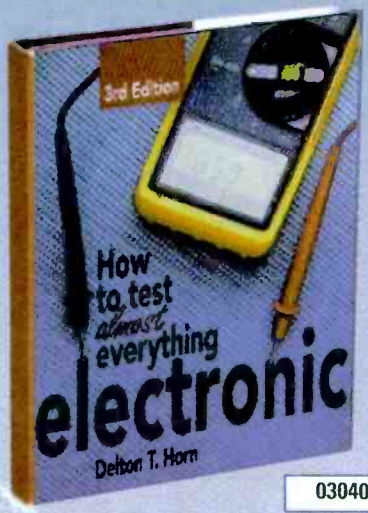

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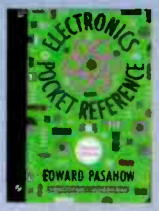

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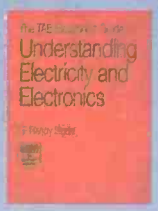

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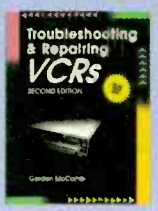

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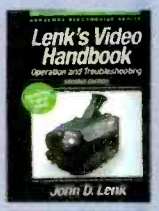

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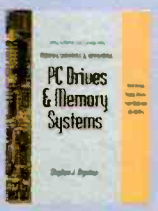

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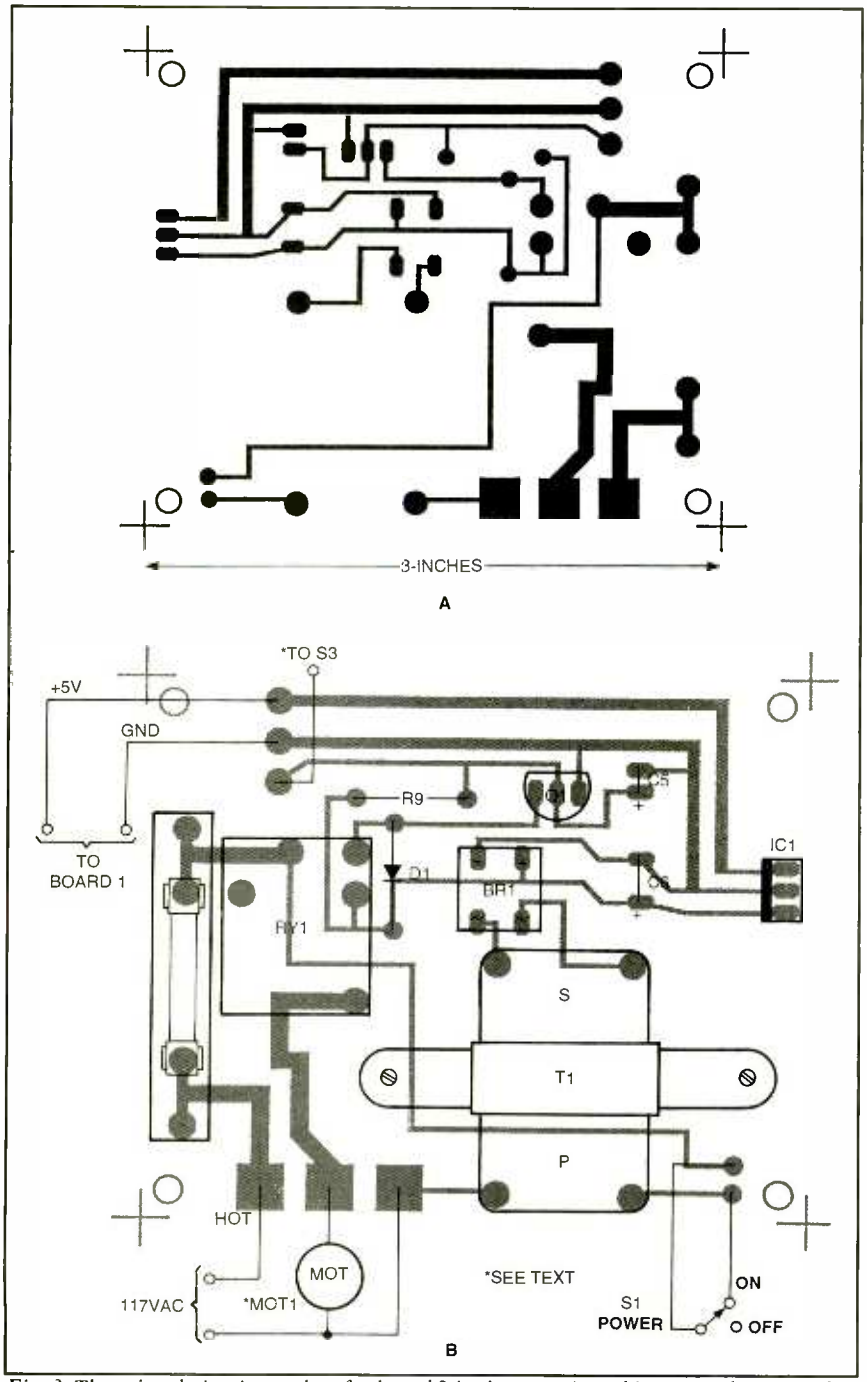


Fig. 3. The printed-circuit template for board 2 is shown in A, and its parts-placement diagram is shown in B. Once both boards have been populated with their on-board components, make the appropriate inter-board connections. When connecting the mains and the motor to board 2, heavy-gauge wire rated at 15 amps must be used.

Because the LEDs must protrude through the holes in the lid, their heights have to be right. The best way to ensure the proper height is to insert their leads through board 1, mount the board on the lid with the spacers, turn the assembly upside-down, and solder their leads on the copper side of the board. When mounting the other components on board 1, make sure that their lead lengths do not cause them to extend above the board by more than a $^1/_2$-inch.

Board 2 is mounted on $^1/_2$-inch spacers to the bottom of the enclosure. Because the transformer is the tallest component on board 2, make sure that it is mounted as close to the board as possible. The fuse (F1) is a glass-cartridge unit. Fuse-mounting clips were soldered to the printed-circuit board at the position indicated to hold the fuse in place. Because IC1 can get quite warm during operation, be sure to attach a TO-220-style heatsink to the tab of the device.

Holes were also drilled at a convenient location on one side of the enclosure, through which to pass the wires that connect the ECC circuit to the 117-volt AC mains and the A/C blower motor. Though not essential, in the author's unit a barrier strip was mounted to the bottom of the enclosure next to board 2 for making the mains' connections.

Calibration. Before the ECC can be expected to function properly, the circuit must be calibrated. The reason for calibration is twofold. First, it sets the span of temperatures that are indicated and controlled. And second, it corrects for inaccuracies of IC4. To calibrate the circuit, you'll need a thermometer and a digital voltmeter. The calibration is performed so that the temperature is controlled between 65°F and 85°F. Note: The temperature indicated by LED1–LED10 lies between 67°F and 85°F (see Table 1).

TABLE 1—LED TEMPERATURE INDICATION

LED	TEMPERATURE
1	67
2	69
3	71
4	73
5	75
6	77
7	79
8	81
9	83
10	85

The calibration procedure must be performed in a place where the ambient temperature remains reasonably constant and within a range of 67°F and 85°F. Make sure that IC4 is free-standing in air and away from any source of heat, such as your soldering iron or lamps in the room. Apply AC power to the circuit after finishing the construction and double checking all the solder connections and component placements. Keep the lid of the unit open. Do not connect the motor to the unit yet. Be careful not

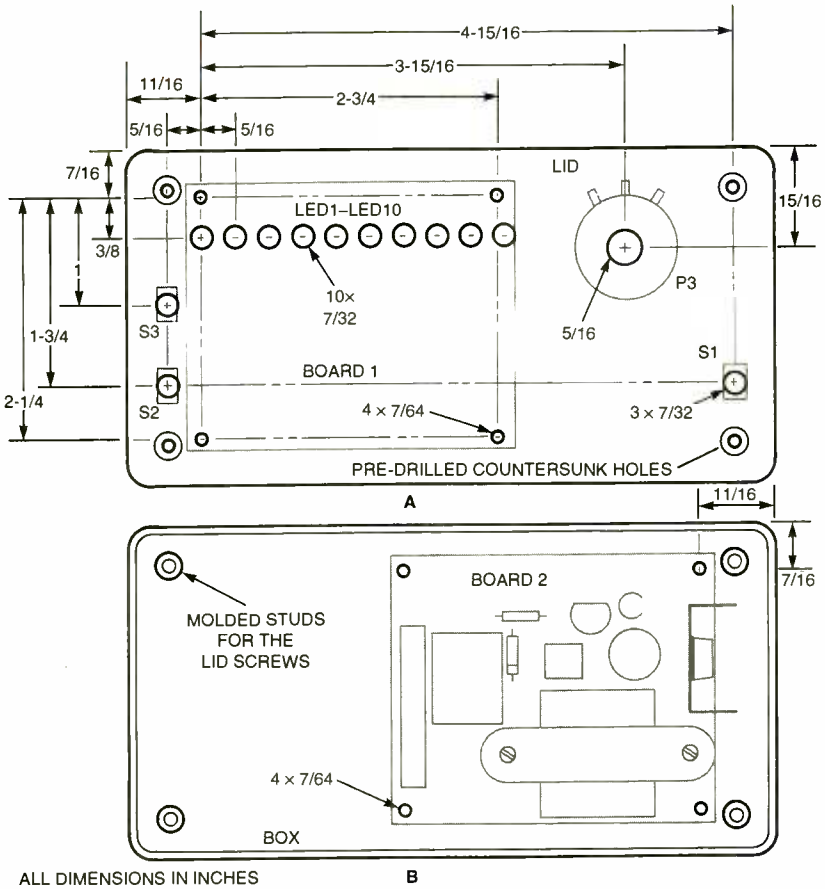


Fig. 4. The placement and dimensions of holes for mounting board 1 to the lid are shown in A, while B shows the mounting location of board 2 in the bottom of the enclosure. Board 1 is mounted to the lid on $^1/_2$-inch spacers. Board 2 is mounted on $^1/_4$-inch spacers to the bottom of the enclosure.

to touch anything on board 2, since some of its components are at line (117-volt) potential.

Use the thermometer to take a room temperature reading. Adjust R11, so that the LEDs indicate a corresponding temperature. For instance, if the temperature is 75°F, LED1-LED5 should light, while LED6-LED10 remain extinguished. That adjustment corrects for calibration errors of IC4, as well as errors due to self-heating. Next, with the voltmeter connected across the two ends of R12, adjust R10 so that the voltage read is exactly 0.111 volt. That adjustment sets the span of temperatures that can be set by potentiometer R12, between 65°C and 85°C. The adjustments of R10 and R11 are somewhat interactive; you might have to repeat them once or twice, in the previously mentioned order. The calibration is now complete. Connect the motor to board 2 and close the lid.

Finishing Touches. The ECC can be neatly dressed up with the controls and indicators properly marked. Figure 5 shows the author's front-panel layout for the ECC. That label, which is shown full size, can be photocopied on a card sheet, cutouts

(Continued on page 46)

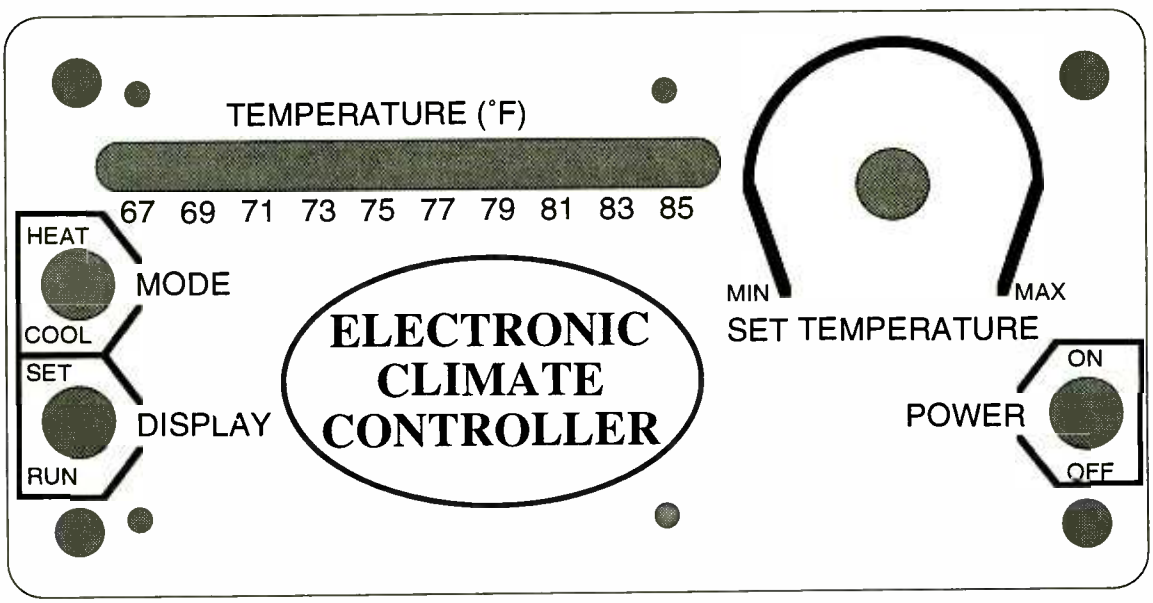


Fig. 5. Shown here, at full size, is the author's front-panel layout for the ECC. The layout can be photocopied and glued to the lid of the enclosure to give the unit a professional-looking finish.

BUILD THE DECID-O-TRON II

Decisions! Decisions! Decisions! Are you tired of weighing the pros and cons of life's everyday problems in an ill-fated attempt to come to some conclusion? If so, perhaps this electronic decision maker can help to alleviate the stress.

LEWIS J. NEWMIRE, K5KXM

Do you have too many decisions to make and too little time in which to make them? Has your industrial-grade *Ouija* board been caught lying lately, and are your darts not even sticking on the board? By now you probably do not trust the old coin toss. You need assistance! Why not make your decisions the way many business and political leaders do—with the help of electronics. Build the *Decid-O-Tron II* and end the agony! Good idea you say—but what is this Model II stuff all about—was there a Model I, and did I miss it? The answer is "Yes there was, and possibly you did." The original was published in the November, 1972 ***Popular Electronics*** and again in the Winter 1975 *Popular Electronics Experimenters Handbook*.

The original model was built around RTL ICs, used four C-cell batteries for power, and relied on two incandescent lamps with colored jewels for the decision indicators. Unlike the original, the Decid-O-Tron II is built around CMOS logic, is powered from a 9-volt battery, uses a bi-colored light-emitting diode as a decision indicator, and is much smaller and lighter. Its greatly reduced weight and size make it an ideal assistant in the home, office, or on the golf course!

How It Works. A schematic diagram of the Decid-O-Tron II is shown in Fig. 1. Pressing S1 connects the 9-volt battery source to the circuit. Transistor Q1 (a unijunction transistor-UJT), which operates as a relaxation oscillator, outputs a frequency that is determined by the values of C2 and R2. The output of the oscillator is a 5- to 6-volt, fast-rising, positive-going pulse that is applied across R5. That positive-going pulse is also applied to the base of Q2 by way of R6, causing it to go into saturation. When Q2 saturates, its collector (which is tied to the CLOCK input of IC1, the JK flip-flop) goes low. The output collector voltage of Q2 remains in that state until the pulse across R5 decays to near zero.

Note that all of the J and K inputs of IC1 are tied high, while both the SET and RESET inputs are tied low. Under those conditions, each clock pulse causes the flip-flop to toggle, thus causing the Q and $\overline{Q}$ outputs to alternately go low and high. The state of the Q and $\overline{Q}$ outputs determine the direction of current flowing through R8 and LED1. When current flows in one direction, LED1 emits red light, but when the direction of current is changed, LED1 emits green light. The LED's color changes hundreds of times per second (once for each pulse from relaxation oscillator Q1). To the naked eye, the LED appears to give off a yellow light.

Pressing S2 causes the unit to eventually reach a "decision." The current that, to this point, flowed

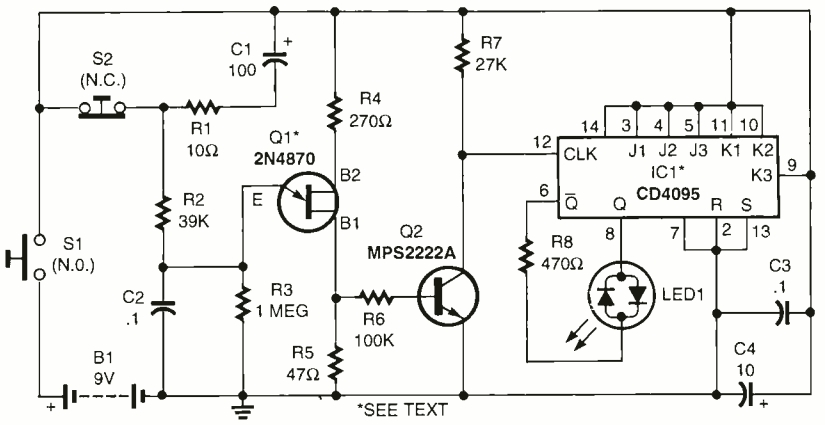


Fig. 1. The Decid-O-Tron II, comprised of a single integrated circuit, a pair of transistors (one of which, Q1, is configured as a relaxation oscillator), and a few support components, uses a bi-color LED to indicate a yes or no decision.

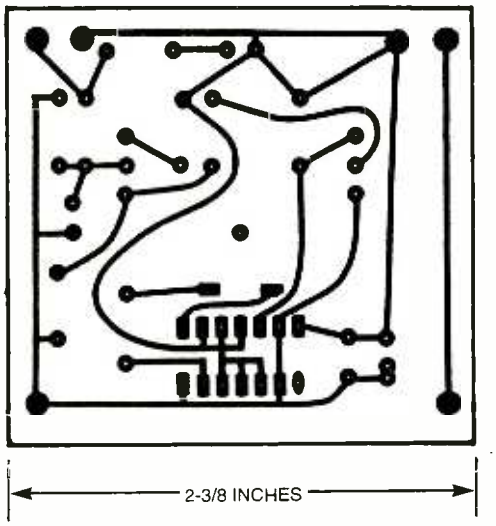


Fig. 2. For ease of construction, while reducing the possibility of construction errors, it is recommended that the project be assembled using this template of the author's printed-circuit layout, which measures 2-3/8 by 2-1/8 inches.

PARTS LIST FOR THE DECID-O-TRON II

SEMICONDUCTORS

IC1—CD4095BE CMOS J-K flip-flop, integrated circuit
LED1—Bi-color (red/green) light-emitting diode
Q1—2N4870, 2N4871 or SK9121 N-channel UJT
Q2—MPS2222A general-purpose NPN silicon transistor

RESISTORS

(All resistors are 1/4-watt, 5% units.)
R1—10-ohm
R2—39,000-ohm
R3—1-megohm
R4—270-ohm
R5—47-ohm
R6—100,000-ohm
R7—27,000-ohm
R8—470-ohm

CAPACITORS

C1—100-mF, 35-WVDC, electrolytic
C2, C3—0.1-mF, ceramic disc
C4—10-mF, 16-WVDC, tantalum

ADDITIONAL PARTS AND MATERIALS

B1—9-volt, transistor-radio battery
S1—SPST normally-open, momentary-contact, push-button switch
S2—SPST normally-closed, momentary- contact, push-button switch
Printed-circuit materials, enclosure (RS part #0270-233 or similar), battery holder (RS part #0270-326 or similar), 9-volt battery connector, wire, solder, hardware, *etc.*

Note: The following parts for the Decid-O-Tron are available from: EIjay Electronics, PO Box 690863 Tulsa, OK 74169. The printed-circuit board only for $5.00 postage paid; Q1 (the 2N4870 N-channel UJT) for $3.00 postage paid. Please allow 4 to 6 weeks for delivery.

through S2 and the timing network comprised of R2 and C2 now flows through R2 and C2, as well as R1 and C1. That rerouting of current causes C1 to begin charging, thereby reducing the amount of voltage applied to the emitter of Q1. Eventually, the voltage applied to Q1 reaches a level that's insufficient to sustain oscillation. When the oscillator stops, LED1 will be red or green, indicating that a "decision" has been reached—green for yes and red for no.

Construction. Although the circuit is simple enough to be assembled using any type of construction, it is recommended that the project be assembled using printed-circuit construction. The author's prototype was assembled on a printed-circuit board, measuring 2-3/8 by 2-1/8 inches. A template of the author's printed-circuit layout is shown in Fig. 2. The printed-circuit approach was used because it simplifies construction, while reducing the possibility of construction errors.

Once you've etched your printed-circuit board and obtained all of the components listed in the Parts List, construction can begin. **Note**: For the circuit to perform properly, C1 must have very-low leakage current. Connecting C1 across a power supply of 10 to 15 volts for several minutes will properly "form" it, thereby reducing leakage current to an acceptable level.

Assemble the printed-circuit board, using Fig. 3 as a guide. Pay close attention to the orientation of the polarized components (Q1, Q2, C1, C4, and IC1). Note that because

LED1 is a bi-color unit, its orientation is of little concern, but there is another concern. The leads of LED1 must be trimmed to about 3/4 of an inch and bent as shown in Fig. 4 at about 1/2 inch from the base to form "feet." The feet formed by the bend in the leads of LED1 are then soldered to the appropriate pads on the foil side of the unit's board.

Unlike the original Decid-O-Tron (which was housed in an oversized enclosure in order to accommodate the unit's power source), the present incarnation—the Decid-O-Tron II—is housed in medium-sized plastic enclosure, measuring 5-1/8 by 2-1/8 by 1-5/8 inches. Drill mounting holes for S1 and S2 in opposite sides of the enclosure. Be sure to allow sufficient clearance so that the circuit board does not physically contact the switches. Mount the switches, and secure a 9-volt battery holder to the bottom of the enclosure using an ample amount of epoxy.

In the author's prototype, the printed-circuit board was mounted to the enclosure using a single #6-32 × 1-1/4-inch, flat head screw, as shown in Fig. 4, and secured in place using #6-32 nuts. (Using that scheme also allows the board to be adjusted up or down with the nuts to set the appropriate height for the LED.) The screw was secured to the bottom of the enclosure with epoxy. In order to set the proper position for the board, temporarily mount the board (with the foil side up) to the screw. Place a generous layer of epoxy over the head of the screw and lower the assembly into the case. Press the assembly firmly into the enclosure to spread the epoxy. Allow the epoxy to cure thoroughly.

After the epoxy has cured, remove the board from the mounting screw and build a layer of epoxy over the head of the screw and on to the case to form a solid mount. Allow that layer to cure. Once cured, permanently mount the printed-circuit board, and adjust it to the appropriate height. Solder the wires from the switches and battery connector to their respective pads, as outlined in Fig. 3.

Your Decid-O-Tron II is now ready to help you make those difficult decisions for years to come. Is the output truly random? Is this model as reliable as the original? We asked the Decid-O-Tron II those very questions and 50% of the time it said "Yes".

Whatever your intended use for the Decid-O-Tran II, it is sure to give you and your family and friends hours of fun. Or, perhaps it could be used as your young child's next science project. ■

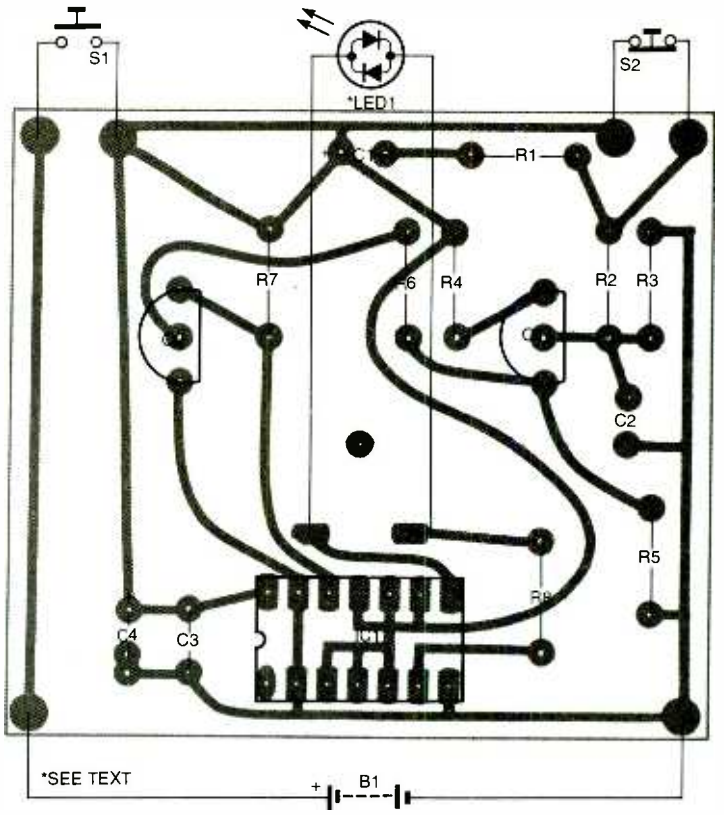


Fig. 3. Once you've etched your printed-circuit board and obtained all of the components listed in the Parts List, assemble the printed-circuit board, using this parts-placement diagram as a guide. Be sure to pay close attention to the orientation of the polarized components.

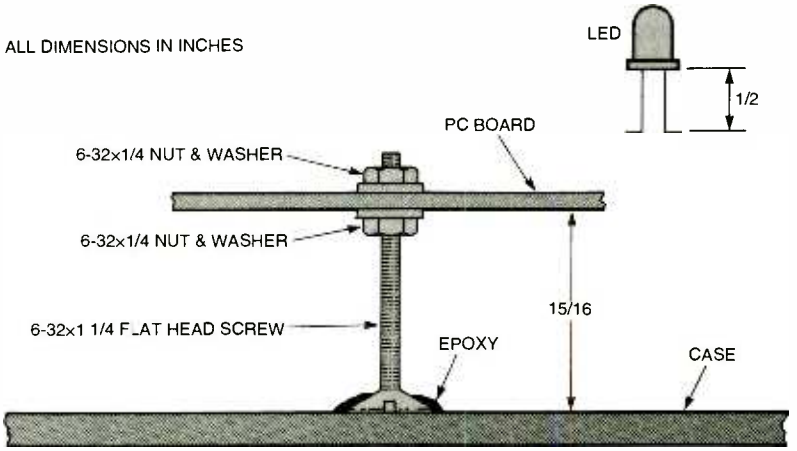
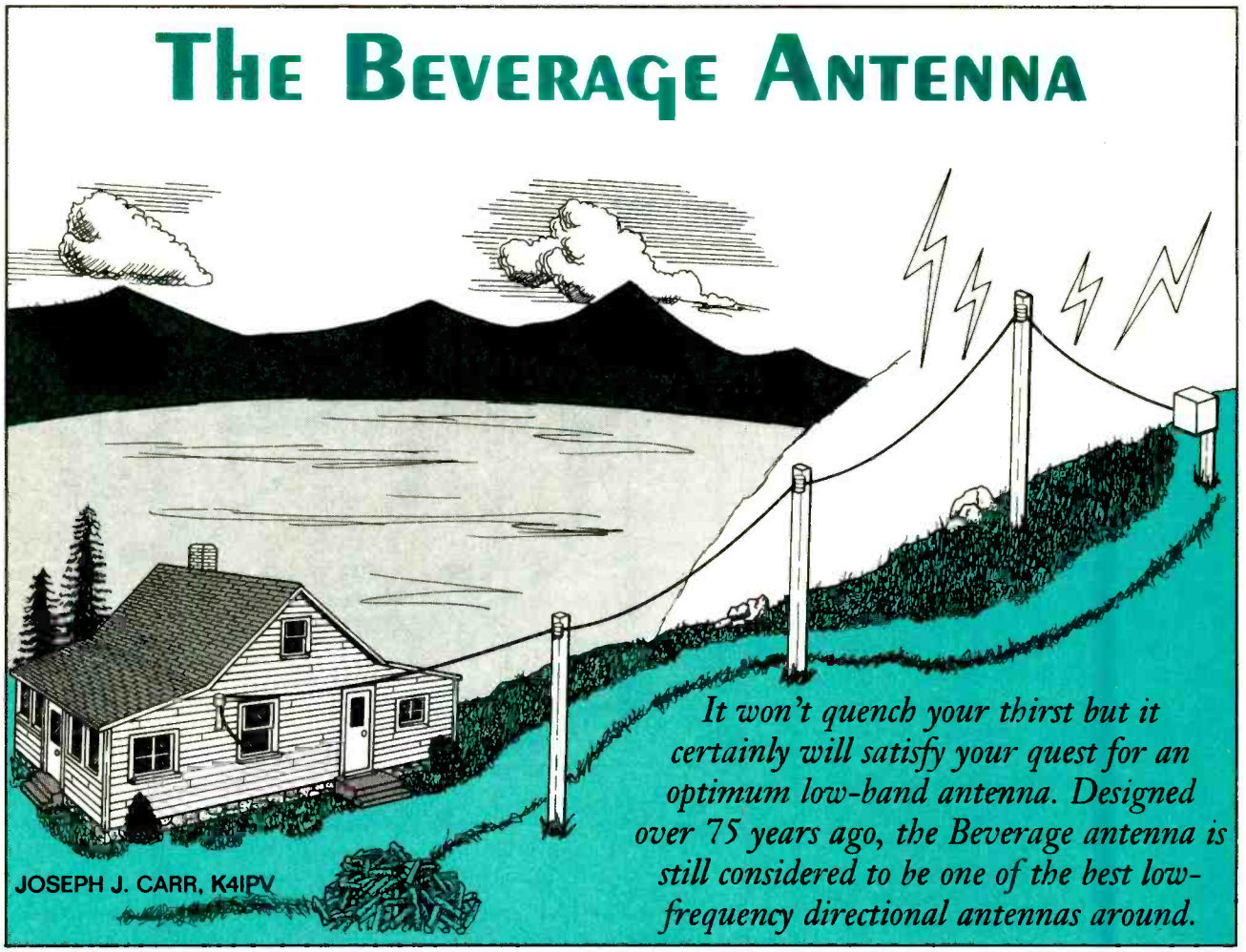


Fig. 4. In the author's prototype, the printed-circuit board was mounted to the enclosure using a single screw, as shown here, and secured in place using a pair of matching nuts.

The Beverage Antenna



It won't quench your thirst but it certainly will satisfy your quest for an optimum low-band antenna. Designed over 75 years ago, the Beverage antenna is still considered to be one of the best low-frequency directional antennas around.

JOSEPH J. CARR, K4IPV

The Beverage (or Wave) antenna is considered by many experts to be the best receive antenna available for Very Low Frequency (VLF), AM broadcast band (BCB), medium wave (MW), or Tropical Band (low HF region) DXing. The Beverage was used by RCA at its Riverhead, Long Island, NY station in 1922, and a technical description by Dr. Harold H. Beverage (for whom it is named) appeared in *QST* magazine in November 1922. The U.S. Navy is said to have erected a "Beverage antenna farm" in Hawaii during World War II to listen to Japanese home islands broadcasts on the AM broadcast band. Dr. Beverage, a pioneer in radio communications, was awarded the U.S. Army Signal Corps Certificate of Appreciation in 1944 for numerous wartime contributions to the Army's communications systems. Dr. Harold H. Beverage, W2BML, passed away in January 1993, at the age of 99.

Properties of the Beverage Antenna. The Beverage antenna is a long-wire antenna of very special design—more than one wavelength (1λ) in length, although some authorities maintain that >0.5λ is sufficient. The Beverage provides good directivity and gain in the low-frequency bands, VLF through MW, although good results are relatively easy to obtain up to the 31-meter (9.5 MHz) band. Some attempts have been made at making Beverage antennas work as high as the 11-meter Citizen's Band or the 10-meter ham band (28.0–29.7 MHz).

In reception (and due to reciprocity, also in transmission), the Beverage antenna works on vertically-polarized waves arriving at low angles of incidence. These conditions are normal in the AM BCB, where nearly all transmitting antennas are vertically polarized. In addition, the ground-and sky-wave propagation found in the VLF, AM BCB, and low MW bands are relatively consistent. As the frequency increases, however, two factors become increasingly dominant. First, the likelihood of horizontal polarization increases, since the shorter wavelengths at those frequencies make horizontal antennas easier to construct. Second, shortwave propagation becomes less consistent at higher frequencies. The polarization of the received signals not only changes in those bands, but constantly does so when conditions are unsettled. It is the strong dependence of the Beverage on relatively constant vertical polarization that makes me suspect claims of Beverage-like performance above the 25-meter band.

Beverage antennas are commonly found in receiving stations. For a transmitter, the earth losses are large compared with the radiated energy, and the reduced efficiency more than offsets any improvement in directivity.

Figure 1 shows the basic single wire Beverage antenna. It consists of a single conductor (No. 16 to No.

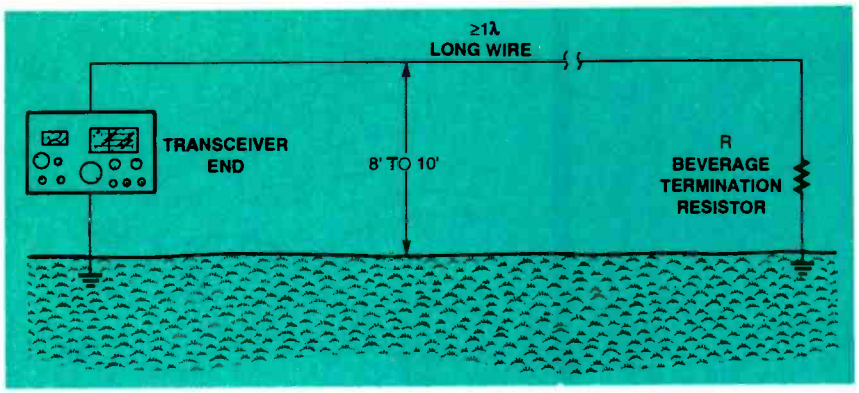


Fig. 1. The Beverage antenna for low frequency reception.

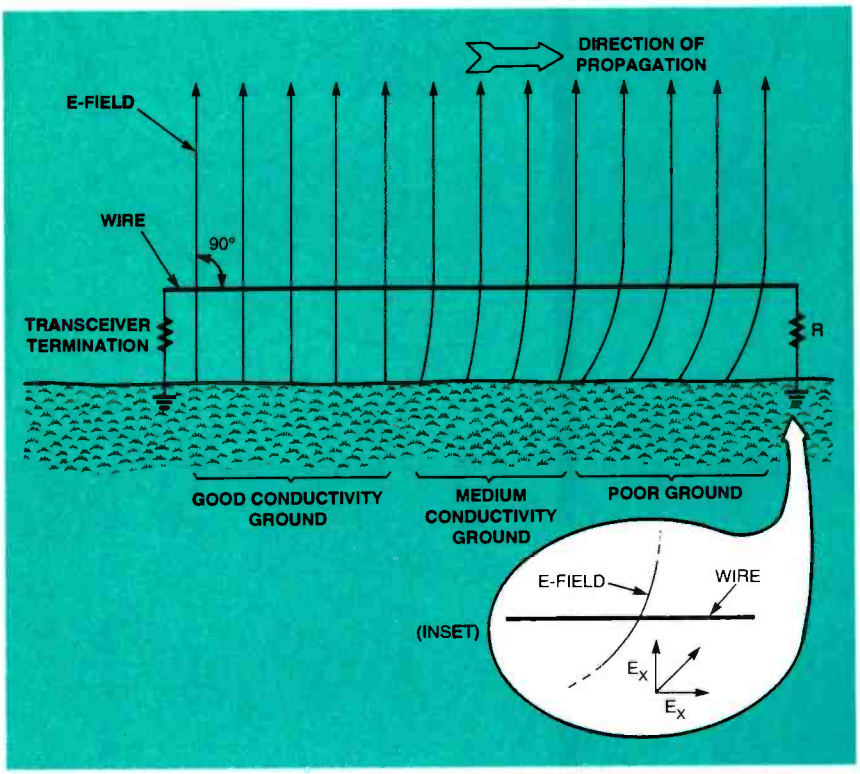


Fig. 2. Beverage antennas work best over poorly conductive ground because of bending of the E-field lines of force.

8 wire, with No. 14 being most common) erected about eight to ten feet above ground. The antenna is pointed in the direction of the desired receiving (or transmitting) station. Some Beverages are unterminated (and bi-directional), but most are terminated at the far end in a resistance (R) equal to the antenna's characteristic impedance. The receiver (or transmitter) end is also terminated in its characteristic impedance, but generally requires an impedance matching transformer to transform the antenna impedance to the 50-ohm impedance input used by most modern transceivers.

The Beverage antenna depends on being erected over poorly conductive soil, even though the terminating resistor needs a good ground. Thus, one source claimed that sand beaches adjacent to salty marshes make the best Beverage sites (a bit of overstatement). Figure 2 shows why poorly conductive soil is needed. The E-field vectors are launched from the vertically-polarized transmitting antenna perpendicular to the Earth's surface. Over perfectly conducting soil, the vertical waves would remain nearly vertical. But over imperfectly conducting soil, the field lines tend to bend close to the point of contact with the ground. As shown in the inset to Fig. 2, the bending of the wave provides a horizontal component of the E-field vector, and this provides the means of generating an RF current in the conductor wire.

Beverage directivity is an interesting phenomenon. Considering the Beverage as a receiving antenna, when signals arrive from either side—that is perpendicular or broadside to the wire—all sections of the wire are excited in-phase with each other. When these signals propagate along the wire, they reach the receiver end essentially out of phase with each other, so they cancel. Thus, the Beverage exhibits very deep nulls off the sides at right angles to the wire. The directivity pattern of a 1λ-long terminated Beverage antenna is shown in Fig. 3.

Signals arriving from either end of the wire produce electrical situations that are similar to each other, but with opposite results. Signals from either direction set up in-phase reinforcing waves at the ends. Signals arriving from the forward direction propagate along the wire towards the receiver end, and to build up a strong resultant that is heard by the receiver. Signals arriving from the rear direction also build up in-phase reinforcing electrical signals, but these propagate towards the termination resistor end, where they are absorbed by the resistor and are therefore lost. If the termination resistor, R, is matched to the characteristic impedance of the antenna, Z_O, then there will be no reflections back down the wire (which could reduce the depth of the rear null).

Beverages and Transmission Lines. A good "thought model" for the Beverage antenna is to regard it as a parallel wire transmission line with one good conductor (the wire) and one lossy, poor conductor (the soil underneath). As with any transmission line, the electrical wave in the wire has a lower velocity of propagation than the electromagnetic (EM) wave in free space. The free space EM wave travels at the speed of light (denoted by the letter c), while the electrical signal in the wire set up by the passing EM wave travels at a velocity of 0.85c

to 0.98c, depending on the design and installation of the antenna. The velocity factor (k) is the ratio of the actual velocity (v) to the free space velocity (c), or k = v/c. The velocity factor is sometimes expressed as a decimal (e.g. 0.90), and sometimes as a percent (e.g. 90%). The velocity factor for the Beverage increases with antenna height, although the rate of increase slows down above heights of approximately ten feet.

All transmission lines have an attribute called characteristic impedance, symbolized by Z_O. Although the rigorous definition is a bit more complex, it is possible to define Z_O in terms of what happens in practical circuits. If an electrical signal is launched onto a transmission line that is terminated at its far end by a resistance (R) equal to Z_O, then all of the forward signal power is either radiated as an EM wave or absorbed by the terminating resistor; no signal is reflected back down the line towards the source. But if $R \neq Z_O$, a reflected signal will arise, and its amplitude is proportional to the mismatch between R and Z_O.

In a similar manner for the Beverage receiving antenna, a component of the signal set up in the wire by the EM wave travels towards the receiver, while another component travels towards the termination. The signal heading towards the termination is absorbed by the resistor. At the receiver end, if the value of Z_O does not fall on a standard resistor value, then you can do either of two things—make a network of standard value resistors that does match Z_O, or use a potentiometer (variable resistor) and set it to a value equal to Z_O. In any event, only non-inductive resistors such as carbon composition or metal film are suitable (Note: Many potentiometers are wire-wound).

In the ideal situation, the Beverage is a traveling wave antenna and exhibits no standing waves from the incoming EM transmission. Part of the received signal is absorbed in the termination and the remaining energy travels down the line to the receiver.

Like the long-wire antenna, the Beverage antenna needs a termination resistor that is connected to a good ground. This requirement may

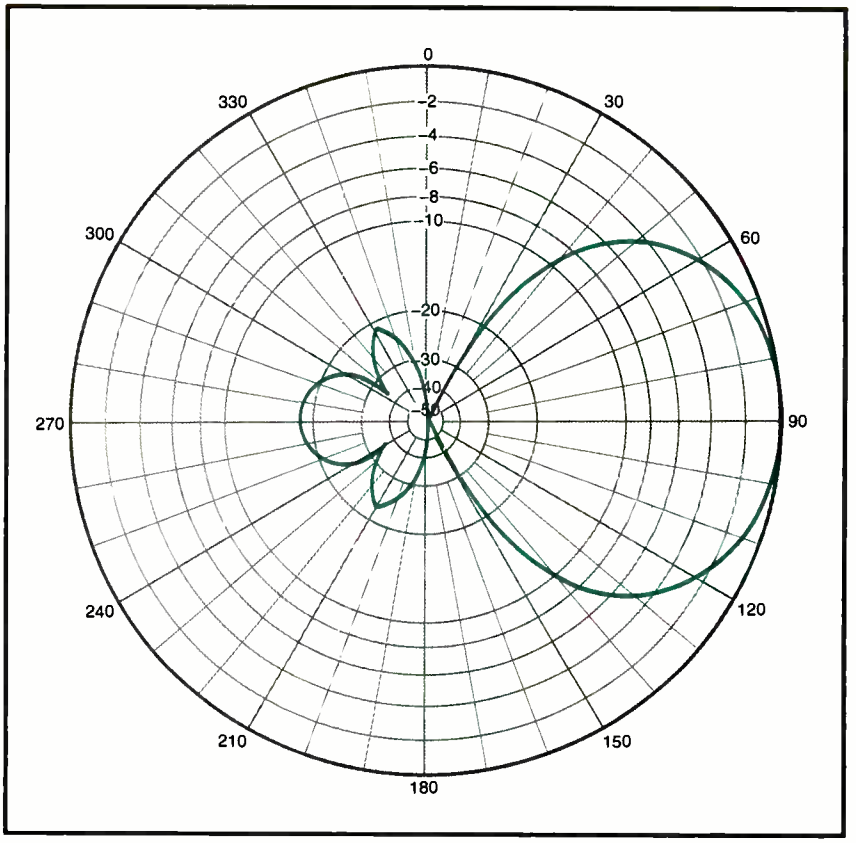


Fig. 3. Directivity pattern for a 1λ Beverage terminated in its characteristic impedance.

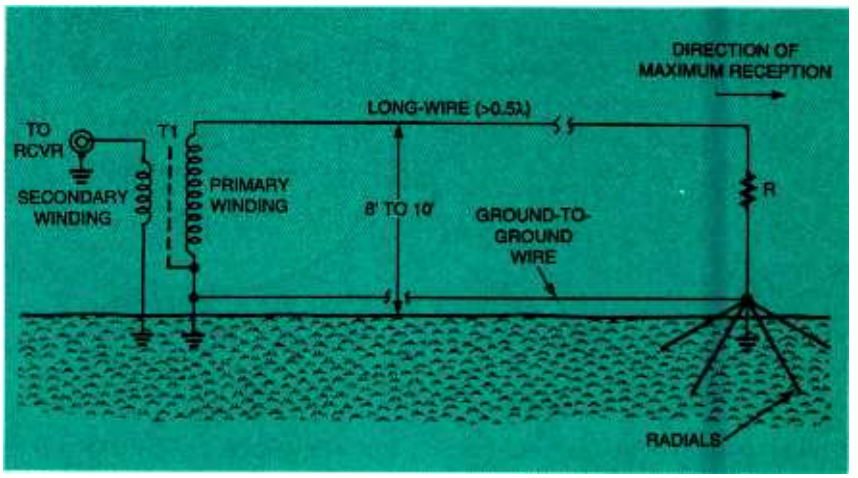


Fig. 4. Use of a ground-to-ground wire and radials to improve Beverage performance.

be harder to meet on Beverage antennas because they work best over lossy ground, which doesn't make a very good ground connection. On Beverage installations, a set of resonant radials can be used at the resistor ground to form an artificial "good ground." Insulated or bare wire, quarter- wavelength long, makes the best radials. However, a substantial improvement in the ground is possible using just bare wires from fifteen to twenty feet long, buried in the soil just below the surface far enough to prevent erosion from bringing it to the surface. Many articles and books on Beverages show ground rods of two or three feet long, which borders on the ridiculous. Poor soil requires longer ground rods, on the order of six to eight feet. Copper-clad steel make the best rods.

In his *Beverage Antenna Handbook* (see sidebar), Victor Misek, who may well be the leading exponent of the Beverage antenna, also recommends using a wire connec-

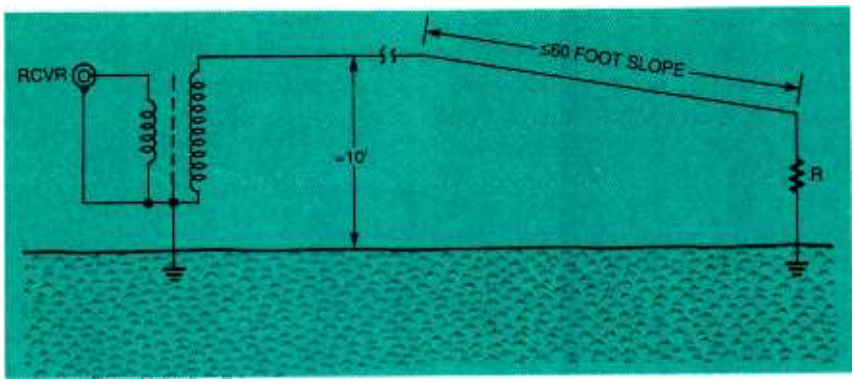


Fig. 5. Slope the last 60 feet or so from the 10-foot height of the wire to the grounded end of the resistor.

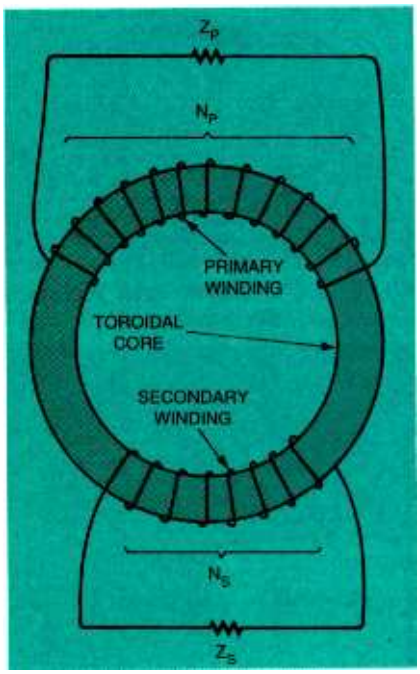


Fig. 6. Toroid transformer for the receiver end.

tion between the ground connection at the termination resistor and the ground connection at the receiver transformer (Fig. 4). According to Misek, this wire helps stabilize the impedance variations at higher frequencies.

Length of the Beverage Antenna. Another of the debates found among Beverage fans regards the best length for the antenna. Some sources say that the length can be anything! $\geq 0.5\lambda$, while others say $\geq 1\lambda$ is the minimum size. One camp says that the length should be as long as possible, while others say it should be close to a factor called the Maximum Effective Length (MEL), which is calculated from:

$$MEL = \lambda/(4(\{100/k\} - 1))$$

where: MEL is the Maximum Effective Length in meters; λ is the wavelength in meters; and k is the velocity factor of the wire, expressed as a percentage. Just to give you a feel for the numbers, if you want to figure the MEL for a 1.8 MHz amateur frequency Beverage, then use λ = 160 meters. Assuming a velocity factor, k, of 85%, we find that the Maximum Eeffective Length should be around 227 meters or 744 feet long—over two football fields long!

Misek uses numbers like 1.6λ to 1.7λ over the 1.8 to 7.3-MHz region, and 0.53λ to 0.56λ on frequencies lower than 1.8 MHz. Dr. Beverage was once quoted as saying that the optimum length is 1λ.

Building the Beverage. Installation of the Beverage antenna is not overly critical, if certain rules are followed. The antenna should be installed at a height of eight to ten feet off the ground, and should be level with the ground over its entire length. If the ground is not flat enough to make a level installation possible, then try to use a height that is eight to ten feet above the average terrain elevation along its run. A popular installation method is to erect 16-foot 4×4 lumber such that three to four feet are buried in a concrete filled post-hole. Use lumber that is treated for outdoor use, that is, lumber sold for add-on decks and porches. The wire can be fastened to the 4×4 posts using either ceramic stand-off ("beehive") insulators or electric livestock control fence insulators (which are preferable). Try to use one contiguous length of wire for the antenna, if possible, in order to avoid soldered splices and joints.

One of the Beverage installation difficulties shared with other long-wire antennas is the need to slope down to a point where a termination resistor can be easily installed close to the ground. While the long-wire can be sloped over a large portion of its length, the Beverage should only be sloped downwards over the last sixty feet or so (Fig. 5).

Feeding the Beverage Antenna. As pointed out, the Beverage antenna must be matched at both ends with terminations equal to the characteristic impedance of the antenna. At the feed end, where the receiver is connected, this requirement usually means that a transformer is needed because the usual receiver antenna connection wants to see a 50-ohm source.

A transformer consists of two or more coils of wire arranged so that the magnetic field of one coil cuts across the other. Although air transformers are common, those used with Beverage antennas tend to be either powdered iron or ferrite toroid (*i.e.* "doughnut" shaped) cores (see Fig. 6). These cores are available from Amidon Inc. (250 Briggs Avenue, Costa Mesa, CA 92626. Tel. 800-898-1883). Sizes range from 0.125 inch outside diameter (o.d.). to 5.2 inches o.d. For transmitting, size is important, but for receiving, the convenience of building the transformer is more important. The cores are also classified according to material, and this attribute is frequency sensitive. The Amidon catalog gives data and ordering instructions for the various frequency ranges and sizes.

Transformers produce an impedance transformation according to the expression:

$$Np/Ns = \sqrt{Zp/Zs}$$

where: Np is the number of turns in the primary winding; Ns is the number of turns in the secondary winding; Zp is the impedance connected to the primary winding (in Beverage antennas it is Z_O); and Zp is the impedance connected to the secondary winding (typically 50 ohms). We know the required impedance transformation (Zp/Zs) by comparing the value of Z_O (which connects to the primary

winding), and the receiver system impedance (which connects to the secondary winding)—the latter is usually 50 ohms.

The usual practice is to select an inductance for the transformer winding that is high relative to the highest impedance to be matched. Beverage antenna experts recommend an inductance of 637 μH for the primary, which translates to 35 turns of wire on the Amidon FT-50-43 core ("FT" denotes ferrite material, "50" means a 0.50 inch o.d., and "43" is the material mixture type. The 43 mixture is nickel-zinc, works to about 50 MHz, and has a permeability μ of 850). To match 500 ohms to 50 ohms, we need 11 turns on the secondary. Thus, we can select an FT-50-43 ferrite toroid core, and then wind the primary with 35 turns of No. 26 enameled wire, and the secondary with 11 turns of the same wire. Other cores are also useful, and indeed may be better for the BCB. These would require different turns ratios from the example given above.

The ≈500-ohm impedance of the Beverage makes a reasonable match to the "HI-Z" (high impedance) inputs of some receivers (as well as the normal impedance of older receivers), but direct connection is not recommended because of safety reasons. The Beverage is a huge static electricity generator. Static build-up on the wire can produce discharges that will destroy the RF input circuitry of solid-state receivers. As a result, even when no impedance transformation is needed, a 1:1 transformer is recommended because of the discharge path to ground through the secondary winding.

Better performance, especially noise performance, is achieved if the transformer is wound using a Faraday shield technique. This method is shown in Fig. 7. The primary winding is wound in the normal manner with enameled hookup wire. The secondary, however, is made with a length of coaxial cable for the wire. Small sizes, such as RG-174/U or even RG-58/U, will suffice for medium to large size cores. One end of the wire is stripped back and the shield removed, exposing the inner insulator and conductor; remove about 1/4-inch of the inner insulator to expose the conductor. The other end is trimmed to allow 1/4-inch of inner conductor to be exposed, along with 1/2-inch of inner insulator and 1/2-inch of the shielding outer conductor; solder the inner conductor of the other end to the outer conductor of this end (be sure not to use too much heat, or the inner insulator will melt).

The transformer can be mounted in either a shielded metal box or a non-shielded box, but it must be mounted at the feed end of the wire, with no down-lead (other than the coax). The chief requirement is that the box be weatherproofed. Avoid mounting the transformer on the pole if possible. This can be done if the Beverage wire is sloped gently from the normal height (8 feet to 10 feet) to the ground level (Fig. 8). As in the case of the termination resistor mentioned earlier, the slope should be over about sixty feet, but not significantly more. Also shown in Fig. 8 is an alternate transformer scheme (see inset) that can be used with any Beverage, not just the sloping feed type. This transformer is called an autotransformer because the same winding is used for both primary and secondary. The secondary is merely tapped down on the primary at the correct impedance level. Some people use a series of taps on the primary, and a switch to select one tap from the many, in order to accommodate several different impedance levels.

Figure 9 shows a Zepp-fed Beverage antenna. A parallel transmission line is made by spacing two No. 14 lengths of wire, each long enough to reach the feed end of

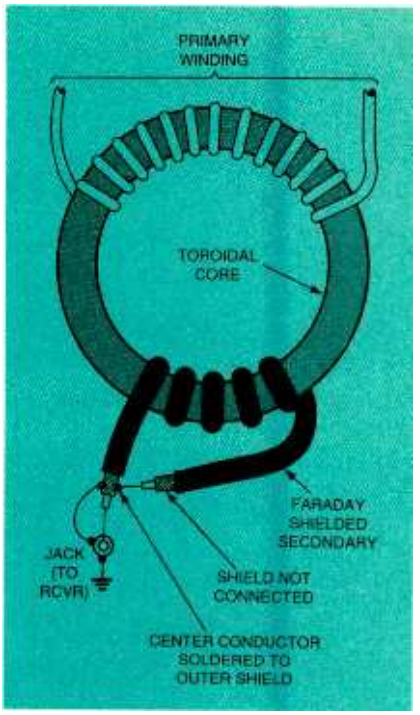


Fig. 7. Use of coaxial cable to form a Faraday-shielded transformer.

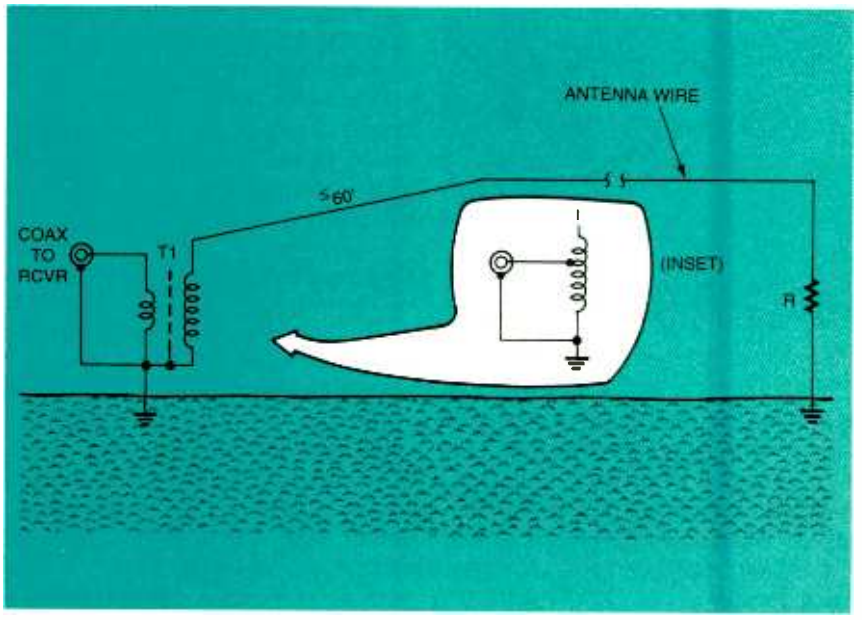


Fig. 8. Use the same sloping of the last 60 feet down to the receiver end as was used at the ground end.

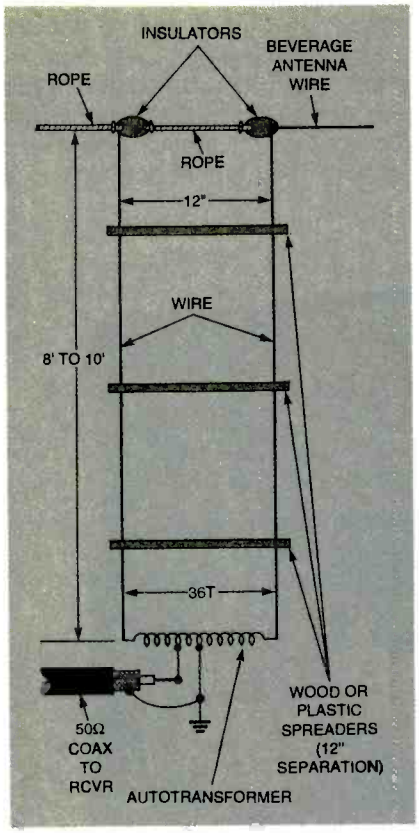


Fig. 9. Zepp-fed Beverage antenna.

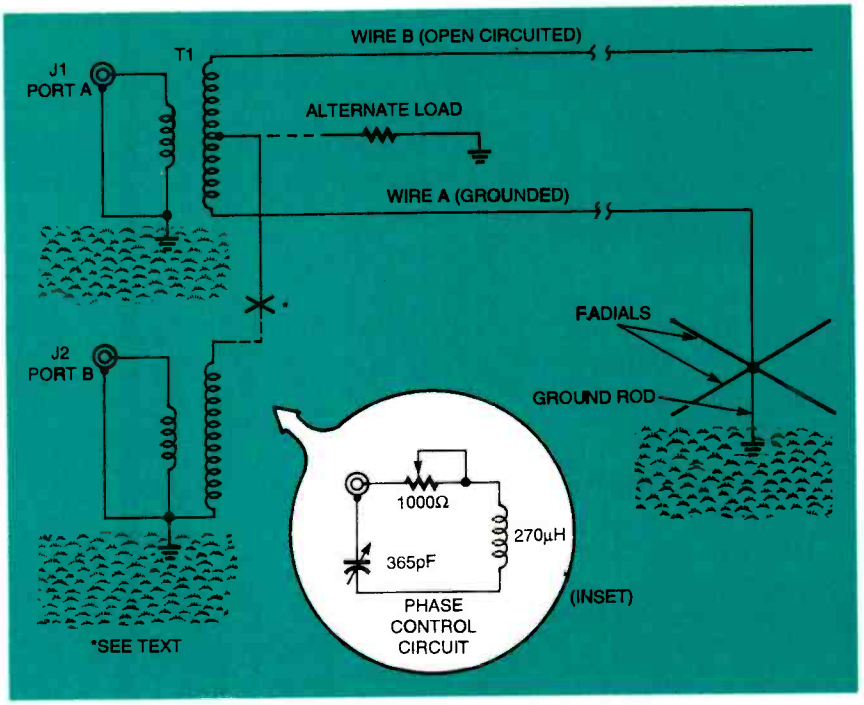


Fig. 10. Steerable-notch Beverage antenna.

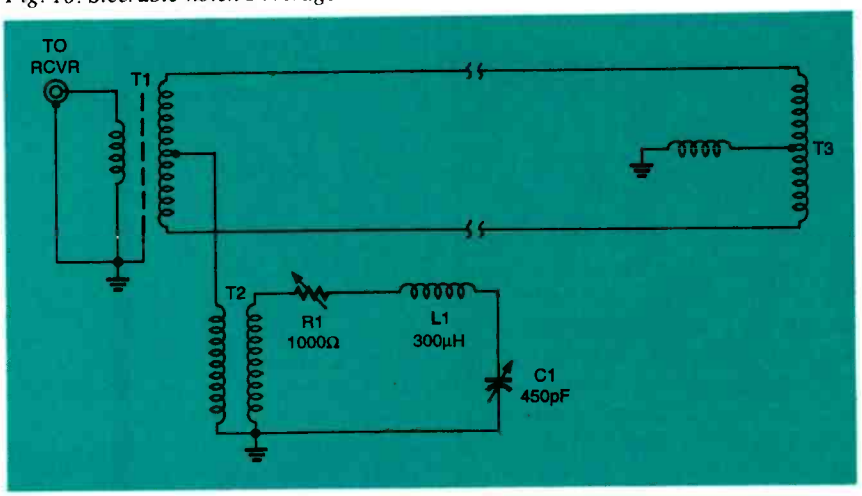


Fig. 11. Balanced version of the steerable-notch Beverage.

the Beverage, twelve inches apart. Use either plastic or wooden dowels to keep the wires spread apart (as many dowels as needed may be used). The feed transformer is a balanced autotransformer consisting of 36 turns of No. 26 enameled wire over a suitable core (e.g. FT-50-43). The center tap is at eighteen turns and is grounded. The center conductor of the coaxial cable to the receiver is connected to a tap on the "cold" end that matches the impedance. For 50 ohms, tap the coil six turns from the ground connection.

Steerable-Notch Antennas. A Beverage erected with two wires—parallel to each other, at the same height, spaced about 12 inches apart, with a length that is a multiple of half wavelength—is capable of null steering. That is, the rear nulls in the pattern can be steered over a range of 40 to 60 degrees. This feature allows strong off-axis signals to be reduced in amplitude so that weaker signals in the main lobe of the pattern can be received. There are at least two varieties of the steerable wave Beverage (SWB). One variety is shown in Fig. 10.

The two parallel wires in Fig. 10 are terminated differently. Wire A is grounded in a radial and ground rod system, without a termination resistor; Wire B is open-circuited. When a passing signal produces a voltage in these wires, the results are exactly opposite. Both wires form a "transmission line" to ground, but one is open-circuited so it sees an infinite load impedance, while the other is shorted so it has a zero load impedance. In both wires, the traveling wave propagates to the other end, and reflects 100 percent back towards the receiver. In Wire A, however, the reflected signal reverses phase with respect to the incident forward signal, while in Wire B the open-circuit load causes an in-phase reflection. Whether these signals cancel or add depends on the nature of the load circuit. If the load is resistive (see "alternate load" in Fig. 10), the antenna is unidirectional. If the second transformer, T2, is used as the load for T1, however, the reception is bi-directional, but only one direction at a time. A two-antenna coaxial switch can be used to select Port-A or Port-B, depending on the desired direction of reception.

If null steering behavior is desired, then use is made of a Phase

FOR MORE INFORMATION

A DXer's Guide to Beverage Antennas
John H. Bryant
Publication No. A9
and
Beverage and Longwire Theory
National Radio Club
P.O.B. 164
Mannsville, NY 13661

The Beverage Antenna Handbook
Victor Misek, W1WCR
142 Wason Road
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The ARRL Antenna Handbook-18th Edition
Publication 6133
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Antenna and Techniques for Low-Band DXing
Publication 4661
John Devoldere, ON4UN
American Radio Relay League
225 Main Street
Newington, CT 06111

Practical Antenna Handbook-2nd Edition
Joseph J. Carr
TAB Books, 1994.
ISBN 0-07-011105-7

Control Circuit, PCC, (see inset to Fig. 10) consisting of a potentiometer, an inductance and a variable capacitor in series with each other. Varying both the "pot" and the capacitor will steer the null. You can select the direction of reception, hence the direction of the null, by using a switch to swap the receiver and PCC between Port A and Port B.

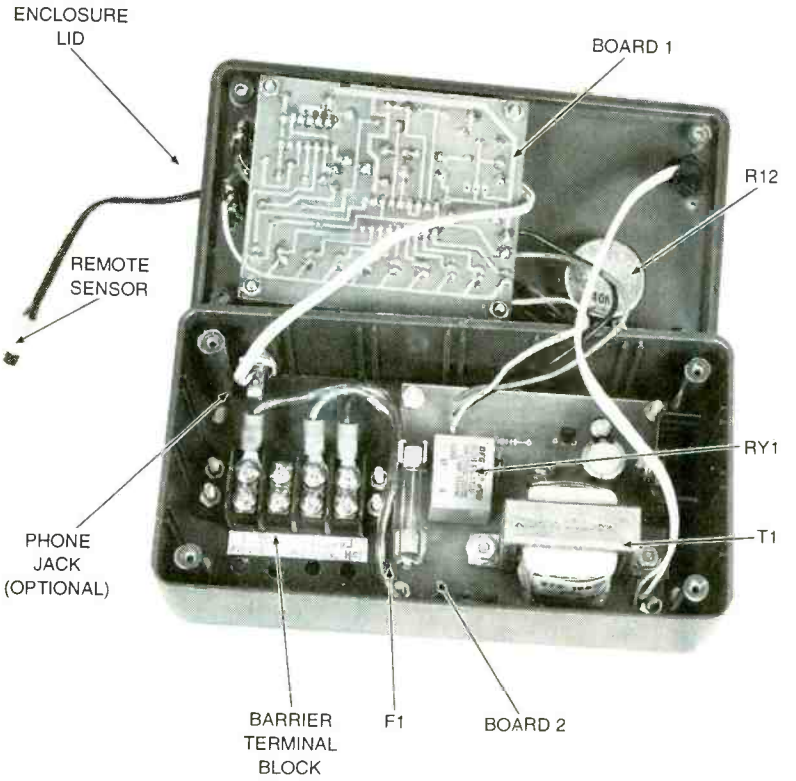
The other variation on the theme is shown in Fig. 11. This antenna is the same as the previous case on the receiver end, except for the PCC being hard-wired, rather than movable—both designs are acceptable. On the termination end, however, a trifilar transformer (three interleaved windings) is used to terminate the two wires.

So there you have it—designed over 75 years ago, the Beverage antenna still finds wide usage for the low-frequency *aficionados*. With its unique propagation properties coupled with its inexpensive material cost, the Beverage antenna is the optimum low-frequency antenna available today. ■

CLIMATE CONTROLLER

(continued from page 36)

made at the appropriate locations (the shaded areas), and glued to the lid of the enclosure to give the unit a professional finish. Now all that's left to do is install your Electronic Climate Controller in your environmental control system and sit back in complete comfort. ■



The two printed-circuit boards, as well as the off-board components that make up the Electronic Climate Controller's circuitry, are easily housed in and mounted on the unit's simple plastic enclosure. The optional barrier block makes it easy to wire the unit into your existing climate control system, while the optional phone jack allows for easy connection of a remote sensor.

The appearance and functionality of the finished project can be greatly enhanced by affixing a photocopy of the author's front panel label to the lid of the enclosure. The label includes switching designations as well as outlining the significance of each lighted LED.

Electronics Library

BUILD YOUR OWN INTELLIGENT AMATEUR RADIO TRANSCEIVER

by Randy L. Henderson

Aimed at amateur-radio operators and anyone else interested in how modern radio transceivers work, this book is a complete guide to the entire process of building, using and enjoying a sophisticated radio transceiver. It thoroughly explains how to build a microprocessor-controlled, multiband, multimode HF transceiver. Using a building block approach, it starts with the speaker and microphone and ends with the antenna.

The book provides easy-to-follow descriptions of how the radio works, features easy-to-build single-sided circuit boards, and contains detailed circuit-board layouts and extensive parts lists. A source list for parts suppliers is also included. Plans for smaller projects such as a simple frequency synthesizer and a spectrum analyzer are presented. As well as examining construction techniques, the author describes the operation and purpose of each circuit. Unlike some home projects, the main transceiver calls for techniques that are similar to those for commercially produced equipment.

The how and why of frequency synthesis is emphasized. The book covers, in detail, interfacing digital and analog circuitry, keeping digital switching noise out of sensitive analog circuits, understanding the real-world behavior of RF circuits, and mastering circuit-board fabrication. How to interface a microcontroller to various I/O devices and how to do assembly programming of the Intel 80C31 microcontroller is explained.

The author is an electronics technician with more than 20 years experience in the design, fabrication, troubleshooting, and repair of many types of electric and electronic circuits.

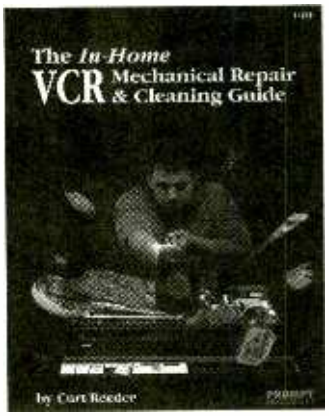
Build Your Own Intelligent Amateur Radio Transceiver costs $39.95 hardcover, and $29.95 paperback, and is published by McGraw-Hill, Inc., 11 West 19th Street, New York, NY 10011; Tel. 800-2MCGRAW or 212-337-5951.

CIRCLE 91 ON FREE INFORMATION CARD

THE IN-HOME VCR MECHANICAL REPAIR & CLEANING GUIDE

by Curt Reeder

Geared to home VCR users who would like assistance in maintaining their equipment, this book also serves as a guide for people considering starting a VCR service business of their own. Like anything in the home, a VCR requires minimal maintenance to keep functioning well. All you need are a few small hand tools such as tweezers, cleaning fluid, a power screwdriver, and cotton swabs—a technical or electrical engineering degree is not required.



This guide shows readers the many tricks and secrets of VCR maintenance. The information that's included gives a firm foundation for servicing your own VCR or creating a personal service business. Based on the notes and remedies that the author compiled while running his own in-home VCR repair and service business, this book is written in easy-to-understand terms. It presents the repair and cleaning of VCRs as a step-by-step process, teaching the reader how to identify the fault affecting the VCR and how to correct it.

The reader is led through the fundamentals of getting started and the basic tools and tricks of the trade. This is followed by a description of the parts of the VCR, how they work, and how they go together. The author then goes on to a discussion of common problems and how to fix them. The book ends with an analysis of 12 actual service calls.

The In-Home VCR Mechanical Repair & Cleaning Guide costs $19.95, and is published by Prompt Publications, Division of Howard W. Sams and Company, 2647 Waterfront Parkway East Drive, Suite 300, Indianapolis, IN 46214-2041, Tel. 800-428-7267.

CIRCLE 92 ON FREE INFORMATION CARD

MCM ELECTRONICS CATALOG #39A

from MCM Electronics

Included in MCM Electronics' latest catalog are over 36,000 national brand-name items for the consumer electronics repair, hobbyist and service industries. The catalog is organized into 25 groupings for easy reference.

Over 9,000 new items have been added—their biggest expansion to date. Project accessories, semiconductors, connectors, test equipment,

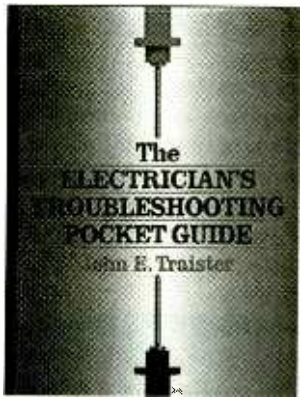
computer, audio products, hundreds of original OEM and generic TV/VCR repair parts are just some of the new items. Among the manufacturers who are represented for the first time are Philips/Magnavox, Sony, Tektronix, Duracell, Belden and Klein Tools.

MCM Electronics Catalog 39A is free upon request from MCM Electronics, 650 Congress Park Drive, Centerville, OH 45459-4072; Tel. 800-543-4330; Fax: 937-434-6959; Web: www.mcmelectronics.com.

THE ELECTRICIAN'S TROUBLESHOOTING POCKET GUIDE

by John E. Traister

This handy reference provides instant access to all the practical information and expert guidance that the electrician needs. It covers methods to effectively test and troubleshoot all types of electrical systems: residential, commercial, and industrial. With abundant illustrations and useful checklists, the book shows exactly how and when to use a wide variety of testing equipment, including meters, ammeters, voltmeters, and megohmmeters. It also spells out crucial precautionary measures for preventing circuit and component damage during testing.



Readers will find detailed, step-by-step procedures for verifying that instruments are working properly, and for calibrating sensitive electronic instruments and equipment. Techniques for troubleshooting various circuits and equipment—ranging from incandescent fixtures to mercury lamps, from motors to motor controls, and from overcurrent devices to transformers—are explained in detail. Extensive troubleshooting charts help electrical technicians become familiar with common malfunctions, identify their probable causes, and take corrective action.

Small enough to fit in a toolbox, this sturdy little guidebook is a valuable working companion for every electrician.

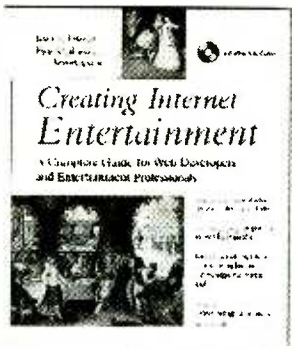
The Electrician's Troubleshooting Pocket Guide is published by McGraw-Hill, 11 West 19th Street, New York, NY 10022;. Tel. 800-2MCGRAW or 212-337-5951; Fax: 212-337-4092; Web: www.ee.mcgraw-hill.com.

CIRCLE 93 ON FREE INFORMATION CARD

CREATING INTERNET ENTERTAINMENT: A COMPLETE GUIDE FOR WEB DEVELOPERS AND ENTERTAINMENT PROFESSIONALS

by Jeannie Novak & Pete Markiewicz

This book and CD-ROM package provides a complete guide to planning, creating, operating, and marketing entertainment-based sites on the Internet ("Intertainment"). It is aimed at Web site developers and professionals in the entertainment industry, as well as people who work for non-entertainment companies but would like to add entertainment components to their Web sites.



The book analyzes Internet audience demographics and shows how to appeal to the emerging entertainment marketplace. It details the design principles and software tools needed to make Intertainment "sizzle," including how to set up a complete virtual production studio. The book teaches effective publicity and promotion techniques for Internet entertainment sites, and outlines new entertainment business and financial models and management methods.

The accompanying CD-ROM provides Internet connectivity software with one-step installation and demos of cutting-edge site development tools. It also features multimedia helper applications and plug-ins needed to get the most out of today's "Intertainment" sites. Updates to the book and links to new technologies and "Intertainment" sites can be accessed at *http://kspace.com/intertainment.*

Creating Internet Entertainment: A Complete Guide for Web Developers and Entertainment Professionals costs $39.95 and is published by John Wiley & Sons, Inc. 605 Third Avenue, New York, NY 10158-0012; Tel. 800-225-5945; Web: http://www.wiley,com/compbooks/.

CIRCLE 94 ON FREE INFORMATION CARD

B&K 1997/98 TEST INSTRUMENTS & ACCESSORIES CATALOG

from B&K Precision

B&K Precision's new line of high-performance oscilloscopes, digital multimeters and power clamp-on meters is highlighted in their 1997/98 product catalog. B&K now offers one of the largest selections of test instruments available, with the addition of such products as the 5300 series, 50,000-count, digital multimeters. All price ranges and performance levels are represented.

The 72-page catalog features an index and product guide for quick reference, as well as detailed specifications on each product category. The product categories are oscilloscopes, DMMs, power supplies, function generators, spectrum analyzers, oscilloscopes, and a wide variety of component testers, test leads and accessories.

The 1997/98 Test Instruments & Accessories Catalog is free upon request from B&K Precision, 6470 W. Cortland Street, Chicago, IL 60707-4098; Tel. 773-889-1448; Fax: 773-749-9740; Web: www.bkprecision.com. ■

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SCANNER SCENE

CODEBREAKER?

MARC SAXON

If you want to glean the maximum amount of information possible from your scanner intercepts, you will need to know certain things that aren't apparent by simply listening. For instance, when a keypad is used to send telephone or other numbers, the transmission is heard as a series of 16 so-called dual-tone mutifrequency (DTMF) code tones. Your ears can't decode the digits those tones represent.

The Optoelectronics DC442 Decoder can be used with any scanner or receiver. It automatically and instantly provides a readout of DTMF, CTCSS , and DCS data.

Also, the majority of VHF and UHF communications systems utilizing repeaters employ any of 52 standard continuous tone-coded squelch system, or CTCSS (popularly known as "PL") tones, or 106 standard digital-coded squelch, or DCS codes to limit or specify repeater access. Both CTCSS and DCS codes are buried in the signal and cannot even be heard when you're monitoring. Yet knowing what they are when you monitor them can help sort out and identify unknown communications networks. For instance, the Drug Enforcement Agency stations use a standard 156.7 Hz CTCSS tone, while FBI stations use 167.9 Hz.

The new *Optoelectronics DC442 Decoder* can be used with any scanner or receiver to automatically and instantly provide a readout of DTMF, CTCSS, and DCS data. It easily hooks externally to the REC OUT jack on the rear of the scanner, and it also has a built-in RS232- and CI-5-compatible interface for computer-controlled installations.

Unlike earlier models that required the scanner owner to manually switch to the various functions to obtain decoding, the Model DC442 features fully automatic switching to the proper decoder function. Data is displayed on a two-line backlit LCD display. An asterisk appears on the LCD next to any active tone, ensuring accuracy. The DTMF memory stores more than 1000 digits (about 145 local phone numbers), and it can be scrolled. Operation is from an external plug-in power supply or optional internal NiCd batteries.

The DC442 sells for $259, or $299 with the NiCds installed. It comes from Optoelectronics, 5821 N.E. 14th Avenue, Ft. Lauderdale, FL 33334; Tel. 954-771-2050; Fax: 954-771-2052; Web: *http://www.optoelectronics.com.*

WHAT'S IN A NAME?

In the VHF aeronautical band, there are several frequencies where pilots like to chit-chat with one another while flying along. If you have tuned in to 122.75, 123.075, or 123.45 MHz, you know what I mean. In fact, 123.45 MHz, which is preferred by airline pilots as their equivalent to CB Channel 19, isn't even designated (or permitted) for casual inter-plane chit-chat by the FCC. But note that it has a novel arrangement of successive numbers, and because it had something distinctive to set it apart, it became special.

What is less known, but even more interesting, is the fact that the UHF military aeronautical band (225 to 400 MHz, AM mode) also has its share of quirky off-beat air-to-air channels where pilots can be found chatting. Often these conversations are hilarious. Usually the channels have distinctive numerical arrangements and are frequently referred to by the pilots by unofficial "nickname" designators.

Here are interesting air-to-air military channels we have monitored, or have had reported to us, along with their unofficial channel names:

"Cheap Suit"	299.5 MHz
"Full House"	333.55
"Haircut"	351.0
"Magnum"	357.0
"Pistol Five"	384.55
"Quad Three"	333.3
"Quad Three Five"	333.35
"Remington"	300.6
"Sierra One" or "Sierra Two"	226.4
"Straight Flush"	345.6
"Straight Flush Two"	345.65
"Thirty-Thirty" or "Winchester"	303.0

BIG CHANGES FOR VHF MARINE RADIO

The FCC has several major changes up its sleeve that (if and when finalized) will significantly impact the VHF maritime radio channels. To at least some extent, these proposed changes were inspired by the popularity of cellular telephones aboard vessels operating within range of shore cell sites. This has resulted in making the existing 160 MHz "Marine Operator" services rather obsolete and left them largely underutilized in many areas.

Among the changes planned, coastal marine operator stations would be able to directly and automatically connect marine radios with landline telephones. No time would be wasted verbally providing calling number and vessel name information to live opera-

(Continued on page 63)

It's Not Just Training...

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New Products

CABLE ANALYZER

Fluke's DSP-2000 digital *CableAnalyzer* tester offers automatic fault-isolation that analyzes marginal and failed cabling links with the touch of a button. The handheld device can quickly resolve any network problems caused by defects in a cabling plant and is well suited for maintaining and installing high-speed networks on Category 5 or Class D cabling installations.

Designed to help network owners deal with cable problems that they are likely to encounter as they move to faster network technologies, the DSP-2000 meets the most stringent accuracy requirements for testing the Basic Link (wiring from the patch panel to the wall as well as the complete Channel—the cabling link from workstation to hub). Thanks to a technology called TDX, the tester can pinpoint the source of crosstalk caused by improper cabling, untwisting of twisted-pair cabling, bad patch cords, or poor workmanship. With the touch of a button, the FAULT INFO—the DSP-2000's diagnostic mode—intelligently decides which tests to execute and displays the problem in an easy-to-interpret graphical format.

The DSP-2000 displays utilization and collision information, even on fast networks, allowing network managers to monitor traffic on 100Base-TX networks. Its monitor function also lets the technician quickly see if a cabling link is connected to an active hub port and is transmitting "legal" Ethernet traffic.

Operating two to eight times faster than most other cable testers, the DSP-2000 lets technicians accurately complete a two-way test in 20 seconds or less. The device is protected from live ISDN circuits, so telecommunication voltages and over-currents will not damage the unit or harm the user. Depending on the combination of tests run, the results for 600 to more than 2000 tests can be stored.

Options include CableManager software, a program that organizes, searches, sorts, and stores test results in a database and allows users to create and organize projects by site or by customer and to create customized reports. A fiber-optic test kit for measuring power loss from fiber-optic cables is also available.

The DSP-2000 CableAnalyzer has a list price of $5495. For more information, contact Fluke Corporation, P.O. Box 9090, Everett, WA 98206; Tel.800-44-FLUKE; Fax: 800-FLUKE-FAX; e-mail: fluke-info@tc.fluke.com; Web: *http://www.fluke.com/nettools.*

CIRCLE 80 ON FREE INFORMATION CARD

DEFECTIVE COMPONENT LOCATOR

Electronic Design Specialists has just released the improved *LeakSeeker 82A*. It is described as the only test gear to identify exactly where a leaky or shorted component is located on a printed circuit board, with a precision of 0.1 inches.

More choices have made the improved unit more versatile. Now it can be switched from automatic to manual calibration, allowing the user to do quick covering of long pcb traces on the automatic setting or fine searching of a small area on the manual setting. Having both standard and fine resolution provides the option of working with fine traces, such as in camcorders, or wide traces as in high-power or industrial equipment. Advance warning of re-calibration, another added feature, is given by a beep sound and the calibration LED lighting up before re-calibrating.

This test gear is useful for locating a shorted or leaky capacitor or diode, or for finding a solder bridge or pinched wire along a p.c. board trace that shows a suspiciously low resistance. The defective component can be any resistance from 150 ohms to zero ohms.

The Leak Seeker 82A has a suggested retail price of $169. Contact Electronic Design Specialists, 4647 Appalachian Street, Boca Raton, FL 33428; Tel. 561-487-6103 for more information.

CIRCLE 81 ON FREE INFORMATION CARD

COLOR VIDEO LAMP

The *VL-300 Color Lamp* from *American Innovations* is an ordinary-looking desk or table lamp that covertly houses a color camera. The camera has a low 2-lux sensitivity rating. It also has built-in backlight compensation and a horizontal resolution of 380 lines. These features result in excellent picture quality.

This affordable, high-tech surveillance device is designed for use in any hidden video application—at home or in the business world—where one wants to observe what's happening without being observed. Requiring

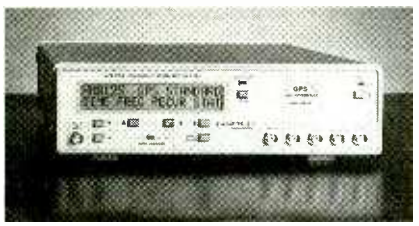
only a pinhole opening—1.5 mm—at the base of the lamp, the video camera is virtually undetectable. No one would believe that a camera could see out of a hole this small. The attractive black and gold touch lamp, which stands 19-inches high, blends in with any environment.

The VL-300 Color Video Lamp has an introductory price of $595. For more information, contact American Innovations, Inc., 119 Rockland Center, Ste. 315, Nanuet, NY 10954; Tel. 914-735-6127; Fax: 914-735-3560; Web: *http://www.spysite.com.*

CIRCLE 82 ON FREE INFORMATION CARD

GPS TIME/FREQUENCY STANDARD

Hameg Instruments has recently introduced its *GPS Time/Frequency Standard HM 8125.* It is based on the NAVSTAR Global Positioning System (GPS), the most accurate radio navigation system ever developed, that enables users world-wide to determine the correct time with a very high degree of accuracy.



The unit automatically acquires and tracks satellites, and calculates time, frequency, and position within 2 to 15 minutes after power-up. Synchronization is confirmed via a front panel LED indicator. The actual deviation can be read on a 2 × 20 character LCD. In the field, the geographic position can be read from the LCD screen.

The HM 8125 provides ultra-precise outputs: timing outputs are within 100 ns of UTC; frequency outputs are accurate to 1×10^{-12} when tracking satellites. It produces a 2.048 MHz frequency output that is locked to the GPS system, and can also measure external frequencies with an accuracy of 5×10^{-10} at a gate time of 2 seconds. Time and accuracy data are available on the built-in RS-232 serial communications port. The unit comes complete with the antenna, converter, and BNC cable.

The HM 8125 GPS Time/ Frequency Standard costs $2780. For more information, contact Hameg Instruments, 255 East Meadow Avenue, East Meadow, NY 11554; Tel. 800-247-1241 or 516-794-4080; Fax: 516-794-4080; e-mail: hameg@aol.com.

CIRCLE 83 ON FREE INFORMATION CARD

LIQUID ELECTRICAL TAPE

Liquid Electrical Tape from *Star brite* is a liquid vinyl, which is applied to wires or terminal junctions to seal out moisture and prevent corrosion. It's easy-to-use—just apply and let dry—and it dries to a flexible protective coating. The coating also helps hold wires and terminals together so that vibration does not loosen the connection. Because the tape is applied as a liquid, it can be used in hard-to-reach areas and on irregularly-shaped electrical connections.

Compared to conventional electrical tape, liquid tape produces a protected connection that is neat, clean, and totally waterproof; and it has much better dielectric properties, according to UL testing. In addition, the coating is resistant to acids, alkalies, petroleum-based chemicals, and other corrosion-causing materials.

The product comes in black, red, green, clear, and white. It is packaged in a 1-ounce squeeze tube, a 4-fluid-ounce can, or a 32-fluid-ounce can. Suggested retail prices are $3 for the tube, $5 for the 4-ounce can, and $24 for the 32-ounce can. Contact Star brite, 4041 S.W. 47th Avenue, Davie, FL 33314; Tel. 800-327-8583.

CIRCLE 84 ON FREE INFORMATION CARD

PROCESS CALIBRATOR MULTIMETER

Designed for professionals in the field, *Extech's CMM-15 Process Calibrator Multimeter* combines a process calibrator and a true RMS 15-function multimeter. The handheld device (approximately 1½-×3½-×7½-inches) simultaneously sources and measures current, voltage, and frequency. The CMM-15 provides a precision constant voltage and current calibration source with .03% accuracy, as well as a wide-range frequency source with adjustable amplitude, pulse width, and duty cycle. Current and voltage outputs are bipolar for constant current output for loads up to 500 ohms.

Multimeter functions include measuring DC and AC voltage, temperature, and frequency. The meter also measures duty cycle, pulse width, resistance, continuity, and diodes. True RMS measurements are provided for non-linear voltage and current loads.

Primary, secondary, source/measure ranges, and the function selected are displayed on a large 4000/40,000-count backlit LCD. Other features of the unit include a RS-232 interface and a programmable 16-step memory for continuous, ramp, or step output.

The CMM-15 also offers a 1-ms peak hold for glitch captures, auto- and data-hold capabilities, 20 measurements/second bargraph response, and auto power off. It comes complete with I/O test leads, K thermocouple, probe, 9-volt battery, external battery pack, protective holster, and pouch case.

The CMM-15 Process Calibrator Multimeter costs $499. For more information, contact Extech Instruments Corp., 335 Bear Hill Road, Waltham, MA 02154; Tel. 617-890-7440; Fax: 617-890-7864; e-mail: extech@extech.com; Web: *http://www.extech.com.*

CIRCLE 85 ON FREE INFORMATION CARD

POWER CINEMA VCR

Is your home entertainment system suffering from an acute case of cord clutter? Does the thought of connecting

(Continued on page 59)

CIRCUIT CIRCUS

Solid-State Switches

CHARLES D. RAKES

This month we are going to look at a few circuits featuring the SCR and the triac. These close cousins are found in many circuit applications including AC/DC control circuits, light dimmers, motor speed controls, high voltage generators, power supplies, and countless other circuit functions.

The SCR, or silicon-controlled rectifier, is a four-layer semiconductor device produced in a PNPN configuration. The triac, or bi-directional triode thyristor, can be thought of as a pair of SCRs connected in inverse parallel and sharing a single gate. Both are members of the thyristor family.

The SCR is a solid-state switch that is turned on with a positive gate current, and remains on as long as the anode voltage remains positive and the anode current stays above its minimum holding current value. The only way to turn the SCR off is to lower the anode's current below this level or to momentarily interrupt the current flow. After the gate turns the SCR on, its function is over, and as long as the SCR remains on, the gate has no influence on its operation. The SCR is the solid-state equivalent of the thyratron tube.

So far it would seem that the SCR is a perfect solid-state switch that's controlled only by its gate. Not so! There is a small internal capacitance between the gate and anode that exists because of the semiconductor's layered construction, and can cause the SCR to turn on unexpectedly under certain circuit conditions. If the voltage applied to the anode is a super fast-rising source, the current through this small internal capacitance can be sufficient to cause the SCR to turn on. Although this condition is not too common, it is easy to overcome by adding a small capacitance between the SCR's anode and cathode. This added capacitance will take the edge off the fast-rising anode voltage and usually cure this unwanted turn-on problem.

A triac is a three-terminal AC semiconductor switch that is triggered into conduction by a gate signal similar to a thyristor. The triac provides current flow in both directions with the application of a gate signal. Since the device is operative during both half cycles, less power is wasted—and it is much more efficient than a SCR. Let's now look at some SCR-type circuits first, and then we will end with a couple of triac designs.

SIMPLEST SCR CIRCUIT

A basic SCR circuit is shown in Fig. 1. The SCR, in Fig. 1A, is operating in a DC circuit with an incandescent lamp as the anode's load. Pressing momentary switch S1 completes the circuit between the gate and the positive source—turning on the SCR. In this DC circuit, the SCR remains on as long as the DC source remains on and the lamp's filament remains true.

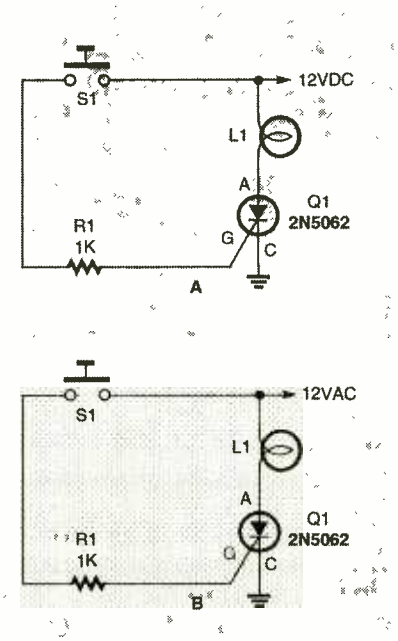


Fig. 1. This simple circuit uses the SCR to control lighting of the lamp. In (A) the source power is direct current, while in (B) the lamp is AC-driven.

PARTS LIST FOR SIMPLEST SCR CIRCUIT (FIG. 1)

L1—12-volt, 50-mA lamp (RadioShack 272-1154, or equivalent)
Q1—2N5062 or similar low current SCR, 100-volt, 0.8-amp (NTE5402, or equivalent)
R1—1000-ohm, ¼-watt, 5% resistor
S1—Normally open push-button switch

The AC circuit in Fig. 1B is the same circuit configuration as the DC version, but with an AC anode voltage. Pressing S1 and holding it closed will turn the LED lamp on, and it remains on as long as S1 is kept closed. Since the SCR must have a positive anode voltage, the lamp will only be on during the positive half of the AC cycle. The light output will be much less than the DC circuit using the same lamp.

TURNING THE SCR OFF

Turning off the SCR is a necessary function of many DC circuit applications. The circuit in Fig. 2 shows one method. Pressing S1 keeps the lamp on. Pressing auxiliary switch S2 diverts the SCR's anode current through the switch contacts, which reduces the SCR's current to zero and turns it off. If S1 remains closed during this time, the SCR will turn back on when S2 is released.

Another way the SCR can be turned off is to momentarily reverse its anode voltage. The circuit in Fig. 3 shows how it's done. With S1 closed, the SCR is on and its anode voltage is near ground level. This causes C1 to charge to about 12 volts with the negative end connected to the SCR's anode and its positive end connected to S2. Closing S2 takes the positive end of C1 to ground leaving the negative end tied to the SCR's anode. The capacitor discharges, reversing the anode's polarity from positive to negative and turns the SCR off.

FLIP-FLOPPIN' SCR

Two SCRs can be connected in a flip-flop circuit as seen in Fig. 4. Switch S1 is shown in the "A" position, supplying gate current to Q1 and turning the SCR on. This turns on LED1 and takes that end of C1 to near ground level. The other end of C1 is tied to the anode of Q2, which is off, and sets this point

at a 12-volt level. Switching S1 to its "B" position removes the positive voltage from Q1's gate and applies it to the gate of Q2, turning this SCR on. LED2 lights and the positive end of C1 is taken to ground, reversing the voltage polarity at the anode of Q1 and turning it off. Switching S1 back to the opposite position reverses the procedure—turning Q2 off and Q1 on again.

SCR CONTROLLERS

The SCR in Fig. 5 operates as an on/off latching switch in a power-control circuit. As shown in the figure, S1 is normally open and S2 normally closed.

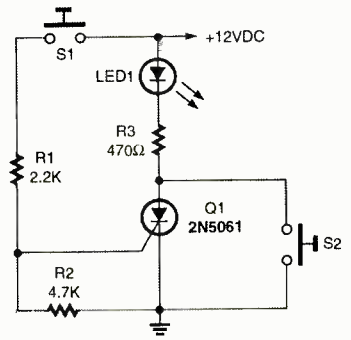


Fig. 2. With the LED on, auxiliary switch S2 can be used to turn the lamp off by providing a shunt path around the SCR.

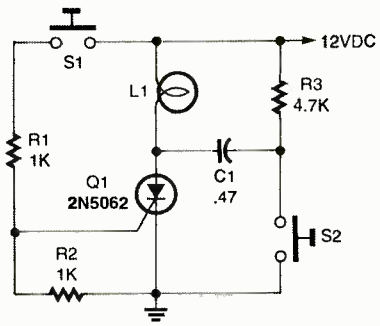


Fig. 3. In this case, auxiliary switch S2 turns off the lamp by reversing polarity of the voltage across the SCR.

In this condition Q2 is turned off, supplying no output voltage to the load circuit. Closing S1 sends current to the gate of Q2, turning it on, and pulling the junction of R3 and R4 to near ground level. This takes the base of Q1, a PNP power transistor, to ground through R4, turning it on and supplying power to the connected load. The power will remain turned on as long as the source is not interrupted, or until S2 is pressed. Operating S2 opens the circuit from the SCR's anode to the positive supply, turning it and Q2 off. This removes power from the load. Closing S1 will again send power to the load circuit to repeat the process.

Our next SCR circuit, see Fig. 6, takes on an AC-control application. The SCR in this circuit is used to control a heavy duty high current relay that supplies power to a large AC load. The on/off switch, S1, is a small low current switch that is operated by a function of the machine and can not be used

PARTS LIST TO TURN THE SCR OFF—SWITCHING THE SCR (FIG. 2)

LED1—Light-emitting diode, any color
Q1—2N5061 or similar low current SCR, 50-volt, 0.8-amp (NTE5401, or equivalent)
R1—2200-ohm, ¼-watt, 5% resistor
R2—4700-ohm, ¼-watt, 5% resistor
R3—470-ohm, ¼-watt, 5% resistor
S1, S2—Normally open push-button switch

PARTS LIST TO TURN THE SCR OFF—REVERSING ITS POLARITY (FIG. 3)

C1—0.47-µF, 50-WVDC, mylar or similar capacitor
L1—12-volt, 50-mA lamp (RadioShack 272-1154, or equivalent)
Q1—2N5062 or similar low current SCR
R1, R2—1000-ohm, ¼-watt, 5% resistor
R3—4700-ohm, ¼-watt, 5% resistor
S1, S2—Normally open push-button switch

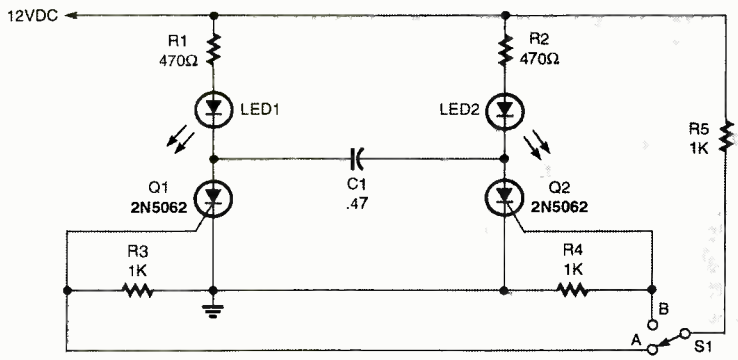


Fig. 4. Here's an arrangement of SCRs in a flip-flop circuit. Each LED's turn-on will toggle in accordance with the position of switch S1.

PARTS LIST FOR FLIP-FLOPPIN' SCR (FIG. 4)

C1—0.47-µF, 50-WVDC, mylar or similar capacitor
LED1, LED2—Light-emitting diode, any color
Q1, Q2—2N5062, or similar low current SCR
R1, R2—470-ohm, ¼-watt, 5% resistor
R3, R4, R5—1000-ohm, ¼-watt, 5% resistor
S1—SPDT toggle switch

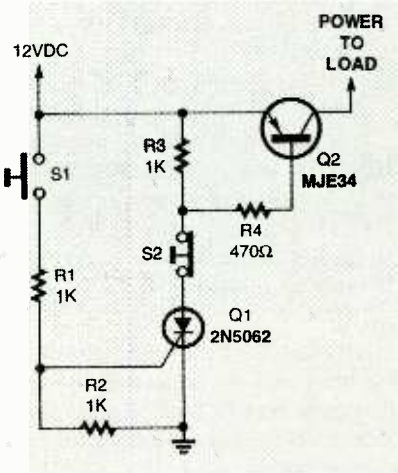


Fig. 5. This neat circuit operates as an on/off latching switch to control power to a load. Closing switch S1 sends power to the load, while pressing switch S2 removes this power flow.

PARTS LIST FOR POWER CONTROL CIRCUIT (FIG. 5)

Q1—2N5062, or similar low current SCR
Q2—MJE34 PNP power transistor (RadioShack 276-2027, or equivalent)
R1-R3—1000-ohm, ¼-watt, 5% resistor
R4—470-ohm, ¼-watt, 5% resistor
S1—Normally open push-button switch
S2—Normally closed push-button switch

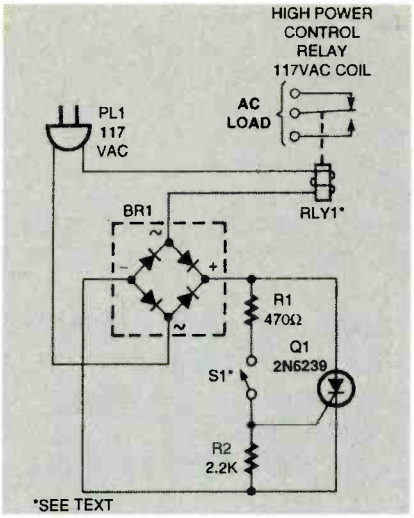


Fig. 6. Here the SCR is used to control the turn-on of an AC relay coil that operates an AC load. Switch S1 is tied back to the load—controlling operation of the relay.

PARTS LIST FOR CONTROLLING HIGH CURRENT (FIG. 6)

BR1—3-amp bridge rectifier (RadioShack 276-1171, or equivalent)
Q1—2N6239 or similar SCR, 200-volt, 3-amp (NTE5414, or equivalent)
R1—470-ohm, ¼-watt, 5% resistor
R2—2200-ohm, ¼-watt, 5% resistor
RLY1—High power control relay (117-VAC coil) suited to the control application
S1—SPST switch

directly to control the relay. One side of the relay coil is connected directly to the power source, and the other side is connected through a 3-amp full-wave rectifier bridge circuit.

No current flows through the bridge circuit while Q1 is turned off. Closing S1 supplies gate current to Q1—turning the SCR on and closing the relay. The bridge circuit is necessary so the SCR can turn on during a complete AC cycle. Without the bridge circuit, the SCR could only apply power to the relay coil for 50 percent of the time and would be insufficient for reliable operation.

LIGHT-CONTROLLED LAMP

How would you like to amaze your friends at the next party with an electric light that can be lit with a match or another light source? Well you can, by building the circuit in Fig. 7. The magic lamp operates like this. Apply power and adjust R2 for the maximum resistance possible without causing the lamp to light. If the ambient light level is low, R2 may reach maximum value without causing the lamp to light. If you don't want to use matches for safety's sake, take a small flashlight and aim it at the photo-transistor, Q2, for a second or two. The lamp should come on and stay on. Another bit of magic may be performed to turn the lamp off. Just reach over and act as if you are pinching the light out, so the photo-transistor is blocked from the light source for an instant—and the lamp will go out!

The circuit uses a Mouser L14G2 photo-transistor (Mouser Electronics can be reached at 800-346-6873), although any general purpose photo-transistor operating in the visible spectrum should work. The magic lamp circuit can be constructed in a small plastic or metal enclosure as shown in Fig. 8, with the lamp located on the surface of the cabinet facing up. The photo-transistor is located about 3 inches above and facing down at the lamp. Power for the lamp is provided through a miniature step-down power transformer and diodes arranged in a full-wave bridge rectifier configuration. For compactness, a bridge module may be used instead of these diodes.

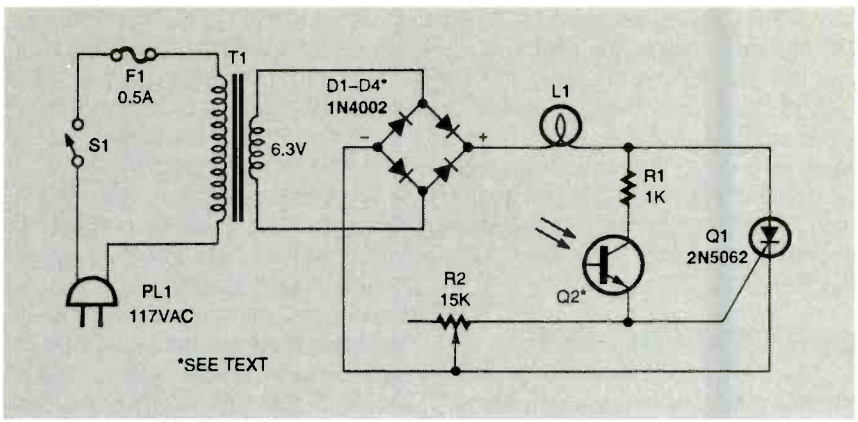


Fig. 7. This trick circuit uses a photo-transistor and SCR to control lamp L1. Light impinging upon Q2 turns on the lamp—removal of the light turns the lamp off.

PARTS LIST FOR LIGHT-CONTROLLED LAMP (FIG. 7)

D1-D4—1N4002 silicon diode
F1—0.5-amp fuse
L1—#46 lamp, 6-volt, 250-mA (RadioShack 272-1130, or equivalent)
Q1—2N5062, or similar low current SCR
Q2—Mouser part L14G2, or similar photo-transistor
R1—1000-ohm, ¼-watt, 5% resistor
R2—15,000-ohm, potentiometer, linear taper
S1—SPST toggle switch
T1—Power transformer, 6.3-volt, 0.6-amp (Mouser part 553-F-13X, or equivalent)

TRIAC AC LOAD CONTROL

Our next entry, see Fig. 9, places a triac in a simple AC load-control circuit. Q1 is connected in series with the load and the 117-volt AC power source. With S1 open, there is no gate current and the triac is turned off like an open switch. No power reaches the load. Closing S1 supplies gate current to the triac, turning it on, and sending power to the load. With the triac specified, the load to be controlled should not exceed a few amperes.

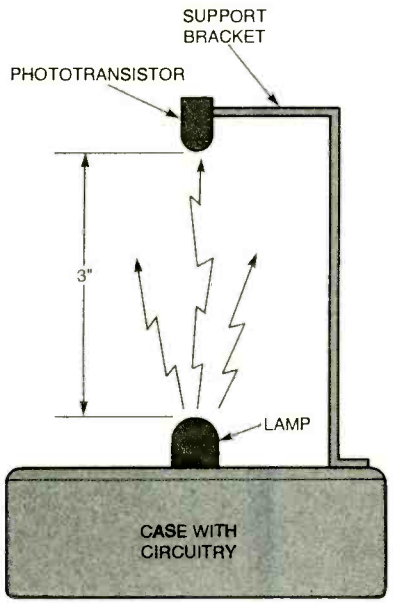


Fig. 8. The magic lamp circuit can be constructed in this small enclosure.

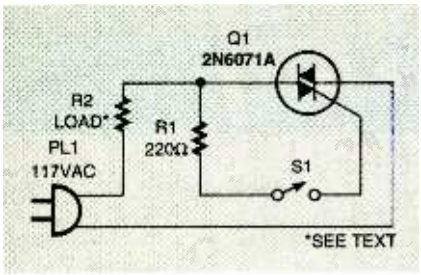


Fig. 9. In this circuit, a triac is used to control power to load the RI.

PARTS LIST FOR TRIAC AC LOAD CONTROL (FIG. 9)

Q1—2N6071A triac, 200-volt, 4-amp (NTE5603, or equivalent)
R1—220-ohm, ½-watt, 5% resistor
S1—SPST switch

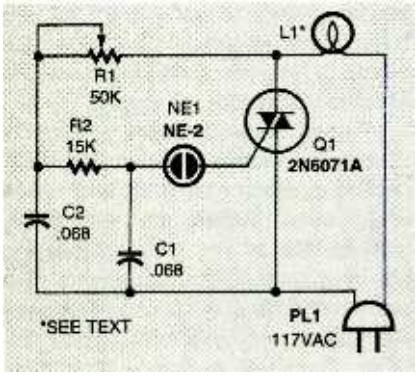


Fig. 10. This circuit is used in many lamp-dimmer applications. Once the lamp is lit, continuous control of its brightness is obtained by varying potentiometer R1.

PARTS LIST FOR TRIAC LAMP DIMMER (FIG. 10)

C1, C2—0.068 µF ceramic-disc capacitor
L1—incandescent lamp(s) (up to 350 watts, when Q1 properly heatsunk)
NE1—NE-2 neon lamp
Q1—2N6071A triac, 200-volt, 4-amp (NTE5603, or equivalent)
R1—50,000-ohm potentiometer, linear taper
R2—15,000-ohm, ½-watt, 5% resistor

TRIAC LAMP DIMMER

Our last entry, see Fig. 10, is a low-cost triac-controlled lamp dimmer circuit. When the AC power is applied (and potentiometer R1 is initially set for maximum resistance between its hot lead and wiper), the incandescent lamp, L1, will not light. When R1 is lowered and the neon lamp starts to conduct, L1 will light brightly. The lamp can then be set to a soft glow by adjusting the value of R1. Using a heatsink with Q1, this circuit can handle a lamp load up to 350 watts.

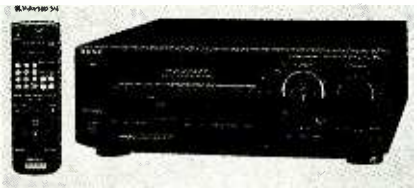
As with many lamp dimmer circuits they may radiate electrical noise to household radios, TVs, etc. A simple approach which may work is to place one 0.001-µF ceramic disc capacitor across the circuit's leads to L1, and another 0.001-µF ceramic disc capacitor across the two terminals of the dimmer.

If you haven't worked with solid-state switches before, maybe these few simple circuit applications will give you an idea or two for their use in a future project. In any case we're about out of sand for now, so come back next month and see what's cooking here at the *Circus*. ■

NEW PRODUCTS

(continued from page 55)

the VCR to the A/V receiver send you into a panic? By combining a hi-fi stereo VCR with a Dolby ProLogic A/V receiver, *Sony's Power Cinema VCR* solves the problem for you.



The VCR, easily connected to a television and speaker system, provides the audio power needed to deliver the enhanced effects of surround sound. It comes as a stand-alone unit or bundled with a five-speaker surround package. Slightly larger than an A/V receiver, its sleek, space-saving design fits into the most compact home entertainment system.

Among the features of the VCR are VHS hi-fi stereo recording and playback, VCR Plus+ timer programming, MTS stereo reception, 4-head dual azimuth recording/playback, and APC II for outstanding picture quality. The built-in AM/FM tuner comes with 30 station presets and six additional inputs for other components: two audio and four audio/video. Included with the VCR is an illuminated, multi-brand remote with a large shuttle dial that allows for simple operation of all major VCR functions, from freeze frame to search to fast forward, just by turning one button.

The *Power Cinema VCR* Model has a suggested retail price of $699. Contact Sony Electronics, Inc.,1 Sony Drive, Park Ridge, NJ 07656; Web: *http://www.sony.com*.

CIRCLE 86 ON FREE INFORMATION CARD

SINGLE OUTPUT POWER SUPPLY

The *Model 1332A Single Output Power Supply* from *Global Specialties* is a digital DC power supply that provides variable voltage of 0-32 volts and variable current of 0-5 amps. The compact (9×11½×5½), fully solid-state unit can be operated in constant current or constant voltage modes. The floating ground feature allows for outputs of either full negative or full positive output potential. Output settings can be varied manually using front-panel coarse and fine controls. Separate front-panel meters monitor output voltage and load current, with easy-to-read green and red digital LED indicators

The innovative circuit design allows for a cleaner, more efficient operation that significantly reduces the amount of heat generated by the supply, even under full load. Automatic overload protection, which is achieved by fast transition from constant current to constant voltage, may be set at any point in the current or voltage ranges. Additional short-circuit protection is provided by the isolated design of the heavy-duty transformers.

The Model 1332A is a useful instrument in industry, the laboratory, and technical schools and universities. Among the power supply's applications are product development, testing, circuit design, quality control, servicing, and education.

The Model 1332A Single Output Power Supply costs $360. Contact

Global Specialties, 70 Fulton Terrace, New Haven, CT 06512; Tel. 800-572-1028 or 203-466-6103; Fax: 203-468-0060; Web:*http://www.global specialities.com*.

CIRCLE 87 ON FREE INFORMATION CARD

DX LISTENING

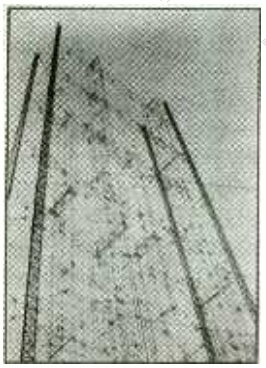
Get Organized!

DON JENSEN

Next year I'm going to get organized!

That's a resolution I'll bet we've all made. But now that the new year is here, it is the perfect time to make good on that vow, especially when it comes to your shortwave listening activities. Now you don't *have* to have a plan to listen to SW stations around the world, but a little organization makes it a whole lot easier and more efficient. So let me suggest a couple of ideas to help you get organized.

The first is a Log Book. This is a permanent record of your listening activities. It may be a simple coil-bound or loose-leaf notebook, or it might be a computer file. In it, in chronological order, you should list your loggings as you make them. Minimally you should have columns for date, time, frequency and the name of the station. It is also helpful to note the conditions of reception, signal strength, possible interference, and the identity of the interfering station, if known. You can enter more extensive details about your receptions, including something about the programming heard, and possibly an address to send verification reports. The amount of log book details you want to keep is your decision.



Curtain antenna with eight parallel-fed dipoles, 20M for special event.

This commemorative QSL from station HCJB was issued to celebrate 60 years of SW broadcasting.

The longer you keep entering your reception information in the log, the more it can help you recognize reception patterns, and from those, you can plan your future listening sessions. You may find, as I have over the years, that the few weeks from Christmas to mid-January seem an especially good time to tune for the regional SW stations from India and Pakistan on the shortwave bands below 5,000 kHz. Studying my logs of past receptions has shown me that early Spring and early Fall, the vernal and autumnal equinox periods, tend to favor reception of low-power Indonesian SW stations.

Do you know when the West African signals begin fading in during January? How early in the morning should you arise to catch the Andean stations of South America signing on? The more recorded data you have from your own past receptions, the better you can use that information to predict favorable times and frequencies to tune for other stations in the same general areas of the world. And, besides that, it's a lot of fun to browse the log book, rekindling memories of some of those exciting SW catches from past months and years.

Besides a log book, the well-organized SWL also has a Want List. While a log book is a record of stations you've already heard, a want list is a collection of information and tips from others to help you tune in some of the stations you've not yet logged.

A good place to begin is with *DX Listening*'s monthly "Down the Dial" section in which I list what, when, and where other listeners are hearing SW stations. Maybe you get your listening tips from the bulletin of a listeners' club such as the North American Shortwave Association or England's World DX Club. Maybe you exchange information with SWL penpals. Perhaps you tap into some of the shortwave listening Web sites and newsgroups.

Wherever you get your tuning tips, you'll do better if you organize it into a "most wanted" list of targets. Again, the want list should include the frequencies and times to look for these target stations, and the language used at those times. Is reception more likely after an interfering station on an adjacent frequency signs off, or before they sign on? A want list should probably include about ten stations you really want to log, focusing your attention and all your available information on these key stations. As you manage to hear these stations, you mark them off your want list—replacing them with other new desired target stations.

A log book and station want list will bring some needed organization to your shortwave listening efforts.

MONGOLIAN PROFILE

The Voice of Mongolia is the only overseas broadcasting service in this Asian nation, notes Michael Beesley, writing in *CONTACT*, the monthly bul-

(CREDITS: Brian Alexander, PA; Jerry Berg, MA; William McGuire, MD; Jim Moats, OH; Mark Mohrmann, NY; Stephen Pitts, MN; Ed Rausch, NJ; Bob Raymond, NH; Chuck Rippel, VA; Errol Urbelis, NY; North American SW Association, 45 Wildflower Road, Levittown, PA 19057; World DX Club (England), c/o Richard D'Angelo, 2216 Burkey Drive, Wyomissing, PA 19610).

GLOSSARY

BBC—British Broadcasting Corporation
DS—domestic services: broadcasting intended primarily for audiences in the home country
DX—listening to distant radio stations
ES—external services: broadcasting intended primarily for audiences abroad
Green Stamp—generally a U.S. one dollar bill: term used commonly in association with return postage for QSL card
IRC—International Reply Coupon, sold by U.S. Postal Service as return postage
KW—kilowatt (1000 watts)
LSB—lower sideband
QSL—verification cards confirming a listener's receptions
R—radio
RTTY—radioteletype
SW, SWL—shortwave, shortwave listener
USB—upper sideband
UTC—Coordinated Universal Time, formerly known as Greenwich Mean Time (GMT) or Zulu time (Z), equivalent to Eastern Standard Time plus 5 hours; CST+ 6 hours; MST+7 hours or PST+ 8 hours
v.—generally used in association with a frequency to indicate that the listed frequency is one that is unstable or drifting because of a transmitter mal-function or to avoid jamming
VOA—Voice of America

letin of the World DX Club. The government station began shortwave broadcasting more than 30 years ago in September 1964. The first program consisted of one-half hour transmission in the Mongolian and Chinese languages and was beamed to neighboring China. Today the SW station's daily schedule has grown to eight hours in those two languages, plus Japanese, Russian and English. The half-hour English program, repeated daily three times a day, began on January 29, 1965.

The Voice of Mongolia broadcasts from Khonkhor, a transmitting site about 25 kilometers east of Ulaanbaatar, the country's capital. The facility includes Soviet-made 100-, 250- and 500- kilowatt shortwave transmitters. The curtain array antenna system is vintage, dating back to the 1960s, but still seems to perform efficiently.

The current schedule, reported by the British Broadcasting Corporation's Monitoring Service, shows the English half-hour broadcast on 15,170 kHz from 0900 to 0930 UTC; on 12,085 kHz from 1230 to 1300 UTC (perhaps the best time to hear the station in North America); and 1500 to 1530 UTC on 9,720 and 12,085 kHz.

Reception reports may be sent to the Voice of Mongolia, External Service, Radio Ulaanbaatar, C.P.O. 365, Ulaanbaatar, Mongolia. Send your reports to the Mail Editor for the English program, Batbayar, who, following Mongolian custom, uses only a single name. If you would like a QSL card, I suggest including two IRCs or at least $1 U.S. for return postage.

CHANGES FOR HCJB

For decades, the "Voice of the Andes," HCJB, the pioneer and widely-heard religious SW station in Quito, Ecuador, has broadcast from Pifo, a transmitter site east of the capital of Quito. Here HCJB has 11 transmitters and 32 antenna systems and towers.

The station, however, has announced that it will relocate its transmitting operations, closing down the 110-acre Pifo site, which is considered too close to a new airport to be built by the Ecuadorian government. The move is expected to take up to four years, and details are not yet fixed. While HCJB likely will continue to broadcast on shortwave from Ecuador, look for the station to do what so many other international broadcasters have done—lease airtime for some of its programs on shortwave transmitters elsewhere in the world closer to its targeted audiences.

DOWN THE DIAL

Here are some shortwave targets to look for. Maybe you'll want to add some of them to your new "want list."

AUSTRIA—9,655 kHz, Radio Austria International, Vienna, is reported on this frequency with good signals during an English language program at 0030 UTC.

BRAZIL—3,365 kHz, Radio Cultura was logged on this frequency around 0230 UTC with Portuguese announcements and an eclectic mix of old songs, from "Guantanamera" to "Baby Elephant Walk." 4,756 KHz, Radio Rural was found here at 0150 UTC with Portuguese play-by-play of a Brazilian "futbol" or soccer game, station identification and jingles.

GERMANY—5,910 kHz, Lithuania's Radio Vilnius shortwave service is relayed by German transmitters. Look for it in English around 0050 UTC, with news, a mailbag program, and Lithuanian music.

GREECE—7,480 kHz, Voice of Greece signs on at 2056 UTC with tuning signal, multilingual identifications, then a talk in Greek, and Greek music. If you don't find it here, try the station's parallel frequency at 9,425 kHz.

ITALY—6,010 kHz, RAI, Rome has been logged here at 0050 UTC, with identification in English and political and economic news.

MALAWI—3,380 kHz, Malawi Broadcasting Corp., was heard during the 0330-0400 UTC period with African highlife music, some pops, and English language programming, including a pet shop advertisement and station identification.

PAPUA NEW GUINEA—3,205 kHz, Radio Sandaun is noted around 1030 UTC with "island" music and announcements in the Pidgin language.

SAO TOME—4,960 kHz, Voice of America programming, relayed from this island off the west coast of Africa, has been logged. Programs in the Hausa language, intended for Nigeria, were heard until 0530 UTC sign off.

SOUTH KOREA—6,480 kHz, Radio Korea International, Seoul, has English programming at 2100 UTC, including news, commentary and a feature, "Seoul Calling." You may find some interference from an adjacent radioteletype transmission.

SURINAM—4,991 kHz, Radio Apintie is a very nice bit of DX which has been logged on this frequency around 0800 UTC with coral hymns, Dutch talk and popular music. The frequency is blocked by a Peruvian station signing on just before 0900 UTC.

SWEDEN—7,290 kHz, Radio Sweden is noted here in English at 0130 UTC with identification, program schedule and political news referring to Estonia.

THAILAND—9,680 kHz, Radio Thailand moved to this frequency from 9,535 kHz. It has English scheduled at 2030 UTC, with news and commentary, a gong interval signal, and identification. ■

Verticals and SWR

JOSEPH J. CARR, K4IPV

Question—If you take a bagel, slice it in half through the horizontal plane (so as to produce two "half doughnut" shapes) and then lay it on a flat table (Fig. 1A), what do you have?

Answer—A reasonable model for the elevation aspect of a vertical antenna's radiation pattern (Fig. 1B).

Vertical antennas probably provoke more heated arguments in ham radio than any other antenna topic, save possibly the topic of standing wave ratio (SWR). This month we are going to look at vertical antennas from the perspective of their ground systems and SWR (that's really "riding the tiger"—both controversial topics in one column!). Why? Because no other single aspect of the vertical antenna more profoundly affects its operation than the ground system used.

VERTICAL ANTENNAS

Vertical antennas come in several different styles. One aspect where they can differ is in the length of the radiator element. For our purpose we will use the quarter-wavelength (¼)λ vertical antenna as our model. The nature of the ground system is another place where differences occur. For example, some verticals are mounted above the earth, and utilize a set of user-installed resonant radials to form a counterpoise, or artificial "ground plane" which creates an "image" vertical antenna below ground. Other verticals are mounted on ground and use the earth as the connection to produce the necessary ground plane.

STANDING WAVE RATIO

Most of us at one time or another have a less-than-perfect understanding of standing wave ratio (SWR). The usual practice is to use a resonant antenna matched to the feedline. This produces a minimum SWR at the resonant frequency of the antenna. At frequencies away from resonance, the SWR climbs. This is believed to be bad, bad, bad—but that's sometimes a myth. The "ideal" antenna is said to be one that has a low SWR (for example an SWR <1.5:1) over a wide frequency range (where 1.0:1 is a "perfect" match).

Here's a paradox—with vertical antennas it is often true that a very low (or "lower than expected," the way one textbook reads) SWR on a quarter-wavelength vertical antenna could indicate a very *inefficient* antenna. In such a situation the SWR might be low all across the band and it would *appear* to be a very good, wideband antenna. Now I'm really going to shock you. When we finally get the antenna *working properly*, the efficiency of the antenna (as measured by actual radiated power) can increase as much as 3 to 6 dB. Contrary to normal wisdom, however, the SWR will also *rise* considerably.

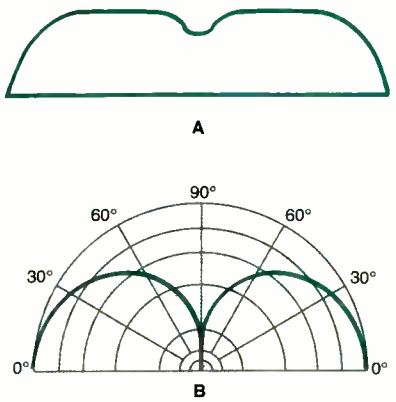


Fig. 1. The cross section of a bagel sliced horizontally in half (A) can represent the ideal elevation pattern for a quarter-wave vertical antenna over perfect ground (B).

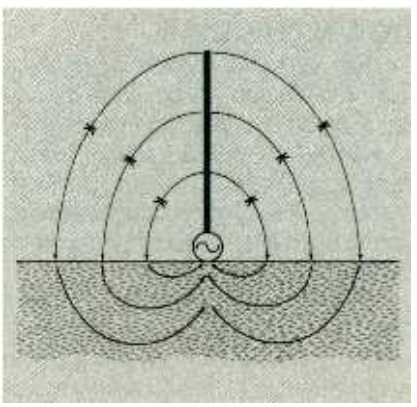


Fig. 2. Electric field lines as source of ground currents (side or elevation view).

So what's the problem? You spent a lot of time trying to make that SWR low, low, low. And now some clown in a magazine comes along and tells you that the low SWR might not be good? Why?

The reason is that the earth ground can be lossy. Part of your RF power is used to heat the ground, and that power is subtracted from the power available for radiation. To understand how this works, consider Fig. 2. The vertical radiator is connected to one side of a signal source, or transmitter, and the ground is connected to the other side of the source.

On one half of each RF cycle the currents flow to ground through the electrical field lines established by the radiator-to-ground capacitance. These field lines extend out from the vertical to about 0.4λ (actually, they go out further, but beyond the 0.4λ point their contribution is negligible). Those coupled currents return to the generator through the earth. If the composition of the soil is sand, then you lose a lot of power in ground resistance, but if it is a salt marsh, a reasonably good conductor of RF, you fare a lot better. Most sites range somewhere in between these extremes. The capacitive coupling that gives rise to these ground currents is distributed all around the vertical antenna. These currents in turn produce the ideal circular (omnidirectional) pattern in the horizontal or azimuth plane.

Some vertical antennas use a single ground rod driven into the soil, or the antenna's mounting pipe, or a cold water pipe as the ground return. Unfortunately, those methods are probably the least useful because they keep the ground resistance quite high. Better-designed verticals use a system of radials to form a low-resistance ground. The radials are wires connected to the ground side of the RF signal source (which in practical terms means the shield side of the coaxial cable). If the radials are mounted above ground, then they must be resonant (quarter-wavelength radials are

typically specified). But if the radials are in contact with the ground or buried (which is safer from the point of view of pedestrians), then they do not need to be resonant. Currents coming to the end of the buried radial just keep on flowing out into the soil. There is no reflection back towards the source as in radials on above-ground mounted verticals. Buried radials can be as long as 0.4λ (which is the point of diminishing returns). Because the radials form a low resistance return path for ground currents, the longer they are the better they work out to about 0.4λ.

HOW MANY RADIALS?

The simple answer is "the more there is, the better it works." But that's not a practical answer. One or two radials is clearly a losing proposition because you will have most of the ground currents flowing through soil instead of copper. Most amateurs use four radials (Fig. 3), but that number is barely sufficient. AM broadcasting stations use 120 radials, but for amateurs that is totally excessive. Most of us couldn't afford 120 radials—never mind the time and effort to put them in.

The optimum number of radials for amateur installations seems to be about 16 radials (Fig. 4). Various amateur sources recommend 12 to 16 radials. More is better, but there is a point of diminishing returns beyond which the ground resistance drops less and less for each additional radial.

TRANSMISSION LINE LOSS

Which type of transmission line has the lowest loss figures and why: RG-58 coaxial cable, RG-8 coaxial cable, 450-ohm twin-lead, or parallel open feeders?

The answer is that parallel open feeders have the lowest loss figures. There are two reasons. First, the usual characteristic impedance of parallel open feeders is 500 to 1000 ohms, depending on conductor size and their center-to-center spacing. The other forms of transmission line have lower characteristic impedance. As a result, for any given power level, the current is higher in those transmission lines, so ohmic losses (I^2R) are higher.

Second, the other forms of transmission line (coaxial cable and twin-lead) have dielectric material in the space between the conductors, while parallel open feeders use air dielectric. The plastic-like dielectrics used in coaxial cable and twin-lead are inherently lossier than air dielectrics.

One interesting thing about SWR is that the losses to your signal level from high SWR are only really significant when the transmission line is lossy. Using a low-loss transmission line reduces the mismatch loss to a tiny amount. The result is that we usually pay far too much attention to reducing the SWR to the lowest possible value. If it ain't 1:1, then we're not happy! At least this is the case in the high frequency shortwave bands and low VHF bands. As frequency goes up, however, the importance of transmission line losses becomes a lot more significant because the losses rise substantially in the UHF region. That's why television antennas switched to "UHF" cable when the UHF bands began to open up big-time in the 1960s.

One reason to worry about SWR in the HF bands, however, is that modern solid-state transmitters won't work properly into a high SWR. They typically have an automatic load control (ALC) circuit, or something similar, that reduces output power when the SWR goes above about 1.5:1. By the time you get to 2.5:1 or 3:1, the RF output power of the transmitter drops to nothing. This design tactic arose when the solid-state final amplifiers came into being. They were a lot less forgiving of mismatch than the vacuum tube transmitters that were previously popular. But more on this in a future column. I can be reached by snail mail at P. O. Box 1099, Falls Church, VA, 22041, or by e-mail at carrjj@aol.com. ■

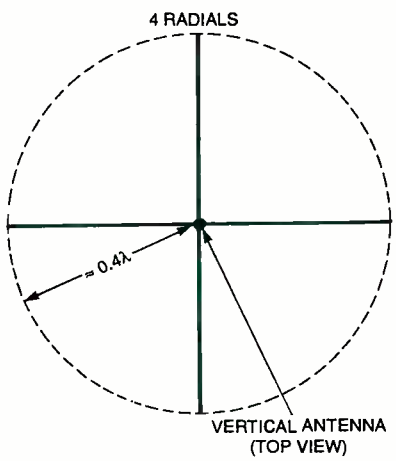


Fig. 3. Four-radial system.

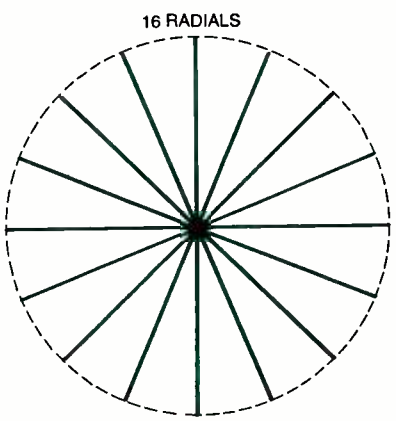


Fig 4. Sixteen-radial system.

SCANNER SCENE

(continued from page 50)

tors. VHF marine radios would be able to receive calls by means of selective calling tones that would sound a priority alert, and skippers would no longer need to personally monitor the channel or check in for their traffic.

Perhaps the most startling change is that the VHF coastal stations would, on a secondary basis, now be permitted to serve units on land. That is to say, owners of handheld transceivers at boat yards and marinas—and even of mobile radios installed in trucks and cars—would be permitted to place and receive phone calls through marine operators. Monitoring the VHF marine operator channels would sound all the more like cellular conversations.

For the record, those frequencies are: 161.80, 161.825, 161.85, 161.875, 161.90, 161.925, 161.95, 161.975, and 162.00 MHz. In a few limited areas (such as Puget Sound, the St. Lawrence Seaway, and some of the Great Lakes), 162.025 MHz is also used. At least one frequency should be active within range of every inland waterway, navigable river, commercial harbor, and large lake. In busy areas, several frequencies may be in use.

We have always found these channels to be quite interesting. If the changes go through (and I think they will), watch for activity to dramatically increase. If you have comments and thoughts on this, e-mail me at: sigintt@aol.com. Let's also hear from you with additional thoughts, plus loggings, new frequencies, and whatever. Our address is: Scanner Scene, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

ANTIQUE RADIO

Some Interesting New Books

MARC ELLIS

This column comes due just as I'm preparing to leave for the big Antique Wireless Association meet in Rochester, NY. Of course, it's too late for me to talk you into attending; the early-September event will be ancient history by the time you read these words. However, I haven't missed this four-day extravaganza of fine flea marketing, outstanding programs, and general antique radio camaraderie for the past several years.

I don't know the dates for the 1998 meet, but one way to find out in plenty of time is to join the Antique Wireless Association. It will set you back only $15 to hook up with this fine organization for a year ($27 for two years). You'll then receive the club's most excellent quarterly publication, *The Old-Timer's Bulletin*, of which I am privileged to be Editor. In the OTB, you'll find complete information on all AWA meets (and those of other clubs). The OTB is also chock-full of fascinating articles on radio history and vintage radio hardware. To join, send your check to Joyce Peckham, Secretary AWA, Box E, Breesport, NY 14816.

What with packing and readying the car for the 10-hour drive to Rochester, I've had to put aside my soldering iron once more and postpone the next installment of the Neutrodyne restoration. However, this does give me a chance to talk about some interesting new books that have arrived on the scene and to acknowledge some of the mail.

CRYSTAL SET PROJECTS

Edited by Rebecca Hewes.
Published by The Crystal Set Society, P. O. Box 3026, St. Louis, MO 63130; Soft-cover; 6 × 9-inches; 160 pages; $14.95 plus $2.50 S&H.

Produced by the publishers of *The Crystal Set Society Newsletter*, this engaging book presents 15 projects for your home workshop. The projects were originally entries in a contest set up to encourage the development of novel and practical crystal set circuits.

Camilo Castillo's just-restored Star Roamer poses for a shot on his workbench.

If the sets appearing in this book are any indication, the contest judges must have had quite a hard time picking the winners. Most of the crystal set projects that appear in hobbyist literature are variations of the same simple basic circuit, but that's not the case here. Though you'll find plans based on classic design practices, you'll also see modern high-tech maximum-performance entries. How about a set designed for short-wave reception—or one with a loop antenna for broadcast-band DXing—or one that fits into a small matchbox, earphone and all? You'll find them all in *Crystal Set Projects*!

Though seasoned old-timers will find plenty of fodder for their soldering irons in this book, the beginner is not neglected. A helpful introduction shows the newcomer what he/she needs to know about reading schematic diagrams and provides an introduction to crystal set theory. There's also a vendor list at the end with parts sources and publications of interest to antique radio hobbyists.

HOW TO MAKE A NEUTRODYNE

By F. F. Webb
Reprinted by Lindsay Publications, P. O. Box 538, Bradley, IL 60915; Soft-cover; 7 × 5-inches; 64 pages; $6.95 plus S&H.

Those who are into replicating classic circuits from the dawn of the radio broadcast era will be pleased to get their hands on this recent Lindsay Publications reprint. Originally published in 1924 by The Radio Library Company, *How to Make a Neutrodyne* provides the specs to build a 3- or a 5-tube Neutrodyne receiver from the ground up.

Though the sets do use commercial tube sockets, jacks, audio transformers, variable capacitors and other generic parts, the constructor is given complete details for building his own RF transformers ("Neutroformers") and neutralizing capacitors.

The book also contains hints for laying out and drilling the front panel, assembling the components, and soldering the bus-bar connections. Additional chapters discuss the advantages of the Neutrodyne, and show how to neutralize the completed receiver, do any necessary troubleshooting, hook up an antenna and ground, and operate the completed set.

This is a fine reference for those who would like to build, adjust and operate an important vintage receiver design in the most authentic manner.

1937 SYLVANIA TUBE MANUAL

Reprinted by Lindsay Publications, P. O. Box 538, Bradley, IL 60915; Soft-cover; 5-1/2 × 9-inches; 184 pages; $12.95 plus S&H.

Everyone who works with antique radios needs a vintage tube manual. To get one, the new collector has a choice of purchasing a reprint or combing the antique radio swap meets for an original. Finding an original is not a really daunting task, but if you don't have access to swap meets or want your copy right now, you'll probably purchase a reprint.

Whichever route you take, the manual's original publication date is an important consideration. The very early ones won't cover all of the tubes you might encounter. The later ones might relegate the early tubes to a "seldom used types" appendix providing minimal data—or not include them at all. Many collectors have a small collection of manuals dating from different eras.

The 1937 Sylvania manual Lindsay

chose to reproduce is a nice compromise. It was published late enough to include many of the tubes of interest to collectors, yet early enough so that the earliest tube types are given adequate attention and space. Very early tubes are placed in a special "supplementary" section, but complete data is given on each type. It's fun to browse through this manual's typographically pleasant pages undistracted by the huge variety of television tubes and other special-purpose types that would proliferate in later years.

I'd recommend this reprint as a good starter manual, but it's important to note that the classic radio period extended at least through the outbreak of World War II. Plan on purchasing a supplementary book dating from 1946 or so—later if you collect more recent sets.

FROM THE MAILBAG

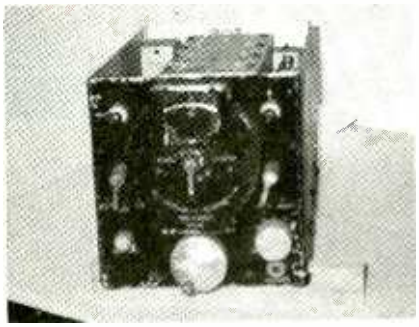
Let's use the space I have left this month to look at some of the questions and comments received in the mail.

Dave Zavracky (Ridgewood, NJ) wants to know if we have ever covered procedures for capacitor replacement in this column. Yes, Dave, the May and June, 1987 columns in **Hands-On Electronics** (predecessor to **Popular Electronics**) dealt with the replacement of electrolytic filter capacitors.

Terry Stivers (St. Louis, MO) is interested in obtaining copies of the issues containing the tube tester project ("The Cunningham Special") we tackled some years ago. This project was covered in the September, October and December 1990 issues and the January, February and May 1991 issues of **Popular Electronics**. Back issues are available from the **Popular Electronics** Reprint Bookstore—but only for the last five years, so you might fall back on your local library for copies. The same answer applies to *Eric Collins'* (Baltimore, MD) query about back issues of this column.

Mike Thomas (5524 McCoy Rd., Oxford, OH 45056) recently acquired an RCA Radiola 18 and would like information about its history and value, as well as some restoration tips. *Burton H. Werthman* (RD2 Box 177, Little Falls, NY 13365) needs a schematic and operating manual for a Simpson Model 383 In-Circuit Capacitor Leakage Tester.

Last May, we published a photo of a tube tester for which information was being sought by *Douglas D. Fox* (603



If you can identify this "mystery" military set, Camilo Castillo would like to hear from you (see text).

S. 12th Ave., St. Charles, IL 60174-3238. Unfortunately the reference to the tester and contact information for Doug were accidentally omitted from the text. The tester in question is an EMC Model 208, manufactured by Electrical Measurements Corporation, New York, NY.

Camilo Castillo (Dept. Pty. 1789, P. O. Box 02507, Miami, FL 33102-5207) sent a photo of a military receiver he'd like to know more about. No model number was given, but it covers 7.0 - 27.0 MHz in five bands. Tube complement: 6SK7 (5), 6V6 (1), ECH35 (1), 6SR7 (1). Camilo also included a photo of a Knight Kit Star Roamer he recently restored.

Tim Sayers is in the middle of restoring a Star Roamer and needs a source of electrolytic filter caps. Try Antique Electronic Supply, 6221 S. Maple Ave., Tempe, AZ 85283. And speaking of the Star Roamer, our recent restoration of this model brought *Eddy Strickland* (Warrenton, NC) fond memories of the one he built with his Dad's help in 1968.

Archie F. Boscia (Las Vegas, NV) sent us a photo of a near-mint Zenith Transoceanic (transistorized model) he was fortunate enough to pick up at a thrift store for $10.00. It covers 150 kHz to 18.4 MHz, including the FM band. It's a great photo, but since he marked it "not for publication," I can't show it to you.

Bob Blum (11 Sunnywoods Dr., Huntington, Station, NY 11746; Tel. 516-423-0255; e-mail: rfblum@worldnet.att.net) needs help with a restoration problem involving a Majestic Model 90 chassis. The plates of the 5-gang tuning capacitor are unmeshed and cannot be meshed. It appears that the material separating the stator plates has expanded somewhat, causing the stator plate separation to be a little greater than that of the rotors. The result is the stator and rotor plates don't line up properly, and the capacitor jams.

Finally, thanks to *James T. Hawes* (Skokie, IL) and *John H. Claar* (Tracey, CA) for copying me in on their excellent responses to *Bob Firchau's* query in the May, 1997 column. Bob was searching for the construction article for a one-tube (type 30) regenerative short-wave receiver he built in the mid-1930s and for suggestions on how to build a transistorized version.

The type 30 tube was developed primarily for battery-powered radios to be used in rural areas without commercial electric power. Its low-drain (.06 ampere) filament operated at two volts, so it could be powered by a single rechargeable lead-acid wet cell. However, rural electrification was gaining momentum about the time this tube was being released, and soon most farms were being served by a power line. As a result, much of the production of 30 tubes was never put to its intended use.

However, the 30 quickly became a favorite of experimenters—replacing the 01-A, which had been commonly used for small battery-powered regenerative sets. With its small current draw (compare with the 01-A's 0.25 amperes), the filament could be operated for reasonable periods of time from a couple of "D" cells instead of the four No. 6 dry cells commonly used with single-tube 01-A sets. Perhaps we should consider doing a one-tube regenerative project using the type 30 in this column someday. ■

COMPUTER BITS

Telephone Talk

JEFF HOLTZMAN

A market research firm called the other day collecting opinions about how I view my local telephone provider, including what I liked best and worst about my service. The only plus I could come up with was that it's pretty damn reliable. And don't get me wrong—that means a lot. I also like talking with the occasional installer or repair person who comes by, usually after a winter storm.

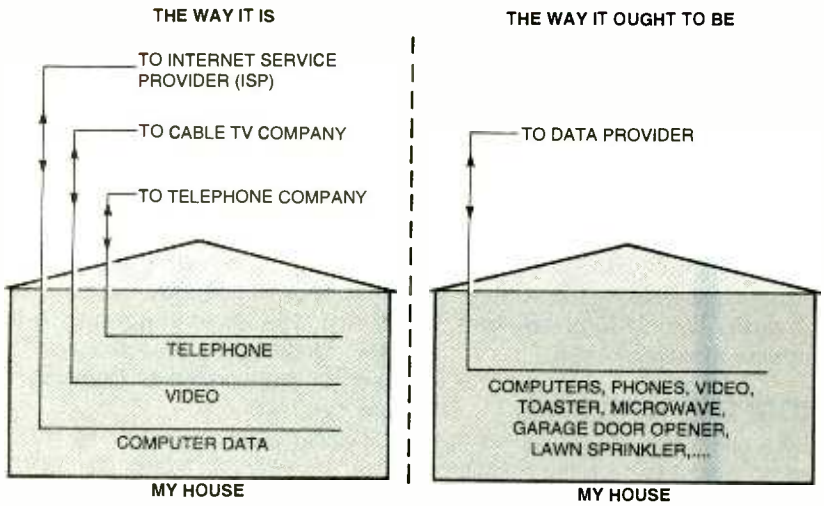
What bothered me the most was and is the incessant calls trying to get me to switch the long-distance services used at home, business, or both. What bothered me the second most was the continual advertising for the same old tired services (call waiting, call forwarding, etc.). Ironically, the phone company itself is much more annoying in this respect than the third-party providers.

TRAVELING MAN

Recently I attended a conference in an adjoining state. That state is also served by my phone company. Coincidentally enough, both states happen to coincide with the region served by my cable TV provider, MediaOne. I hardly ever watch TV at home, but stuck in a hotel room, I had nothing better to do. So I flipped on the set and was immediately overwhelmed by an ad for said cable company, which is in the beginning stages of offering what it calls "broadband" services in several of its geographically-dispersed regions.

Apparently, MediaOne has been buying up local cable TV providers and linking them. Now it is beginning to supply basic Internet connectivity to homes, schools, and businesses. Following that will come in-depth Internet support, for example, Website hosting. By the time you read this, they will have started trials of telephone service, with deployment scheduled for 1998. I find this extremely exciting.

If this is real, and if the company can maintain quality and performance, I think it's going to be extremely compelling for lots of people. Of course, that is a lot of *ifs*.



Most data is transmitted in packets of digital bits, even if it starts out analog. Do we really need multiple wiring systems and communications protocols?

THE INFRASTRUCTURE

The company has taken an interesting means of delivering bits—a hybrid network infrastructure that allows me to continue to use my existing in-house coax for video, data twisted pair for my computer network, and twisted pair for the telephone. From my house to the central office, there is (presumably) copper, although there may be intermediate concentrators converting copper wire to fiber-optics and aggregating channels. Beyond the central office, it's presumably all super-high bandwidth fiber-optic cable.

The only on-premises installation required is a broadband cable modem, which separates out the video, telephone, and data signals. On the computer, if you don't have a NIC (network interface card), TCP/IP stack, or web browser, the company can install them for you. The video portion is available immediately; data is available in some locations, and telephone is coming.

What does all that technology buy you, and what does it cost? For $39.95 per month you get a 1.5 -Mbps downlink and a 300kbps uplink. You get more downlink capacity because most people download more than they upload.

One major ease-of-use factor is that once things are installed properly, there is no on-going "connect hump" to overcome. With an analog modem you have to run a dialer, wait while it dials, wait while it connects, and finally run your browser. With the "broadband" system, by contrast, you boot your PC and you're connected, just like running on a corporate network.

CAVEATS

For forty bucks a month, subscribing is a no-brainer for most individual users. For business users, however, not all the pieces are in place yet. For example, without Web site hosting, I would still have to use my good old 28.8K analog ISP. Paying $40 a month extra just for faster browsing is not worth it.

Another problem is networking. Will all the computers on my network automatically get access? Or does one PC have to function as a gateway (a proverbial "bottleneck") through which the others obtain access? What kinds of charges will be involved? How will the system handle multiple mail accounts? What will that cost? It would be nice to get broadband connection

(Continued on page 74)

Think Tank

Craig Takes the Day

JOHN J. YACONO
TECHNICAL EDITOR
COMPUTER RESELLER NEWS, IEEE

Once again, Craig Kendrick Sellen of Waymart, PA has sent in enough circuits to fill a column, so he'll receive a kit and an MC1010L chip, in addition to the book awarded for single submissions. We've got only one kit left, so if you want to nab it, send in a bunch of circuits soon.

Most XX7 adjustable regulators can be divided into two main groups—positive regulators (denoted X17) and negative regulators (denoted X37). The first digit in the part number (either 1, 2, or 3) indicates the grade or quality class of the component. If a regulator's first digit is 1, it falls into the military class, which means it's extremely voltage and temperature stable. If the first digit is 2, it falls into the industrial class and is stable enough for industrial use. Hobbyists will find regulators beginning with a 3 (the commercial class) more than adequate for most projects. So, the numbering scheme allows for three positive regulators (the 117, 217, and 317) and three negative regulators (the 137, 237, and 337).

All of them are generally capable of output from around 1.25 to 37 volts and a power dissipation of about 15 watts (with proper heatsink). Their output voltage is determined or "programmed" by the values of two external resistors. They also have a short-circuit shutdown feature—short the regulator's output and current limiting turns the regulator off, automatically turning on again once the short is removed. If internal power dissipation becomes too high for the heatsinking provided, a thermal shutdown circuit takes over, preventing the IC from overheating. Pretty neat, huh? Next month I'll delve into how to use them. Now, let's look at Craig's circuits.

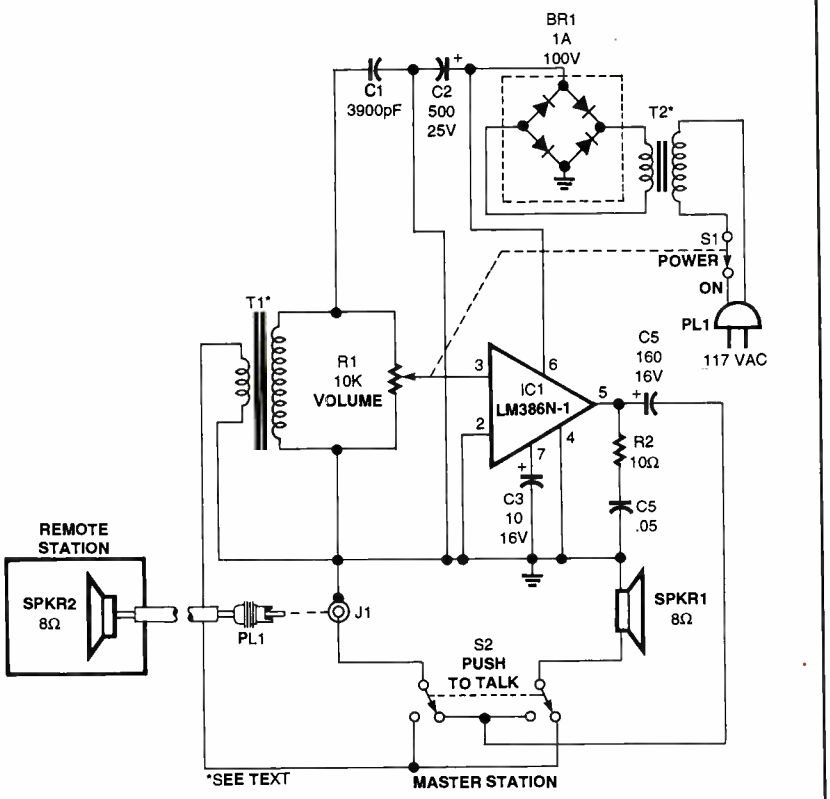


Fig. 1. This simple intercom system can be used in a number of household functions when you want to monitor, or converse with, another location.

Last month we discussed constant voltage regulators, and I promised we would examine adjustable or programmable units this month. A positive-voltage adjustable regulator can perform the same tasks as a 5-volt, 12-volt, 15-volt, or any common fixed-voltage regulator, or be configured to cover any voltage in its range. The most popular variety for hobbyists is the XX7 series. They are very versatile, inexpensive and commonly available. Furthermore, as regulators go, they provide excellent ripple rejection.

INTERCOM

One handy gadget to add to your collection is an intercom. With mine (shown in Fig. 1), the master station always monitors the remote station. Just two wires are needed to connect the remote to the master station. It can be used as an electronic baby sitter, camper-to-cab communicator, or doorbell monitor.

The master station consists of an audio transformer T1, gain control R1, and an amplifier subassembly using the popular LM386N-1 low-voltage power amplifier IC (equivalent part is the Thomson SK9210). The power source can be anything from 9 to 15 volts, at about 5-mA idling current. In my model, a transformer and bridge rectifier was used, but a battery can be used instead.

Though the project is simplicity itself, one note of caution—do not eliminate transformer T1. The remote speaker can drive the master amplifier without T1, but direct output from a speaker sounds very bassy and muffled. The transformer corrects the frequency response—any standard audio transformer with a 1000-ohm to 8-ohm impedance match (such as Radio-Shack 273-1380). The power transformer, T2, is a miniature-type, with a 12.6-volt, 300-mA secondary (Radio-Shack 273-1385), while S1 is a DPDT momentary push-to-talk switch. A rocker-type switch was selected for convenience.

The master station is housed in a 5 × 3 × 7-inch wood cabinet. The amplifier was built on a 1¾ × 3-inch piece of perfboard. Push-in terminals are used for all tie points. Do not eliminate capacitor C1; the amplifier might break into oscillation without it—and observe proper polarity for C2, C3, and C4.

Craig, that circuit is useful and pretty easy to build. I'd use shielded cable to avoid AC hum for the long run to SPKR2.

A WIRELESS FM MICROPHONE

The wireless microphone shown in Fig. 2 can transmit on any clear spot in the 88– to 108-MHz commercial FM band, and has a range between 50 to 150 feet depending on the type and location of the receiver's antenna. The unit has high speech quality and low current drain. A conventional 9-volt transistor radio battery provides the power. The antenna length has been limited to keep radiation within the FCC regulations for wireless microphones.

Any type of neat construction can be used to build the wireless microphone, but if you want to duplicate the prototype, use perfboard. The coil, L1, is made of 4 turns of no. 18 solid wire on a ¼-inch diameter, 1-inch long form, tapped at the second turn from ground. The wire should be enamel-covered solid copper ("magnet" wire). Tuning capacitor C9 is soldered directly to the top side of the first and last coil turns, and physically arranged so it can be adjusted through a small hole drilled in the project enclosure. The antenna is made from a 2½-inch long piece of 3/16-inch diameter brass rod that has one end threaded. Mount it on one end of the project case with a soldering lug between the mounting screw and the plastic case. The lug serves as the antenna connector. Mount miniature potentiometer R5 and power switch S1 at the other end of the plastic case.

To use the wireless microphone, tune an FM receiver to a quiet spot on the dial and, if possible, turn off the receiver's AFC to prevent it from tuning automatically to a strong adjacent station. Turn on the power switch and speak into the speaker/microphone, while adjusting capacitor C9 through the hole in the box, until your voice is heard through the FM radio. Adjust potentiometer R5 for the desired modulation level. If commercial stations in that frequency range are not too closely spaced, the AFC of the receiver can be used to hold the radio to the frequency of the wireless microphone. Fixed resistor R4 should be selected for best transmitted gain and modulation—try standard values between 100k-ohm to 500k-ohm.

FM mics are always fun projects. A novel approach by Craig was to use an old transistor speaker as the microphone. One tip to make the coils easier to build—use a chemical stripping agent (like "Strip-X") to take the insulation off the magnet wire. Craig used the same audio transformer (RadioShack 273-1380) in this project. The 741 op-amp is available from a number of sources (RadioShack 276-007, NTE941M or SK3552). The 1N4817 varactor diode cross-references to SK5010 or NTE125, while the 2N3904 can be obtained as a SK3854 or NTE123AP device.

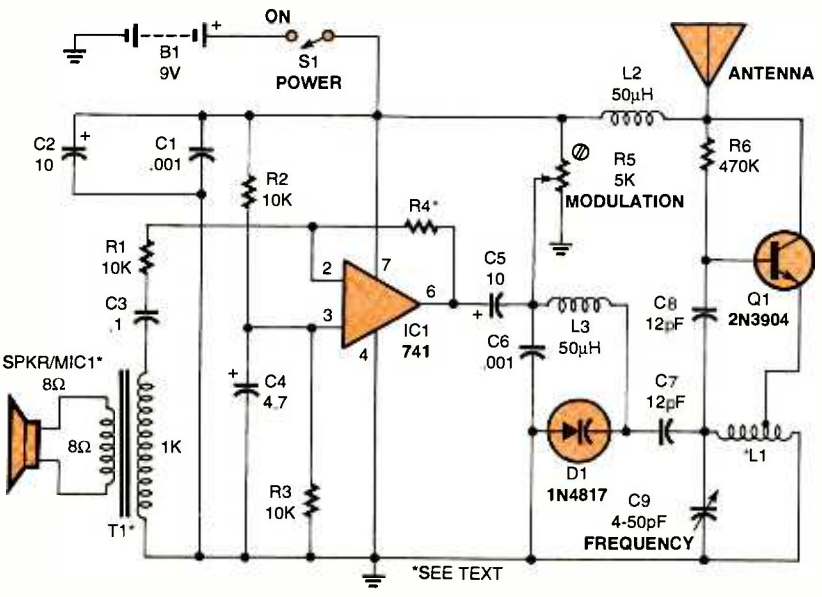


Fig. 2. Have fun with your friends and family. This wireless microphone will project your voice into any FM receiver up to 150 feet.

CLAP-TWICE SOUND SWITCH

The clap-twice sound switch (see Fig. 3) will turn power on and off, control lights as well as just about any other electronic device—by a simple sound command. For example, my unit is wired to control 117 VAC. Depending on how the contacts of relays RLY1 and RLY2 are used, they can switch power from one appliance to another, such as turning off the hi-fi and turning on the TV, or one relay alone can be used to control a speaker or low-voltage circuit. Whichever way you connect the relays, operation is still controlled by *two* hand claps or finger snaps, whistles or taps *within a one-second time interval.* A single clap or sound such as that of a dropped book or ash tray will not trip the switch, nor will two sounds spaced more than one second apart. Also speech or music sounds normally will not affect the switch operation.

The unique operation of this circuit is derived from the pair of monostable one-shots contained within the 556 dual timer, IC2. The signal is picked up by MIC1 and amplified by one-half of the quad op-amp, LM324, IC1-a and IC1-b. Small value coupling capacitors, C1 and C2, attenuates the low frequencies predominant in speech and music, or heavy footsteps. Maximum gain is given to high frequencies produced by impulse sounds like claps. The amplifier output is then applied to a voltage-doubler made up of diodes D1, D2 and C3. Any standard diodes can be used for D1-D4 in this circuit. Although the 1N914 was selected, 1N34, 1N60 or 1N270 diodes could have also been used.

Normally pin 5 of op-amp IC2-a is low. When a clap sound is amplified, a negative-going spike produced by D2 appears on pin 6 of IC2-a. Ignoring IC3 for the moment, that spike in turn

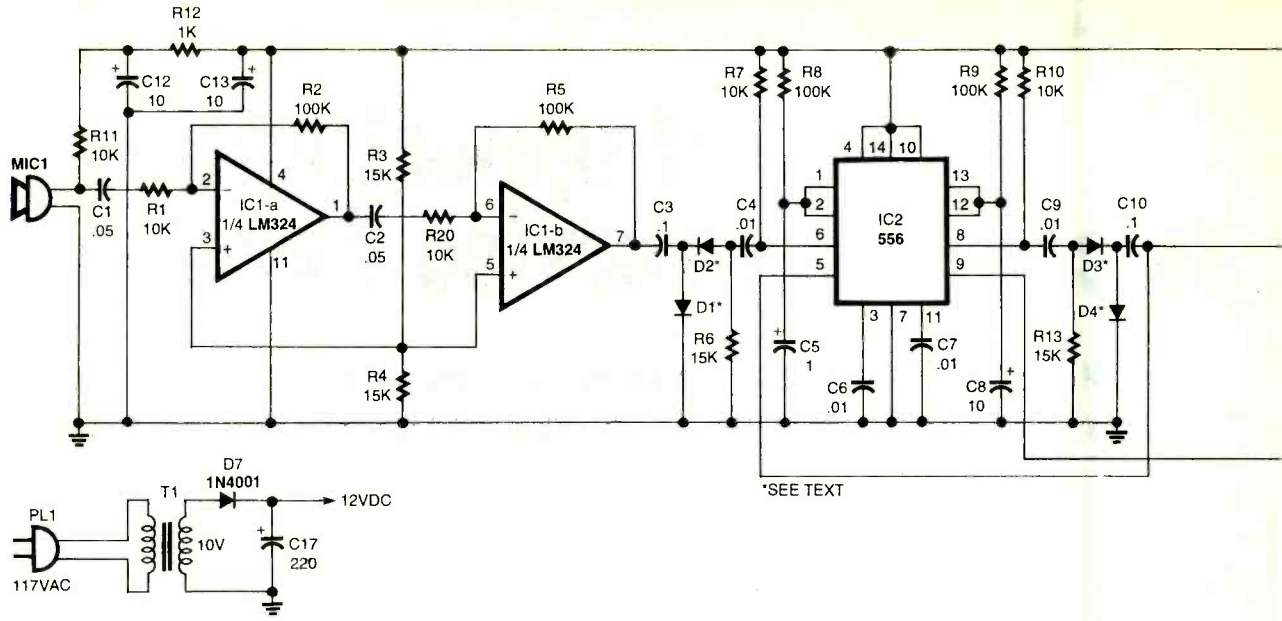


Fig. 3. Here's another amazing circuit. The two output relays can control a number of electronic devices. Just a clap of your hands twice, or almost any other quick double sound within a one second interval will activate operation.

causes pin 5, a monostable output, to go high for 0.1 seconds. The falling edge of the monostable pulse triggers IC2-b into operation by way of diodes D3, D4 and C10 at pin 8. That causes pin 9 to go high for a period of one second. For the other half of the LM324 quad op-amp, gates at IC1-c and IC1-d form a triggered flip-flop that will flip only when the inputs of IC3-b are both at logic high. Gates IC1-c and IC1-d will not flip until another hand clap sounds at the flip-flop to turn off the item you wish to control.

Nice work, Craig. The flip-flop portion of IC1-c and IC1-d and the 74C08 IC AND-gate section could probably be simplified with different logic gates.

PARTS LIST FOR THE CLAP-TWICE SOUND SWITCH (Fig. 3)

SEMICONDUCTORS

IC1–LM324 low power quad op-amp, integrated circuit (SK3643, NTE987, or equivalent)
IC2–556 dual oscillator/timer, integrated circuit (SK3689, NTE970, or equivalent)
IC3–74C08 CMOS quad 2-input positive AND gate, integrated circuit (NTE74C08, or equivalent)
Q1, Q2–2N2222 general-purpose NPN transistor (SK3444, NTE123A, or equivalent)
D1-D4–1N914 signal diode, or equivalent
D5-D7–1N4001, 1-amp, 50-PIV rectifier diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1, R7, R10, R11, R20–10,000-ohm
R2, R5, R8, R9, R14, R15–100,000-ohm
R3, R4, R6, R13–15,000-ohm
R12–1000-ohm
R16, R17–1-megohm
R18, R19–4700-ohm

CAPACITORS

C1, C2–0.05-μF, ceramic disc
C3, C10, C11–0.1-μF, ceramic disc
C4, C6, C7, C9–0.01-μF, ceramic disc
C5–1-μF, 50 WVDC, electrolytic
C8, C12, C13–10-μF, 50 WVDC, electrolytic
C14, C15–0.001-μF, ceramic disc
C16–100-μF, 25 WVDC, electrolytic
C17–220-μF, 16 WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

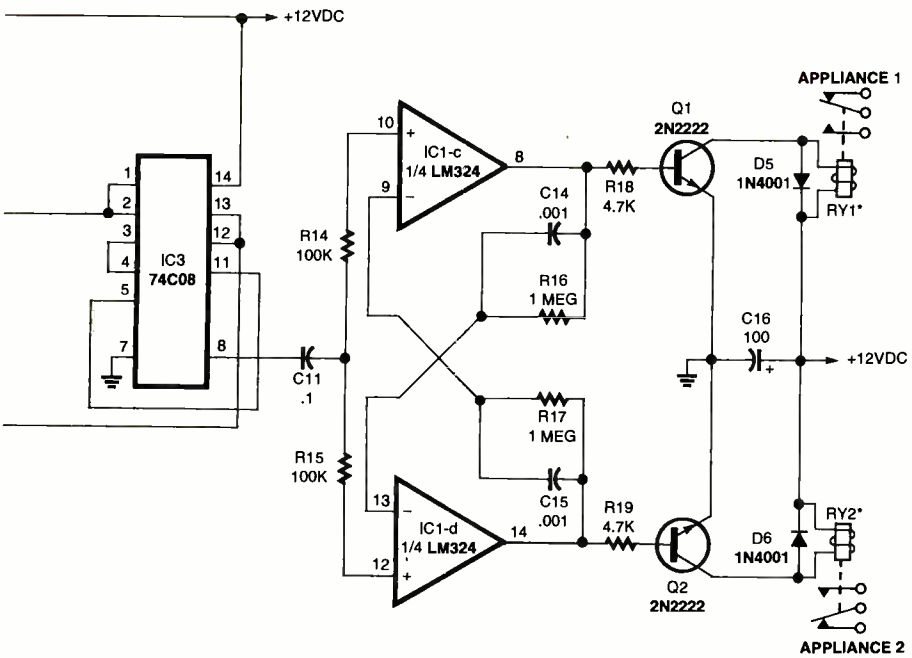
RY1, RY2–SPDT relay, ratings must satisfy appliance being switched
T1–power transformer, 117 VAC to 10 VAC, 200-mA minimum (RadioShack 273-1385, or equivalent)

ELECTRONIC KEYER

The keyer shown in Fig. 4 was designed using inexpensive components and can be built in one evening. It is a relatively simple, straightforward circuit requiring no tricky adjustments. In fact, a simple meter is all that is required for the initial adjustment. Once the ratio and the weight controls have been set up, the only control that needs to be varied during normal operation is the SPEED control, which is adjusted to suit the operator. The speed is adjustable from 8 to 40 words per minute. A built-in monitor provides a clear side-tone to a speaker so the operator can hear precisely what is sent out with the station receiver muted during the transmission.

The master timer for the keyer is a sawtooth generator consisting of transistors Q1 and Q2. The leads to the key jack for the dots and dashes have been labeled on the diagram. When either of these leads are grounded through the key, dots, or dashes are formed. When the key is in the open position, Q1 conducts but Q2 is biased off because of the conduction state of Q1.

When the key is closed, in either the dot or dash position, Q2 conducts slightly, and C2 begins to charge. As C2 charges, the voltage change is coupled from the emitter of Q2 to the emitter of Q1 through feedback capacitor C1. The voltage change is ampli-



fied by Q1 and then applied directly to the base of Q2, further increasing its conduction. The net result is that C2 charges even more. The whole charging cycle takes place quite rapidly. When the charge across C2 reaches that of the 15-volt supply voltage, Q1 drops to its original conduction point because a voltage change is no longer coupled through C1. When this happens, Q2 ceases to conduct. The base-emitter circuit of Q2 is now reverse biased by the charge on C2 and then C2 discharges through R6 and R7. When the charge drops sufficiently, the entire cycle repeats.

The waveshape across C2 is a sawtooth with a very fast rise time at the leading edge and a long or slow decay time following. As long as the key contacts are closed in either position, the master timer will oscillate. In the dash position, C2 charges to nearly the full supply voltage. In the dot position, it does not charge to the full supply voltage, due to the resistance of R9 in the dot lead. In fact, when RATIO control R9 is set properly, the charge on C2 is equal to one half of the supply voltage. Since the rate of discharge is the same in either the dot or dash positions, the frequency of oscillation in the dot position will be twice as fast as that in the dash position—RATIO control R9 varies the speed of the dots with relation to the speed of the dashes. The SPEED control potentiometer, R6, varies the discharge time of C2, and ensures that the speed of the dots and dashes are varied by the same amount. A separate side-tone oscillator, derived from IC2, is furnished with several user adjustments—PITCH control, which is varied by potentiometer R18, and TONE control, which is adjusted by potentiometer R16, sets the audio qualities of the keyer monitoring at SPKR1. The volume of this side tone is controlled by potentiometer R15, which is

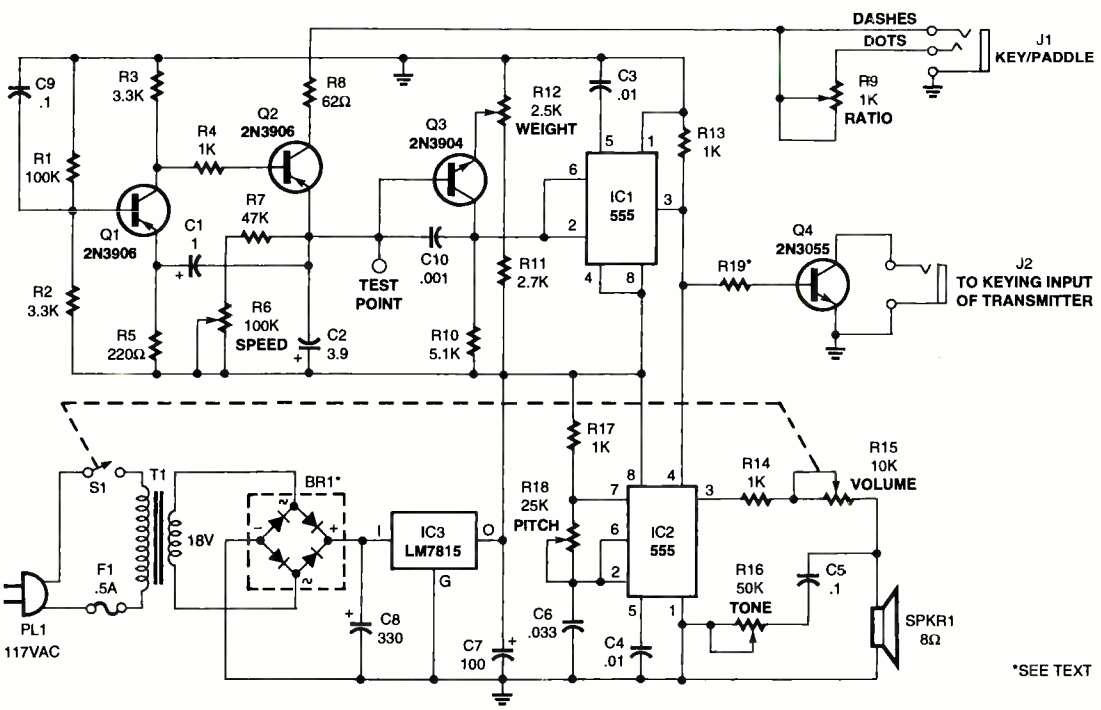


Fig. 4. Who said CW is dead? Dust off your key or paddle and start practicing Morse code again. This versatile electronic keyer provides adjustable speed from 8 to 40 words per minute plus a host of other controls to accommodate your CW fist. A built-in monitor provides a clear side-tone to a speaker.

PARTS LIST FOR THE ELECTRONIC KEYER (Fig. 4)

SEMICONDUCTORS

IC1, IC2–555 oscillator/timer, integrated circuit, (SK3564, NTE9555M, or equivalent)
IC3–LM7815, 15-volt, 1-amp fixed voltage regulator, integrated circuit, (SK3593, NTE968 or equivalent)
Q1, Q2–2N3906 general-purpose PNP transistor (SK3466, NTE159, or equivalent)
Q3–2N3904 general-purpose NPN transistor (SK3854, NTE123AP, or equivalent)
Q4–2N3055 NPN power transistor (SK3027, NTE130 or similar device with collector-to-emitter- rating and current-rating to handle requirements of transmitter keying circuit
BR1–1-amp, 50-PIV, full-wave bridge rectifier(RadioShack 276-1146)

RESISTORS

(All fixed resistors are ¼-watt, 5% units, except where noted.)
R1–100,000-ohm
R2, R3–3300-ohm
R4, R13, R14, R17–1000-ohm
R5–220-ohm
R6–100,000-ohm, linear potentiometer
R7–47,000-ohm
R8–62-ohm
R9–1000-ohm, linear potentiometer
R10–5100-ohm
R11–2700-ohm
R12–2500-ohm, linear potentiometer
R15–10,000-ohm, audio potentiometer
R16–50,000-ohm, linear potentiometer
R18–25,000-ohm, linear potentiometer
R19–at least 100-ohm, ½-watt, depending upon transmitter keying current requirements

CAPACITORS

C1–1-μF, 25 WVDC, electrolytic
C2–3.9-μF, 25 WVDC, electrolytic
C3, C4–0.01-μF, ceramic disc
C5, C9–0.1-μF, ceramic disc
C6–0.033-μF, ceramic disc
C7–100-μF, 16 WVDC, electrolytic
C8–330-μF, 30 WVDC, electrolytic
C10–0.001-μF, ceramic disc

ADDITIONAL PARTS AND MATERIALS

F1–fuse, 0.5-amp
J1–phone jack, 3-terminal, normally open
J2–phone jack, 2-terminal, normally open
S1–SPST switch, part of R15
SPKR1–speaker, 8-ohm
T1–power transformer, 117 VAC to 18 VAC, 1-amp minimum (RadioShack RSU 10524239, or equivalent)

part of switch S1. A test point is made available across C2 for use with an oscilloscope should you wish to critically adjust the sawtooth parameters.

The 2N3904 transistor Q3 operates as a phase inverter and as an amplifier. The DC level at its collector is directly coupled to the pins of the IC1 timer. This DC level is adjusted with R12 which serves as the WEIGHT control, effectively setting the length of the dots, dashes, and spaces. Timer IC1 is configured as a switch circuit. It closes when the input DC level reaches a predetermined level, and turns off again when the level drops below that point—R12 sets this trigger level of this switch.

The Schmitt trigger of IC1 drives the base of Q4, the 2N3055 transistor, which is configured as a switch, and is inserted directly in the emitter or cathode circuit of the transmitter to be keyed. The voltage appearing at this point in the key-up condition should be no greater than 60 volts, since the 2N3055 has a collector-to-emitter rating of a 60-volt transistor and is used to drive the keying circuit of the transmitter. For transmitters with a reduced keying voltage/current rating, a common 2N2222 transistor could be substituted.

Wow, this circuit certainly has a lot of user controls and features available.

Send your circuits to me at *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735.

COMPUTER BITS

(continued from page 66)

to the Internet as long as it gave me a Web site, multiple e-mail accounts, and simple administration. But what I really want is...

WISH LIST

Intelligent Networked Telephony. I want a telephone system built around some standard networking scheme (Ethernet or Universal Serial Bus), and with smart phones. The interface to the phone company side of the box is just a big fat bit pipeline, like the broadband system under discussion. My side of the box should just connect to the network. But it should provide intelligence so I could do things like the following.

I'm having European family visit over the holidays. I want to give them a dedicated phone line while they are here. With an intelligent system, I wouldn't have to run any more wires. I'd simply lease a new number for that time, configure the phone in their room to respond to it, and configure the other phones to ignore it. When they leave, I'd terminate the lease.

As my network evolves and my children grow, I have different phone line needs. I'd like to be able to share a single "virtual" number with the kids. When one party starts using that number, it should appear busy to the other parties. I just had to reroute a dedicated line from the kids' room through one of those $100 phone switches to avoid contention. (I'll show what I did, and how, next month.)

The phones themselves should be smart, and should "know" and "remember" the number(s) to which they respond. I should be able to move any phone to any outlet and achieve the same behavior. For that matter, I should be able to move any phone line accessory to any outlet and achieve the same behavior. By analogy, I can move a network server from the basement to the 20th floor of an office building, and users should never notice the difference.

Even longer term I'd really like to see a "grand unification" of data communications standards. Voice, fax, modem, Ethernet—one should be enough. With a fat bit pipe, we should be able to connect any or all such devices to a single network, and configure and administer those devices in a consistent manner. As it is I have a laser printer that connects to three separate networks via separate connectors: fax, parallel port, and AppleTalk. I came close to putting it on Ethernet as well. The point is, all that is ridiculous. One high-speed connection ought to be enough.

Ah, well. Those are all dreams. Next time I'll show the lengths I had to go to achieve my only moderately complex telephony-integration goals. Stay in touch—jkh@acm.org. ■

Popular Electronics
Supplement to Popular Electronics
January 1998

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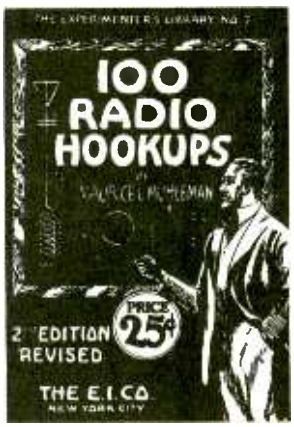
GREAT BOOKS AT BUDGET PRICES

☐ 100 RADIO HOOKUPS —#7—$3.00

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



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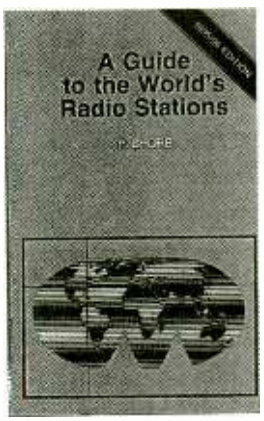

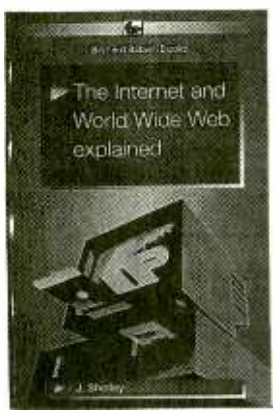

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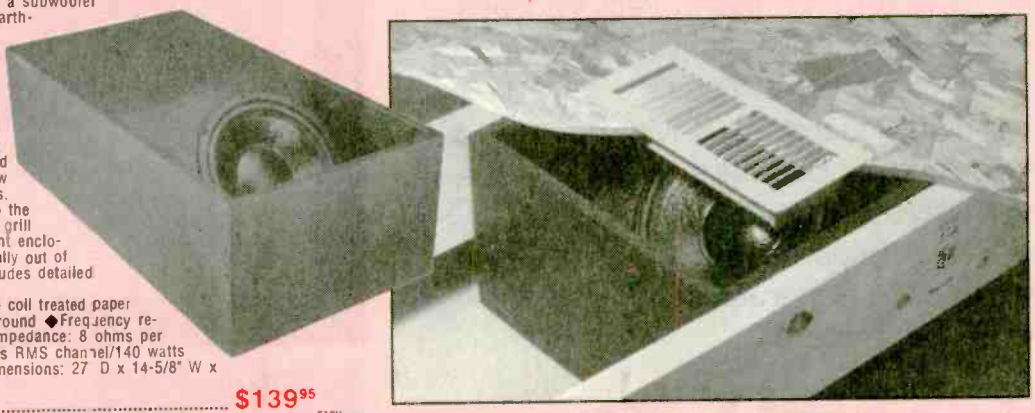

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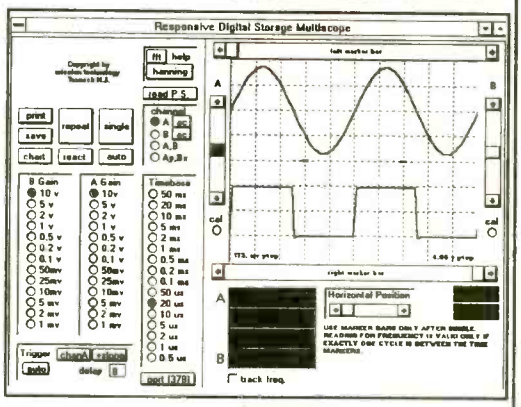

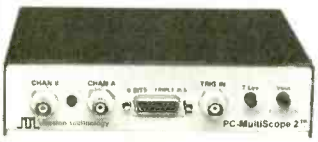

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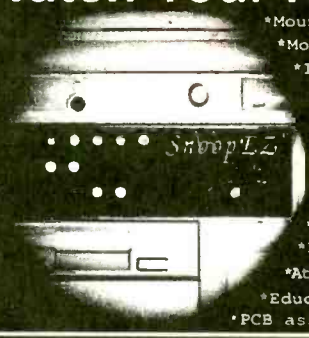

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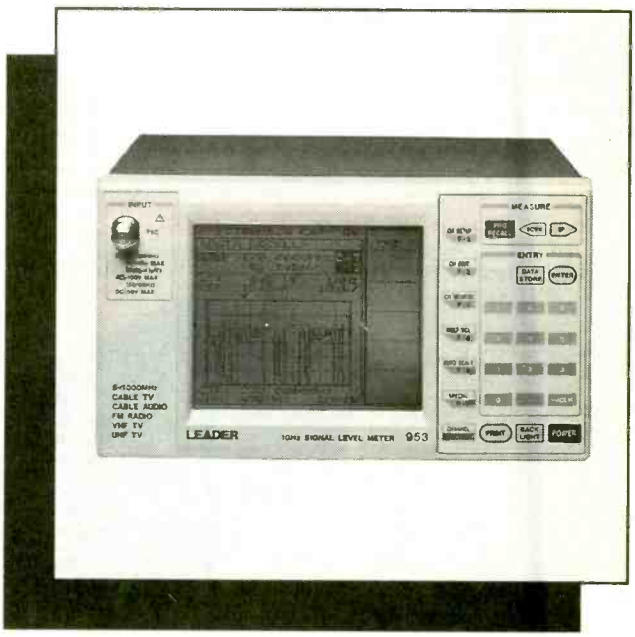

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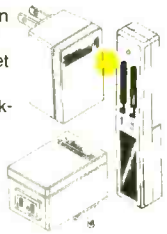

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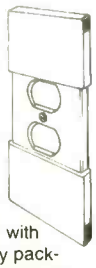

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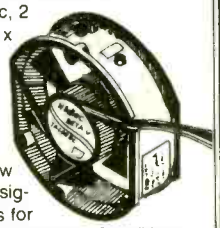

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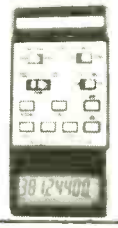

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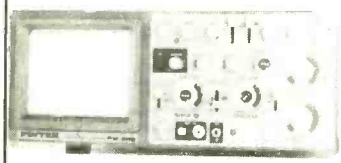

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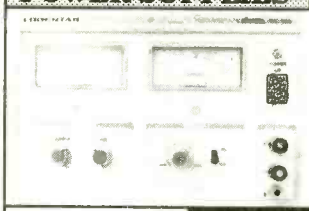

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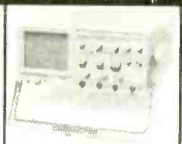

- Dual CH / Delay sweep
- ALT trigger, trigger lock
- 1mV/div sen., delay line
- Zaxis input,CH1 output
- Hold off, TV syn.
- 2 probes (x1, x10)

- Dual CH/X-Y operation
- 1 mV/div sensitivity
- Z-axis input,CH1 output
- TV syn., trigger level lock
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- Const. volt, current mode
- 4 analog or 2 digital display

PC-3030 ($499.95)
PC-3030D ($549.95)

Single Output

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- Voltage regulation <0.01%
- Current regulation <0.2%
- PS: 2 analog or 1 digital dis
- PR: 2 analog or 2 digital dis

Analog Meters Display
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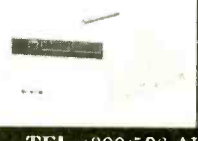

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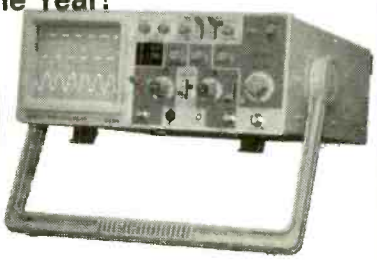

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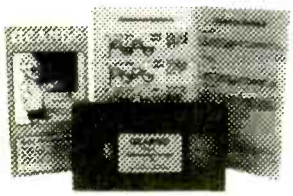

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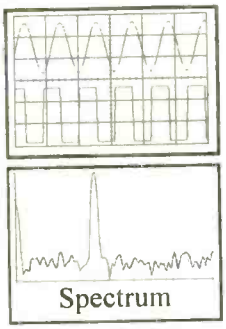

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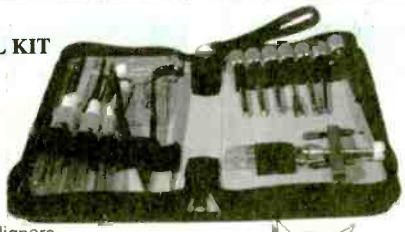

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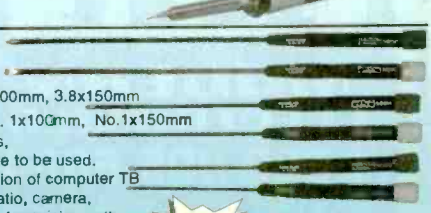

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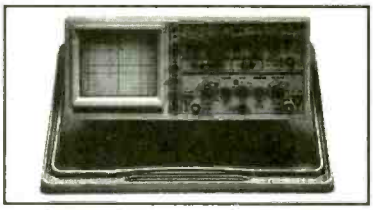

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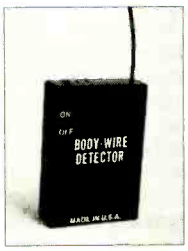

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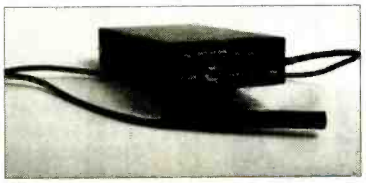

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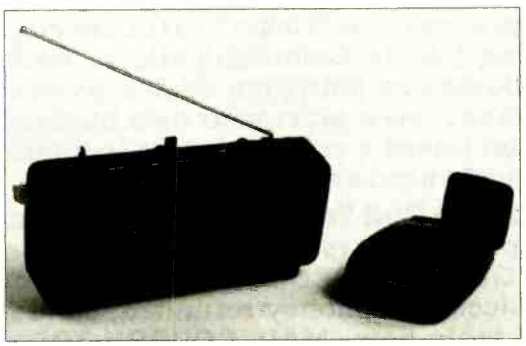

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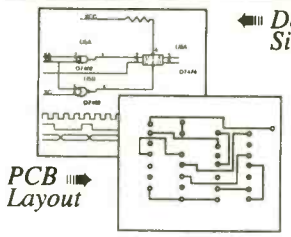

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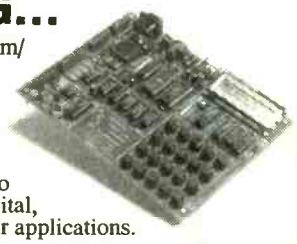

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Range:	Resolution:	Accuracy:
200mV	100µV	
2000mV	1mV	±(1%rdg+2dgts)
20V	10mV	
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200µA	100nA	
2000µA	1µA	±(1.2%rdg+2dgts)
20mA	10µA	
200mA	100µA	±(1.2%rdg+2dgts)
10A	10mA	

Overload Protection: mA Input. 2A/250V fuse.

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	
200Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

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Response: Average Responding. Calibrated in rms of a Sine Wave.

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Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

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CAT NO	DESCRIPTION	PRICE
PROTEK506	Digital Multimeter	$139.00

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

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

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

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

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

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

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12"	22.09	18.35	14.68

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CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

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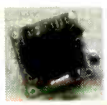
Picture Elements	EIA=512(H) x 492(V)
Pixel Pitch	EIA=9.6UM (H) x 7.5UM (V)
Scanning System	2 : 1 Interlace
Scanning Frequency	EIA=525 lines, 60 field/sec (II) 15.750 KHz x 60 HK
Resolution	430 Lines
Minimum Illumination	0.03 LUX
S/N Ratio	45DB
Lens Mounting	4.3mm standard, 5mm pinhole
Video Output	1.0 VP-P/750OHM composite signal
Power Requirement	8-12 VDC (9VDC standard)
Power Consumption	100mA
Operating Temperature	-20C -+ 70 C RH 95% Max
Storage Temperature	-40C -= 85 C RH 95% Max
Audio Pick-Up Sensitivity	-60 DB (0DB = 1B/UBAR. 1KNZ)
Audio Frequency Range	20 Hz to 20KHz
Audio S/N Ratio	More than 35DB
Audio Output Level	1VP-P/600 OHM

Dimensions

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



WDP-2000

WDS-2005

WDI-4000

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDP-2000	1/3" B&W Pinhole Lens with Audio	$89.00	$77.00
WDS-2005	1/3" B&W Standard Lens with Audio	89.00	77.00
WDI-4000	1/3" B&W Infra-RED (no audio)	89.00	77.00
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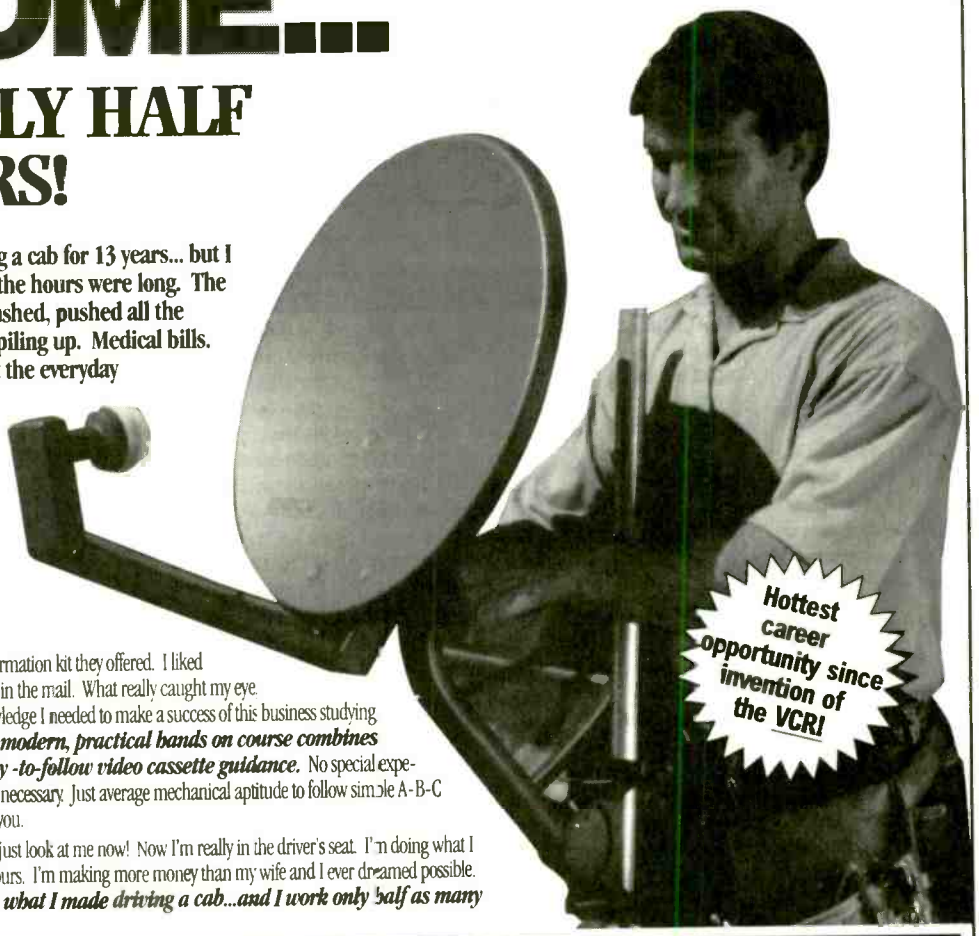

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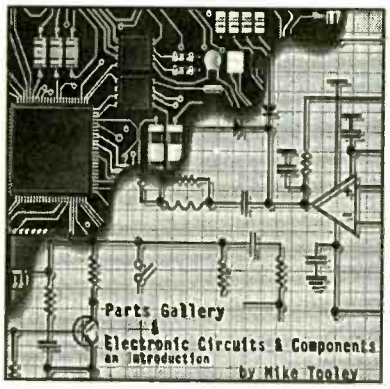

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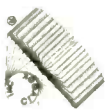

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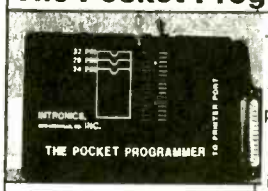

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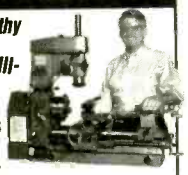

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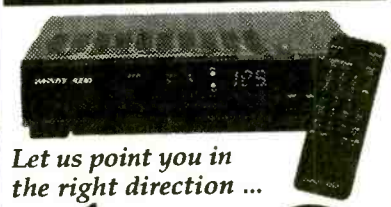

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How to make your car invisible to radar and laser...*legally!*

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

by Phil Jones

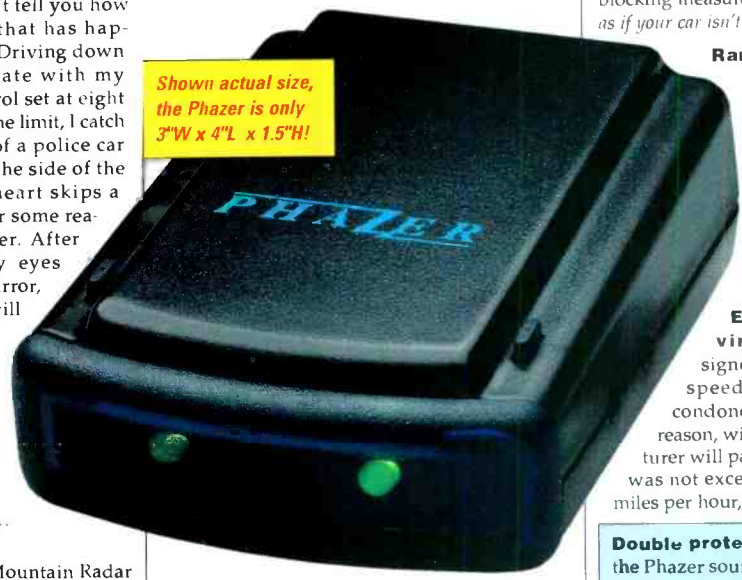
If your heart doesn't skip a beat when you drive past a speed trap—even if you aren't speeding—don't bother reading this. I can't tell you how many times that has happened to me. Driving down the interstate with my cruise control set at eight miles over the limit, I catch a glimpse of a police car parked on the side of the road. My heart skips a beat and for some reason I look at my speedometer. After I have passed the trap, my eyes stay glued to my rear view mirror, praying the police officer will pass me up for a "bigger fish."

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

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

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

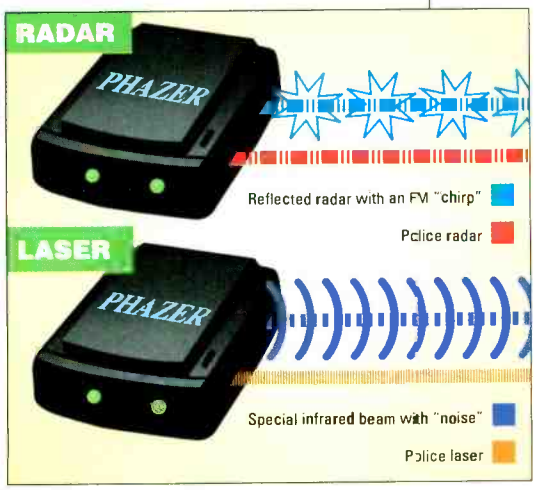
The radar component works by mixing an X, K or Ka radar signal with an FM "chirp" and bouncing it back at the squad car by way of a waveguide antenna, effectively confusing the computer inside the radar gun. The laser component transmits an infrared beam that has the same effect on laser Lidar units.



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

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

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



HOW TO MAKE YOUR CAR DISAPPEAR

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

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

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

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

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

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

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

Double protection from speed traps. If the Phazer sounds good, but you prefer to be *notified* when you are in range of a police radar, the Phantom is for you. The Phantom combines the Phazer (including the Ticket Rebate Program) with a radar detector. It's legal in every state except Minnesota, Oklahoma, Virginia and Washington, D.C. Ask your representative for more details!

Risk-free. Thanks to Rocky Mountain Radar, speed traps don't make my heart skip a beat anymore. Try the Phazer or the Phantom yourself. They're both backed by our risk-free trial and three-year manufacturer's warranty. If you're not satisfied, return them within 90 days for a full "No Questions Asked" refund.

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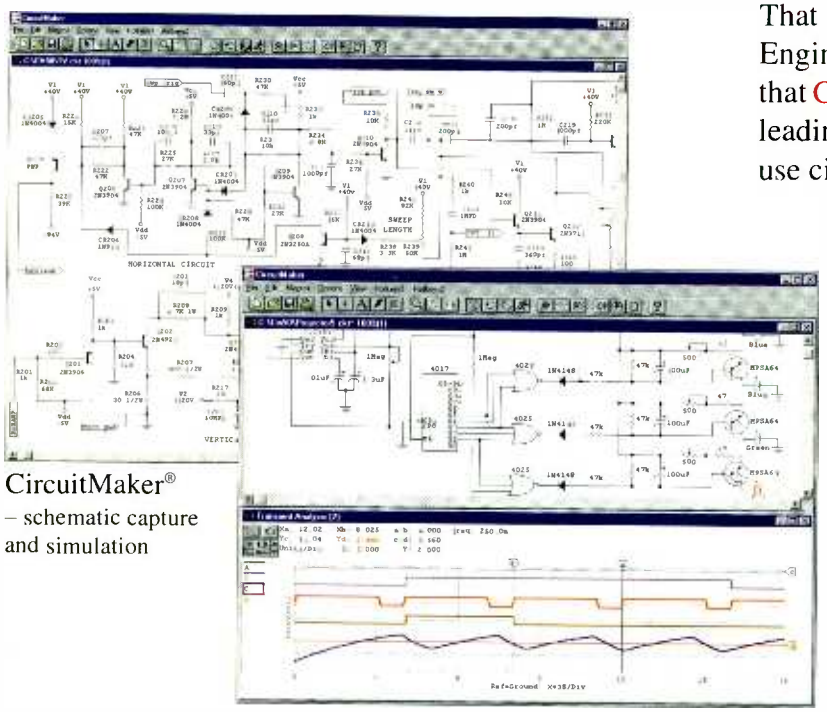

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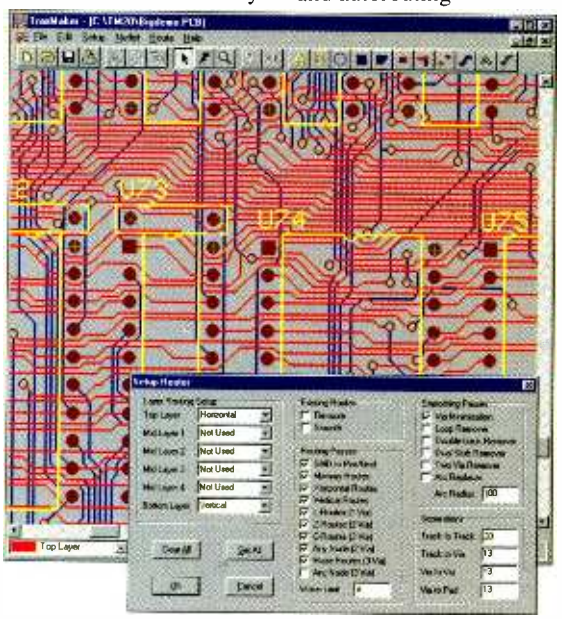
SIMULATE and **ANALYZE** what you create – try all the "what if" scenarios with:

- Fast, proven 32-bit SPICE 3f5/XSpice simulator
- True mixed analog/digital simulation
- Fully interactive digital logic simulation
- 4,000-device library
- AC Frequency Analysis
- DC Operating Point Analysis
- DC Transfer Function
- Transient Analysis
- Step Function – step component values and sources over a user-definable range

TraxMaker® – PCB layout and autorouting



TAKE MEASUREMENTS at any point in the circuit with a click of the Probe tool. Results appear immediately on virtual instruments like the Digital Oscilloscope, Curve Tracer, Digital Multimeter and Bode Plotter. No other simulator lets you take measurements as quickly and easily as CircuitMaker.

COMPLETE the design process with TraxMaker, a professional printed circuit board layout program with built-in autorouter. Import netlists from CircuitMaker and other schematic programs, or design boards from scratch.

- Includes autorouter, auto component placement and Design Rules Check
- Supports up to 8 copper layers, board sizes up to 32 x 32 inches
- Surface mount and through-hole components from a customizable library
- Outputs your PCB as a Gerber file, Excellon N/C drill file, and prints to any Windows-selectable printer or plotter

RELY ON free technical support from qualified engineers. And every MicroCode product is backed by our **30-day Money-Back Guarantee** if it does not live up to your expectations.

Call 800-419-4242 for more information and free demos

(or download from www.microcode.com)

CIRCLE 171 ON FREE INFORMATION CARD

CircuitMaker Version 5	**$299**
TraxMaker Version 2	**$299**
CircuitMaker Design Suite™ (CircuitMaker and TraxMaker)	**$549**

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